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# **A RESEARCH MODEL FOR MEASURING IT-EFFICIENCY IN GERMAN HOSPITALS**

## ***RESEARCH IN PROGRESS PAPER***

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### **Abstract**

*More than 10% of the German gross domestic product is spent on health related services every year a good proportion of these funds allocated to information technology (IT). A review of the literature reveals that IT in hospitals is a vastly under researched area, although anecdotal evidence reveals that the efficiency of IT usage in German hospitals offers room for improvement.*

*Therefore we ask the research question: What are the salient factors influencing the efficient usage of IT in hospitals? To answer this question we set up a research project combining technology acceptance models, social cognitive theory and perceived risk theory to frame the perceived risk of liability for medical malpractice due to incorrect system usage.*

*This research in progress paper presents the theoretically derived research model and gives an overview of the research project. The project is scheduled to start in July 2011 and is carried out in conjunction with two hospitals and a leading provider of IT and services for the health care sector. Anticipated findings are not only insights into the antecedents of user behavior but also an instrument to measure efficiency of IT usage and a framework to positively influence IT usage in German hospitals.*

*Keywords: Technology adoption, IT-efficiency, health care, case study research.*

## Introduction

More than 10% of the German gross domestic product is spent on health related services every year summing up to 263bn € in 2008 (Destatis, 2010). A large proportion of these funds is invested into information technology (IT). Although solid empirical data on the allocation of these funds is scarce, the available studies offer interesting insights into the importance of IT in German health care: IT accounts for an estimated 2.9-3.7% of hospitals overall budget (VHitG, 2010) and for an estimated ~14% of hospital investments (Blum and Schilz, 2005).

IT in health care is used to lower the cost of health care delivery, to improve the quality of care for patients, to reduce medical errors and adverse patient events, thus improving health and well-being for the population (Devaraj and Kohli, 2000). These outcomes are particularly salient in the current context of rising health care costs. The rising age of the population thus the increasing number of patients along with a declining number of medical doctors and nurses calls for efforts to optimally focus resources in this sector.

As mentioned above IT can support efforts to increase both efficiency e.g. in hospital processes by freeing up scarce human resources from administrative task and effectiveness, e.g. by providing means to improve the quality of care. However, health care presents a particularly difficult context for leveraging investments in IT, with highly decentralized structures, localized processes and specialized roles and skills becoming barriers to successfully deriving value from IT investments. Anecdotal evidence from expert discussions almost unanimously underlines a big potential to increase the value of IT often quoting inefficient usage of the deployed systems. This implies that even if the IT systems are the right ones (i.e. effective) the degree of usage is often suboptimal (i.e. inefficient). The role of IT usage as critical factor for leveraging IT investments has been shown in previous studies. In the context of hospitals -building on usage concepts of DeLone and McLean (1992) and Doll and Torkzadeh (1998)- Devaraj and Kohli (2003) identified IT usage as the missing link between investment into IT and performance effects.

If users refrain from using the provided IT systems<sup>1</sup> correctly as planned, inefficiencies are inevitable. The main concern in this kind of environment is that the actions of few have a big impact on the whole group of users mainly due to unavailability, inconsistency and incompleteness of data. In a patient care area incomplete or inconsistent data is virtually useless due to threats of malpractice.

Information systems (IS) research has investigated the factors influencing usage behavior in great detail, however, predominantly in contexts other than health care. For example, a large number of studies investigated usage behavior based on the Technology Acceptance Model (TAM) and its derivatives (DeLone and McLean, 1992; DeLone and McLean, 2003). Lately, the TAM and similar research models were consolidated, extended and reformulated as Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al. (2003). While studies using TAM or UTAUT focus on technology acceptance with special respect to IT, another more general theoretical perspective is rarely applied to the IT context: Social Cognitive Theory (Compeau and Higgins, 1995) which explains usage behavior as influenced by psychological factors. E.g., individuals' beliefs about their abilities to handle IT systems was shown to exert an influence on their usage behavior (Compeau and Higgins, 1995) and in turn on the extent of IT usage.

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<sup>1</sup> There are multiple types of IT-systems deployed within a hospital. This research focuses on the systems that support the major business process of a hospital (providing patient care). The systems associated to this process are administrative systems like electronic patient file. Specialized systems to analyse client health data, diagnostic or technical medical systems etc. as well as inter-organizational systems are not in scope.

