Characteristics of German Hospitals Adopting Health IT Systems – Results from an Empirical Study

Jan-David LIEBE[a,1], Nicole EGBERT[a], Andreas FREY[a] , Ursula HÜBNER[a]

[a]*University of Applied Science Osnabrueck,*
Health Informatics Research Group

Abstract. Hospital characteristics that facilitate IT adoption have been described by the literature extensively, however with controversial results. The aim of this study therefore is to draw a set of the most important variables from previous studies and include them in a combined analysis for testing their contribution as single factors and their interactions. Total number of IT systems installed and number of clinical IT systems in the hospital were used as criterion variables. Data from a national survey of German hospitals served as basis. Based on a stepwise multiple regression analysis four variables were identified to significantly explain the degree of IT adoption (60% explained variance): 1) hospital size, 2) IT department, 3) reference customer and 4) ownership (private vs. public). Our results replicate previous findings with regard to hospital size and ownership. In addition our study emphasizes the importance of a reliable internal structure for IT projects (existence of an IT department) and the culture of testing and installing most recent IT products (being a reference customer). None of the interactions between factors was significant.

Keywords. adoption, health information systems, clinical information systems, hospital

1. Introduction

Health IT adoption is a multidimensional process that is influenced by internal and external factors as well as technological and institutional issues. It can be analysed at the level of individuals, groups (micro level), of organisations (meso level) and countries (macro level). In the past 20 years a great number of studies focussed on the meso level and addressed internal characteristics of hospitals such as hospital size (number of beds [1]), type (teaching vs. non-teaching hospitals [2]), ownership (for-profit vs. not-for-profit hospitals [3]), system affiliation (hospitals in a system vs. single hospitals [4]), location (urban vs. rural area [5]), IT budget [6], IT plan [7] and IT staff [8]. IT adoption often referred to clinical IT systems and in recent years to the adoption of electronic patient/medical/health record systems [9]. Whereas hospitals in a health system and teaching hospitals were uniformly found to have more IT systems, all other factors were discussed controversially or were mentioned by one study only.

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[1] Jan-David Liebe, University of Applied Science, Health Informatics Research Group, PO Box 1940, 49009 Osnabrueck, Germany; E-Mail: j.liebe@hs-osnabrueck.de

Interactions between factors cannot be excluded such as hospital size and IT budget [8]. Other factors may have selective effects, e.g. while clinical IT systems were reported to have a greater prevalence in not-for-profit hospitals than in for-profit hospitals [2,6], managerial IT systems were found to be more often installed in for-profit hospitals [10]. Yet other factors are not independent from each other, such as hospital size and teaching status.

Despite the amount of previous studies there remain several uncertainties. The aim of this work therefore is to perform a combined analysis of the factors reported in the literature and to distinguish between the overall adoption of IT systems in hospitals and the specific adoption of clinical systems.

2. Method

A set of variables was drawn from the literature that represent those factors which were most likely to have an effect on IT adoption at the meso level. These variables were sorted by the number of studies that reported a significant influence and were matched with the attributes that were collected in the data set of the *2010 IT Report Gesundheitswesen*, a national survey of health information systems in German hospitals [11]. Based on the match the following independent variables were selected for a stepwise multiple regression analysis (SPSS 18.0): hospital size (logarithm of number of beds), system affiliation, ownership, location (logarithm of population density), IT plan, IT department, IT decision making, reference customer, IT budget in relationship to economic development of the hospital. Due to low data quality absolute values of IT budget were excluded. Nonlinear variables were made linear by taking the logarithm. Nominal and ordinal attributes were represented as dummy variables. In addition to the variables mentioned above we also included several interaction variables, e.g. location by ownership. IT adoption was measured by the number of subsystems in the health information system (overall adoption) and the number of clinical subsystems (specific adoption).

The regression analyses were performed on a data of 126 acute German hospitals [11] which resulted from a mail survey including all 2061 German acute hospitals (6.12% response rate). These hospitals represent all different sizes, types and geographical regions of Germany. In χ^2 tests the sample differed significantly from the population regarding size and region, however not from type [11].

