



Patterns of business intelligence systems use in organizations



David Arnott^{a,*}, Felix Lizama^b, Yutong Song^a

^a Faculty of Information Technology, Monash University, PO Box 197, Caulfield East, Victoria 3145, Australia

^b Faculty of Economics and Business, Universidad de Chile, Diagonal Paraguay 257, Santiago 8330015, Chile

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ABSTRACT

Business intelligence (BI) is often used as the umbrella term for large-scale decision support systems (DSS) in organizations. BI is currently the largest area of IT investment in organizations and has been rated as the top technology priority by CIOs worldwide for many years. The most important use patterns in decision support are concerned with the type of decision to be supported and the type of manager that makes the decision. The seminal Gorry and Scott Morton MIS/DSS framework remains the most popular framework to describe these use patterns. It is widely believed that DSS theory like this framework can be transferred to BI. This paper investigates BI systems use patterns using the Gorry and Scott Morton framework and contemporary decision-making theory from behavioral economics. The paper presents secondary case study research that analyzes eight BI systems and 86 decisions supported by these systems. Based on the results of the case studies a framework to describe BI use patterns is developed. The framework provides both a theoretical and empirically based foundation for the development of high quality BI theory. It also provides a guide for developing organizational strategy for BI provision. The framework shows that enterprise and smaller functional BI systems exist together in an organization to support different decisions and different decision makers. The framework shows that personal DSS theory cannot be applied to BI systems without specific empirical support.

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1. Introduction

Business intelligence (BI) is often used as the umbrella term for large-scale decision support systems (DSS) in organizations. Surveys by industry analysts and vendors consistently find that BI development and deployment is one of the highest priorities for CIOs and will remain so at least until 2017 [26,30,33,54]. Kappelman et al. [38] in the annual *SIM IT Issues and Trends Study* reported that BI was the largest organizational IT investment in 2015, and has been the largest since 2009. Put simply, BI is one of the most important IT applications in an organization and is expected to remain so for some time.

It is important to distinguish between the general IS movement of BI/Analytics/Big Data and the IT artifacts that are used in organizations. This project focuses on the IT artifacts that are BI systems. Davenport's definition is used to guide the research: a BI system is "a wide array of process and software used to collect, analyze, and disseminate data, all in the interests of better decision making" ([17], p. 106). BI systems can be defined by their organizational scope. The most complex systems that support management decision-making, enterprise BI systems, are usually developed by the central IT department to support as many

managers in an organization as possible. At a minimum, they have users from more than one division. The data available to an enterprise BI system is organization-wide in scope and interest and often comes from a data warehouse (DW) or a federation of data marts. A second type of BI system, functional BI, is where development is restricted to one division, department, or function and the governance of the system is the responsibility of that business unit rather than the IT department. Most commonly functional BI systems have their data provided by a specialized data mart. When vendors, consultants, and researchers talk about BI, they usually mean enterprise BI systems.

Use patterns in decision support are normally concerned with the type of decision to be supported and the type of manager that makes the decision. The reason for this focus is that the type of task and type of user in DSS are fundamentally different from the users and tasks supported by enterprise transaction-based, web-based, mobile, social systems, and other IS. The decision/manager focus is unique to DSS and is central to understanding BI systems. A review of BI case study research in all journals and the four major AIS conferences (ICIS, ECIS, PACIS, AMCIS) from 2000 to 2016 found 68 papers. Of these, 13 addressed BI systems use in some way. None addressed decision maker and decision type use patterns. This means that BI use patterns is a gap in the BI research literature.

In terms of BI systems use by managerial level, Negash [57] related that "BI assists in strategic and operational decision making" (p. 179) and that "Business intelligence is used by decision makers throughout

* Corresponding author.

E-mail addresses: david.arnott@monash.edu (D. Arnott), felix@fen.uchile.cl (F. Lizama), yuri.song@monash.edu (Y. Song).

the firm. At senior managerial levels, it is the input to strategic and tactical decisions. At lower managerial levels, it helps individuals to do their day-to-day job.” (p. 189). Audzeyeva and Hudson [8] argued in their study of BI benefits that “Key organizational benefits of BI ... include better management decisions at both middle management and strategic levels and support for the accomplishment of strategic business objectives.” Arnott and Pervan [7] as part of a critical analysis of 25 years of general DSS research examined the level of decision tasks addressed in BI research. They found that 22.5% of BI research concerned strategic decision tasks. Isik et al. [35] reported “many companies currently utilize BI primarily for structured decision making based on internal data” (p. 14). Collectively this means that, to some extent, BI aims to address many types of decision making in organizations.

Based on this discussion, the phenomenon of interest of this project is the pattern of use of BI systems in organizations. The unit of analysis is a BI system, a large-scale IT artifact that supports decision making in organizations. The formal research question that guided this project is “What are the patterns of BI systems use in organizations?” The paper is organized as follows: first, the theory background and the design of the secondary case study research is described. Case study research involving eight BI systems is then described and analyzed. From the cross-case analysis a framework for the pattern of BI systems use in organizations is developed. After considering the limitations of the research, the paper concludes with a discussion of the academic and professional implications of the research.