In addition, we expect Perceived Risk Theory (PRT) (Bauer, 1967) to play a vital role in our research context for the following argument: In health care doctors and nurses are liable for the actions they perform or chose not to perform on patients and may face lawsuits for malpractice in case of wrong decisions. The judgment whether a decision to perform certain action (or not) is appropriate, needs to be based on the information available at the time a certain decisions was made. It is important to recognize that IT systems like the electronic patient file provide quantitatively and qualitatively much more information than the old paper based file. This information needs to be taken into account for all patient related decisions in order to control liability issues.

Using these IT systems therefore involves two aspects that are considered by the users of these systems: (1) it becomes much easier to prove which information has been available at which point in time for diagnostic purposes, and (2) the doctor or nurse may face the allegation not to have taken all information into account which was available within the electronic file.

“Medical graphics” for example comprise the monitoring data and daily actions performed per patient by different nurses and doctors. In paper-based systems it is documented for which reason a patient is in hospital (main diagnosis). In electronic files issues as medication, body temperature, and blood pressure are documented additionally. Furthermore, new systems require the documentation of the complete anamnesis, e.g. patient often suffers from migraine but currently is in hospital because of heart insufficiency. In addition, issues as the registration of pain attacks (at which time, how long, which part of the body), nausea, appetite, and stool are required to be documented. Thus documentation is far more comprehensive than in the paper-based system and encompasses previously orally communicated issues when changing of shifts. Thus the use of these IT systems may subjectively increase the risk of malpractice lawsuits due to the vast amount of information per patient and the high degree of documentation and thus negatively influences IT usage (or foster resistance to use the system). Additionally, the system can document exactly at which time a doctor accessed which information, opening the door to delicate questions about personal prioritization of tasks. Therefore, PRT analyzing the risk a person subjectively associates with the consequences of a decision and its impact on the intention to perform the applicable action is also a relevant theory to incorporate.

Although there is a considerable amount of research in the IT usage context, the picture changes if it comes to the health care domain. The main issues are the influencing factors of IT usage rather than the IT usage construct itself. Devaraj and Kohli (2003) highlight the need for future research in particular for the following topics:

- Scrutinize factors influencing IT usage
- Determine key variables related to IT usage, and
- Investigate hospitals in different contexts.

Similarly, presenting one of the rare quantitative studies regarding the business value of IT in hospitals, Föhling et al.(2009) state that causal relationships are not sufficiently known and ask for further investigation.

In fact, research into IT usage in hospitals is indeed rare and insights into its antecedents are practically unknown. Regarding IT usage in German hospitals we were not able to locate academic research publications in this area. Given the importance as well as the anecdotal evidence regarding deficiencies in IT usage stated above it seems an obvious case for IS research to analyze user behavior in terms of systems acceptance and usage in a hospital environment and provide recommendations to increase efficiency.

To close this gap we formulate the main research question: *What are the salient factors influencing the efficient usage of IT in hospitals?*

To answer this question we built on previous research to propose a research model based on a combination of UTAUT, Social Cognitive Theory and PRT to provide a comprehensive basis for the analysis of usage. Furthermore, we refer to current research regarding the measurement of IT usage to

measure the efficiency of IT in German hospitals. As outcome, we expect to provide a twofold theoretical contribution: (1) by using three rarely combined theoretical perspectives that all fit the research setting we expect to be able to more comprehensively explain IT usage in general and (2) by applying it to the health care sector we expect to deliver additional insights regarding IT usage, its antecedents and performance aspects in this research domain.

For practice, we aim to identify the levers influencing technology acceptance in the specific environment of public hospitals and to provide recommendation to increase user acceptance and thus overall efficiency.

To carry out this research project we engaged with two public hospitals (medium size and large) as well as a leading information technology provider with extensive experience in health care. We would be grateful for having the opportunity to discuss this proposal at ECIS 2011 with other researcher of this area in order to sharpen the model before we actually engage in the research project which is targeted to start in July 2011.

