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IT Induced Health Care Reconfiguration: German Hospitals in Transition

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***Abstract* – This paper presents the results of an exploratory study undertaken in conjunction with managing directors and medical chiefs of staff in German hospitals. Following the framework of a model developed by Venkatraman, it analyzes how information technology permeates this type of organization, how it changes its focus during evolution towards higher levels of sophistication, and which determinants affect the evolution.**

I. RESEARCH OBJECTIVES AND QUESTIONS ADDRESSED

This paper aims to explore the status quo of the Information Systems / Technology (IT) function in German hospitals from a top management perspective. It analyzes how organizational strategies and structures affect the IT function within hospitals from an evolutionistic perspective. Thus, an evolutionistic model will be chosen and utilized as a research framework. Based on the observed results, additional research questions will be formulated with regard to the penetration of the IT function in hospitals.

II. THEORETICAL FOUNDATIONS OF THE STUDY

Evolutionistic models have been utilized within the field of IS research for more than two decades. They explain the logic of a development, typically in the form of stages that follow one another. Each stage is the precursor of the next , representing a higher level of maturity or perfection [1] and may be categorized into two perspectives. The *internal perspective* focuses merely on the evolution of the IT function from an intra-organizational point of view. Probably, the most widely cited representative of this category is Nolan's stage hypothesis which divides the evolution of the data processing (DP) function into six stages [2]. The properties of each stage are classified in the light of four distinct characteristics (e.g. applications portfolio, DP organization, DP planning and control, user awareness) which in turn determine the level of DP expenditures. Since While Nolan's work has received a considerable amount of criticism,numerous subsequent contributions with different focuses have been published [3].All representatives of this perspective have one aspect in common: They concentrate solely on the IT function neglecting other elements of the internal and external environment of an organization.

Examples such as airline reservation systems, or efficient customer response, provide evidence that the IT function is not merely an isolated business function, but rather an opportunity to reconceptualize the role of IT within business. Thus, this function should be regarded from an inter-functional, as well as inter-organizational point of view, which in turn may be conceptualized as the *external perspective* of IT evolution. Representatives of this category are not as widespread as the internal perspective [4] [5].Venkatraman's model especially has received attention [6]. It highlights how the business is reconfigured not only to fully exploit the available IT capabilities but also to differentiate operations from those of the competitors. Venkatraman classifies the changing role of IT in business in terms of five levels of business reconfigurations [4]:

- Level one is named *localized exploitation* which concerns itself with the exploitation of IT within business functions, or isolated business activities within these functions. IT applications are deployed in order to improve the task efficiency of operations achieving function-specific goals without necessarily affecting related areas of operations.
- Level two is *internal integration* which is considered a logical extension of level one. IT capabilities are exploited in all possible activities where the deployment of a common IT platform serves to integrate the organization's business processes, enhancing its efficiency and effectiveness.
- Level three is termed *business process redesign*. It involves the reconfiguration of the business using IT as a central lever. Instead of treating the existing business processes as a constraint in the design of a coherent IT infrastructure, the business process itself is redesigned to maximally exploit the available IT capabilities.
- Level four is *business network redesign* and is concerned with the scope and tasks of the business network involved in the creation and delivery of products and services. This includes the business tasks within, and outside, the boundaries of an organization, and the consequent redesign of this electronic business network through IT capabilities. Electronic integration across key

partners in the changed business network becomes the dominant management challenge.

- Level five is labeled *business scope redefinition* which deals with an organization's right to exist. It covers the possibilities of enlarging the business´ mission and scope through related products and services, as well as shifting the business scope through the substitution of traditional capabilities with IT-enabled skills.

