Getting value from Business Intelligence systems: A review and research agenda

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ARTICLE INFO

ABSTRACT

Much of the research on Business Intelligence (BI) has examined the ability of BI systems to help organizations address challenges and opportunities. However, the literature is fragmented and lacks an overarching framework to integrate findings and systematically guide research. Moreover, researchers and practitioners continue to question the value of BI systems. This study reviews and synthesizes empirical Information System (IS) studies to learn *what we know, how well we know, and what we need to know about the processes of organizations obtaining business value from BI systems*. The study aims to identify which parts of the BI business value process have been studied and are still most in need of research, and to propose specific research questions for the future. The findings show that organizations appear to obtain value from BI systems according to the process suggested by Soh and Markus (1995), as a chain of necessary conditions from BI investments to BI assets to BI impacts to organizational performance; however, researchers have not sufficiently studied the probabilistic processes that link the necessary conditions together. Moreover, the research has not sufficiently covered all relevant levels of analysis, nor examined how the levels link up. Overall, the paper identified many opportunities for researchers to provide a more complete picture of how organizations can and do obtain value from BI.

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1. Introduction

'Business Intelligence' (BI) has become an increasingly important concept with the availability of 'big data' and advances in machine intelligence [1]. Receiving widespread interest in both academia and industry [2], BI systems are now used extensively in many areas of business that involve making decisions to create value. However, to help BI achieve its full potential, practitioners and researchers need to more fully understand the processes through which organizations can get value from BI. To date, researchers have examined BI using a variety of theories, research lenses, and empirical approaches. While these various streams of study provide diverse views on BI, they can also make it difficult to build a holistic and integrated view of BI business value and sustain a cumulative research tradition. While many authors address rather specific research questions relating to how BI creates business value, no comprehensive research agenda has been developed to understand the process of organizations obtaining business value from BI. Therefore, the research question addressed in this paper is: *What do we know, how well do we know, and what do we need to know about the processes of organizations obtaining business value from BI systems?* The aim of this literature review is to learn the extent to which we can answer this question based on existing literature, identify which parts of the answer are most in need of further research, and reveal key research questions for future work.

Rather than having a well-accepted and specific definition [3], BI is typically used as an 'umbrella' term to describe a process [2], or concepts and methods [4], that improve decision making by using fact-based support systems. Many terms (such as "*business intelligence*", "*business analytics*", "*big data*", "*data mining*", and "*data warehousing*") are often used interchangeably in the literature, with authors variously describing BI as a "process and a product" [5 p.121], "a process, a product, and a set of technologies, or a combination of these" [2 p.87], or a product alone [6]. As a result of these diverse definitions and perspectives, and the growing interest in BI in academia and importance to industry, it is important to synthesize the literature to determine what we already know about the process of generating business value from BI, what we still need to know, and how we can get there. There are a number of studies that contribute, in different ways, to this knowledge. Seddon et al. [6], for example, developed a BI success model but did not expose gaps in the literature or propose future directions. Similarly, while Arnott and Pervan [7] analysed BI studies from 1990 to 2003, and Jourdan et al. [5] analysed BI studies from 1997 to 2006, neither paper focused on the process through which BI contributed to business value. Thus, there remains a need for a deeper analysis of the processes of organizations getting value from BI [8].

In keeping with past literature, in this paper the term BI is used to refer to a set of concepts and methods based on fact-based support systems for improving decision making [9], and the term 'BI system' is used to refer to both model-oriented [7] and data-oriented decision support systems [7,10,11]. Specifically, BI system here is defined as a system comprised of both technical and organizational elements that

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presents historical information to its users for analysis, query and reporting, to enable effective decision-making and management support, to increase the performance of business processes. To learn what the research literature can tell us about the processes of organizations obtaining value from BI, the IS business value model of Soh and Markus [12] is used, incorporating constructs suggested by Melville et al. [13] and Schryen [14]. Drawing on BI research published from 1/2000 to 8/2015, insights are explored in each area of the framework to expose gaps and reveal unexplained or partially unexplained areas in need of further research.

2. Review of prior literature: paper selection, framework, and coding process

In this section, the conduct of the literature review is explained and the framework used to structure the coding is described and illustrated.

2.1. Paper selection

Fig. 1 shows the paper selection process. This review covers BI research published from 1/2000 to 8/2015. Since there are no clear criteria governing the choice of outlets [15,16], journals were selected using a two-step approach. First, to survey IS literature, major IS journals (included in the Association for Information Systems' Senior Scholars' Basket of Journals), and the *Decision Support Systems* journal, in which BI research often appears, were included. Because quality BI research could also be published outside these journals, Scopus's citation count was used as a proxy for the relative importance of works published outside the Information Systems' Senior Scholars' Basket of Journals and Decision Support Systems, with the threshold for inclusion set to a minimum of 25 citations as deployed by Tamm et al. [17]. Thus, as Table 1 shows, this review focuses on papers in any of nine top IS journals (the Senior Scholars' Basket plus DSS), whether highly cited or not, plus other BI papers cited 25 times or more in Scopus. ProQuest, Ebsco, ScienceDirect, ABI/INFORM, and Wiley-Blackwell Pilot 2015 were used to search for articles; book reviews or editorials were excluded.

