International Study of Technology Investment Decisions at Hospitals

Christian Wernz\textsuperscript{a}, Hui Zhang\textsuperscript{a}, Kongkiti Phusavat\textsuperscript{b}

\textsuperscript{a} Grado Department of Industrial and Systems Engineering, Virginia Tech, Blacksburg, VA 24061, USA
\textsuperscript{b} Faculty of Engineering, Kasetsart University, Bangkok 10900, Thailand

ABSTRACT

Purpose: Healthcare costs have increased considerably over the past decades around the world. Major contributors to this trend are expensive medical technologies. In this research, we used a case study approach to understand how organizational and country level factors influence hospital investment behavior.

Design and methodology: We developed a conceptual framework based upon decision theory and institutional theory from which key questions were derived. We conducted semi-structured group interviews with relevant stakeholders in six hospitals located in five countries (Germany, India, Thailand, South Korea, United States).

Findings: We found that the investment decisions of the interviewed hospitals are primarily affected by the healthcare system, the socio-economic and cultural context, and the organization’s mission. Most of the interviewed hospitals consider multiple criteria in their decision-making framework and share similar organizational processes.

Practical implications: We identified an international best practice approach to investment decision-making at one of the hospitals. The other hospitals, despite being leading institutions in their respective countries, do not have sufficiently advanced and objective assessment approaches and would benefit from a more data-driven and systematic decision process.

Originality: Prior research has documented that investment decisions at hospitals are driven by organizational factors. This paper shows how, in addition, country level factors – in particular healthcare system and cultural aspects – affect hospital decision-making behavior.

Keywords: Health care industry, management and investment decisions, international study, medical technology, quality management
1. Introduction

Technological advances for medical devices, such as computed tomography (CT) scanners, magnetic resonance imaging (MRI) and surgical robots, have improved the quality of care in terms of medical efficacy, patient satisfaction and operational efficiency. However, the adoption, i.e., investment and use, of new technologies is expensive for hospitals, payers and society. In the U.S., an estimated 50% of the growth in healthcare spending can be attributed to medical technologies (Kaiser Family Foundation 2007).

Hospitals are the main purchasers and user of medical technologies. Their technology adoption affects the financial and medical performance of a country’s healthcare system. For every hospital, technology investments play an important role due to the long-term organizational impact on finances and quality of care. Understanding and improving the investment decision processes at hospitals is the key to achieving better, more affordable care at the hospital and country level.

Investment decisions are influenced by organizational and country-specific factors. Approaches to investment decision-making vary between hospitals, even within the same country. Variations in decisions and decision processes result from differences in organizational structure, mission, leadership style, and patient demographics. These variations become even more pronounced in an international context, where hospitals are further affected by the nation’s healthcare system and political, socio-economic, and cultural factors.

This paper presents an international study of technology investment decision processes at hospitals. Through interviews with six hospitals in five countries, we documented these organizations’ budgeting and technology investment processes, examined common and distinguishing aspects, and identified the influence of country-specific characteristics. Our study

2. Literature Review and Theory

Despite the societal and organizational importance of hospitals’ technology investment decisions, empirical research on decision processes is sparse and mostly over a decade old. In prior studies, personal interviews (Focke and Stummer 2003), phone call surveys (Li and Collier 2000) and questionnaires (Greenberg et al. 2005; Li and Collier 2000) were used to collect primary data. Secondary data studies by Teplensky et al. (1995) and Yang and Park (1991) analyzed national and regional databases. However, the standardized data collecting methods used in these studies did not describe hospitals’ investment processes in detail.

Furthermore, these studies have focused on hospitals in a specific country: U.S. (Kamath and Elmer 1989; Li and Collier 2000; Reiter and Song 2011), South Korea (Yang and Park 1991) and Israel (Greenberg et al. 2005). In our study, we accounted for the effect of country level characteristics, which had not been investigated previously.

We conducted semi-structured interviews to capture and describe the details of hospitals’ decision processes. The development of our interview questions was informed by institutional theory and decision theory. In the following sections, we discuss both of these theories followed by the presentation of our conceptual framework that we used to derive our interview questions.