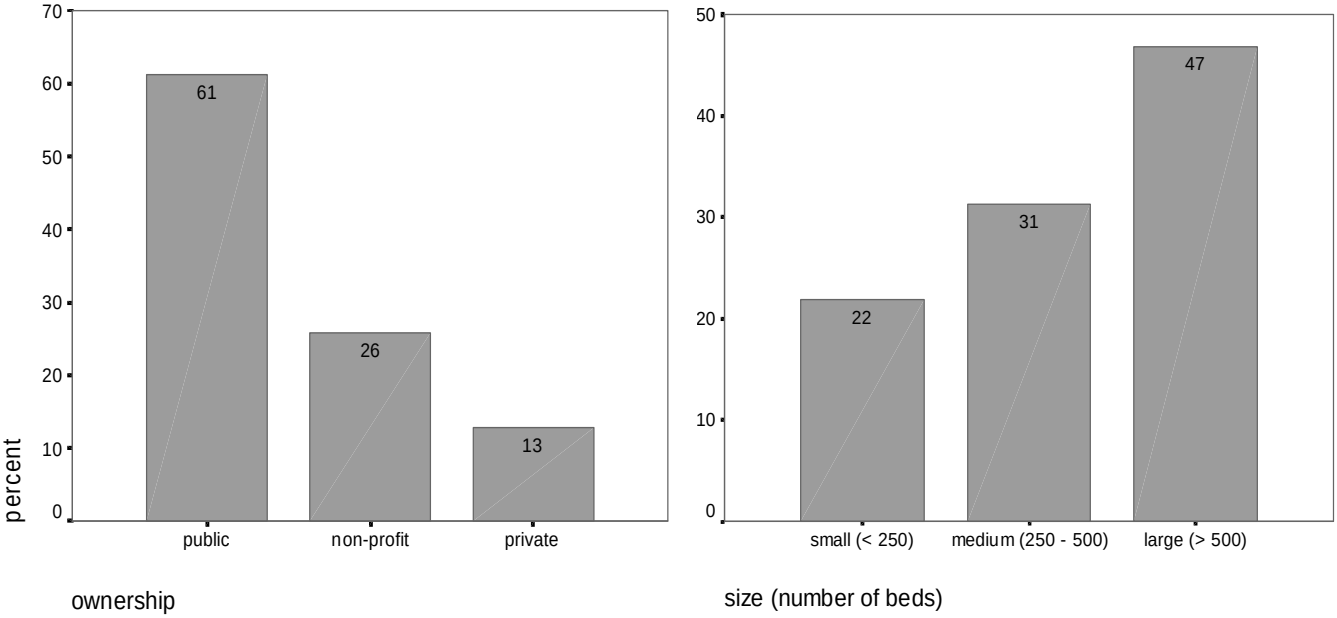

Fig.1. Characteristics of hospitals involved

In this study, we focus on the reconfiguration of the German health care sector where the legislator has recently undertaken some deregulatory efforts. Since the passing of the third phase of the German Health Structure Bill (Gesundheitsstrukturgesetz) in 1996, public health insurance providers not longer cover expenses caused by medical treatment of patients. Instead, flat rates and special compensations are granted for each type of treatment, no matter how long the treatment takes. Since these functional prices are subject of mutual negotiations between the insurance providers and medical organizations, the cost structures will become transparent as well as comparable. In order to avoid cost pressures, medical organizations are likely to respond by adapting various strategies such as enhancing cost effectiveness or differentiation through quality leadership or redefinition of services [7].

The IT function has played a crucial role during the deregulation of other industries, e.g. air transportation or banking, [7] providing evidence that this too will be the case in health care. Hospitals account for almost two third of the cost within this sector. Since very few contributions have been made to assess the role of IT in Germany's health care sector [8] [9] we intend to analyze how the deployment of IT affect the reconfiguration of German hospitals, following Venkatraman's model as a research framework.

III. Research Methodology Employed

The nature of this research project is exploratory. 95 hospital managers were contacted during the period of spring and summer 1998. Finally, 32 respondents accepted the invitation to participate in the study. For each hospital involved additional information was gathered from public databases like the DKA (German Hospital Addressbook) and Genios.The participants were then sent a two page semi-structured questionnaire four weeks in advance of scheduled face-to-face interviews.

Each interview took approximately two hours per hospital. The participant's responses were recorded, transcribed, extracted, classified and aggregated from the transcripts. In order to reduce bias, a co-coding procedure was deployed which yielded congruence in more than 81% of all cases. Deviating items were subject to further analysis based on a mutual discussion and argumentative justification of the categories involved.