## Related Literature

### IT Business Value and IT Usage

The value contribution of IT is controversially discussed in theory and practice alike. Although some empirical studies demonstrate a positive relationship between IT and success variables (Bharadwaj, Bharadwaj, and Konsynski, 1999; Brynjolfsson and Kemerer, 1996; Devaraj and Kohli, 2000; Dewan and Min, 1997; Mukhopadhyay, Rajiv, and Srinivasan, 1997) overall results are contradictive and result the so called "IT paradox" (Brynjolfsson, Hitt, and Yang, 2002).

Recent studies address these contradictions and argue that the business value of IT is more indirect and characterized by a complex network of additional and moderating influence factors (Lee, 2001). Melville et al. (2004) argue that both IT and organizational resources combined and orchestrated will create an output in the context of business processes which then affects the overall performance of a company.

One pivotal element found in studies dealing with the business value of IT is the "right" usage of provided information systems. In a study among US hospitals Devaraj and Kohli (2003) identify IT usage as the "missing link" to explain the business value of IT. They state that business value of IT accrues from IT usage and therefore, individual as well as organizational IT usage is crucial for exploiting e.g. the capacity of information systems.

Accordingly, many models have been developed to explain levels of usage. One of the most well-known models of usage at an individual level is the Technology Acceptance Model (TAM) and its derivatives investigating the effects of perceived usefulness and ease of use on user acceptance of IS (Lewis, Agarwal, and Sambamurthy, 2003; Limayem and Hirt, 2003; Taylor and Todd, 1995; Venkatesh et al., 2003) as well as the enablers and inhibitors of technology adoption, acceptance, and usage (Cenfetelli, 2004). Existing studies of IT usage mostly focus on the individual or task level (DeLone and McLean, 2003; Doll and Torkzadeh, 1998).

The extent to which IT is deployed can be measured along the four dimensions volume, diversity, breadth and depth that was proposed by Massetti and Zmud (1996) when examining EDI usage in complex organizations. Recently, Burton-Jones and Straub (2006) revised prior theoretical considerations on IT usage and propose measurement scales. Burton-Jones and Gallivan (2007) define a multi-level measurement of the IT usage construct.

This study builds on these insights of prior literature and addresses the IT usage context in hospitals.

## IS Research in German Health Care

Given the importance of health care for the German economy and the relatively large role IT plays in it one wonders about the scarce body of research developed in this field to date. Research has not yet collected sufficient data, formulated the right research questions and developed adequate models to answer IS question in a hospital environment (Leimeister, Klapdor, Hörmann, and Krcmar, 2008).

Amongst the few recent academic publications the work of Leimeister et al. ((Leimeister et al., 2008), (Fähling et al., 2009), (Köbler, Fähling, Leimeister, and Krcmar, 2010)) based on a large scale quantitative empirical study is a rare exception. Leimeister et al. analyze questions of IT-strategy, IT-management practices and governance. However, they do not focus on IT efficiency and their outlook to further research explicitly calls for work on the causal connections determining the value of IT in hospitals.

Other research on IT in German hospitals focuses on budget related issues, methods to increase quality of patient treatment or the overarching question whether IT increases efficiency and effectiveness in hospitals. Köbler et al. (2010) provide a review of this literature. All these articles have one thing in common: although they focus on IT in German hospitals, none of them asks the question whether the IT is used efficiently.

## Fundamental Research Model

The research approach is based on the assumption (backed by prior literature) that IT can generate more business value (e.g. by affecting business process performance) if the users, e.g. medical doctors, nurses, hospital administration, adopt and use the provided systems to a higher degree. Thus, human behavior is key to efficient usage. For explaining IT usage we combine three theoretical perspectives all dealing with the explanation of usage behavior.

First, the well-known Technology Acceptance Model and its derivatives (e.g. DeLone and McLean, 1992; DeLone and McLean, 2003; Venkatesh et al., 2003) have been discussed and empirically tested in numerous studies covering several research domains.

Second, Social Cognitive Theory (Bandura, 1977; Bandura, 1978; Bandura, 1982; Bandura, 1984; Bandura, 1986; Compeau and Higgins, 1995) deals with the influence of psychological factors on usage behavior and complements of what we know from TAM and its derivatives.

Third, because case studies in the hospital context provide evidence for the importance of perceived risk and its influence on usage behavior, we also refer to Perceived Risk Theory (Bauer, 1967). PRT analyses the risk a person subjectively associates with the consequences of a decision and its impact on the intention to perform the applicable action. PRT implies that, as long as the perceived benefits outweigh the perceived risks, the person has a positive attitude towards the particular decision. The perceived risk construct has been used to explain systems usage in areas where risk perception plays a vital role such as online banking or using online shops (e.g. (Cunningham, Gerlach, and Harper, 2005)).