2.1 Applying institutional theory to cross-country differences in healthcare organizations

Institutional theory suggests that organizational environments are shaped by “the elaboration of rules and requirements to which individual organizations must conform if they are
to receive support and legitimacy” (Meyer and Scott 1983). Institutional theory has been used to study cross-country differences and their influence on healthcare organizations with a focus on ownership, financing methods, reimbursement methods, and culture (Preker and Langenbrunner 2005; Retzlaff-Roberts et al. 2004; Wagstaff and Van Doorslaer 1992). Institutional theory has not yet been applied to a cross-country study of technology investment decisions.

Organizational behavior is influenced by functional, political, and social factors (Oliver 1992; DiMaggio and Powell 1991). For investment decisions, functional factors are hospitals’ strategic focus and market forces. Political factors include the characteristics of a country’s healthcare system, regulations and policies. Social factors refer to the social norms with which organizations comply. These factors, which differ across countries, were included in our conceptual framework as we expected them to play a role in hospitals’ decision-making processes.

2.2 Applying decision theory to investment decision processes at hospitals

In decision theory, one can distinguish between normative (how people should make decisions), descriptive (how people make decisions) and prescriptive (helping people make better decisions) research. Our study is descriptive, but also aims to be prescriptive through identification of global best practices.

From a normative perspective, a technology investment decision is a typical decision-making problem that is comprised of decision makers, decision objectives and decision alternatives (Zeleny and Cochrane 1982). Decision makers can be individuals or a group, which receive information from other stakeholders in the organization. The decision objectives should be derived from the organization’s mission. Previous research has identified three main objectives: technology leadership, profitability, and value for patient and community (Greenberg
et al. 2005; Li and Collier 2000; Teplensky et al. 1995). Additional considerations are budget constraints, competition and requests from physicians. Decision alternatives represent discrete investment options.

In normative decision theory, mathematical optimization approaches are used to identify best alternatives, e.g., goal programming (Keown and Martin 1976; Wacht and Whitford 1976), economic evaluation (Birch and Gafni 1992; Laupacis 1992), real options analysis (Pertile 2009, Wernz et al. 2013), game theory (Levaggi et al. 2009), and multi-objective optimization (Focke and Stummer 2003). Through our interviews, we assessed to what extent these methods are used in practice.

Prescriptive decision theory leverages normative approaches to help decision makers make better decisions recognizing the limitations of mathematical models, but also the idiosyncrasies of human and organizational processes. Decision support systems (DSS) are often used in practice to support the decision makers. Wernz et al. (2013) proposed a data-to-decision (D2D) framework that combines operations research techniques with decision analysis. In our study, we assessed to what extent DSS or decision analysis tools are used.

2.3 Conceptual framework of investment decision-making

Informed by institutional theory and decision theory, we developed the following framework from which our questions were derived (Figure 1).
3. Methods

3.1 Sample selection

We conducted interviews in Germany, India, Thailand, South Korea and the United States. We chose these countries due to their diversity and differences in functional, political and social factors. For each country, we identified one major hospital among the nation’s most renowned institutions (two hospitals in Germany). Given their leadership role and size, we expected to identify global best practices in technology investment decision processes.

3.2 Design and conduct of interviews

The interviews followed a semi-structured approach, with questions covering six aspects: (1) hospital characteristics, (2) general budgeting process, (3) technology investment decision-making process, (4) considerations during the adoption of new technologies, (5) information sources, and (6) software and decision support.

Group interviews were held in English (except for German in Germany) and lasted 60-90 minutes. Interviewees (total of 23) included executives, surgeons, device experts, financial
analysts and insurance managers. The lead researcher asked the prepared questions, which had been sent to interviewees beforehand. One to two additional researchers were present during each interview and followed-up with additional questions. The presence of multiple interviewers and a diverse group of interviewees allowed for data and investigator triangulation and increased the validity and reliability of our study (Mathison 1988, Voss et al. 2002).

Tests of construct validity, internal validity, external validity, and reliability were used to assess the quality of the research design (Voss et al. 2002). All interviews were recorded, and later transcribed. Key insights were extracted in case write-ups, which underwent independent assessments by each member of the research team and multiple revisions. The results were supplemented with archival data from the hospitals’ websites and were shared with interview participants to confirm accuracy of collected information.

4. Interview Results

Table 1 provides an overview of the organizational profiles and key results followed by a detailed discussion.

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TABLE_1

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4.1 Germany

The Statutory Health Insurance (SHI) is the major insurance option in Germany, covering 90% of the population (Jakubowski et al. 1998). The remainder of the population is covered by private insurance, government employee insurance and social welfare. Approximately 40% of
hospitals in Germany are public, another 40% are private, non-profit, and the remaining 20% are private, for-profit hospitals (Augurzky et al. 2009).