Independent variables to be included into the stepwise regression were checked by histograms whether they were represented sufficiently in the data set. We therefore had to discard teaching status because less than 10% of the hospitals were teaching hospitals. The regression models were tested for normal distribution and homoscedasticity of the residuals.

3. Results

The stepwise multiple regression analysis identified four variables that significantly explain the variation of the data (tab.1): 1) hospital size (logarithm of number of beds), 2) IT department (yes, no), 3) reference customer (yes, no) and 4) ownership (private vs. public). All other variables were excluded by the stepwise regression. Whereas

hospital size, IT department and reference customer were positively related to the number of subsystems, ownership had a negative β-coefficient. None of the interaction variables contributed significantly to the model. There was no difference whether total number of IT systems (total IT adoption) or number of clinical IT systems (clinical) was chosen as criterion (tab. 1), the variables selected by regression remained the same.

Table 1. Beta-coefficients and significance level of variables included in the regression model

(*** $p < 0.01$; ** $p < 0.05$)

hospital size		IT department		reference customer		ownership (private hospital)	
total	clinical	total	clinical	total	clinical	total	clinical
0.450***	0.450***	0.169***	0.172**	0.184**	0.176**	-0.258***	-0.251***

Approximately 60 % of the total variance (as reflected by R^2 adjusted for number of predictors and sample size) could be explained by the two models (tab. 2), i.e. whether total IT adoption or adoption of clinical IT systems should be predicted. Residuals of the model were normally distributed and homoscedastic.

Table 2. Coefficients of determination and ANOVA F statistic

criterion variable	R^2	adjusted R^2	F	Sig.
total number of IT systems	0.611	0.592	31.449	0.000
Number of clinical IT systems	0.603	0.583	29.952	0.000

4. Discussion

The results show that irrespective of whether overall or clinical IT adoption was chosen as criterion the number of IT systems could be explained by the size of the hospital, the existence of an IT department, being a reference customer and by the public ownership of the hospital. Among these factors hospital size had the largest impact followed by ownership. Our findings support the literature, which by and large underpins the role of hospital size as an important factor [2]. However, there are also studies that came to different conclusions [4]. Our results match previous studies with regard to public hospitals having more clinical IT than private hospitals [2,6]. In our studies this was also true for the overall number of IT systems.

The most striking difference with other findings concerned the role of hospitals in a health system. Whereas previous studies – most of which are from the United States [4] – clearly demonstrate that being part of a system facilitates IT adoption, system affiliation did not significantly explain IT prevalence in our data. We do not think that organisational networks have no influence on IT decision making. On the contrary, we discussed network effects to explain differences in IT adoption between Austrian and German hospitals [12]. It rather seems to be a matter of how mature these systems or networks are. In Germany hospitals have only recently started establishing clusters. The IT infrastructure and equipment in the different organisations often still remain to be harmonized and upgraded.

In addition to what has been discussed in earlier works we propose two other factors of importance: an IT department in the hospital, i.e. a sufficient internal organisational background for IT projects, and being a reference customer, i.e. maintaining a special relationship with the main IT vendor, interacting with each other

in a trustful way which is the basis for testing and installing most recent and innovative products.

Due to an insufficient number of teaching hospitals in our sample we could not gauge their influence on IT adoption. Another factor that could not be included was IT budget because of low data quality. However, the variable „IT budget in relationship to economic development of the hospital", which we included instead, had no significant influence.

5. Conclusion

The regression model proposed has to be tested for robustness with other data sets. These data sets have to make sure that the variable „status of the hospital (teaching vs. non-teaching hospitals)" can be included and tested for significance. In addition to the two criterion variables „total number of IT systems" and „number of clinical IT systems" other variables have to be analysed, in particular the implementation status and the number of functions of the electronic patient/health record system of the hospital. These variables would give insight not only into the breadth but also into the depth of IT adoption.

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