Geenhuizen, Marina Van; Faber, Sander

Conference Paper

eHealth adoption factors in medical hospitals: A focus on the Netherlands

55th Congress of the European Regional Science Association: "World Renaissance: Changing roles for people and places", 25-28 August 2015, Lisbon, Portugal

Provided in Cooperation with:
European Regional Science Association (ERSA)

Suggested Citation: Geenhuizen, Marina Van; Faber, Sander (2015) : eHealth adoption factors in medical hospitals: A focus on the Netherlands, 55th Congress of the European Regional Science Association: "World Renaissance: Changing roles for people and places", 25-28 August 2015, Lisbon, Portugal, European Regional Science Association (ERSA), Louvain-la-Neuve

This Version is available at:
https://hdl.handle.net/10419/124669

ERSA 55th Congress, World Renaissance: Changing roles for people and places, Lisbon, Portugal, 25-28 August 2015

eHealth adoption factors in medical hospitals: A focus on the Netherlands

Sander Faber & Marina van Geenhuizen
Faculty of Technology, Policy and Management
Delft University of Technology, Delft, the Netherlands
Corresponding author: m.s.vangeenhuizen@tudelft.nl

Abstract
A better understanding of factors influencing eHealth adoption is required given the strong policy attention to eHealth but a low level of actual adoption in many European countries. A model for organisational eHealth adoption is proposed in the study, derived from several adoption frameworks. The empirical part is based on a survey among hospitals in the Netherlands and includes a Structural Equation Modelling (SEM) approach. Specific attention is paid to measurement of organisational readiness and to adoption as a process including different stages. Our results suggest a sharp decrease in the adoption process after the stage of interest/commitment and significant influence of size of the hospital, organisational readiness including technical aspects, and support by top management of the hospital. The paper concludes with some organisational strategies and policies to foster eHealth adoption and suggestions for future study.

Keywords: *eHealth, hospitals, organisational adoption, Technological-Organisational-Environmental (TOE) framework, Diffusion of Innovations (DOI), Structural Equation Modelling, The Netherlands*

1. Introduction: healthcare under pressure but limited eHealth use?

In a time in which the healthcare system in Europe is under pressure as healthcare expenditures are expected to rise significantly in the coming years [1]–[3], eHealth – the use of emergent Information and Communication Technologies (ICT) to improve health and healthcare in terms of operational efficiency and quality – is seen as a promising solution in sustaining the healthcare system. That the pressure is serious, can be illustrated with the Netherlands, where without intervention, healthcare expenditures will rise to 22-31% of the country's GDP in 2040 compared to 15.6% in 2013. Besides, 25% of the working population will be needed to be employed in the healthcare sector in order to meet the demand of healthcare in 2040 [1], [4]. Similar developments are foreseen in other EU Member States.

At both European and national level, policy makers are forwarding the potentials of eHealth in sustaining the healthcare system [5]. Nevertheless, the ground is still weak, recent studies point out that eHealth's potential is not fully deployed in hospitals across Europe, including hospitals in

the Netherlands [6], [7]. In addition, there is quite some differentiation between European countries, with Nordic ones – Denmark, Estonia, Sweden and Finland - as best performing countries, and some Eastern European countries and Greece as less advanced users [8]. But in each country, implementing and embedding of technological innovations of any kind require complex processes of change and learning both at the micro-level of medical professionals and patients and the meso-level of health-care organisations. Our knowledge of this matter is however still limited and fragmented. Therefore, the aim of the study is to gain more insight into the factors causing different levels of organisational adoption of eHealth in a hospital setting. With organisational adoption we mean acceptance and incorporation of eHealth into an organisation's every day practice.

Against this backdrop, we explore two research questions: 1) What is the pattern of organisational adoption of eHealth by hospitals in terms of different stages of the adoption process? 2) What are the factors in the organisational context that influence this pattern and is there a trend of non-linearity in that influence? The focus of the study on the Netherlands where we collected data on 30 representative hospitals. The Netherlands is an interesting case study for (international) decision-makers as the country is doing well in eHealth in a broader context, with far higher scores than the European average eHealth profile, though it is not the best [6]–[8]. Moreover, healthcare in the Netherlands belongs to the top healthcare systems in the world and has recently ranked first in the Euro Health Consumer Index [9]. At the background of this is a healthcare system reform starting in 2005 and intended to result in a more demand-oriented system, in which hospitals delivered higher quality at lower prices, thus increasing cost-effectiveness [10]. On the one hand, it is reasonable to expect an extensive use of eHealth as a result of this development, but on the other, the increased cost-effectiveness and efficiency might have caused tightness and too small 'room' for experimentation and learning preventing the actual adoption.

Much research has been done over the past decade on evaluating the practical implementation and integration of eHealth solutions and systems in the healthcare sector. Aside from important successes, studies also report ambiguous outcomes and complexity. According to various reviews, the literature is fragmented and has a focus on various parts of the healthcare system and different levels of analysis (system, organisation, professional) (e.g. [11], [12]). This study therefore clearly limits itself to hospitals and the organisational level. In addition, information and communication technologies (ICT) are regarded as a promising source of innovative solutions in helping to sustain the healthcare system. The use of ICT in healthcare, nowadays, is often referred to as eHealth which is a broad phenomenon. For the purpose of this study, therefore, a more delineated definition of eHealth is adopted [13]: eHealth is the use of emerging and existing ICT, especially the Internet, to improve or enable health and healthcare, limited to state-of-the-art applications used in the interaction between healthcare professional and patient with the emphasis on cure.

The contribution of the study to the literature is as follows. It is one of the first in its kind in providing a more detailed picture and understanding of eHealth adoption – by distinguishing between more stages compared to previous research – including a more refined design and testing of various constructs concerning adoption. This more refined approach has proven its value since the eHealth adoption by Dutch hospitals appeared to be largely concentrated in the early stages of the adoption process, at the level of 60 to 63% in the stage of interest and commitment. In addition, the study provides an exploration of the influence of a TOE (technological, organizational and environmental) framework in a hospital setting, with an emphasis on the organizational context. This framework has been selected because of its proven usability in organizational innovation studies [14]. We have found significant relationships between several existing TOE framework factors and eHealth adoption, namely, size of the hospital and support of

adoption by top management. Besides, we extended the construct of organisational readiness with IT governance and IT security for the reason of potential delay in adoption due to lack of alignment, vision and learning. From a methodological point of view, the study is unique because it makes use of a specific Partial Least Square-Structural Equation Modelling (PLS-SEM) adapted to a small sample size through which non-linear relations could be identified, better than using a linear model.

The remainder of this paper is structured as follows: the next section provides the theoretical background. In section 3, the conceptual model including the hypotheses is presented. Section 4 describes the methodology including the measurement instrument and the structural model. The results of the empirical analysis are discussed in section 5, including the assessment of the measurement model and structural model. Section 6 concludes with the main findings and implication of this study as well as suggestions for future research.