The University Medical Center Mannheim (UMCM) is a public hospital with 4,500 employees and treats 67,000 inpatients and 230,000 outpatients per year.

The hospital has a corporate development division, which considers the strategic focus of the hospital in its medical and business related investment decisions. The division negotiates with SHI its budget, which is based on the number of beds, patients, and achieved case-mix points. The funding quota for UMCM is between 50% and 70%; the rest comes from hospital profits.

The budgeting process at UMCM considers a five-year horizon. At the beginning of each five-year period, an investment plan lists all major devices under consideration. UMCM also has a replacement plan for small devices (up to €5,000) that is based on devices’ expected lifetime. For major investments, management makes its decision based on the following criteria: financials, including how many cases can be completed with the device; services that can be offered; insurer reimbursement; and payback time. The key decision criterion is profitability. The interviewees recognized the need for a more comprehensive decision matrix that incorporates evidence-based information and allows for a more objective and comprehensive evaluation.

The University Hospital Tübingen (UHT) is a public hospital with 9,000 employees, 67,000 inpatients and 330,000 outpatients per year. UHT has established itself as one of the leading medical centers in Germany.

Similar to UMCM, the areas of activities of UHT are research, education and patient care. The hospital’s budget for capital investments comes from the state. Additional investments can be made with accrued operational surplus (i.e., profits). The business division “construction and
technical” plans, purchases and operates medical technologies in the hospital, and is responsible for their life cycle management. UHT has an investment plan of 5-10 years for major medical devices, but no long-term plan exists for minor devices, such as laboratory equipment, in part due to the difficulty in forecasting demand from hospital research staff.

To identify investment opportunities, each department compiles a needs and requirement list. The department and division heads jointly populate an assessment matrix, which is submitted to their director, who evaluates the alternatives with respect to investment goals and criteria. The board makes the final investment decisions.

The assessment matrix considers 10-20 criteria, such as technology leadership, patient demand, and cooperation agreements. Medical quality is the primary objective at UHT. Investment decisions for new and expensive technologies also include market and strategic considerations and a financial benefit assessment. Discussions regarding these investments can be controversial and can last months. For established technologies, such as MRI or CT scanners, the decision focuses on new device quality, utilization, maintenance and operating cost. Decisions for small devices, such as ultrasound or laboratory equipment, can be difficult since data on utilization and maintenance costs may not be readily available. In such cases, interviews with technology specialists are conducted.

4.2 India

Estimations are that only 3-15% of the Indian population is covered by health insurance and 90% of healthcare expenses are paid out-of-pocket by patients (Sloan and Hsieh 2012). Two kinds of hospitals exist in the Indian healthcare system: 1) hospitals providing primary and secondary care, and 2) hospitals providing tertiary care, e.g., bypass surgery, kidney and other transplants. Most of the high-end medical services are only provided in major cities.
Apollo Hospitals Corporation (AH) is located in Delhi. AH has approximately 50 hospitals in India and is the second largest hospital chain in the country after Fortis Healthcare. It is the first public-private partnership hospital in the country; the Government of Delhi funds the hospital while AH has independence in management. AH serves a mixed patient pool that includes affluent, suburban and rural populations, as well as international patients. Patients from the city and surrounding area account for 40%-50% of customers; international patients constitute 12-16%. The majority of the international patients come from neighboring countries for high-end, elective procedures, such as bone marrow and kidney transplants, spine surgery, and hip replacements.

AH classifies its budgeting process into three categories: equipment replacement, equipment additions, and new equipment adoption. Equipment replacement is triggered by physician requests, top management initiatives, or infrastructure needs at hospital branches. For additional equipment, the decision is based on a financial analysis that compares patient demand with current load to estimate the revenue that could be generated from the additional unit. For new adoption, profitability is the main decision criterion.

The investment decision is made by a committee that discusses the above-mentioned criteria. Investments costing less than $9,000 are reviewed and approved by departments and directly paid for with their budgets. For technologies above $9,000, the main considerations are patient demand and financial feasibility. The committee also considers technological advancement, medical quality, and competition.