Data analysis was performed with the help of a statistical software package. The predominant methods are descriptive statistics and contingency analysis. In this context, the likelihood ration (χ_L^2) is preferable to the Pearson criterion

(χ^2) since this has in general proved to be a reliable instrument [10].

The properties of the hospitals and respondents involved are shown in figure 1 and 2. The institutional characteristics indicate that the majority of hospitals are owned by public institutions and that they accommodate more than 500 beds[1]. These properties may be considered a representative image of the hospital structure in Germany [11]. Interestingly, a statistical relationship exists between these two variables. Large hospitals tend to be under public ownership whereas small and medium-sized medical centers are owned by charitable non-profit organizations and private institutions ($\chi_L^2 = 5.183$ and $\alpha = 0.023$).

Moreover, the hospitals included may be categorized using a group criterion which indicates whether a hospital is operating as an independent entity responsible for all functions, or whether it is part of a group of hospitals where certain functions like quality assurance, supply management, or IT can be centralized on a group level. In this survey, 31% of all hospitals are part of a larger group, whereas the remaining 69% operate as single entities.

The majority of participants had an administrative background. 81% of all persons interviewed acted as chief administrator or managing director. Only 19% of the interviewees had a medical background. Their positions were either medical directors or chiefs of medical staff. Furthermore, a total of 16% of all respondents had previously been working within the IT function, or were actively involved in an IT project. Another 47% had been concerned with IT issues as a member of an IT steering committee or had been part of IT planning and budgeting processes. The remainder (37%) had little or no experience with regard to the IT function.

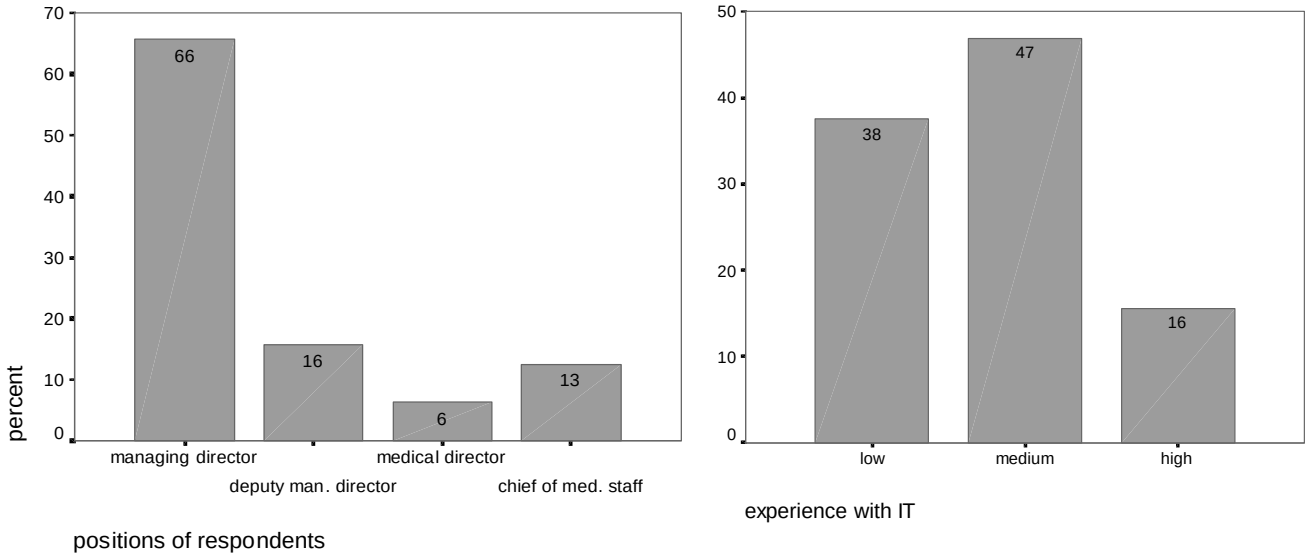

Fig.2. Characteristics of respondents

IV. Observed Results and Their Analyses

A. *Characteristics of the IT function*

In order to get an overview of the hospitals´ IT functions, this section provides an overview of primary characteristics and activities.