2. Theory on adoption of innovation

Organisational innovation has generally been defined as "the development (generation) and/or use (adoption) of new ideas or behaviours", see also Damanpour (2006) who distinguishes between 1) generation, and 2) adoption as two dimensions of organisational innovation. Our study has a focus on the last dimension. Additionally, the idea or behaviour may pertain to a product, service, technology, system, or practice [16] and may be new to an individual adopter, to most people in the unit of adoption, to the organisation as a whole, to most organisations in a sector (i.e. an industry), or to the entire world [15]. In our study, we see an eHealth application as an innovation if it is perceived as new by an adopting hospital organisation, discontinuous with previous practice and which is intentionally introduced and directed at improving health outcomes in terms of efficiency and effectiveness [17].

Many IT innovations in organisations, including hospitals, involve a two-part multi-level adoption decision process. First, a formal adoption decision is made by key decision makers to purchase, adopt, and acquire an innovation, and to make that innovation available to the organisation. This is followed by local adoption decisions by the intended users (e.g. medical professionals) about whether to actually use the innovation, and how [18], [19]. Accordingly, we draw upon the IT implementation model of Cooper and Zmud [20] which is most widely used in IT studies. We adjust the model slightly by distinguishing awareness, interest and ex-ante evaluation – consistent with the model of Fichman and Kemerer [21] – in order to capture more detail in the pre-adoption stage.

Table 1. Stages of organisational innovation adoption

Stage	Description
Awareness	Key decision makers are aware of the innovation.
Interest	The organisation is committed to active learning about the innovation.
Ex-ante evaluation	The organisation has initiated ex-ante evaluation and trial.
Adoption	A decision is reached to invest resources necessary to accommodate the implementation effort.
Adaption (implementation)	The innovation is developed, installed and maintained, and available for use in the organisation.
Acceptance	The innovation is fully employed in organisational work; personnel is committed to using it.
Routinization	Use of the innovation is encouraged as a normal activity; the innovation is no longer perceived as something extraordinary.
Full use	Use of the innovation to its fullest potential and in a comprehensive way.

Source: Adapted from [20] and [21].

Related to this, we assume that innovation as a process typically moves through a number of common, sequenced stages (as outlined in Table 1) leading to their eventual use in an organisation and that specific organisational factors are associated with higher or lower levels of adoption. In such one-directional and overall linear process, cyclical developments may often happen if the organisation needs to go back to a previous stage to be able to move to the next stage.

Several theories and models on innovation adoption are used in the Information System (IS) literature [22]. At organisational level, the Diffusion of Innovation (DOI) theory and the Technological-Organisational-Environmental (TOE) framework are most widely applied [14]. Accordingly, we adopt the TOE framework and elements of the DOI theory in developing the conceptual model for adoption of eHealth by hospitals. Rogers' theory of Diffusion of Innovation (DOI) provides a fundamental theoretical base of innovation adoption research in many disciplines [14], [23]. The TOE framework, as presented by Tornatzky and Fleischer (1990), extends the DOI theory by identifying three dimensions of the organisation's context that influence the adoption of an innovation: technological, organisational, and the environmental dimension. The TOE framework has been used successfully to understand key contextual elements that determine IT innovation adoption, including Health Information Systems [14], [25].

In Information Systems research, the TOE framework has often been supplemented by factors originating from the Resource-Based View (RBV) theory. RBV on innovation is based on the premise that organisational resources and capabilities determine an organisation's capacity for innovation in a context of competition [25]. Various resources have been seen as imperative for organisational innovation, for instance, Iacovou et al. [26] perceive organisational readiness as important and they conceptualize it as "the availability of the needed organisational resources for adoption". Similarly, Glaser [27] and Katri [28] on the strategic applications of ICT in healthcare organisations identify several relevant organisational resources such as IT infrastructure, IT staff and IT governance. A more general concept derived from learning on innovations is absorptive capacity, broadly seen as organisational learning ability, specifically in selecting relevant information and transforming it in strategies [29]. In the next section, we combine influences from the above theoretical perspectives in a conceptual model.

3. Conceptual model and hypotheses

The organisational context of adoption in hospitals will be investigated by taking the following characteristics into account: Size of the hospital, top management support, organisational readiness, centralisation in decision-making, and absorptive capacity (see Figure 1).

Size of the hospital

Size refers to the size of the hospital organisation. DOI theory suggests that a greater organisational size is related to a larger propensity to adopt any innovation [16]. Size is one of the best three predictors of IT adoption by organisations according to a literature review by Jeyaraj et al. [30]: Larger organisations possess greater slack in resources and are therefore able to allocate greater organisational resources (i.e. financial, technical, and human resources) to the adoption of an innovation [31]. Accordingly, the following hypothesis is proposed:

H1: Size has a positive influence on eHealth adoption.

Top management support

Support by the top management refers to the extent of commitment and resources provided by the top management for adopting eHealth innovation and related adaption processes in the organisation [31]. According to Jeyaraj et al. [30], top management support also acts as one of the three best predictors of IT adoption by organisations, which can be explained in two ways. First,

top management support ensures that there is a commitment to spend the required resources to the testing and implementation of an innovation. Secondly, top management can stimulate change (or overcome resistance) by communicating and reinforcing values through an articulated vision throughout the organisation, and by that, play a crucial role in influencing employees in accepting an innovation [18], [31]. Accordingly, the following hypothesis is proposed:

H2: Top management support has a positive influence on eHealth adoption.

Organisational readiness

From a Resource-Based View [25], organisational readiness has been defined as "the availability of the needed organisational resources for adoption" [26]. According to Iacovou et al. [26], organisational readiness falls apart into technological readiness and financial readiness. The first has been supported by a number of empirical studies [26], [32] and refers to the sophistication level of IT usage and IT management, which reflects the level of required technological resources. We may distinguish between the following four dimensions of technological readiness: 1) available IT infrastructure, including interoperability, 2) available IT human resources (support), 3) IT governance in terms of IT vision and strategy, and 4) IT security in terms of compliance to information security standards, including privacy issues. Further, financial readiness, as the second dimension of organisational readiness, refers to the amount of financial resources available to an organisation to invest in the innovation including key services and maintenance [26]. Implementing an innovation in an organisation that is overall more ready with regard to organisational resources is more likely to be successful [16]. Therefore, we propose the following hypothesis:

H3: Organisational readiness has a positive influence on eHealth adoption.

So far we have hypothesized direct effects of factors on eHealth adoption. Yet, theory also indicates indirect effects on eHealth adoption. Specifically, a positive relationship between size of the hospital and innovation adoption is typically perceived as relevant for larger organisations possessing greater slack in organisational resources (i.e. financial, technical, and human resources) which can be allocated to the adoption of an innovation [31]. Additionally, top management support is needed to ensure that there is a commitment in allocating these required resources to the implementation of an innovation [18], [31]. This study expects the effect of size and top management support on eHealth adoption is to a certain extent explained through organisational readiness. Therefore, this study additionally proposes the following hypotheses:

H4: Size has a positive influence on organisational readiness.

H5: Top management support has a positive influence on organisational readiness.

Centralisation in decision-making

Centralisation in decision-making refers to "the extent to which decision making authority is dispersed or concentrated in an organisation" [16]. In centralised decision-making, the decision-making is performed by the top of the organisation hierarchy (top-down), whereas in a decentralised model, decision-making is distributed throughout a larger group within the organisation (to a larger extent bottom-up). Centralisation has usually been found to be negatively associated with innovativeness; that is, the more power is concentrated in the top of an organisation, the less innovative that organisation tends to be [16], [18]. Although the initiation of innovations in a centralised organization is usually less frequent than in a decentralised organisation, the centralisation may eventually encourage the implementation of innovations, once the innovation decision has been made [16], [18], [25]. Responding to this ambiguity, the following hypotheses are proposed:

$H6_a$: Centralisation in decision-making has a negative influence on eHealth adoption.