2. Theory background

To explore the patterns of BI systems use, two groups of theory were used. The first is the seminal framework of Gorry and Scott Morton. The framework led to the development of the DSS field and is still influential in DSS and BI research. The second theory background is the dominant contemporary approach to understanding human decision-making from behavioral economics. This is followed by a note about the transfer of theory between DSS types and the nature of frameworks in IS theory.

2.1. The Gorry and Scott Morton framework for decision support systems

Defining management processes and decision-making tasks in three level typologies has been a persistent theme in business research since the 1960s. These typologies have attained paradigm status and are often used without citation (for example, [1,2,63]). The most popular management process typology is Anthony's strategic planning/management control/operational control continuum [3]. According to Anthony and Dearden [4] strategic planning is the process of deciding on the goals of the organization, the resources needed to attain these goals, and the policies for acquisition and use of these resources; management control is the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's goals; and operational control is the process of assuring that specific tasks are carried out effectively and efficiently. The process typology is not isomorphic with management tiers but is in a sense related. For example, an executive who is at the highest level of an organization can tackle strategic and tactical tasks and use a range of operational and management control processes. However, the general argument is that the higher that a manager is in an organization the more likely they will be to use strategic planning processes and make strategic decisions. Anthony's typology is widely accepted in business research and critiques are rare. An exception is Langfield-Smith [47] who argued that in terms of management accounting “the artificial boundaries between, operational, managerial and strategic control, as initially described by Anthony [3], may no longer hold.” (p. 209). Most IS researchers view Anthony's typology as a continuum rather than discrete categories.

The three-level typology of decision tasks that has reached paradigm status is Nobel Prize winner Herbert Simon's phase model of decision-

making [67,68]. The phase model views decision making as taking place in three staged, iterative and recursive processes of intelligence (gathering data), design (arriving at alternative solutions), and choice (choosing the best alternative). An important part of the phase model is the concept of decision structuredness. A totally structured decision is one where all decision phases can be specified; a totally unstructured decision is one where no aspect of the decision phases can be articulated. Lying on a continuum between structured and unstructured decisions are semi-structured decision tasks that exhibit varying degrees of structure or clarity of definition and understanding.

The seminal article of the general DSS discipline is the 1971 paper *A Framework for Management Information Systems* by Anthony Gorry and Michael Scott Morton. Their framework was based on a combination of Anthony's management process and Simon's decision structuredness typologies and is shown in Fig. 1 ([28], p. 62). The tasks below the dotted line in Fig. 1 have decreasing levels of structure and Gorry and Scott Morton termed the IS that can support these tasks “decision support systems”. Above the line they typified IT support as structured operational IS; today many of these would be regarded as DSS. The important implication is DSS can support most of the cells in the framework. Further, they argued that over time, with increasing research and practice, the line would move down the figure as semi-structured tasks become structured. In Fig. 1, structured operational control tasks are the easiest for an IT professional to conceptualize and then develop systems to support. Keen and Scott Morton [41] suggested that unstructured tasks, especially the bottom right hand of Fig. 1, are mainly supported by human intuition. Kirs et al. [44] provided an experimental validation of the Gorry and Scott Morton framework that, at the time, justified the framework's seminal position.

Gorry and Scott Morton's framework is one of the most important contributions to DSS research and with 2233 citations¹ it is one of the most cited papers in all IS research. Fig. 2 shows citations of the framework over time and the most interesting aspect of the figure is that the 1971 framework is more popular with researchers today than when it was published. The DSS framework has attained paradigm status and is often used uncritically as the basis of recent research. For example, Isik et al. [35] in developing their project's hypotheses relate: “Gorry and Scott Morton's [28] framework of management information systems is a well-established, theoretically grounded representation of the decision environment.” (p. 16).

The main issue with the Gorry and Scott Morton framework is the validity of Simon's phase model of decision making – the source of the vertical axis of the framework. Simon's phase model was developed in the 1940s and Simon's is a different kind of scholarship to current business research; most of Simon's publications would now be classified as conceptual studies. The nature of business and behavioral science research is radically different today and the standards of rigor and validity, and the statistical techniques that are currently used, did not exist when Simon developed his theory of decision-making. The problem is as Lipschitz and Bar-Ilan [49] relate “Considering the variety and ubiquity of phase models, it is surprising to find that the empirical evidence for their descriptive and prescriptive validity is very slim.” (p. 48). Lipschitz and Bar-Ilan conducted experimental research that found disconfirming evidence for the phase model's prescriptive validity and only weak support for its descriptive validity. The conclusion from the empirical testing of the phase model is that it lacks the necessary scientific validity to be part of an important and influential framework like Gorry and Scott Morton's. Another issue with the Gorry and Scott Morton framework is that, like Simon's research on decision making, it is a conceptual study and the assignment of decision tasks and systems in the framework was based on opinion, rather than on empirical research.

¹ Google Scholar, February 2017.

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