1) *Size, organizational structure and reporting structure:* Despite the fact that some of the participating hospitals employed more than 7000 peopleand had more than 2400 beds, the size of the IT departments was relatively small. 3 out of 32 hospitals did not have an IT department at all. 17 hospitals (63%) employed less than ten full-time IT employees. Nine hospitals (33%) had a unit size between ten and 30 employees. Only one institution employed more than 30 IT people. Two hospitals did not indicate the size of their IT departments. Considering the fact that ten IT departments (37%) employed only three IT specialists or less, the small size of the IT units involved became apparent.

[1] This categorization was adapted from [8], p. XIII.

In 25 out of 29 hospitals (86%), the head of the IT unit reported directly to one of the managing directors. The IT departments of the remaining four hospitals (14%) reported to the second level of organizational hierarchy.

systems, supplementing the administrative management systems with integrated clinical information systems as well as functions for patient management. Only three medical institutions (9%) were occupied with managerial projects such as transfer pricing schemes, steering

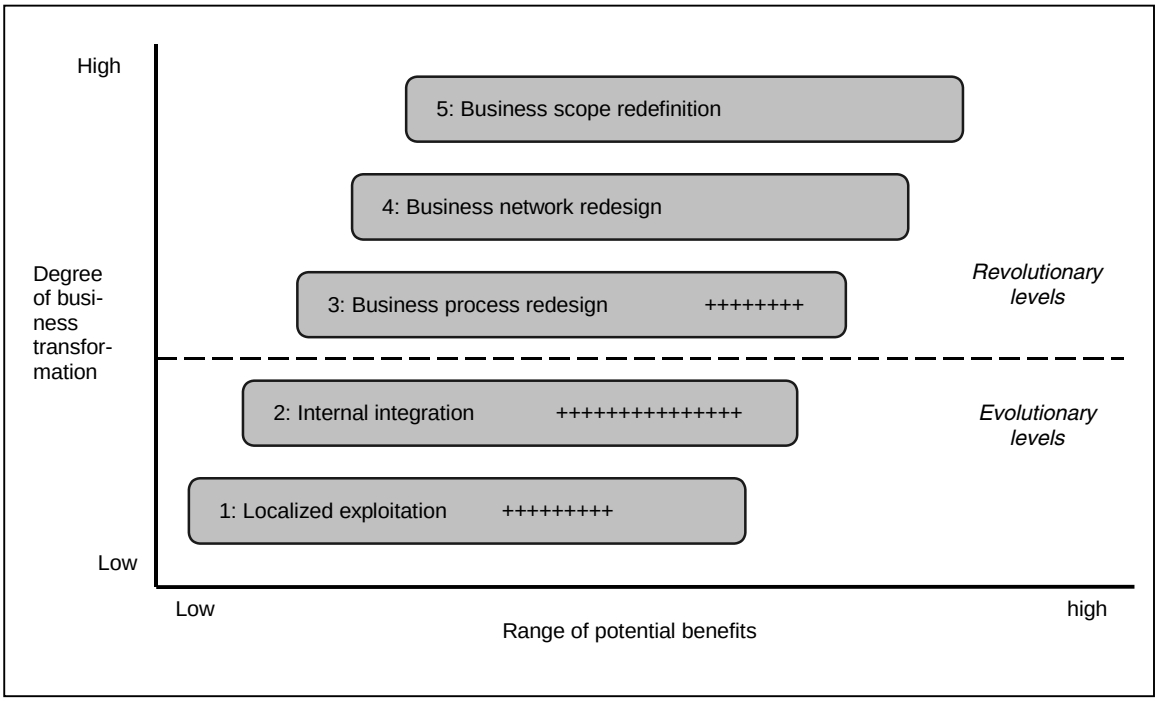

Fig. 3. Categorization of hospitals within the Venkatraman model

21 IT departments (72%) were totally centralized, whereas eight hospitals (28%) had a hybrid IT structure. A central IT department was complemented by decentralized units in functional units such as wards and clinics. Examples for an entirely decentralized IT function could not be found [12].

2) *Infrastructure and projects:* The IT infrastructures deployed were mostly distributed. 22 hospitals (68%) already implemented a client/server-architecture. Four hospitals (13%) utilized stand-alone PCs, whereas six other hospitals (19%) were still using mainframe or minicomputers [13].

