Antecedents of CIOs' Innovation Capability in Hospitals: Results of an Empirical Study

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Abstract. CIOs' innovation capability is regarded as a precondition of successful HIT adoption in hospitals. Based on the data of 142 CIOs, this study aimed at identifying antecedents of perceived innovation capability. Eight features describing the status quo of the hospital IT management (e.g. use of IT governance frameworks), four features of the hospital structure (e.g. functional diversification) and four CIO characteristics (e.g. duration of employment) were tested as potential antecedents in an exploratory stepwise regression approach. Perceived innovation capability in its entirety and its three sub-dimensions served as criterion. The results show that CIOs' perceived innovation capability could be explained significantly ($R^2=0.34$) and exclusively by facts that described the degree of formalism and structure of IT management in a hospital, e.g. intensive and formalised strategic communication, the existence of an IT strategy and the use of IT governance frameworks. Breaking down innovation capability into its constituents revealed that "innovative organisational culture" contributed to a large extent ($R^2=0.26$) to the overall result sharing several predictors. In contrast, "intrapreneurial personality" ($R^2=0.11$) and "openness towards users" ($R^2=0.18$) could be predicted less well. These results hint at the relationship between working in a well-structured, formalised and strategy oriented environment and the overall feeling of being capable to promote IT innovation.

Keywords. CIO, innovation capability, intrapreneurship, strategic cooperation

1. Introduction

Health information technology (HIT) innovations are considered to be an intrinsic component of hospital success [1]. This said, HIT innovations are less about specific IT applications, but about building "digital options" through complex integrated and multifunctional systems [1, 2]. In expert organisations like hospitals, this goal can only be achieved by making the right IT investments and by considering the complex network of social, organisational and technical aspects that surround successful HIT implementation [3]. Chief information officers (CIOs) stand at the heart of corresponding management activities [4]. Their perceived ability to initialise, implement and institutionalise new and suitable HIT solutions can be defined as *innovation capability* [5], a construct composed of latent personal and organisational characteristics. These are in detail: an *innovative organisational culture* and the CIOs'

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intrapreneurial personality and *openness towards users* [6]. Innovative organisational culture describes a working environment that nurtures unorthodox thinking, which is based on shared values, basic underlying assumptions and observable artifacts [7, 8]. With regard to HIT, innovative organisational culture can be characterised by shared visions about the future role of HIT, by a supportive hospital board (HB) and by a certain degree of flexibility in organisational structures, processes and work routines [3, 6]. Intrapreneurial personalities were originally characterised as "(..) dreamers who do. Those who take hands-on responsibility for creating innovation of any kind, within a business" [9]. Intrapreneurial hospital CIOs' can be characterised as being risk-affine and pro-active in regard to new HIT solutions [6, 10]. They are inclined to compensate a lack of decision-making power with entrepreneurial thinking and actions [6, 10]. Openness towards users can be defined by a strong orientation to clinicians' needs, the willingness to cooperate with users in IT project and by the awareness of social standing and professional autonomy [3, 5, 6].

In a previous study, we reported about developing an *innovation capability* score for hospital CIOs [6]. Based on this, it seems to be promising for researchers and practitioners (i.e. hospital managers) to explore antecedents of CIOs' innovation capability. In HIT adoption research, several approaches to explain the origin of innovations theoretically and empirically can be found [11,12]. Various studies focus on the status quo of IT management, which surrounds HIT implementation, e.g. the sophistication of strategic cooperation between CIO and HB, the use of IT governance frameworks or the existence of an IT strategy [10]. While other studies investigate the influence of structural hospital characteristics like size, functional differentiation, teaching status or ownership on HIT implementation [11]. Finally, there is a large body of research on individual characteristics to explain innovativeness (e.g. qualification in terms of working experience or degree) [12]. Considering these diverse research streams, this study intends to explore antecedents of the CIOs' innovation capability in hospitals.

2. Methods

The study was based on data captured in a nationwide survey among 1284 CIOs in German hospitals between February and April 2016 [13]. It furthermore builds on a composite score to measure the perceived *innovation capability* of CIOs [6]. This score, which consists of the three sub-scores *innovative organisational culture*, *intrapreneurial personality* and *openness towards users,* was found to be reliable and valid [6]. In order to explore the antecedents of the CIOs' innovation capability in this study, we performed four stepwise regression analyses. The composite score and its three sub-dimensions served as criterion. Sixteen attributes that described the status quo of IT management, the structure of the hospital and individual characteristics of the CIO were entered as predictors. The status quo of IT management was operationalised by eight items: (1) number of frequently communicated strategic information between CIO and HB as a measure of communication intensity, (2) communication environment of CIO and HB (e.g. coffee breaks vs. official meetings) as a measure of formalisation, (3) use of a management cockpit to visualise strategic information, (4) use of IT governance frameworks, (5) existence of an IT strategy, (6) membership of a nurse and/or (7) a physician in the HB to measure participation and (8) status as reference hospital as a measure for a formalised cooperation with IT vendors. Structural hospital

demographics were measured by four items: (1) number of in-patient beds as a measure of size, (2) number of clinical units as a measure of functional diversification, (3) teaching status and (4) ownership (private vs public). Individual characteristics of the CIO were measured also by four items: (1) work experience (in years), (2) duration of employment (in years), (3) clinical background of the CIO (e.g. nursing) and (4) academic degree. We tested for normal distribution and homoscedasticity of the residuals as well as for multicollinearity (by calculating the variance inflation factor (VIF)). Data were analysed with SPSS 24®.

