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## The effects of asset specificity on maintenance financial performance: An empirical application of Transaction Cost Theory to the medical device maintenance field

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## ABSTRACT

This study uses multivariate regression analysis to examine the effects of asset specificity on the financial performance of both external and internal governance structures for medical device maintenance, and investigates how the financial performance of external governance structures differs depending on whether a hospital is private or public. The hypotheses were tested using information on 764 medical devices and 62 maintenance service providers, resulting in 1403 maintenance transactions. As such, our data sample is significantly larger than those used in previous studies in this area. The results empirically support our core theoretical argument that governance financial performance is influenced by assets specificity.

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## 1. Introduction

Medical equipment maintenance increasingly demands larger sums from hospital budgets, with services that are often outsourced, while the quality of maintenance services is pivotal for overall delivery of healthcare quality to patients. While in 1996 such contracts generated revenues of US\$10 billion (Blumberg, 2004), the global medical devices outsourcing market is projected to reach US\$42.6 billion by the year 2015, according to the Medical Devices Outsourcing: A Global Strategic Business Report published by Global Industry Analysts, Inc (GIA), indicating that this market is still growing (GIA, 2010). Yet the anticompetitive nature of the medical device maintenance market generates extreme inefficiencies in both cost and service quality, suggesting that while the industry continues to grow, service quality is not keeping pace with rising costs and sales volumes (Smithson & Dickey, 2004:136). In the quest to overcome these obstacles, the scientific literature has identified the collaboration between the healthcare and systems engineering fields as possessing great potential, and recent interdisciplinary studies have suggested interesting solutions to healthcare efficiency problems from engineering, operational research, and business management perspectives (Boyer & Pronovost, 2010; Friedman & Mitchell, 1991; Grossmann, Goolsby, Olsen, &

McGinnis, 2008; Mahara, Bretthauerb, & Salzaruloc, 2011; Richman, Udayakumar, Mitchell, & Schulman, 2008).

In particular, fields such as industrial engineering, systems engineering, management and operations research, with vast experience in system design, analysis and implementation of solutions across a variety of industries have the potential to increase the effectiveness, safety, efficiency and value in a variety of healthcare scenarios and institutions (Kolker, 2011:9; Richman et al., 2008). Without the intention of listing all, management and operations research can help in a set of very common problems presented in the healthcare environment including: decision making, capacity, staffing, scheduling, and resource allocation. In order to deliver quality health services, not only is it important to guarantee qualified staff, availability of beds, etc., but also it is essential to undertake effective healthcare technology management (Lenel, Temple-Bird, Kawohl, & Kaur, 2005:3). Particularly, maintenance tasks are an essential part of technology management systems because depending on how well a piece of equipment is looked after, its expectancy life can be prolonged or cut short (i.e. the equipment is not safe anymore, and/or it costs more to repair it than to replace it). However, the variety of medical devices is huge, and the resource costs needed to maintain these devices in proper working condition are high. Thus, health care managers face an important set of questions: which modality should be used to perform the medical device maintenance tasks? In other words, do I outsource or internalize the maintenance tasks for medical devices?

Despite the demonstrated applicability of interdisciplinary approaches to other healthcare systems problems, the decision-

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making process for medical device maintenance outsourcing appears trapped in antiquated paradigms that generate tremendous inefficiency, contributing to these growing costs. This may be especially true in developing countries, where limited funds or a lack of confidence in the skills of in-house staff lead to the outsourcing of maintenance services, under the belief that narrowing the scope of in-house tasks will lead to cost-savings and improved quality. As a result, the outsourcing of medical device maintenance activities appears to be a growing trend in the healthcare industry, as hospitals increasingly outsource maintenance services and eliminate their in-house service staff (Blumberg, 2004; Cruz, Perilla, & Pabon, 2010: 144). The problem is not exclusive to the healthcare industry – according to a survey performed by Deloitte Consulting, 44% of respondents<sup>2</sup> indicated that they saw no cost savings in their outsourced activities, while only 34% of respondents were satisfied with the supplier's service quality (Landis, Mishra, & Porrello, 2005). This problem is compounded by the fact that maintenance outsourcing studies appear contradictory and incomplete (Assaf, Hassanain, Al-Hammad, & Al Nehmi, 2011; Benaroch, Webster, & Kazaz, 2012; Berradea, Cristiano, & Scarf, 2012; Garg & Deshmukh, 2006; Miguel & Rios, 2012; Shafiee & Chukova, 2013; Simoes, Gomes, & Yasin, 2011). For example, Miguel and Rios (2012) found particular deficiencies in the few existing studies on medical device maintenance outsourcing. They identified a cluster of papers that apply mathematical models to maintenance outsourcing problems, noting that while these models were proposed for specific industries, none was applied specifically to the maintenance outsourcing of medical devices (e.g. Asgharizadeh & Murthy, 2000; Jackson & Pascual, 2008; Lisnianski, Frenkel, Khvatskin, & Ding, 2008; Lugfigheid, Jardine, & Jiang, 2007; Murthy & Asgharizadeh, 1999; Murthy & Yeung, 1996; Plambeck & Zenios, 2000; Rahman & Chattopadhyay, 2007; Tarakci, Tang, Moskowitz, & Plante, 2006a, 2006b; Tarakci, Teyarachakul, & Tang, 2009). Further, they identified weaknesses in several papers that made critical assumptions that would fail to hold in real-world applications (e.g. assuming equipment does not become more likely to breakdown as it ages). In a second cluster of papers, identified as empirical-longitudinal studies of maintenance outsourcing problems, they found only five papers related to the performance measurement of medical device maintenance outsourcing (Cruz, Aguilera-Huertas, & Dias-Mora, 2010; Cruz & Denis, 2006; Cruz, Perilla et al., 2010; Miguel, Barr, & Pozo Puñales, 2007; Miguel, Denis, & Sanchez, 2002). However, these papers do not mention any discussion about the managerial implications of the findings is non-existent, making it difficult to apply results in a meaningful way in terms of the make or buy making decision paradigm. Additionally, no empirical proposal whose research was grounded in management or strategic management theory dealt in detail with the issues related to maintenance outsourcing, nor did any specifically deal with the outsourcing of medical device maintenance (Macher & Richman, 2008; Shafiee & Chukova, 2013; Shelanski & Klein, 1995).