Seven hospitals (21%) were in the state of conducting infrastructure projects. 14 hospitals (44%) were implementing integrated administrative management systems such as accounting, inventory management, payroll and the like[2]. Ten institutions (31%) were adding clinical subsystems, e.g. radiology, laboratory or operating room management systems to their existing application architecture. A vast majority of 27 hospitals (84%) had introduced hospital information

committees, or major IT reorganizations [14] [15].

3) *Alliances:* 25 out of 32 hospitals (78%) outsourced small portions of their IT function (e.g. systems selection and introduction) to independent service providers, or obtained data center services from municipal or federal service bureaus, university data centers, or medical group utilities. Another six medical centers (19%) undertook efforts for joint development of applications with institutions such as vendors or research organizations.

4) *Top management satisfaction:* The perceived satisfaction of the participants with IT was mixed. Since eight out of 32 respondents (26%) were pleased with their IT function, 14 were neither dissatisfied nor satisfied (44%). Ten participants (31%) disliked the overall performance of their IT function.

The participants who indicated a positive attitude towards their IT function provided arguments such as flexibility, responsiveness, service mentality, and well-regarded skills. Participants who were dissatisfied with this function reported communication barriers, lack of medical knowledge, recruiting and turnover problems,

[2] Multiple answers were possible in this context.

outdated technology infrastructure as well as non-integrated solutions.

B. *Evolutionistic analysis of hospitals*

Using Venkatraman's model as a conceptual framework [4], nine out of 32 hospitals (28%) have been assigned to level one which is *localized exploitation* (see also fig. 1). Among these were still three hospitals which only recently have started exploiting IT for activities such as accounting, controlling, and billing. The major overall objective is to automate labor intensive activities in order to significantly increase the efficiency of these functions.

Another 15 hospitals (47%) have been occupied with integrating different functions into a coherent application architecture. According to Venkatraman's model, these activities are central to level two which is called *internal integration*. Within this level, most hospitals deploy large-scale software packages like SAP R/3, CLINICOM or ORBIS either for administrative functions only, or in addition, for administrative and medical functions such as patient management or communication management among wards. The objective is to penetrate and couple critical hospital functions with IT yielding higher returns in efficiency, quality and effectiveness.

The remaining eight hospitals (25%) have initiated considerable efforts to *redesign* their existing *business processes*. According to Venkatraman these organizations can be categorized into level three. Hospitals at this level frequently cooperate with external consultants or research institutions for streamlining their medical, nursing, and administrative processes. These processes are often analyzed with the help of graphical modeling or simulation tools. The motivation for streamlining medical, nursing, and administrative processes is to further reduce the cost of medical treatments, to increase patient satisfaction, as well as effectively managing the available medical and nursing staff.

Since no examples could be found for level four and level five hospitals, there are at least some indications that a few hospitals are currently moving to these levels. One hospital, for example, which is about to enter level four, e.g. *medical network redesign*, is preparing an Internet-based application system which permits access to electronic patient records for general practitioners for follow-up treatments outside the hospital.

Another hospital is developing a Web-based system that allows referring doctors to search for the next available admission date for patients requiring cardiovascular surgery. Interestingly, this system is designed for medical doctors abroad in order to attract wealthy patients from other nations. Since the hospitals are part of a nationwide network, this "reservation system" will automatically display alternative locations or optional dates if no beds are available at a requested date and site.

Two other hospitals are about to enter level five of the Venkatraman model, *redefining the scope* of their medical institutions. One hospital, for example, has developed a concept for mobile medical care and offers franchise agreements to third party medical institutions. Since the franchisees are offered certain support functions like marketing, inventory management, logistics as well as IT operations on a mandatory basis, the franchiser will be able to sell benchmarking data either to the franchisees or to other institutions.

Yet another hospital has carried out a reengineering project with a public research institute. One part of this project was the development of a dedicated tool for modeling and simulating discrete event medical processes with three-dimensional computer animations. The project was so promising that both partners decided to form a joint-venture in order to market the simulation tool continentwide. In the meantime, major hospitals in Germany have been undertaking serious efforts in applying this dedicated simulation tool, redefining and enhancing the scope of the hospital to some extent.