3. Results

Data from 142 CIOs (response rate 11.1%) were included in the analysis after the original data set (n=176 [13]) was adjusted for missing data. CIOs in the final sample were responsible for 17.6% of all German hospitals (n=344) [14]. Table 1 and Table 2 show descriptive statistics of all items that were included in the regression models.

Table 1. Descriptive statistics of binary items (n=142)

Item	Yes	No
Formalisation (CIO and HB rather communicate in formal meetings)	57.0%	43.0%
CIO uses a management cockpit to visualise strategic information	14.8%	85,2%
IT governance frameworks (e.g. COBIT, ITIL) are used	35.2%	64.8%
An IT strategy exits	76.8%	23.2%
Formalised cooperation with IT vendors (status of a reference hospital)	42.3%	57.7%
A nurse is member of the HB	59.9%	40.1%
A physician is member of the HB	71.8%	28.2%
Hospital is a teaching hospital	56.3%	43.7%
Hospital is privately owned	12.7%	87.3%

Table 2. Descriptive statistics of metric items (n=142, [1]value range 1 to 100)

Item	Mean	SD	Min.	Max.
Communication intensity (freq. communicated information)	2.6	0.5	1.0	3.9
Functional diversification (number of clinical units)	9.2	8.0	1.0	45.0
Size (number of beds)	414.0	321.0	45.0	1563.0
CIOs' work experience (years)	14.0	8.3	0.0	35.0
CIOs' duration of employment (years)	11.7	7.8	0.0	32,0
Composite score: innovation capability[1]	56.0	12.4	28.2	87.9
Sub-score: innovative organisational culture[1]	43.8	21.1	0.0	100.0
Sub-score: intrapreneurial personality[1]	42.3	15.0	36.2	100.0
Sub-score: openness towards users[1]	74.7	14.1	0.0	86.7

The stepwise inclusion of the 16 predictors resulted in four significant regression models. Five predictors, assigned to status quo of IT management, significantly explained 34 % variance of *innovation capability*. Four of these predictors also significantly explained 26 % of *innovative organisational culture*. *Openness towards users* was significantly explained (18 %) by three predictors (number of clinical units, physician HB member, academic degree) and *intrapreneurial personality* (11 %) by the two IT management related variables "formalisation" and "IT governance" (Table 3). Residuals were normally distributed and showed no signs of heteroscedasticity, neither did the calculated VIF indicate multicollinearity.

4. Discussion

The main finding of this study is that CIOs innovation capability can be significantly explained by a formalised, intense, professional and strategic cooperation between the CIO and the hospital board. In hospitals, as in other organisations, technological innovations require the redirection of resources that would otherwise be allocated to non-IT related strategic objectives [5].

Table 3. Stepwise regression models (n=142)

	Innovation capability		Innovative org. culture		Intrapreneurial personality		Openness towards users	
	Cor. R^2= .34		Cor. R^2=.26		Cor. R^2=.11		Cor. R^2=.18	
	Beta	VIF	Beta	VIF	Beta	VIF	Beta	VIF
Status quo of IT management								
Communication intensity	0.23	1.23	0.27	1.22	-	-	-	-
Formalisation	0.31	1.13	0.24	1.10	0.26	1.03	-	-
Use of mgmt. cockpit	0.15	1.11	0.15	1.08	-	-	-	-
Use of IT governance	0.19	1.08	-	-	0.20	1.03	-	-
Existence of IT strategy	-	-	0.15	1.08	-	-	-	-
Reference hospital	-	-	-	-	-	-	-	-
Physician is HB member	0.12	1.03	-	-	-	-	0.15	1.01
Nurse is HB member	-	-	-	-	-	-	-	-
Structural hospital demographics								
No. of beds	-	-	-	-	-	-	-	-
No. of clinical units	-	-	-	-	-	-	0.19	1.15
Teaching hospital	-	-	-	-	-	-	-	-
Private ownership	-	-	-	-	-	-	-	-
Individual characteristics of the CIO								
Professional activity	-	-	-	-	-	-	-	-
Duration of employment	-	-	-	-	-	-	-	-
Academic degree	-	-	-	-	-	-	0.19	1.06
Clinical background	-	-	-	-	-	-	-	-

It can be assumed that an intense and formal exchange of strategic information in association with the use of IT based management cockpits, supports the lobbying in favour of HIT initiatives. A sophisticated strategic cooperation might furthermore lead to optimal trade-offs between clinical and technical requirements [3, 10]. This assumption is supported by the fact that CIOs perceive their innovation capability to be higher if a physician is part of the hospital board. Working together on establishing strategic IT initiatives might provide opportunities to educate each other about technical and clinical requirements [10]. In addition, clinicians in top management teams might act as "boundary spanners" to champion IT initiatives on the frontline level [3]. The certainty to be backed by clinical champions may furthermore facilitate the perceived capability to implement and institutionalise new HIT in clinical practice [5]. The ability to refer to hospital wide accepted IT strategy and to IT governance frameworks could have similar effects on certainty in actions [4]. Structural hospital characteristics, which were found to determine HIT adoption rates [11], could not explain innovation capability. Thus, CIOs' perceived innovation capability seems to be rather a function of proper management conditions than of size, teaching status or ownership. This study is limited with regard to the response rate of 11.1% that might have caused a non-response bias in our sample. The results therefore require further validation. Future research approaches could peruse additional predictors for

intrapreneurial personality and *openness towards users* (e.g. the "big five" personality traits [12]) to better explain the perceived *innovation capability* as a whole.

5. Conclusion

This study is the first step towards a deeper understanding of CIOs' perceived innovation capability in hospitals and its antecedents. These insights help paving the way for establishing an innovation culture in healthcare organisations.

6. Conflict of Interest

The authors state that they have no conflict of interests.

7. Acknowledgement

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