$H6_b$: Centralisation in decision-making has a positive influence on eHealth adoption.

Absorptive capacity

Absorptive capacity refers to an organisation's "dynamic capability pertaining to knowledge creation and utilisation that enhances an organisation's ability to gain and sustain a competitive advantage" [29]. Zahra and George (2002) proposed four dimensions of absorptive capacity: 1) acquisition (the ability to find and prioritise new knowledge quickly and efficiently), 2) assimilation (the ability to understand it and link it to existing knowledge), 3) transformation (the ability to combine, convert and recodify it), and 4) exploitation (the ability to put it to productive use). Together, these four dimensions enable organisations to systematically identify, capture, interpret, share, re-frame, and re-codify new knowledge, to link it with their own existing knowledge base, and to put it to appropriate use, resulting in an improved ability to assimilate innovations [18], [29], [33]. Thus, an organisation's absorptive capacity is positively associated with adoption [18], [33], [34]. Accordingly, the following hypothesis is proposed:

H7: Absorptive capacity has a positive influence on eHealth adoption.

As opposed to an organisation's size and top management support, we do not expect absorptive capacity to (partially) influence organisational readiness. In contrast to the resources that are 'captured' by organisational readiness, absorptive capacity is seen as being of a different order that is not directly employable or controllable [29], [35], [36].

The above-mentioned concepts and relations, as well as the hypotheses concerned are presented in our conceptual model (see Figure 1).

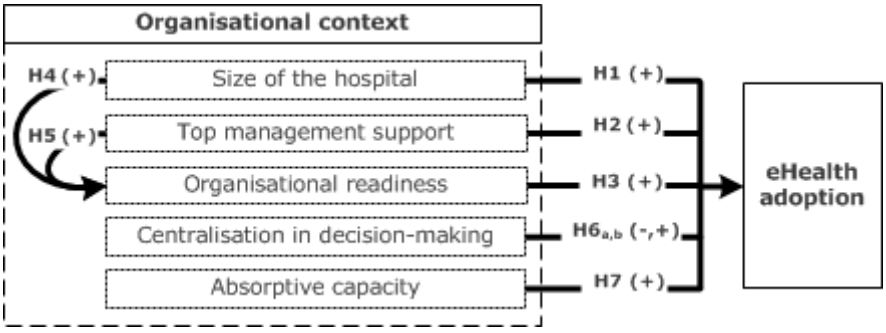


Figure 1. Conceptual model of eHealth adoption

Non-linear relationships

As argued by Kock [37], the vast majority of relationships between variables in both natural and behavioural change phenomena are non-linear and usually take the form of U-shaped or S-shaped curves. Likewise, the process of innovation typically is not linear [38]. In a linear system, the relationship between cause and effect is smooth and proportionate, whereas non-linearity underscores the observation that effects or responses are disproportionate to their causes. For instance, Gulati [39] suggests that the relationship between innovation and organisational slack is curvilinear, or inverse U-shaped. Similarly, Rogers [16] noted that the relationships of socioeconomic status (and perhaps other independent variables) with innovativeness should not be assumed to be linear. Consequently, addressing a non-linear model will more complete and provide more differentiated insights into the phenomena under study [40]. Therefore, we use an

unique modelling software in computing non-linear relationships between some of the above mentioned factors.

4. Methodological aspects of the study

Given the purpose and research questions, the study is of quantitative nature and adopts a survey research design. Below we discuss the collection of data as well as measurement issues.

4.1. Sample

Data were collected by means of a survey questionnaire sent to all relevant hospitals (85) in the Netherlands and a secondary source, the last to collect data regarding hospital size and type. Online questionnaires were distributed to one CIO or top-level ICT manager at each hospital, in the period from June 15th to August 25th 2014. The initial response rate was 68% resulting in a first dataset of 58 unique (based on IP-address) responses. Next, after deleting incomplete responses list-wise, 30 valid responses (35% of the population) remained as the base of our empirical study. A check of representativeness learned that our sample is representative for the entire population of general and academic hospitals with respect to the hospital type, size and annual turnover (see Appendix A).

4.2. Measurement instrument

There was no readily available measurement instrument that could be used for the purpose of this study, therefore, we developed one derived from theory and several existing surveys in the literature [23], [41]–[48]. Our measurement instrument was designed to be comprehensive in covering all constructs of the conceptual model as well as relatively easy to answer for Chief Information Officers (CIO) or top-level ICT managers of hospitals. The measurement instrument in its first design was discussed and evaluated by an expert group consisting of two experts at Delft University of Technology (innovation and ICT) and two healthcare consultants, also an interview with a health information systems (HIS) specialist and field testing in a hospital was performed. The remaining subsection describes how the variables were operationalized in the measurement model. The measurement model defines the relations between the latent variables (constructs) and the observed indicators (manifest variables or items) [49].

Dependent variable and independent variables

The dependent variable, eHealth adoption, was measured as a compound indicator reflecting the degree of adoption of three eHealth applications, namely, telemonitoring in heart failure, telemonitoring in diabetes, and online access to Electronic Health Record (EHR) using an eight-point scale corresponding to the stages of the innovation adoption process (see Table 1) [50]. We have put emphasis on telemonitoring as this broad application has received priority in adoption policy by the Netherlands government.

With regard to independent variables, the constructs were reflectively measured in the sense that the observed indicators are assumed to be the reflex of the latent variables, except for the construct of organisational readiness, which was formatively measured, the last meaning that the observed indicators are assumed to cause or form the latent variables [49]. As Appendix B indicates, each construct was measured by two to five corresponding indicators. With the exception of IT budget, respondents were asked to indicate whether the statements were applicable to the situation within their organisation, using a Likert seven-point scale (strongly disagree – strongly agree). For instance, the question was posed to what extent top management encourages the use of eHealth in the organisation. Aside from predefined scaling questions, one open question was posed, namely about most important barriers to eHealth adoption, which was answered if the respondent wanted to put emphasis on the problematic character of adoption.

4.3 Partial Least Squares – Structural Equation Modelling

The measurement model and structural model were tested using a Partial Least Squares – Structural Equation Modelling (PLS-SEM) approach through WarpPLS4.0 [37]. The choice for PLS-SEM through WarpPLS is justified on three counts. First, PLS-SEM can accommodate both reflective and formative measurements easily, compared to covariance structural analysis. Second, PLS-SEM does not require any a priori distributional assumptions and a relatively small sample size is acceptable. Third, WarpPLS is unique among SEM software in computing nonlinear relationships between constructs [37], [49]. In addition, mediation effects are assessed by using Baron and Kenny's (1986) criterion. As suggested by Kock (2013), the "Stable" method for p-value estimation is employed, as resampling methods (such as bootstrapping and jack-knifing) tend to yield unstable standard errors at very small sample sizes. Furthermore, all hypotheses are tested using one-tailed t-tests since all of them are forwarded as one-directional [52].

