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Ready for HIT Innovations? Developing a Tool to Assess the Professionalism of Information Management in Hospitals

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Abstract. Current frameworks postulate the success of health IT innovations to be determined by the professionalism of the information management (PIM). Still, empirical knowledge about PIM is scarce up until today. This study seeks to answer three research questions: (1.) How can PIM be measured in a reliable and valid way, (2.) how pronounced is PIM in German hospitals and (3.) do hospital characteristics have an impact on the degree of PIM? Based on the results of an expert workshop and frameworks for information management (IM) items for a PIM inventory were developed and the inventory sent to 1349 chief information officers of German hospitals. A principle component analysis based on the responses of 196 hospitals confirmed the three components that had been proposed by the frameworks: the strategic, the tactical and the operational level. The full inventory implied satisfying reliability and allowed a PIM composite-score to be calculated. The PIM scores for strategic and tactical IM were found to be far lower than for operational IM which hints at strong deficits in these areas. A stepwise regression model indicated that the degree of PIM significantly increased with the size of the hospital, which had been expected and hints the validity of the PIM inventory. This tool offers potentials for hospitals to classify and improve their IM.

Keywords. Hospital information technology, innovation, information management

1. Introduction

Although health information technology (HIT) innovations possess great potentials to improve the quality and efficiency of patient care within the hospital environment [1], a growing body of knowledge indicates that the realisation of HIT innovations is a complex undertaking. It seems to follow no straightforward process but is subject to dynamic cycles of iteration as technological, social and organisational dimensions incrementally align over time [2]. In the course of these processes, diverse barriers may arise and endanger or even halt the digitalisation agenda of hospitals. In order to better understand the underlying mechanisms, these barriers can be investigated in relation to the three stages of the adoption process (initiation, implementation, institutionalisation) and with regard to the inter-organisational level where they occur (strategic, tactical and operational level) [3]. In the initiation stage, where a new HIT solution is typically recognised as a potential way for improvement, a misalignment between the strategic

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hospital objectives and the technology in question may prevent further developments right from the outset [4]. The late participation of key stakeholders, i.e. representatives of future end users, can lead to similar consequences [2, 5]. Once the decision to purchase the new technology has been made, successful implementation can be jeopardised by an insufficient fit between the attributes of the end users (e.g. computer anxiety), attributes of the HIT (e.g. usability), and attributes of the processes (e.g. task complexity) [6]. Finally, even if the new HIT solution was effectively initiated and implemented, the innovations process cannot yet be described as being successful. Quite frequently HIT innovations fail as end-users fall back into old patterns [2, 3] or because the value contribution of the new HIT seems hard to detect from a strategic point of view [4, 7].

Against this background it can be assumed that the professionalism of the information management (PIM) might be a decisive factor to overcome barriers in HIT innovation processes. IM in hospitals and other large organizations is a crucial multiplier of health information management itself. Only they have the power and strength to provide a highly sophisticated IM that is necessary to turn data into knowledge. Winter et al. (2011) define IM as activities, which are carried out to manage the hospitals information system (HIS). On a strategic level, IM deals with the HIS‘ long-term development. Tactical IM introduces HIT components by projects. Operational IM ensures the daily IT operation of the HIS [8]. According to industrial IT governance and best practice frameworks like COBIT® and ITIL® IM activities can be conducted ad hoc (whenever there is a need) or on a regular and formalised basis [7]. Up until today, the application of these frameworks was not empirically tested in a larger hospital population and transferred into a valid and reliable measure. This measure could help to empirically identify facilitating conditions as well as outcome effects of PIM. Furthermore this measure could be an efficient way to capture PIM and therefore complement more differentiated approaches like COBIT® or ITIL®. The presented study seeks to answer three research questions: (1.) How can PIM be measured in a reliable and valid way, (2.) how professional is the IM in German hospitals and (3.) do hospital characteristics have an impact on the degree of PIM?

2. Methods

We developed a standardised questionnaire based on established procedures for construct measurement in information system research [9]. In a first step we defined professionalism of information management (PIM). Essentially, the definition was derived of the normative work by Winter et al. (2011) [8] and industrial IT governance frameworks like COBIT® and ITIL® [7]. Building on these frameworks PIM should focus in particular on IM activities to realize of HIT innovations. Aiming on a measurable concept, which implies a continuum between more or less professional IM, we conducted an expert workshop including five CIOs and seven scientists on the field of medical informatics. The workshop also ensured the applicability of the concept to the hospital setting. PIM was defined as the quantity, the regularity and the formalisation of IM activities, which need to be conducted to successfully initiate, implement and institutionalize HIT innovations. Following this definition an item set was developed to operationalise the construct. The item set consisted of 15 statements about activities on the strategic, tactical and operational level (five items each). All items could be answered on a 4-point Likert scale ranging from “No, this activity is not carried out at all” to “Yes, this activity is carried out in a regular and formalised way”. The items where

implemented in the IT-Report Health Care [10], which is a major survey that is send to a majority of German hospital-CIOs on a regular basis. To ensure criterion validity, an additional question was added with which the participants should estimate the hospitals *HIT innovation power* [11] on a 10-point Likert scale. At the end of December 2016 the survey was sent to 1349 CIOs, responsible for 1950 hospitals.
In order to explore underlying patterns of the data and to develop an empirically rooted composite-score, we performed a principal component analysis (PCA). Applicability of the matrix was evaluated based on the Kaiser-Meyer-Olkin (KMO) criterion and Bartlett's test of sphericity. Components were extracted if their eigenvalue exceeded 1. The corresponding item sets of the identified components were tested for reliability using Cronbach's alpha. To quantify PIM we calculated a composite score ranging from 1 to 100 points. To test for criterion validity the composite score was correlated with perceived HIT innovation power of the hospital. Finally we tested the impact of hospital characteristics on PIM by calculating a stepwise regression model. Teaching status (yes vs. no), ownership (private vs. public hospital), system affiliation (part of a hospital group or stand alone hospital) and size (number of beds) served as independent variables and the calculated composite score served as dependent variable. To ensure that the data fulfilled all assumptions of linear regression we tested for homoscedasticity, normality, linearity and multicollinearity.

