



Technology acquisition and efficiency in Dubai hospitals



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ABSTRACT

The paper studies the impact of the acquisition of relevant medical technology and information technology on the efficiency of hospital wards in three public hospitals in Dubai. Efficiency scores are obtained through bootstrapped data envelopment analysis, and are then regressed on variables assessing the extent of technology acquisition using truncated regression. Results show that both the acquisition of medical technology and of information technology have a positive impact on the ward efficiency, but that the strength of this relation is moderated by several variables related to organizational and managerial factors. In particular, results point out that the relationship between efficiency and technology is positively moderated by the ability of the head of ward to manage internal conflicts, by the managerial goals, and by the tenure of the head of ward. A negative moderating impact is exerted by perceived constraints to managerial actions, such as conflicting priorities with the hospital general management.

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1. Introduction

Innovations in healthcare organizations can stem from the provision of new services, of new ways of providing care and/or from the adoption of new technologies. Technological innovation is expected to be beneficial both for the patient and for the healthcare organization, giving rise to better health outcomes, higher quality of care, and enhanced efficiency of internal operations (Lämsäsaari et al., 2006). Although innovation remains fundamental in developing the quality of healthcare, reduced budgets and ensuing cost-cutting measures have pushed towards the adoption of health technologies that can improve operations by enabling efficiency and competitiveness. For instance, new medical equipment to be used in diagnosis and treatment of patients is required not only to guarantee better patient outcomes, but also to increase the productivity of hospital providers, and to reduce costs stemming from hospital errors, readmissions, and patient claims. Likewise, information technologies, while reducing the risk of hospital errors and allowing more accurate diagnoses by enabling consultations among physicians, contribute to enhance productivity by leading to significant savings of money and time (Sharma et al., 2016).

In this direction, the significant financial investment often involved in the acquisition of new technology calls for the estimation of the impact of technology on the healthcare organization performance, in order to establish what the payoffs are. There is, however, limited

evidence on how the purchase of medical and information technology by hospitals is related to indicators concerning activity levels, finance, and quality, especially at the micro level (Chaudhry et al., 2006).

In addition, the adoption of technology in the healthcare sector presents other complex challenges relating to organizational, social and psychological aspects (Shortell et al., 2001), which must be carefully managed. The fact that new technology needs to be adopted and adapted to the specific organizational context and that this process of adaptation takes time, has been widely acknowledged in the literature (Devaraj and Kohli, 2003). In the same vein, new technology may require a change in the behaviours of clinicians (Venkatesh et al., 2003) or in current medical practices, requiring efforts at the group and at the individual levels (Ren et al., 2008).

While much effort has been devoted to the understanding of the technology-performance relation, of the technology adoption process (Venkatesh et al., 2003) and of the cost-quality trade-off (Gholami et al., 2015), there is still ample room for investigating the interactions between new technology, organizational and sub-organizational factors, and performance (Williams, 2011). Although capital investment in healthcare in the form of new medical equipment and IT is part of healthcare planning, its actual impact is unquestionably contingent on a set of factors, some of which operate at the sub-organizational level. For instance, in many health systems hospital units enjoy a vast discretionary power in organizing their work and in deciding appropriate treatments, and often exhibit a specific unit organizational climate (Ancarani et al., 2011). Further, even if the purchase of technology must be approved at the hospital central level, the initiation and development of the investment proposals often takes place at ward level

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within the budget allocated to the sub-organizational units. Therefore the ward's autonomy may touch on what equipment is purchased, on how the hospital unit exploits new technology, and therefore on the ward's actual performance stemming from technology acquisition (Jha et al., 2009).

This paper aims to contribute to fill this research gap by investigating how the acquisition of technology affects the production efficiency of hospital wards, and by exploring how this impact is moderated by managerial variables at the sub-organizational level and by contextual variables. Specifically, leveraging on upper echelon theory (Hambrick and Mason, 1984), we analyse how the head of ward's managerial approach in terms of managerial goals and perceived constraints, conflict management, moderate the relation between technology acquisition and efficiency at ward level. The investigation takes into account the acquisition of both relevant medical technology and information technology.

This investigation is relevant insofar as it can help uncover predictable interactions between management and technology performance, thus contributing to the management of innovation and of technology acquisition processes through evidence-based recommendations. To the best of our knowledge, this is the first paper, with the notable exception of the recent contribution by Dobrzykowski and Tarafdar (2016), that opens the black-box of the link between technology acquisition and hospital performance, looking at the sub-organizational level as unit of analysis and exploring the impact of management at that level. Finally, whereas most of the evidence on the impact of technology concerns US hospitals, this study provides evidence in a different institutional setting, namely the Dubai Health Care System, which is akin to several other healthcare systems where physicians are permanent employees of a hospital.