5. Results: eHealth adoption and model assessment

We provide a detailed picture of the current level of organisational adoption of eHealth by Dutch hospitals in terms of various stages of the adoption process and the factors that influence differences in this pattern. We discuss the following applications: telemonitoring in heart failure, telemonitoring in diabetes, and online access to Electronic Health Record (EHR).

5.1. eHealth adoption

Figure 2 shows the degree of adoption per eHealth application in Dutch hospitals according to the stages of organisational innovation adoption. Overall, we observe the trend of high levels of interest in all three applications (about 60%) but limited to very limited adoption, as indicated by 7 to 23%, spanning the stages of adoption to full use. Specifically, 23% of the hospitals have adopted telemonitoring in heart failure, 7% have adopted telemonitoring in diabetes, and 23% have adopted online access to EHR. Even fewer hospitals tend make actual use of the three applications (3-20%, spanning the stages of acceptance to full use), namely, telemonitoring in heart failure is used by 20%, telemonitoring in diabetes only by 3%, and online access to EHR by 13% of the hospitals.

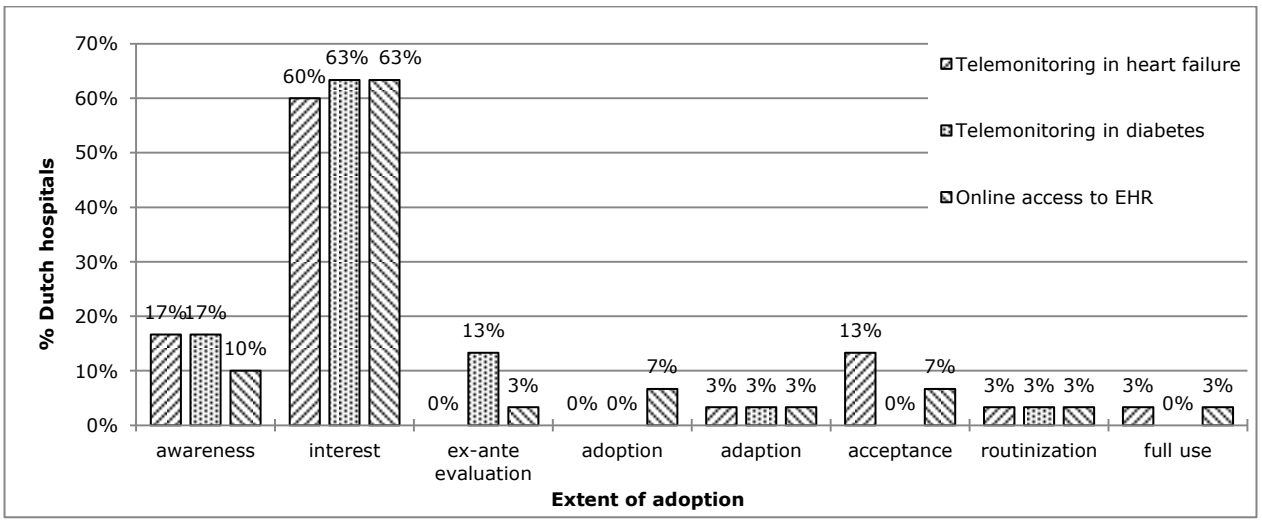


Figure 2. Extent of adoption per eHealth application (N=30)

5.2. Measurement model assessment

In this section we evaluate whether the constructs that we have designed are sufficiently adequate. To assess the measurement model or model constructs, it is necessary to distinguish between reflective and formative models as they require a different assessment [53], [54]. The

measurement model is first tested with regard to reliability, convergent validity and discriminant validity for its reflective measures such as [centralisation] and [top management support]. Results in Appendix B show that indicator reliability is acceptable, with all constructs' items loading at a significant level (.05) and a loading higher than .7, except for IT infrastructure (lowest item loading .643). However, values as low as .5 are acceptable for initial construct development [54]. Furthermore, internal consistency reliability is acceptable, with composite reliability measures exceeding .6 for all constructs. Moreover, convergent validity is acceptable, as item factor loadings are significant ($p<.001$) and the Average Variance Extracted (AVE) exceeds the recommended cut-off of .5 for all constructs [55].

Secondly, the measurement model was tested with regard to indicator validity and discriminant validity for its formative measures such as organisational readiness. Results in Appendix B show that indicator validity is acceptable as the indicator weight's significance exceeds the .05 significance level for all formative constructs [54]. Moreover, indicator validity is confirmed as the VIF values are below 3.3 [49], [56]. Discriminant validity is assessed by testing the inter-construct correlations between formative constructs and all other constructs as well. And finally, discriminant validity is acceptable, with inter-correlations of less than .7 for all constructs [57].

Table 2 provides descriptive statistics of the constructs used in the analysis. Constructs (except for hospital's size and financial readiness) are calculated as the average sum of the items included. Overall, we observe a rather similar variance among the constructs, except for hospital's size and financial readiness, with an average of 1.3.

Table 2. Descriptive statistics of model constructs

Construct	Mean	S.D.	Min	Max
eHealth adoption	2.66	1.23	1.00	6.33
Size of hospital (nr. of beds log-transformed)	508.93	235.88	196	1042
Top management support	2.89	1.31	1.00	5.60
Organisational readiness:				
- IT infrastructure	4.27	1.43	1.00	7.00
- IT human resources	2.67	1.24	1.00	5.50
- IT governance	5.18	1.50	1.67	7.00
- IT security	4.10	1.23	2.00	6.33
- Financial readiness (hospital's IT budget, log-transformed, x1000 Euro)	6838	4105	1500	15000
Centralisation in decision-making	5.08	1.20	2.50	7.00
Absorptive capacity	4.01	1.18	1.80	6.20

5.3. Structural model assessment

To answer the second research question, addressing influences on the adoption process, the factors mentioned in the conceptual model are evaluated by considering the amount of variance explained and the path coefficients including their significance. Figure 3 presents the standardised path coefficients, their significance, and the amount of variance explained (R^2). The model's R^2 of .463 indicates that the model explains a fair amount of variance for eHealth adoption by hospitals [49] and this is mainly due to the hospital's size, organisational readiness, and top management support.

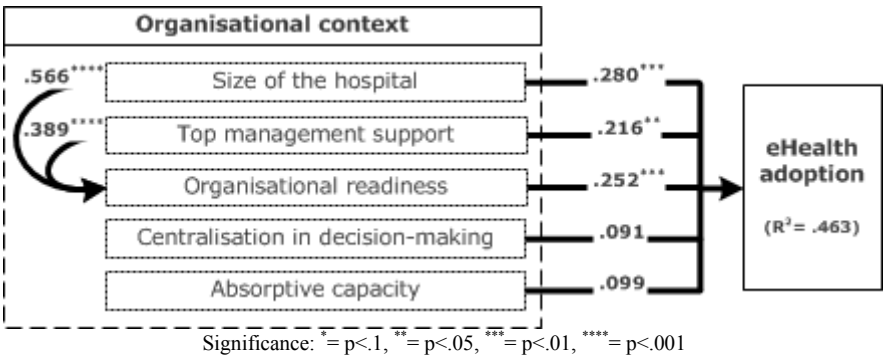


Figure 3. Structural model and path coefficients

In addition, significant paths from hospital size to organisational readiness (ß=.566, p-value=<.001, f^2=.368) and top management support to organisational readiness (ß=.389, p-value=<.001, f^2=.200) indicate mediating effects. The significance of these effects is tested by using Baron and Kenny's [51] criteria, and found to be significant. However, different from our assumptions, the coefficients of centralisation in decision-making and absorptive capacity are found to be not significant.