To ensure data consistency and relevance across the collection, only publications containing "*business intelligence*", "*business analytics*", "*big data*", "*data mining*" or "*data warehousing*" in their title, abstract, or subject indexing (when applicable) were retrieved. The choice of these keywords was intended to focus the search and analysis on publications of direct relevance. Using the described search criteria within the selected journals and highly cited papers in Scopus for the period of 1/2000–8/2015, 738 articles were collected. Papers whose concepts of BI did not match with the proposed definition such as multidimensional cube algebra [18], or large scale multidimensional data [19], were then excluded along with papers which despite

Table 1
Review process.

Year of publication	1/2000–8/2015
Keywords	"Business intelligence", "Business analytics", "Big data", "Data mining", "Data warehousing"
Journals	• *European Journal of Information Systems* (*EJIS*) • *Information Systems Journal* (*ISJ*) • *Information Systems Research* (*ISR*) • *Journal of Association for Information Systems* (*JAIS*) • *Journal of Information Technology* (*JIT*) • *Journal of Management Information Systems* (*JMIS*) • *Journal of Strategic Information Systems* (*JSIS*) • *MIS Quarterly* (*MISQ*) • *Decision Support Systems* (*DSS*) • *Highly cited papers from other journals* (*HCP*)
Search engines and databases	ProQuest, Ebsco, ScienceDirect, ABI/INFORM database, Wiley-Blackwell Pilot 2015, Scopus

having keywords appearing in the abstracts or subject heading did not investigate BI. This resulted in 184 articles which were then filtered for relevance by analysing the abstracts and skimming the content. Non-empirical studies were excluded, leaving 106 papers which formed the set of articles examined in subsequent sections of this paper.

2.2. BI business value framework

To provide a comprehensive end-to-end view of the processes through which business value is obtained from BI systems, a framework is required to structure the analysis. Fig. 2 presents such a framework. The BI business value framework synthesized herein integrates Soh and Markus's [12], Melville et al.'s [13], and Schryen's [14] models on IS business value. The approach of synthesizing three prominent IS business value models to organize the presentation of prior research "is not an attempt to unify (and simplify) different perspectives applied by researchers, but [rather] to identify and present their shared understanding of IS business value …The advantage of drawing on these research models lies in their wide adoption by IS researchers, which allows us to map and assess the research findings of IS business value literature appropriately…" [14 p.142].

In line with an explanatory, theory-based review, the proposed framework is then used to structure the presentation of the research findings in the reviewed papers [20]. While there are other ways to model and review the IT business value literature [e.g. 21–23], the models drawn on here have the advantage of building upon each other, therefore offering a cumulative tradition upon which to build a firm research agenda. These models have also been widely adopted by IS researchers facilitating assessment and mapping of research findings in the BI business value literature.

The foundation of Fig. 2 is the seminal model of Soh and Markus [12]. In their paper, Soh and Markus described the theoretical difficulties researchers were experiencing, and the mixed results researchers were obtaining, in research on IT investment and business value. To address these issues, Soh and Markus [12] proposed a model to explain how the effects of IT play out across a chain of interrelated, yet uncertain outcomes. They used a 'process model' to describe the relationship, and argued that it could help researchers to explain uncertain outcomes better than a variance model could [24]. Whereas variance models account for uncertainty through moderator variables, process models model the underlying probabilistic processes through which outcomes occur [12]. Although published over 20 years ago, the Soh and Markus model remains influential today. For instance, it has been cited as an exemplar for its ability to support cumulative theory building [25 p.5], it continues to be used as a theoretical foundation in leading articles [26 p.63], and it has been recommended as a valuable guide for future research and practice [27 p.832].
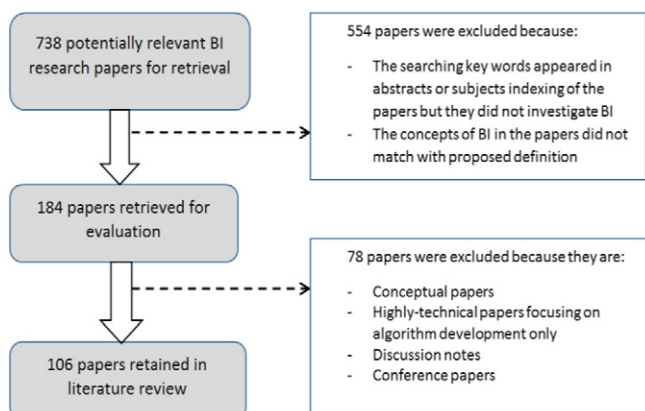

Fig. 1. Diagram of papers selection process.