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Doctors' orders––If they're electronic, do they improve patient satisfaction? A complements/substitutes perspective

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ABSTRACT

Doctors' orders entered with Computerized Physician Order Entry (CPOE) systems are designed to enhance patient care by standardizing routines that are intended to improve quality of healthcare. As with other health information technology (IT) performance studies, literature shows conflicting results regarding the CPOE–performance relationship. By adopting a more nuanced perspective and employing not just adoption but extent of use of CPOE, we first examine whether or not CPOE *use* improves patient satisfaction. Next, given that CPOEs are implemented in the backdrop of other hospital IT infrastructure, we examine how IT infrastructure impacts the relationship between CPOE use and satisfaction, testing both a complementary and substitution perspective. Finally, we examine the differential impact of CPOE use between academic and non-academic hospitals. Using data from 806 hospitals nationwide, we find a positive relationship between extent of CPOE use and patient satisfaction. Contrary to extant research, our results suggest this relationship is stronger in non-academic hospitals. We also find evidence that a hospital's IT infrastructure substitutes for CPOE use in its effect on patient satisfaction.

1. Introduction

In 1999, the United States' Institute of Medicine released a report titled "To Err Is Human," which estimated that between 48,000 and 98,000 deaths occur each year due to medical errors (Kohn et al., 1999). The stark results of this report prompted an increased focus on medical safety and error prevention, and a drive to improve processes to enhance safety (Han et al., 2005). Operations management has a long history of providing insights into process improvement, including building quality into processes (Samson and Terziovski, 1999; Anderson et al., 1994; Flynn et al., 1994). Therefore, it is not surprising that the process of providing care to patients can be improved through embedded error prevention and appraisal tasks, enabled by information technology (IT) systems.

One specific health IT used to improve process quality is a Computerized Physician Order Entry (CPOE) system that enables clinicians to enter orders electronically and alerts them to possible drug interactions or overdoses. Through single-site studies, some researchers have demonstrated that CPOE adoption improves various aspects of hospital quality and/or performance, but other studies found mixed results or unintended negative consequences (for a review see Chaudhry et al., 2006). From an error reduction standpoint, research largely supports the notion that CPOE provides benefits, which is one reason the U.S. Government is encouraging adoption: through the American Recovery and Reinvestment Act Congress set aside $19.2 billion to reimburse healthcare providers who install specific ITs, including CPOE systems. Recognizing the difference between adoption and use, these funds are only available to providers who exhibit "meaningful use" of IT (see www.healthhit.hhs.gov). Because of both the legislative emphasis on "meaningful use" and the scholarly support for measuring system use rather than simply adoption (Devaraj and Kohli, 2003), we include "CPOE use" as a key variable within our study. We will discuss this in greater detail in the hypothesis section.

With few exceptions, prior large-scale studies have simply looked at the presence of CPOE (adoption) as the correlate of quality (McCullough et al., 2010; Yu et al., 2009). In this study we examine the extent of CPOE integration and its impact on one important measure of quality: patient satisfaction. Drawing from prior literature, we acknowledge the importance of complementary technologies and processes in new technology integration. Therefore, our study investigates the role that other health ITs play relative to the link between CPOE use and patient

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satisfaction. Although multiple medical studies have examined how CPOE impacts specific clinical quality measurements, to our knowledge this is the first study that examines how CPOE directly impacts patient satisfaction. We argue that patient satisfaction is part of quality and that it offers a new lens to the discussion of the value of CPOE.

Our study is motivated by the following research objectives. First, building on the nascent research of large-sample-size studies, we empirically examine how CPOE use impacts patient satisfaction across a set of 806 hospitals. Second, we examine the effectiveness of CPOE systems in the context of other IT infrastructure in the hospital. To do this, we adopt a "complements versus substitutes" perspective to test the role that IT infrastructure plays relative to CPOE use in hospitals. Third, from previous operations management research we know that technology investment payoffs vary widely across firms (Hendricks et al., 2007). There is evidence in healthcare research that the academic status of hospitals significantly relates to performance (Ayanian and Weissman, 2002). Therefore, we test for systematic differences between academic and non-academic hospitals in the effectiveness of utilizing CPOE relative to patient satisfaction. Lastly, we introduce a measure of technology infrastructure that is weighted by the innovativeness of the IT adopted (the Saidin index), to the operations management field.

2. Conceptual development and hypotheses

We ground our hypotheses using three complementary perspectives: (1) routines, (2) an IT value model, and (3) the cost of quality. We will argue first that CPOE allows for routinization of care and that routines provide value within organizations. Next, we argue that possession of IT assets does not necessarily translate to positive organizational outcomes; instead, IT assets must be used in a suitable environment in order to positively impact organizational performance. Finally, we assert that investment in CPOE will ultimately reduce a hospital's failure costs, as predicted in the cost of quality literature (Harrington, 1987; Crosby, 1979; Feigenbaum, 1956).