5.4. Hypotheses testing

The model outcomes partially support our hypotheses (see Table 3). To begin with hospital's size (H1), our results are consistent with Diffusion of Innovations (DOI) theory that suggests that a greater organisational size is positively related to an organisation's propensity to adopt any innovation [16], [30]. Further, the extent of eHealth adoption is found to be larger where top management support is stronger (H2). This finding is consistent with prior organisational innovation studies in which top management support is one of the three best predictors [30].

Also, organisational readiness (H3) is found to be significantly influencing the adoption of eHealth, which is consistent with literature suggesting that organisations that are more ready in terms of available resources, are more likely to successfully adopt innovation [16], [17]. In more detail, the trends in our study confirm the positive influence of technological and financial readiness on organisational readiness, as proposed by Iacovou et al. [26]. It appears that technological readiness, encompassing IT infrastructure and IT human resources, has been successfully extended with IT governance and IT security in the current study. As expected, the four dimensions tend to determine an organisation's technological readiness to adopt eHealth in which the IT infrastructure establishes a platform on which eHealth can be build, IT human resources provide the knowledge, skills and support to implement eHealth, IT governance ensures the alignment of IT with organisation goals, and IT security ensures an adequate level of security of the information flows in the use of eHealth, particularly between medical specialists and patients. These results comply with results on trends derived from in-depth questions, namely, indicating that technical issues and a lack of financial resources are among the four most important barriers to eHealth adoption (see Figure 4).

With regard to intermediating influences, we observe the following trends. A significant relation between size and organisational readiness is found and this is consistent with the idea that a larger organisation posits a greater slack in resources (H4), like a larger budget or more employees, which can be allocated to the adoption of an innovation [31]. Also, a positive effect of top management support on organisational readiness is found (H5), which is consistent with the theoretical idea that top management support ensures the allocation of required resources for the implementation of an innovation.

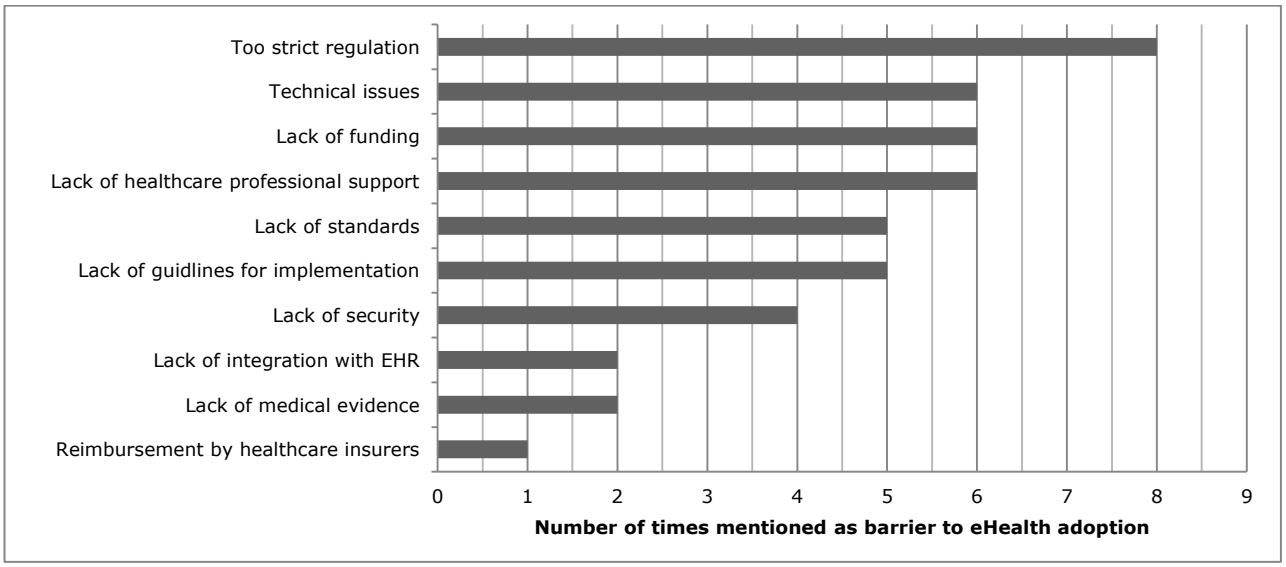
Different from our assumptions, centralisation in decision-making ($H6_a$ and $H6_b$) and absorptive capacity of the organisation (H7) are not found to significantly influence organisational eHealth adoption. With regard to centralisation, the results cannot confirm either of the two hypotheses. However, the results tend to be more in support of (yet not significantly) the hypothesis that centralisation is negatively associated with innovativeness [16], [18]. A negative tendency may be understood by the finding that many Dutch hospitals are currently positioned in the pre-adoption phase and that - due to recent the system reform – only small financial room can be made available for experimentation and trial and error. And finally, a larger absorptive capacity appears not to be associated with a greater extent of eHealth adoption at a significant level. However, there is a weak trend of a positive relationship. A lack of strength of the influence may be understood by the generic character of absorptive capacity and (still) a short in specific absorptive capacity concerning eHealth. On the other hand, absorptive capacity tends to work differently according to specific circumstances and it is difficult to measure in a direct way [29], [35], [36].

Table 3. Overview of testing results

Hypotheses		
H1	Size of the hospital has a positive influence on eHealth adoption.	Supported***
H2	Top management support has a positive influence on eHealth adoption.	Supported**
H3	Organisational readiness has a positive influence on eHealth adoption.	Supported***
H4	Size of the hospital has a positive influence on organisational readiness.	Supported****
H5	Top management support has a positive influence on organisational readiness.	Supported****
$H6_a$	Centralisation in decision-making has a negative influence on eHealth adoption.	Not supported
$H6_b$	Centralisation in decision-making has a positive influence on eHealth adoption.	Not supported
H7	Absorptive capacity has a positive influence on eHealth adoption.	Not supported

Significance: * = p<.1, ** = p<.05, *** = p<.01, **** = p<.001

Figure 4. Indicative barriers experienced in eHealth implementation



5.5 Non-linear relationships

The straightforward interpretation of the hypotheses in the previous section, however, requires some nuance as we may also observe some non-linear relationships between constructs taking the form of various types of S-curves, as illustrated by the relation between top management support and organizational readiness (see Figure 5). Although top management support positively influences organisational readiness, this effect tends to become quickly saturated with higher levels of top management support. As previously indicated, curves like these are a common result in investigations of both natural and behavioural change phenomena, in particular including learning [37]. Yet, there might also be a more specific clarification and this is concerned with the different stages of eHealth adoption (see Table 1) as follows. It seems that there is a typical stage in eHealth adoption, in which not only increasing top management support does not matter but most probably many other internal influences have no impact anymore. The stages that seem to be subject to such a situation are the ones following high levels of interest and commitment in which *external* influences, like regulation barriers, tend to become dominant. Overall, R^2 of the non-linear model turns out to be higher compared to the same but linear model, 0.463 versus 0.349.