Combining these three theoretical perspectives into one research model we intend to get a more complete picture of the influencing factors of user behavior and in turn on IT usage.

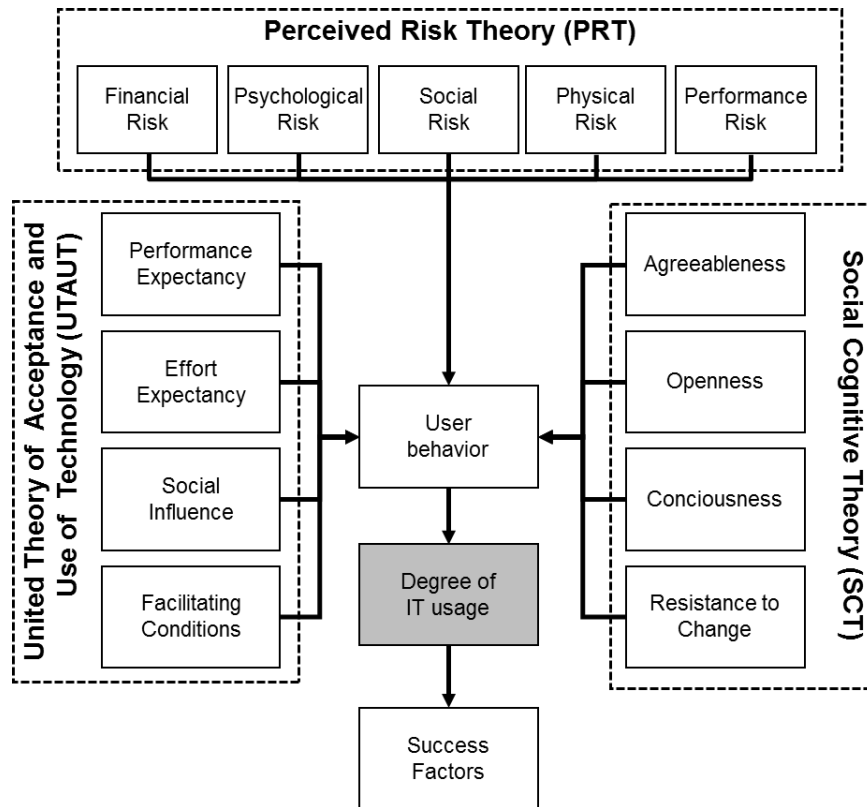


Figure 1. Initial Research Model

In addition to the relationships amongst variables depicted in the research model we will also investigate cross-relationships between variables of one theory to variables of another one. E.g., variables of SCT might have influence on perceived risks.

## Research Project Layout

In order to investigate the research questions described above the research project will focus on a primary business process in hospitals. There is strong evidence from literature to take on a business process perspective, because it is more appropriate to investigate the impact of IT factors on business outcomes (Barua, Kriebel, and Mukhopadhyay, 1995; Tallon, Kraemer, and Gurbaxani, 2000). One of the reasons to focus on business processes is to avoid a level of aggregation (such as analysis on firm level) that would lead to disguising the effects of IT by having too many influencing context factors.

The research project intends to deliver on following goals:

- a) Develop instruments to quantitatively measure the efficiency of IT usage
- b) Develop a research model to explain technology acceptance in a hospital context
- c) Develop questionnaire to measure constructs included in the research model
- d) Carrying-out pilot studies to test questionnaire and possibly adapt questionnaire
- e) Empirically measure the status quo of IT usage (in participating hospitals)
- f) Identify the enablers and inhibitors of efficient IT usage
- g) Develop a framework to increase efficient IT usage (based on research model)
- h) Apply framework in a real life project (action research within participating hospitals)

The scientific research work is supported by two publicly funded and administrated hospitals a very large and a medium sized organisation. Additionally a globally leading provider of information technology and services to the health care industry joined the research group.

A project plan has been compiled consisting of measurable milestones to deliver the anticipated research goals in a three year time frame. Two fulltime research assistants are planned to work on the project supported by administrative staff. The project itself is scheduled to start in July 2011,

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