Being a leading corporation in India, AH’s competition is mainly internal, i.e., among its hospital branches. In case of conflicts between branches or department, benefits to the overall corporation supersede department or branch interests.
4.3 Thailand

Thailand has three main health insurance funds: Social Health Insurance (SHI), the Civil Servants Medical Benefits (CSMBS) and Universal Health Coverage (UC) (Ramesh and Wu 2008). Additional income for many Thai hospitals is generated through medical tourism (Wernz et al. 2014).

Bumrungrad International Hospital (BIH), located in Bangkok, caters to affluent Thais and international patients with high-quality services and globally competitive prices. Among the one million patients BIH treats annually, half are international patients, originating from 190 countries. Medical tourists generated 60% of total revenues.

Medical necessity or replacement needs are the main drivers for technology investments. For devices below $300,000, a wish list is generated by departments and submitted to the board annually. For investments above $300,000, the investment is directly submitted to the board as the need arises. BIH prefers a bottom-up process in which physicians and nurses suggest investments, as opposed to a top-down process in which management initiates investments. BIH does not conduct research and thus does not invest in emerging technologies. However, emerging technologies are carefully monitored and purchased once established in the market and sufficient patient demand exists.

Investment options are debated among administrators, senior corporate leaders, physicians and nurses. Information is supplied by device manufacturers and an internal research group. In some cases, a consulting company is hired to provide additional and more detailed information on technological and medical aspects. The board makes the final investment decisions.
4.4 South Korea

In South Korea, 96.3% of the population is covered by the universal coverage plan. The remaining 3.7% of the population is supported by the Medical Aid Program (Song 2009). Only 10% of hospitals in South Korea are public; private hospitals are the primary healthcare providers (Kwon 2009). Healthcare providers are reimbursed through a fee-for-service system called the national scoring system. South Korea has recently begun to cater to medical tourists. Based on a 2011 estimate, medical tourism is expected to generate an annual profit of $22 million in the next few years (Yoon et al. 2011).

The Severance Hospital (SH) of the Yonsei University Health System is a private hospital affiliated with Yonsei University College of Medicine. The hospital serves 3 million outpatients and 1 million inpatients annually. In recent years, SH has expanded its services for medical tourists and is targeting patients primarily from neighboring countries such as Mongolia and Russia.

At the beginning of a fiscal year, the departments at SH compile an investment wish list. Around the same time, the Yonsei University Health System decides on its budget allocation. Equipment replacement is dependent on anticipated equipment utilization and the equipment life cycle. Devices that are nearing the end of their life cycle are given priority in investment considerations. For new and expensive technologies, the most important decision criterion is medical quality. Other factors, such as patient demand, physicians’ needs, reimbursement and competition, are also considered. In some cases, manufacturers are invited to the hospital to give presentations and provide decision makers with additional information.

A committee consisting of ten people, headed by the hospital’s vice president, reviews the investment alternatives. For investment around $1 million - e.g., for CT scanners, MRI or
surgical robots - the director of the hospital makes the final decision. For investment above $1 million, the CEO of the Yonsei University Health System decides.

4.5 United States of America

In the U.S., healthcare is financed through taxes, social security, private insurance and out-of-pocket payments. Before the 2012/13 healthcare reform, 16% of the population had been uninsured. The majority of U.S. hospitals (77%) are private – the rest is public (American Hospital Association 2008). A variety of methods are used to reimburse hospitals for their services. The most common payment method is fee-for-service for outpatient treatment and per diem or diagnosis-related groups (DRGs) for inpatient treatment. Physicians working in hospitals receive payment through salary, capitation, fee-for-service, incentives, or a combination.

Wake Forest Baptist Medical Center (WF) is a non-profit teaching hospital supported by the state of North Carolina and the federal government. Around 13,000 people are employed at WF and its medical school. WF strives to achieve a minimum profit margin of 4% and to maintain its AA bond rating. Income surplus is used to benefit the community.

Budgets are allocated to three main areas: health services, teaching and research. In a typical fiscal year, departments are given $5 million to spend on devices for new health services. About 20% of this budget is spent on recruiting new physicians, improving patient safety, small equipment replacement, and financially lucrative projects with above average return on investment. In addition, $50 million per year is allocated for routine replacements of equipment.