The goal of this study is to bring operational and management research principles to the problem of medical device maintenance outsourcing. More specifically, we aim to use Transaction Cost Theory (TCT) as the theoretical foundation for a model measuring the financial performance of internal and external governance structures, which may serve as an aid for hospital managers making medical device maintenance outsourcing decisions. Our goal is to provide insight into which governance structures<sup>3</sup>

provide hospitals with the most control over the performance of medical device maintenance under a variety of conditions, and we believe that managers of clinical/biomedical engineering departments and healthcare managers will be the first benefit from this research.

Therefore, our research seeks to extend the literature on how the main variables of interest to TCT influence the financial performance of internal and external governance structures by applying TCT to an examination of outsourcing performance in the maintenance service industry for medical devices. To our knowledge, this is the first study to use a TCT framework to examine the factors that affect the financial performance of both external and internal governance structures for medical device maintenance, while measuring the impact of these variables on financial performance. We believe the novelty of our approach lies both in its theoretical contribution and its examination of previously unexplored relationships between maintenance financial performance and governance selection, while including several control variables in our model that have gone ignored in previous studies. For example, our analysis includes the level of technological complexity of medical equipment, equipment age relative to useful life (equipment obsolescence), the level of training provided to biomedical technicians, and the number of years of experience of maintenance service companies, etc. Thus, by examining new relationships impacting governance structure financial performance, while controlling for a variety of other variables, our model is a unique, integral, empirical study of maintenance financial performance.

On the other hand, while most empirical papers and literature reviews support the assertion that TCT considerations are determinants of governance choice, few empirical studies have demonstrated whether governance structure impacts performance. This is because performance measurement (i.e. cost-inclusive,<sup>4</sup> cost-exclusive<sup>5</sup> measures) should compare the performance of internal versus external governance structures Geyskens, Steenkamp, and Kumar (2006), which becomes problematic since performance of the selected governance structure is observed, while the performance of those governance structures not chosen are not observed (Masten, 1993; Masten, Meehan, & Snyder, 1991). Therefore, we agree with (Geyskens et al., 2006), that “greater effort to understand the influence of governance choice on performance is needed”. While the relationship between performance and the important constructs of TCT have received increasing attention in recent years, this research seems to focus almost exclusively on financial indicators of performance, such as profit, sales growth, and firm mortality rates (Geyskens et al., 2006; Macher & Richman, 2008). We believe that part of the novelty of our approach lies in its operationalization of financial performance as maintenance service costs relative to the original cost of acquisition, a measure of service quality, as opposed to profitability. This approach allows us to measure the performance quality hazards of contract misalignment, which has especially important implications in an industry such as healthcare, where the existence of public sector hospitals makes profitability and firm mortality a less useful indicator of performance. Surprisingly, in doing so, we found that some of our results go against one of the most common assumptions in the medical device maintenance field: that externalizing maintenance services improves service quality (Blumberg, 2004: 144).

This paper is organized as follows: Section 2 presents a brief literature review, identifying the theoretical variables that affect different measures of performance (including financial) and the empirical support they have received, Section 3 presents the formulation of our hypotheses. Section 4 presents the research

<sup>2</sup> Respondents were senior leaders in their corporations and were significantly involved in the decision making processes of outsourcing in manufacturing, education, government, retail, medical, and finance industries.

<sup>3</sup> For example: Market (Classical Contracting), Trilateral Governance (Neoclassical Contracting), Bilateral or Unified Governance Structures. See theoretical framework section for more details.

<sup>4</sup> Measures that encompass the costs of generating performance, including: level and growth of profit.

<sup>5</sup> Measures that do not directly encompass the costs of generating performance.

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