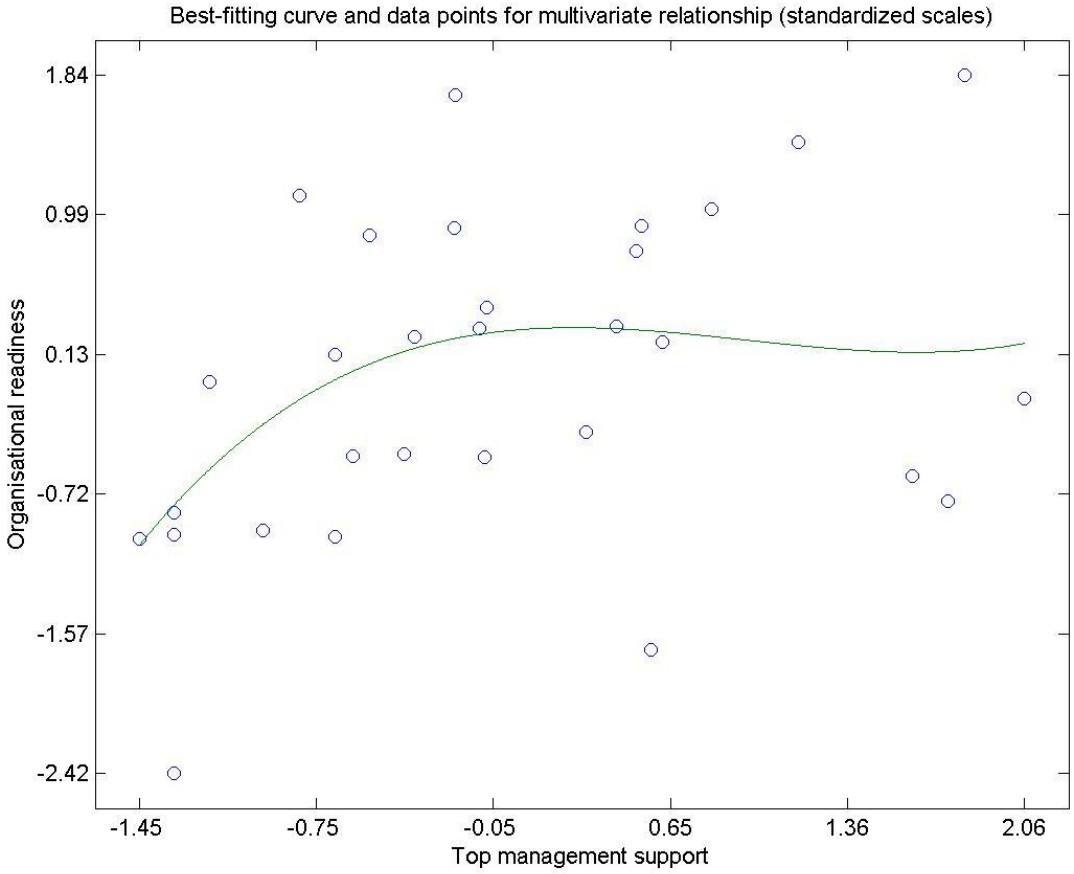


Figure 5. Relationship between top management support and organisational readiness

6. Discussion and conclusion

The aim of this paper was to provide a better understanding of the organisational adoption of eHealth among hospitals. To that purpose, the following questions were addressed: What is the extent of organisational adoption of eHealth by hospitals in terms of different stages? What are the factors in the organisational context that influence differences in adoption and is there a trend

of non-linearity in that influence? The Netherlands served as a case study of a country with a high general e-Health profile and one of the best healthcare systems in the world. The database used consisted of 30 representative academic and general hospitals.

The adoption of e-Health in hospitals in the Netherlands tends to stagnate in the stage of interest and commitment with few hospitals progressing towards adoption in reality. Five factors in the organisational context were identified that potentially influence this pattern: size of the hospital, top management support, organisational readiness, centralisation in decision-making, and absorptive capacity. Among these factors, hospital size, top management support, and organisational readiness were found to be significantly influencing eHealth adoption.

This study makes several contributions to existing literature on organisational innovation adoption. First of all, the empirical study provides an increased understanding of organisational innovation adoption in general with the hospitals as a "case" within the broader adoption domain, as it found that several factors tend to contribute to the organisational adoption of eHealth in a hospital setting. In particular, it provides clear evidence for the applicability of the Technological-Organisational-Environmental (TOE) framework in the domain of eHealth as we have found significant relationships between several existing TOE framework factors. Second, different from the literature that usually examines IT innovation adoption in terms of adoption versus non-adoption [30], [50], this study also took into account the pre-adoption and post-adoption stages as suggested by Fichman (2001). Specifically, we distinguished in the initiation stage between sub-stages of awareness, interest and ex-ante evaluation, in order to better understand the initiation stage. This adjustment has proven to be useful since the eHealth adoption by Dutch hospitals was largely concentrated in the early stages of the adoption process, at the level of 60 to 63% in the stage of interest and commitment. Furthermore, in terms of developing new indicators for measurement, we extended the construct of organisational readiness with IT governance and IT security that were found to significantly contribute to organisational readiness. This attention for IT governance and IT security thus contributed to a better understanding. Finally, in terms of new methods used, this study has been one of the early studies employing Partial Least Squares-Structural Equation Modelling (PLS-SEM) for analysing organisational adoption and fits well in the trend of an increased popularity and analytical support from PLS-SEM in IS research [53], [58]. In addition, the use of WarpPLS allowed for analysing non-linear relationships which matches the usual non-linear nature of behavioural phenomena, and the results of this study tended to confirm such relationships.

This study provided various trends and practical insights on eHealth adoption by hospitals, that can be used in the design of practical guidelines and strategies by decision-makers. For example, larger hospital size is associated with higher levels of eHealth adoption, mainly due to larger budgets and more personnel available. That budgets in smaller hospitals tend to be problematic matches with the lack of financial resources as forwarded as a relatively important barrier in this study. After years of efficiency increase, hospitals in the Netherlands – particularly smaller ones - may not have sufficient financial capability and time available to 'experiment' and learn from some 'trial and error' in the first adoption stage [10], while high costs of system maintenance later on after implementation may cause serious reluctance to move on. Therefore, smaller hospitals preferably identify ways in which their limited resources can be extended and more efficiently used, e.g. through applying for government support – zero-interest programs or revolving loans - and through sharing of and collaborating with other hospitals in use of systems and maintenance services, and of external advisors and vendors. In addition, a stronger recognition of the important role of organisational readiness can stimulate decision-makers in hospitals to pay more attention to training, including teaching about eHealth system features, customize the technology for each particular speciality and help specialists to integrate the system into their medical practice workflow. For example, real time trouble shouting as an online

feedback mechanism preferably provided by internal IT staff of the hospital, may also prevent barriers in using the new technology. Overall, eHealth is not a matter of 'plug and play'. On the one hand, the technical infrastructure must be adequate to function as a foundation on which eHealth can be build, on the other, sufficient support, including training and trouble-shooting, must be available to health professionals to make valuable use of eHealth [6]. If health professionals are not convinced of positive impacts of eHealth on their daily working routines and quality, the adoption of eHealth may well remain limited.