In order to test the hypothesis of a moderating impact of managerial factors, we proceed with a two-step analysis. First, a production frontier technique, namely data envelopment analysis (Charnes et al., 1978), is applied to estimate the relative efficiency of the wards under analysis. Next, a truncated regression analysis is adopted to investigate whether the ward's goals and constraints are related to efficiency. Our analysis considers three (out of four) public hospitals in Dubai, a country that has recently invested considerable resources and efforts in developing its healthcare system with the twofold aim to improve the health of a growing population, and to become a world hub of medical tourism. However, the actual impact of technology acquisition has not been investigated so far, while this knowledge is crucial to evaluate the opportunity of further investments, now that the flow of money has been drastically reduced by the government.

The paper is organized as follows: first, we delve on the background literature by reviewing the determinants of hospital efficiency, and the expected impact of technology acquisition, intended as both new medical equipment and IT. We then present our conceptual model and a set of testable hypotheses. A brief presentation of the organizational context under study (Dubai public Healthcare) and of the data used in the empirical analysis follows. Next, the data analysis is used to test the hypotheses formulated. The discussion and the limitation of the analysis conclude the paper.

2. Background and hypotheses development

2.1. Technology and efficiency in hospitals

Numerous scholars have called for more robust empirical evidence on the relationship between the acquisition of technology and hospital performance (Agarwal et al., 2010). In fact, although several studies have examined the impact of health and information technology on hospital performance, results are mixed (Dobrzykowski and Tarafdar, 2016). Some authors find either marginal improvements (McCullough et al., 2010) or a negative impact on hospital performance (Koppel et al., 2005; Smelcer et al., 2009), at least in the short-term (Zhivan

and Diana, 2012). Kazley and Ozcan (2009), examining the relationship between hospital electronic medical record (EMR) and efficiency change over time by comparing hospitals with and without EMR, find no improvement in efficiency over time.

However, other studies report a positive impact (Devaraj and Kohli, 2003; Aron et al., 2011). In particular, examining the role of IT on patient flow and its consequences for improved hospital production efficiency and performance, Devaraj and Kohli (2003) suggest that IT is associated with improved revenues, and that this is not at the expense of quality. In another study, Menon and Kohli (2013) investigate the impact of past IT spending on the malpractice insurance premium and find that past IT expenditure is negatively associated with malpractice insurance premium and positively associated with quality of patient care. Other studies have indicated that use of new medical technology in the form of capital equipment is associated with higher service quality in healthcare (Dranove and Satterthwaite, 2000; Picone et al., 2003). In the US, Acemoglu and Finkelstein (2008) find that the increase in the capital-labour ratio and the acquisition of a range of new health care technologies brought about by the introduction of prospective payment systems has led to a significant decrease in the hospital length of stay. In turn, this reduction has led to a de facto higher hospital capacity and an increase in production efficiency. These findings suggest that health technology is not necessarily beneficial only to healthcare quality but also to operational efficiency. Based on above discussion we propose the following two hypotheses:

H1. Hospital wards benefiting from the acquisition of new health technology (medical equipment) exhibit higher levels of production efficiency.

H2. Hospital wards benefiting from the acquisition of higher levels of IT exhibit higher levels of production efficiency.

2.2. Moderating effects at the organizational and sub-organizational levels

A relevant theoretical support to our analysis can be found in the upper echelons theory (Carpenter et al., 2004; Finkelstein et al., 2009; Hambrick and Mason, 1984), which posits that the organization is a reflection of its top managers. The theory acknowledges that managers heavily influence organizational outcomes through the choices they make, which, in turn, are affected by the managers' characteristics. Hambrick and Mason (1984) further postulate that the strategic choices of the upper echelons help to explain an organization's performance. Hambrick (2007) suggests that the relationship between top management characteristics and organizational performance is strongly related to managerial discretion, referring to the latitude of action top managers enjoy in making strategic choices (Hambrick and Finkelstein, 1987; Carpenter et al., 2004). A second factor is identified by the challenges top managers face (Hambrick et al., 2005), the tougher the challenges, less time managers will have to contemplate decisions, leading them to rely more on their personal backgrounds. Thus, Hambrick (2007) predicts that the relationship between managerial characteristics and organizational outcomes will be stronger when the level of managerial challenges is high.

In hospitals, several organizational and managerial factors have been known to facilitate or conversely to hinder the beneficial effects of technology acquisition on performance (Dobrzykowski and Tarafdar, 2016). These include decision processes, organizational goals, managerial support for innovation, organizational size, relations and collaboration with other departments, staff turnover, availability of staff to implement the innovation, training and expertise (Fleuren et al., 2004). When analysing these factors it is crucial to consider the specific organizational context of hospitals, and in particular, to take into account the degree of autonomy and discretionary power enjoyed by hospital units (wards). Ward performance is largely influenced by the physicians employed in

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