3. Results

Data from 196 CIOs were included in the analysis after the original data set (n=224) was adjusted. According to a KMO measure of .908 and a highly significant result of Bartlett's test of sphericity ($p < .000$) applying PCA to our data seemed appropriate. Moreover, our sample to variable ratio was 13:1 which is above recommended minimum ratios that typically range between 5:1 to 10:1 [12]. The PCA resulted into three components (table 2). Items, which previously were labelled as IM activities on the tactical level did load onto one component (component 2). With the exception of two items this was also true for items relating to operational IM activities (component 1) and strategic activities (component 3). The full scale and the three sub-scales showed acceptable to good reliability in terms of internal consistency (tab. 1). The correlation between the PIM score and the estimated HIT innovation power was $r_p = .45$ ($p < .000$). The highest average score resulted for PIM on the operational level and the lowest for PIM on the strategic level. Overall the average PIM score was 49.1 (tab. 1). The stepwise regression analysis resulted in a significant model ($p < .000$) with an adjusted R^2 of .31, which indicated that 31% of the overall PIM was explained by the model. Hospital size was the only predictor, which remained in the final model ($\beta = .58$ $p < .000$). The impact of the hospitals teaching status, ownership and system affiliation did not remain significant. The data fulfilled all assumptions for linear regression.

Table 1. Cronbach's alpha and descriptive statistics ([1]value range 1 to 100; n=196,)

Composite Indicator	α	Mean[1]	SD[1]	Range[1]
PIM overall	.92	49.1	18.6	82.2
PIM on the operational level (component 1)	.85	64.3	21.3	86.7
PIM on the tactical level (component 2)	.81	45.3	20.4	100.0
PIM on the strategic level (component 3)	.80	37.6	21.5	100.0

Table 2. Component loading matrix (loadings below .4 are left blank; n=196)

Item	Component		
	1	2	3
"Management and monitoring of the technical performance (e.g. infrastructure, networks)."	.89		
"Application support and maintenance."	.86		
"Operation of the help desk and/ or service desk."	.77		
"Training of clinical end users."	.59		
"Long term HIT related finance- and investment planning."	.48		
"System specification (e.g. requirements definition, specifications, migration plan)."		.76	
"System selection (e.g. market analysis, tendering, bid comparison)."		.74	
"System analysis and evaluation (e.g. process modelling, evaluation of the current state)."		.62	
"System implementation (e.g. implementation strategy and adaptation)."		.60	
“Further collaboration with HIT vendors (e.g. joint product development)."		.51	
"Evaluation of the user satisfaction."			.73
"Identification of efficiency gains (e.g. evaluation of value contribution)."			.67
"Preparation and further development of an information management strategy."			.55
“Strategic risk management (e.g. development of a HIT emergency plans).”			.52
“Preparation and development of a HIT project portfolio (e.g. project prioritisation for 1-2 years)."			.47

4. Discussion

In the context of complex and multi-staged innovation processes it seems likely that a professional information management (PIM) facilitates the initiation, implementation and institutionalisation of HIT on different inter-organisational levels. We defined PIM by applying normative frameworks for IM and IT governance and on the basis of an expert workshop. According to this definition the operationalisation of PIM particularly emphasised IM activities, which where found to be critical for the successful realisation of HIT innovation. The PCA conducted confirmed our approach as the regularity and the formalization of IM activities on the operational, tactical and strategic level were identified as three distinct and reliable descriptors for PIM in hospitals. The moderate positive correlation with the perceived HIT innovation power hints to criterion validity of the PIM measure.

This inventory constitutes an easy to apply diagnostic test for the degree of IM professionalism. The composite score as well as its sub scores reveal different areas, where the participating hospitals have potentials to professionalise their IM. Although PIM on the operational level like the day-to-day support of clinical end users seems to be acceptable in most hospitals, the execution of tactical and especially strategic IM activities need to be improved rigorously. Particularly, the successful implementation of HIT innovations calls for increased efforts to establish a professional requirements management and a sustainable strategic management appear imperative. The results furthermore indicate that potentials for improvement also lie in the way how IM activities are executed in the majority of the observed hospitals. It seems that IM activities are rather conducted ad hoc or whenever specific needs and demands are involved.

To leverage their HIT innovativeness, hospitals need to make efforts for establishing an IM methodology that constantly and proactively seeks to identify and to introduce the

most appropriate solutions. Finally, the calculated regression model points to the hospital size as the most essential hospital characteristic to determine PIM. These results offer a new perspective on several HIT adoption studies, which regularly report size as a positive key factor for HIT innovations [e.g. 13]. It can be assumed that larger hospitals have more slack resources to establish a professional IM so that not the size in itself but the moderating effect of PIM plays a facilitating role regarding higher HIT adoption rates. This study is limited with regard to the response rate of 14.5% that might have caused a non-response bias. The results can therefore require further validation. Future approaches could on the one hand examine which organizational and social factors determine PIM. On the other hand, the effects of PIM on the implementation of HIT innovations can be investigated.

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