As always, the study has some limitations, which in turn, suggest some future research lines. First of all, the empirical study was conducted among hospitals in the Netherlands. Consequently, a transfer of this study's results to any other national or global contexts should consider the potential differences resulting from varying cultural, legal (regulation), and economic setting [58]. In response to this situation, it would be interesting to conduct a cross-country study and evaluate differences in relationships between innovation adoption factors and extent of eHealth adoption, thereby providing a better understanding of the differences in eHealth adoption within the EU, with northern Europe witnessing a relatively high level [8]. Second, due to time constraints we have collected most data from a single respondent from each hospital surveyed. Although the results may not fully capture the perceptions of the entire organisation, the respondents were critical decision makers in the adoption process who are familiar with eHealth and related concepts within their organisations such that their responses can be seen as sufficiently representative. However, it would be interesting to include the practical side of the healthcare professionals in the study. In this way, a multi-level model can be constructed including the CIO, as well as the healthcare professionals and patients as intended users. Third, as this study's focus was on the organisational context of adoption, it excluded possible influences from the technological and environmental system contexts. However, it would be interesting to include them in future research, especially because we identified "too strict regulation" as an important background barrier to eHealth adoption. Fourth, as this is one of the early studies employing Partial-Least-Squares Structural Equation Modelling in analysing the organisational adoption, future research should further explore the possibilities of this modelling, particularly in studies with a small population of interest. Finally, because the study is of cross-sectional nature, it is not possible to analyse how patterns of organisational adoption change over time providing a limited view on causal effects. Hence, in future studies, it would be interesting to examine on the basis of longitudinal data how the impact of various factors on the organisational adoption of eHealth change over time and are different in various stages, creating a better picture of causal relations and barriers.

Acknowledgement
We kindly acknowledge EY Advisory in The Hague, the Netherlands, for the internship offered to the first author of this study, including collaboration in the data collection. However, the two authors remain responsible for the content of the paper.

Appendix

A. Representativeness of the sample

A Chi^2-test has been performed to test whether the sample composition is representative for the entire population, indicating that there is no reason for concern. A p-value of .608 indicates that the composition of the sample is equal to the real population. In addition, two one-sample t-tests have been performed on the variables [size of the hospital] and [annual turnover] to assess the whether the sample means are representative for the real population means. The results indicate no difference in mean between the sample and the real population (p-value=.934 for [size of the hospital] and p-value=.707 for [annual turnover]).

B. Design and testing of constructs

Measurement of constructs

Construct	Operationalization (items)
Size of the hospital (R)	The number of beds (log-transformed).
Top management support and commitment (R)	The management rewards staff for eHealth innovation and creativity.
	The management strongly encourages the use of eHealth.
	The management provides adequate resources (time and money) available for eHealth.
	The Board has developed a vision on eHealth.
	Evaluation between the management and medical professionals about eHealth impact takes place on a regular basis.
Organisational readiness (F)	A higher level formative construct consisting of two dimensions: 1) Technological readiness and 2) Financial readiness. (see below)
Technological readiness (F)	A higher level formative construct consisting of four dimensions: 1) IT infrastructure, 2) IT human resources (support), 3) IT governance, and 4) IT security. (see below)
IT infrastructure (within the hospital) (R)	The IT infrastructure is sufficient for eHealth.
	Wireless Internet is available for medical professionals, anywhere and anytime.
	Wireless Internet is available for patients, anywhere and anytime.
	The organisation facilitates the use of Bring Your Own Device (BYOD) by medical professionals.
IT human resources (support) (R)	When implementing an eHealth application the organisation will have sufficient supporting staff.
	When implementing an eHealth application the organisation will have sufficient support in training.
IT governance (R)	An IT strategy has been prepared and approved by the board.
	A short-term (1 to 2 years) vision concerning IT policy has been prepared.
	A long-term (5 years) vision concerning IT policy has been prepared.
IT security (R)	The organization uses DigiD.
	The organization meets all requirements of the NEN7513 (2010).
	The organization meets all requirements of the NEN7510 (2011).
Financial readiness (R)	The IT budget of the hospital (log-transformed).
Centralisation in decision-making (R)	The management of the organization is highly decentralized (reversed).
	Decisions on the implementation of new IT are taken in a centralised way.

Absorptive capacity (R)	Your organization is well capable to identify new eHealth applications.
	Seeking new eHealth opportunities is an everyday activity in your organization.
	The organization regularly visits meetings to acquire new knowledge about eHealth.
	In the organization there is a good communication between medical professionals and IT professionals.
	The organization constantly considers how new IT knowledge can be better utilized.

R=Reflective measure; F=Formative measure

Reflective measurement validity

Construct	Item loading	AVE	CR
Top management support	.832****	.716	.926
	.804****		
	.892****		
	.867****		
	.832****		
IT infrastructure	.643****	.626	.867
	.928****		
	.897****		
	.652****		
IT human resources	.962****	.926	.962
	.962****		
IT governance	.815****	.764	.906
	.904****		
	.900****		
IT security	.752****	.610	.823
	.728****		
	.856****		
Centralisation	.889****	.791	.883
	.889****		
Absorptive capacity	.850****	.653	.904
	.810****		
	.781****		
	.739****		
	.855****		

Significance: *= p<.1, **= p<.05, ***= p<.01, ****= p<.001; AVE=Average Variance Extracted; CR=Composite Reliability

Formative measurement model validity

Indicator	Weight	VIF
Second order formative construct (Technological readiness)		
IT infrastructure	.341****	1.023
IT human resources	.362****	1.023
IT governance	.409****	1.023
IT security	.433****	1.023
Third order formative construct (Organisational readiness)		
Technological readiness	.659****	1.023
Financial readiness	.659****	1.023

Significance: *= p<.1, **= p<.05, ***= p<.01, ****= p<.001; VIF=Variance Inflation Factor

Discriminant validity

Construct	eHA	SIZE	TMS	OR	CE	ACAP
eHealth adoption (eHA)	**1.000**					
Size (SIZE)	.521***	**1.000**				
Top management support (TMS)	.342*	.200	**.846**			
Organisational readiness (OR)	.526***	.582****	.355*	**.758**		
Centralisation (CE)	.060	-.167	.249	.045	**.889**	
Absorptive capacity (ACAP)	.303	.137	.702****	.346*	.078	**.808**

Significance: *= p<.1, **= p<.05, ***= p<.01, ****= p<.001; Square roots of average variances extracted (AVEs) shown on diagonal

References

[1] C. Van Ewijk, A. Van Der Horst, and P. Besseling, “The future of health care,” The Hague, 2013.

[2] European Commission, “eHealth Action Plan 2012-2020 - Innovative healthcare for the 21st century,” Brussels, 2012.

[3] M. van Rooijen, R. Goedvolk, and T. Houwert, “A vision for the Dutch health care system in 2040: Towards a sustainable , high-quality health care system,” Amsterdam, 2013.

[4] L. Voorrips and O. van Hilten, “Gezondheid en zorg in cijfers 2014,” Statistics Netherlands, The Hague, 2014.