These examples indicate some evidence of the model deployed. Unfortunately, Venkatraman considers his model as a hierarchy of five levels but makes neither assumptions about their order, nor any remarks about the omission of certain levels. For example, the future level five hospital did not go through level four. After integrating systems (level two) and redesigning processes (level three), it proceeded directly to level five. Thus, electronic medical networks must not be a prerequisite for substituting medical capabilities with IT-enabled skills.

Following a similar pattern, five out of eight hospitals which have already begun to streamline their medical, nursing, and administrative processes have not yet accomplished level two. Since the integration of medical and administrative applications can be seen as crucial for using IT as an enabler and lever in redesigning business process, this partial backlog may inhibit the full potential of streamlined and IT supported medical processes.

C. *Determinants of the evolutionistic model*

In order to explore which factors influence the hospitals´ positions in the Venkatraman model, various strategies, IT characteristics, and organizational variables will be subject of further analysis.

1) *Strategy:* Interestingly, hospitals which focus on quality improvement of their medical services as an

organizational strategy are mainly located on level three of the Venkatraman model ($\chi_L^2 = 3{,}606$ *and* $\alpha = 0{,}058$). Similarly, hospitals which aim at generating profits in non-core activities such as food services, pharmacy services or IT, can also be found on level three ($\chi_L^2 = 5{,}288$ *and* $\alpha = 0{,}071$). On the contrary, hospitals that have not yet formulated a coherent strategy for encountering the challenges of the deregulation, remain mainly on level one, and to some extent on level two of the evolutionistic model ($\chi_L^2 = 6{,}564$ *and* $\alpha = 0{,}038$).

These findings reveal the importance of a well-formulated organizational strategy for utilizing IT as a competitive weapon. Without such a strategy, there is virtually no basis for a strategic alignment of the IT function which helps to differentiate the operations of a hospital from those of its competitors.

2) *IT characteristics:* Level three hospitals report solely to first-tier managing directors whereas level one and level two organizations are supervised by second-tier managers ($\chi_L^2 = 4{,}646$ *and* $\alpha = 0{,}098$). This highlights the increasing importance of the IT function as well as the necessity of top management support in order to fully exploit the potential of IT. Without full top management support, it seems to be more difficult to obtain resources in order to implement the required infrastructure and applications architecture. Furthermore, the managing directors have the power and authority which is necessary to initiate the organizational changes in the light of new technologies and systems.

Interestingly, hospitals that have already proceeded to level three are concerned more frequently than expected with the implementation and integration of hospital information systems ($\chi_L^2 = 3{,}174$ *and* $\alpha = 0{,}075$) as well as clinical subsystems ($\chi_L^2 = 4{,}618$ *and* $\alpha = 0{,}099$). Since these types of IS require a considerable amount of funding, this emphasizes strong support and control by at least one of the managing directors. Furthermore, the penetration of primary activities in a hospital's value chain seems to be paramount for delivering effective and efficient medical services. Without supporting primary activities, the full potential of IT as a lever for redesigning medical processes might become more difficult to exploit.

Both findings, top management control and penetration of primary activities may have a positive impact on the perceived satisfaction of the IT function. In this context, respondents whose organizations have not yet moved to level two or level three are significantly less satisfied with their IT function than respondents of higher level hospitals ($\chi_L^2 = 6{,}802$ *and* $\alpha = 0{,}033$). In level one organizations, non-integrated application systems and stand-alone hardware platforms are common. Since these technologies poorly support only a small fraction of the medical and administrative functions in a hospital, the top management is likely to be disillusioned. Quotes from participants which characterize the IT function as a "worry function" or "residual function" provide evidence for this perception.

3) *Organizational variables:* Notably, the hospital's ownership affects its position in the Venkatraman model. Compared to public or charitable non-profit hospitals, private medical institutions have penetrated level three more frequently than expected ($\chi_L^2 = 5{,}327$ and $\alpha = 0{,}068$). This is not surprising, since private hospitals were common before the legislation of the third phase of German Health Structure Bill in 1996. Therefore, they were forced to actively utilize more management options including the IT function in order to be successful in a competitive business environment. This cumulative experience from the past leads to a competitive advantage as long as public and non-profit hospitals are still in the process of adapting these skills.

