



The impact of Health Information Technology bundles on Hospital performance: An econometric study



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ABSTRACT

Hospitals are characterized by high levels of technical expertise as well as patient interactions. In an attempt to improve their performance along these dimensions, hospitals are making significant investments in health information technologies (HIT). However, the performance benefits from these investments are largely unknown. This study employs a portfolio approach to study HIT adoption using a large longitudinal panel data for 3615 US hospitals from 2007 to 2012. Insights from the Advanced Manufacturing Technology (AMT) and existing HIT literature are used to categorize 76 HITs into 3 distinct bundles based on their extent of patient centered integration, and the extent of caregiver interaction. We then examine how two key HIT bundles: Clinical HIT (defined as HIT systems primarily used for patient data collection, diagnosis and treatment) and Augmented Clinical HIT (defined as HIT systems primarily used for integrating patient information and augmenting decision making capability of caregivers) jointly impact cost and process quality outcomes. Cost is measured in terms of total hospital operating expenses per bed while process quality is assessed along two dimensions: conformance quality or the ability to adhere to technical standards and experiential quality or the ability to cater to preferences of the patient. Results suggest complementarities between Clinical and Augmented Clinical HIT with respect to process quality but not cost outcomes. A follow-up post-hoc analysis which divides Augmented Clinical HIT into Electronic Medical Record (EMR) and Non-EMR technologies offers additional explanation to the lack of association with cost. We discuss these implications to both theory and practice of HIT adoption.

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1. Introduction

Advances in information technology (IT) have altered the interface between customers and service providers in numerous professional services settings such as banks, hotels and legal services (Froehle and Roth, 2004). A study by Lewis and Brown (2012) sheds light on the challenges associated with IT implementation, noting that while the firm studied had invested heavily in recent years in distinct IT systems, “the benefit of this type of automation was clear to some but questioned by others” (p. 7). There is a strong

concern in professional service firms regarding the trade-off between the benefits of “distilling knowledge in a reproducible form” versus “treating human beings like bits on a conveyor belt” (Lewis and Brown, 2012: p.12). While Lewis and Brown examine a legal firm, this same sentiment is very common in professional service settings such as hospitals characterized by high levels of technical standards (that lend themselves to standardization) as well as many patient interactions (which are much more heterogeneous). Studies show that hospitals struggle to simultaneously improve on conformance quality focused on technical standards as well as experiential quality that is focused on interactions with the patients (Chandrasekaran et al., 2012). Recent changes in reimbursements by the Centers for Medicare and Medicaid (CMS) penalizes hospitals if they do not show improvement on both these process quality outcomes.

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Health Information Technology (HIT) offers one potential avenue to successfully improve on both conformance and experiential quality. To promote HIT adoptions, the US government passed the Health Information Technology for Economic and Clinical Health (HITECH) Act in 2009 offering stimulus payments of approximately \$27 Billion over the next 10 years to eligible hospital systems (HITECH, 2009). Government policy initiatives such as the HITECH Act have had a huge impact on hospital operations, with the average capital expenditure per bed on HIT increasing by 62% from 2010 to 2011, while total capital expenditure in the same hospitals increased by only 2.6% (Cerrato, 2013). In dollar terms, HIT spending is estimated to be \$34.5 billion in 2014 while maintaining a steady growth to reach \$56.7 billion in 2017 (Manos, 2013; Cerrato, 2013).

Given this emphasis on HIT, numerous scholars have called for empirical evidence on the relationship between HIT and hospital performance (Agarwal et al., 2010). Following these calls, studies have examined the impact of HIT on hospital performance. These studies however yield mixed results and report either a positive impact (Devaraj and Kohli, 2003; Aron et al., 2011), marginal improvements (McCullough et al., 2010) or negative impact (Koppel et al., 2005) on hospital performance. Potential explanations for these conflicting results include limitations such as focusing on a single technology (Kohli and Devaraj, 2004; Wang et al., 2003; Koppel et al., 2005), a lack of consideration for the user/systems interface, and looking at hospital performance measures such as readmissions and mortality that are subjected to several patient characteristics (DesHarnais et al., 1990).