Kuperman and Gibson (2003) describe CPOE as a system that not only allows electronic orders, but also can address quality issues. For example, CPOE allows providers to "standardize practice; incorporate clinical decision support into daily practice; improve interdepartmental communication; facilitate patient transfers; and capture data for management, research, and quality monitoring" (Kuperman and Gibson, 2003, p. 31). We posit hospital processes can be improved through investment in IT and its proper implementation and effective use, which in turn positively improves patient satisfaction. We contend that these process improvements can result from the use of CPOEs and health IT in general because they provide the means to codify routines within hospitals. Routines have been defined as "regular and predictable patterns of activities which are made up of a sequence of coordinated actions by individuals" (Grant, 1991, p. 122). Researchers have long recognized the value routines provide to organizations for improving operations (Peng et al., 2008; Grant, 1991; Nelson and Winter, 1982). CPOEs require users to explicitly follow routines that result from standardized processes and decision support (Davidson and Chismar, 2007; Kaushal et al., 2001; Shojania et al., 2001). Furthermore, because CPOEs provide instructions across organizational boundaries (e.g., an order for transport may be placed by an interventional radiologist but executed by a staff member), they reduce confusion and ambiguity. Prior work shows that communication mistakes in hospitals happen most often at boundaries (Tucker, 2004; Gittell, 2002; Argote, 1982). Because boundaries grow exponentially as more subspecialists with deep knowledge in narrow areas become involved in delivering care (Lee, 2010), IT that codifies knowledge and processes and facilitates coordination should increase efficiency (Davidson and Chismar, 2007; Gattiker and Goodhue, 2004). Although previous work has shown that routines can be a double-edged sword by creating rigidities (Holweg and Pil, 2008; Leonard-Barton, 1992), CPOE promotes routines through suggestions and warnings, but allows physicians to make all final decisions, thus allowing for breaking routines where appropriate (Davidson and Chismar, 2007).

Given that CPOE use and IT adoption can routinize care and improve processes, a process model proposed by Soh and Markus (1995) provides a useful framework from which we can test several relationships proposed by those authors (p. 39). Their model is a set of three interlinked processes: (1) an IT conversion process, (2) an IT use process, and (3) a competitive process. The IT conversion process suggests that firms convert IT expenditures into IT assets only when firms enact good IT management policies and procedures consistently and effectively. The resulting IT asset then is some combination of useful, well designed applications, flexible IT infrastructure, and high levels of user knowledge and skill (Soh and Markus, 1995). The IT conversion process has a well-established base in the literature (Weill, 1992; Ives and Olson, 1984), thus testing it is beyond the scope of this paper. However, we suggest that conversion effectiveness determines the degree to which an IT is being used for its intended purpose. In summary, if the IT expenditure is managed properly, it should produce value-added services that increase commensurate with increasing usage.

Our research focuses on the IT use and competitive processes linkages, specifically examining CPOE use, IT infrastructure, and patient satisfaction, and links between these three constructs. IT Infrastructure is generally regarded as a set of shared, tangible IT resources (i.e., hardware, operating systems, networks, data, and data-processing applications) that provide a foundation to enable present and future business applications (Duncan, 1995). Several studies have investigated the link between CPOE adoption and process quality (Dexter et al., 2001; Bates et al., 1999; Overhage et al., 1997; Overhage et al., 1996; Tierney et al., 1993), with the vast majority showing positive benefits. Other studies have examined the link between CPOE use and clinician satisfaction (Murff and Kannry, 2001; Weiner et al., 1999; Lee et al., 1996) but to our knowledge none explore the link between clinician CPOE use and patient satisfaction. Using the process model proposed by Soh and Markus (1995) as the basis for our study, we argue that by preventing errors through the use of CPOE and IT infrastructure, a hospital can realize "IT impacts" that translate to patient satisfaction (see Fig. 1).

The utility of this model rests on the premise that CPOE use creates quality-improving IT impacts and subsequently that patient satisfaction is a function of quality. According to Mohr (1982) and Soh and Markus (1995), IT assets are necessary but not sufficient to produce IT impacts. IT impacts can take the form of new products and services, redesigned business processes, better decision making, and/or improved coordination flexibility (Soh and Markus, 1995), but these can only occur when organizations use IT assets wisely. We contend the IT assets (CPOE and IT infrastructure) provide the means to better manage quality procedures and routines vis-à-vis improved business processes, decision making, and coordination flexibility. Because hospitals invest in CPOE to reduce failures, we apply the prevention–appraisal–failure model (Harrington, 1987; Feigenbaum, 1956) to operationalize the cost of quality (Crosby, 1979) (see Fig. 2). This model illustrates the increasing progression of quality costs, from prevention to appraisal, to internal failure, and finally to external failure costs.

Prevention costs are those associated with preventing errors before they happen. Because humans can retain and retrieve only limited amounts of information at any time (Simon, 1991) – for