The remainder of the funds is allocated as follows. Departments submit budget requests for new devices, which include an initial functional and financial review. The vice president (for health services projects) or dean (for teaching and research projects) then decides whether these projects should be considered. In the ensuing evaluation stage, projects below $500,000 are
prioritized according to departmental preferences, whereas larger investment requires a strategic evaluation by the resource strategy group. Here, WF uses six weighted investment evaluation criteria: financials (25%), quality (20%), capacity/access (15%), strategic importance (25%), infrastructure (10%), and ease of implementation (5%). A score between 1 and 5 is assigned for each alternative per category. The weights had been determined by a senior leadership group of physicians and operational personnel. The scoring of alternatives is done by the CEO and other top-level executives based on the information gathered in previous stages. WF uses the DSS tool Strata®, which pulls in relevant data during the committee meeting, allows for the entry of the alternative ratings, and computes an optimal investment portfolio based on the available budget.

5. Discussion

5.1 Influence of country level factors

5.1.1 Healthcare system influences

Interview results demonstrate that hospital investment decision-making is strongly affected by the characteristics of a country’s healthcare system, in particular health insurance coverage, financing method, reimbursement method for hospitals, payment method to physicians, and hospital ownership.

Each of the studied countries shows difference in how hospitals are financed. The share of contributions from taxes, social insurance, private insurance, and patients’ out-of-pocket payments varies. This affects hospitals’ available budgets and investment considerations. Furthermore, the way patients pay for healthcare also differs from country to country. Physicians’ treatment decisions are influenced by the financial burden of out-of-pocket payments for their patients. In case of self-paying patients, physicians realize the need to provide cost-effective
services. With insurance coverage, patients and physicians are less sensitive, and often less aware of treatment costs.

The AH case in India clearly demonstrates this relationship. Only a small share of the Indian population is covered by health insurance, with self-paying patients being the majority. Furthermore, hospitals do not receive support from the government for technology investments. Therefore, AH’s major investment criteria is anticipated patient demand. Factored into anticipated patient demand are currently unsatisfied demand and the price that could be charged for the service. If the price-demand curve is favorable, the hospital will purchase additional units of equipment or make investments in new devices.

The way insurance companies reimburse hospitals also varies among countries. Payments are made based on items-of-service, patient days, case characteristics, population served by the hospital or a combination of these factors. Physicians’ payment methods are also diverse, including fee-for-service, capitation and salary. The payment methods for hospitals and physicians result in different incentives that can affect the technology investment and usage decisions.

In South Korea, hospitals are reimbursed according to fee-for-service. The government strictly controls medical fees, and no difference exists in fee schedules between private and public hospitals. In addition, patients freely choose their hospital without referrals, which intensifies competition among hospitals. This explains why SH emphasized competition as an important decision-making criterion. Furthermore, a number of services, such as high-cost robotic surgeries, are not covered by the fee-for-service system, making them less prevalent in the health system (Kim et al. 2005). Interviewees confirmed that reimbursement channels are considered carefully when adopting any expensive equipment.
Another important aspect affecting investment decisions is the source and availability of funds. For example, since UMCM (Germany) is a city-owned public hospital whose funding from the government is often insufficient, it needs to perform financial evaluation on each investment carefully. In contrast, UHT (Germany) is a state-owned public hospital, which generally does not experience shortage in its funding, and hence has more freedom towards making medical-quality-driven and research-driven investments.

5.1.2 Cultural influences

During our interviews, we noticed the impact of a country’s culture on hospitals’ investment behavior. The social relationship between hospital administration and physicians plays an important role. As the BIH example of Thailand demonstrated, top management trusts their physicians and lets them suggest and direct which technologies should be purchased. Interviewees reported that in Thailand, people are “ thriftier” than people in Europe or in North America. Hence, hospitals trust their physicians to use the budget cautiously and make reasonable decisions.

Another interesting finding comes from AH in India. AH has no department head, and it gives equal power to all senior physicians within a department. AH’s decision-making process is conducted in an open-discussion fashion. In the situation where internal competition is fierce and power is not clearly assigned, the open debate form can be very time consuming.

5.1.3 Market influences

Market forces, including competition and patient demand, affect hospitals’ investment behavior. The intense competition in South Korea illustrated how the market affects investment considerations at SH. Another example is patient demand by medical tourists in Thailand. Medical tourists represent a major income source for BIH. Hospitals like SH and BIH see new
technologies as a way to attract patients and compete against other hospitals in the marketplace. The investment criteria of patient needs, competition, technology leadership and reputation are of great importance.