V. Discussion

This paper provides an overview of the status quo of the IT function in German hospitals. It analyzes the evolution of this function from a macro perspective. The findings are limited by several aspects which will briefly be discussed as follows:

- *Survey technique:* Since the research strategy was exploratory, some bias may result from the transformation of semi-structured answers obtained from the respondents into analyzable variables. As mentioned above, all answers were taped, transcribed, classified, and aggregated. The classification schemes applied were mainly derived from the literature, but the categorization itself was based on the perceptions of the authors. The technique of co-coding the data surveyed is a widely accepted instrument for reducing potential distortions, but does not fully eliminate potential bias [16].

- *Information deficits of the respondents*: Additional uncertainties arise due to information deficits from the respondents with regard to functions outside their primary responsibilities. In larger hospitals for example, administrative directors had no overall view of projects in the field of clinical subsystems and cooperative initiatives. Conversely, in a few cases, medical directors were not able to outline key administrative IT efforts. Furthermore, some managers openly admitted that they neither had a distinct background in the use of IT nor in the management of the IT function, leaving these issues to a small group of specialists. Since the assessment of IT potentials from a senior management perspective was

one objective of this study, the resulting, but insurmountable bias from incomplete information, has to be considered.

- *Sample structure and size:* Since the number of respondents with a medical background was only six, the administrative perspective is dominant in this study.

In order to capture the status quo of the IT function in the field as authentically as possible, the technique of semi-structured on-site interviews had an impact on the size of the sample. Since the data collection and analysis from 32 German hospitals was a time consuming experience, the number of cases is rather low.

This holds true especially for cross-tabulations with small expected frequencies. Many sources suggest that more than 80% of all expected values in a table should be greater than 5 for a sound application of the χ^2- test. But [10] states that this "rule" is extremely conservative and demonstrates that the χ^2-criterion may be used for tables with expectations in excess of 0.5 in the smallest cell. This standard was met in all contingency analysis provided by this paper.

A small amount of bias may also result from the utilization of the likelihood ratio criterion χ_L^2. Since some authors demonstrate that the likelihood ratio is preferable to the Pearson ratio in general [10], it has to be noted that it is slightly less conservative for smaller table sizes. Compared to the Pearson ratio, the likelihood ratio may lead to a quicker rejection of the hypothesis that two variables are independent. Considering that the purpose of this research is exploratory, these exceptions should be tolerable.

The same line of argumentation can be followed with regard to the levels of significance used in this study. Some values suggest that two variables are independent at a level of significance between 0.05 and 0.1. Compared to other studies [17], this may be acceptable if the identification of potential relationships between variables is more important than proofing the generalizeability of these relationships. Of course, a less conservative level of significance limits the tranferability of the results presented.

However, it should be noted that this contribution is one of the first surveys which focuses on IT management in German hospitals. It reveals interesting phenomena which indicate the appropriateness of the Venkatraman model as a conceptual research framework. Hopefully, it will motivate more researchers to investigate the IT function in Germany's health care sector from a theoretical as well as practical perspective.

VI. Summary and Outlook

Compared to other industries and leading nations such as the US or the UK, the IT function in German hospitals has up till now reached a lower level of maturity [18] [19]. A regulated market has been inhibiting medical institutions from adopting IT for efficiently improving medical services while maintaining a superior level of service quality. Corresponding with other industries in Germany, the hospitals surveyed strive for an integration of administrative and clinical functions, as well as a redesign of the processes involved. However, few examples could be found, where German hospitals had been using IT for medical network redesign and business scope redefinition. Interestingly, private hospitals seem to have a better starting point since they have been acting in a competitive environment for decades, exploiting the strategic benefits of IT more consequently. Furthermore, their smaller size fosters flexibility and the rapid adoption of innovative IT solutions.

The variety of phenomena emphasizes the need for further investigations. Since the diffusion of IT and its acceptance appears to be slower than in other industries, it may be useful to probe barriers of technology acceptance as well as obstacles of technology diffusion on an organizational level. Since more rigorous instruments have been developed for these issues [20], the evolution of IT in hospitals may be analyzed from a theoretical perspective.

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