Our study overcomes the above limitations by taking a portfolio approach to study HIT adoption and builds on existing HIT and advanced manufacturing technologies (AMT) literature (Meredith, 1987; Boyer, 1999). Recent studies on HIT have recognized the need to study these technologies in bundles (e.g. Angst et al., 2012). We extend this idea by using insights from AMT literature and categorizing HIT based on patient-centered integration and caregiver interactions. We define patient centered integration as the degree to which various HITs allow exchanging, coordinating and effectively utilizing patient health records (excluding administrative data such as billing, insurance, payroll, etc.) to enhance the delivery of care. The second dimension, caregiver interaction, encompasses the degree to which a given HIT is intended to facilitate the work of caregivers such as physicians and nurses (excluding administrative support staff). Based on these dimensions, we categorize HIT into three distinct bundles: (1) Administrative HIT which constitutes technologies that have minimum levels of patient-centered integration and almost no caregiver interaction, (2) Clinical HIT which constitutes technologies that have moderate levels of patient-centered integration (primarily responsible for collection of patient data and helping with diagnosis and treatment) and are used infrequently by caregivers. Finally, (3) Augmented Clinical HIT which constitutes technologies that have a high degree of patient-centered integration and also requires extensive caregiver interaction. Given the minimal to no caregiver interactions with Administrative HIT, our study primarily investigates the relationships between Clinical HIT and Augmented Clinical HIT, after controlling for Administrative HIT, on cost and process quality outcomes. Specifically, the following research question is addressed in our study: *How do Clinical HIT and Augmented Clinical HIT jointly affect cost and process quality outcomes?*

We collect longitudinal data on 76 HIT and their adoption status from 3615 U.S. hospitals during the period 2007–2012 to examine our research question. Cost performance is measured in terms of hospitals' operating cost per bed, while process quality is measured in terms of conformance quality – the level of caregivers'

adherence to evidence-based standards of care (Boyer et al., 2012), and experiential quality – the caregivers' ability to adapt interactions to patients' specific needs (Chandrasekaran et al., 2012). The rationale to investigate the effects of HIT adoption on the process quality outcomes (e.g., conformance and experiential quality) rather than the final quality of care outcomes (e.g., mortality and readmissions) is supported by the following facts. First, studies have shown that final quality of care outcomes such as mortality and readmissions are strongly associated with several diagnosis-related group (DRG) characteristics (DesHarnais et al., 1990) and process quality outcomes (Senot et al., 2015) and hence may not be ideal to study HIT adoption. Second, studying the effects of HIT on final clinical outcomes requires a well-established technology infrastructure which is certainly not the case for a vast majority of U.S. hospitals (Jha et al., 2009). Finally, studies have shown that IT adoption in professional service settings must balance the standardization of procedures with the ability to customize customer care (Lewis and Brown, 2012). A similar reduction in process quality can be detrimental for hospitals that are now being reimbursed by CMS based on their conformance quality and experiential quality scores. Hospitals are at risk losing as much as 2% of their Medicare reimbursements if they do not show improvements in both their conformance and experiential quality scores beginning fiscal year 2013.

Results from our analyses indicate complementarities between Clinical and Augmented Clinical HIT with respect to process quality outcomes but not with respect to cost outcomes. To understand the lack of complementarities with cost, we conducted a post-hoc analysis by looking within the Augmented Clinical HIT bundle. Specifically, we divided Augmented Clinical HIT into Electronic Medical Record (EMR) and Non-EMR technologies. EMR HITs form the basic set of technologies that are required for linking patient records (Furukawa et al., 2010). These technologies have been the primary focus of adoption following the HITECH Act regulations in 2009 (HITECH, 2009). The post-hoc analysis shows that EMR HIT – Clinical HIT interaction is positively associated with cost while the non-EMR – Clinical HIT interaction is negatively associated with cost thereby canceling each other in our main analyses. We also find both EMR and non-EMR HITs benefit process quality outcomes. Taken together these results offers important insights to hospital administrators on cost-quality tradeoffs when implementing HITs. In addition, we also highlight synergies between HIT bundles which can be instrumental in achieving simultaneous improvements in conformance and experiential quality outcomes.

2. Theoretical background

2.1. Technology adoption in healthcare professional service setting

Numerous studies in service settings have argued for a positive association between IT investments and firm performance (Brynjolfsson and Hitt, 1996; Boyer, 1999). However, findings from these studies may not be directly transferable to the hospital professional service settings due to several reasons. First at the organizational level, Harris (1977) described hospitals as a non-cooperative oligopoly with caregivers and administrators focusing on competing objectives – effective care vs. efficient operations. Second, at the individual caregiver level, there is considerable tension between physicians in different specialties as well as between physicians and nurses with respect to the healthcare quality outcomes (Pronovost and Vohr, 2010). For instance, physicians are more focused on the technical aspects of care delivery (i.e., conformance quality) while nurses are considered to be experts in engaging with patients and families and hence are considered to be chief architects to improve experiential quality. These differences

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