5.2 Multi-objective decision-making

All interviewed hospitals use multiple criteria to evaluate and compare investment projects. Cost-effectiveness was identified as the most important driver leading to a technology investment. Two out of six hospitals (UMCM, WF) listed financials as their primary investment driver; two hospitals (AH, BIH) identified “satisfying medical needs” as their major objective; and two hospitals (UHT, SH) classified medical quality as their major objective. All of these factors contribute to cost-effectiveness. Because new technologies often generate both high cost and great medical impact, it is natural for hospitals to use cost-effectiveness as the most important criterion.

Three further objectives in the conceptual framework – technology leadership, profitability, and value for patient and community – have been confirmed through our interviews. Interview partners have also mentioned additional hospital-specific criteria, such as cooperative agreements, competition, strategic importance and ease of implementation.

5.3 Bottom-up decision-making

When considering investment options, hospitals pay close attention to opinions and recommendations from frontline care providers. Two hospitals (AH, BIH) listed physicians’ assessment of medical needs as their major investment criterion. BIH executives believe that physicians instead of upper management should initiate medical technology investments.
Physician input is typically summarized and aggregated at the department level, supported by financial analysts, before being submitted to hospital executives for final consideration. This bottom-up approach ensures that the needs of care providers are met.

Hospitals often use a monetary threshold value to decide how purchase decisions are made and who is involved in the decision process. For example, SH uses a threshold to distinguish between decision processes at the hospital branch and corporate level. At WF, investments below and above a certain thresholds are evaluated according to different criteria.

Another common aspect of all organizations and countries is the use of decision-making committees. In four of the hospitals (UMCM, AH, BIH, SH), committees – consisting of administrators, physicians, nurses, technicians, financial analysts, etc. – are particularly influential. In addition, external consultants are frequently used to support a hospital’s investment decision. Consultants can provide insights in situations where hospitals have limited knowledge or resources to evaluate technical and medical aspects of the investment, particularly for new, emerging technologies.

6. Conclusion

The adoption of new technologies is a major decision-making challenge for hospitals. In this research, we investigated the current investment practices of six hospitals across five countries. Through in-person, semi-structured group interviews, we elicited and documented the details of these organizations’ budgeting and investment selection processes. Our analysis identified how organizational and country-specific characteristics affect hospitals’ decision-making behavior.
This paper contributes to the areas of decision theory, institutional theory, and their applications to healthcare. Prior research has documented that investment decisions at hospitals are driven by organizational factors. This paper shows how in addition to organizational factors, country level factors – in particular healthcare system and cultural aspects – affect hospital decision-making behavior.

The paper provides insights into investment practices in industry and addresses the lack of recent publications that document and analyze these practices. We found that the interviewed hospitals apply a comprehensive decision-making framework and budgeting process. Cost-effectiveness was identified as the most important investment criterion. The hospitals also had similar elements in their decision-making processes, including bottom-up decision-making, information gathering and consensus building through committees, and the use of external consultants.

The hospitals in this study are mostly national leaders in their country’s healthcare industry, yet their practices have some limitations. Only one hospital (WF) used a computer-based decision support system with well-defined decision criteria and weighting of organizational goals. We identified their process as a global industry best practice. The absence of objective and systematic assessment tools limits executives in effectively comparing investment opportunities, especially when conflicts of interests exist among departments. Furthermore, hospitals tend to be reactive as opposed to proactive in their technology adoption. The investment planning process is only triggered if physicians request a device or a competitor forces them to respond. This reactive approach does not address strategic goals of hospitals and can cause delays and impair technology advancements.
A limitation of our study is the small sample size, which affects the reliability and generalizability of our results. We documented existing processes and approaches, but a case study approach cannot determine their prevalence in the industry. Future research can build upon our findings by formulating hypothesizes that can be investigated through larger sample size studies, in particular surveys. Our findings can inform the design of these surveys. A systematic assessment of hospitals’ decision effectiveness could uncover organizational process improvement opportunities and approaches for the industry. From an international perspective, quantifying the influence of organizational vs. country level factors could not only inform hospital executives, but also health policy makers. Lastly, the conceptual framework we developed can be applied to investment decision problems in other industries.

Acknowledgements

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<td>Provide healthcare, research and education to the region</td>
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<td>Generate profits by providing health services to medical tourists and affluent local patients</td>
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REFERENCES

American Hospital Association (2008), "AHA hospital statistics, 2009," Health Forum LLC.