[5] N. Nijland, *Grounding EHealth*. Enschede: Gildeprint Drukkerijen B.V. Enschede, 2011.

[6] J. Krijgsman, J. Peeters, A. Burghouts, B. Brabers, J. de Jong, F. Beenkens, R. Friele, and L. van Gennip, “eHealth monitor 2014: Op naar meerwaarde,” NIVEL, The Hague, 2014.

[7] European Commission, “eHealth Benchmarking III,” 2011.

[8] R. Sabes-Figuera, “European Hospital Survey: Benchmarking Deployment of e-Health Services (2012–2013),” European Union, Luxembourg, 2013.

[9] A. Björnberg, “Euro Health Consumer Index 2014,” 2015.

[10] M. Van Ineveld, J. van Oostrom, R. Vermeulen, A. Steenhoek, and J. van de Klundert, “Productivity and quality of Dutch hospitals during system reform,” *Health Care Manag. Sci.*, pp. 1–12, 2015.

[11] J. Li, A. Talaei-Khoei, H. Seale, P. Ray, and C. R. Macintyre, “Health Care Provider Adoption of eHealth: Systematic Literature Review.,” *Interact. J. Med. Res.*, vol. 2, no. 1, p. e7, Jan. 2013.

[12] F. S. Mair, C. May, C. O’Donnell, T. Finch, F. Sullivan, and E. Murray, “Factors that promote or inhibit the implementation of e-health systems: an explanatory systematic review.,” *Bull. World Health Organ.*, vol. 90, no. 5, pp. 357–64, May 2012.

[13] T. R. Eng, “The eHealth landscape: a terrain map of emerging information and communication technologies in health and health care.” The Robert Wood Johnson Foundation, Princeton, 2001.

[14] T. Oliveira and M. Martins, “Literature review of information technology adoption models at firm level,” *Electron. J. Inf. Syst. Eval.*, vol. 14, no. 1, pp. 110–121, 2011.

[15] F. Damanpour and J. D. Wischnevsky, “Research on innovation in organizations: Distinguishing innovation-generating from innovation-adopting organizations,” *J. Eng. Manag.*, vol. 23, no. 2006, pp. 269–291, 2006.

[16] E. M. Rogers, *Diffusion of Innovations*, 4th ed. New York: Simon and Schuster, 1995.

[17] G. Robert, T. Greenhalgh, F. MacFarlane, and R. Peacock, “Organisational factors influencing technology adoption and assimilation in the NHS: a systematic literature review,” HMSO, London, 2009.

[18] R. G. Fichman, “The diffusion and assimilation of information technology innovations,” in *Framing the domains of IT management: Projecting the future through the past*, R. W. Zmud, Ed. Cincinnati: Pinnaflex Educational Resources, Inc., 2000, pp. 105–128.

[19] T. Greenhalgh, G. Robert, P. Bate, O. Kyriakidou, F. Macfarlane, and R. Peacock, “How to Spread Good Ideas: A systematic review of the literature on diffusion , dissemination and sustainability of innovations in health service delivery and organisation,” London, 2004.

[20] R. B. Cooper and R. W. Zmud, “Information technology implementation research: a technological diffusion approach,” *Manage. Sci.*, vol. 36, no. 2, pp. 123–139, 1990.

[21] R. G. Fichman and C. F. Kemerer, “The assimilation of software process innovations: An organizational learning perspective,” *Manage. Sci.*, vol. 43, no. 10, pp. 1345 – 1363, 1997.

[22] R. A. Wolfe, “Organisational Innovation: Review, Critique and Suggested Research Directions,” *J. Manag. Stud.*, vol. 31, no. 3, pp. 405–431, 1994.

[23] P. F. Hsu, K. L. Kraemer, and D. Dunkle, “Determinants of e-business use in US firms,” *Int. J. Electron. Commerse*, vol. 10, no. 4, pp. 9–45, 2006.

[24] L. G. Tornatzky, M. Fleischer, and A. K. Chakrabarti, *The processes of technological innovation*. Lexington Books, Lexington, 1990.

[25] Y. K. Dwivedi, M. R. Wade, and S. L. Schneberger, Eds., *Information Systems Theory: Explaining and Predicting Our Digital Society*. Springer Science and Business Media, New York, 2012.

[26] C. L. Iacovou, I. Benbasat, and A. S. Dexter, “Electronic data interchange and small organizations: adoption and impact of technology,” *MIS Q.*, vol. 19, no. 4, pp. 465–485, 1995.

[27] J. P. Glaser, *The Strategic Application of Information Technology in Health Care Organizations*, 2nd ed. John Wiley & Sons, San Francisco, 2002.

[28] N. Khatri, “Building IT capability in health-care organizations,” *Heal. Serv. Manag. Res.*, vol. 19, no. 2, pp. 73–79, 2006.

[29] S. S. A. Zahra and G. George, “Absorptive Capacity: A Review, Reconceptualization, and Extension,” *Acad. Manag. Rev.*, vol. 27, no. 2, pp. 185–203, 2002.

[30] A. Jeyaraj, J. W. Rottman, and M. C. Lacity, “A review of the predictors, linkages, and biases in IT innovation adoption research,” *J. Inf. Technol.*, vol. 21, no. 1, pp. 1–23, 2006.

[31] G. Premkumar, “A Meta-Analysis of Research on Information Technology Implementation in Small Business,” *J. Organ. Comput. Electron. Commer.*, vol. 13, no. 2, pp. 91–121, 2003.

[32] K. Zhu, K. Kraemer, and S. Xu, “The process of innovation assimilation by firms in different countries: a technology diffusion perspective on E- business,” *Manage. Sci.*, vol. 52, no. 10, pp. 1557–1576, 2006.

[33] W. Cohen and D. Levinthal, “Absorptive capacity: a new perspective on learning and innovation,” *Adm. Sci. Q.*, vol. 35, no. 1, pp. 128–152, 1990.

[34] R. T. Frambach and N. Schillewaert, “Organizational innovation adoption A multi-level framework of determinants and opportunities for future research,” *J. Bus. Res.*, vol. 55, no. 2002, pp. 163–176, 2002.

[35] N. Murovec and I. Prodan, “Absorptive capacity, its determinants, and influence on innovation output: Cross-cultural validation of the structural model,” *Technovation*, vol. 29, no. 12, pp. 859–872, 2009.

[36] T. Schmidt, “Absorptive capacity-one size fits all? A firm-level analysis of absorptive capacity for different kinds of knowledge,” *Manag. Decis. Econ.*, vol. 31, no. 1, pp. 1–18, 2010.

[37] N. Kock, *WarpPLS 4.0 User Manual*. 2013.

[38] A. H. van de Ven, D. E. Polley, R. Garud, and S. Venkataraman, *The Innovation Journey*. Oxford, New York: Oxford University Press, Inc., 2008.

[39] N. N. and R. Gulati, “Is Slack Good or Bad for Innovation?,” *Acad. Manag. J.*, vol. 39, no. 5, pp. 1245–1264, 1996.

[40] J. Brewster, “Studying Technology Adoption Behaviors with Linear or Non-Linear PLS: Does it Make a Difference?,” in *First International Conference on Engaged Management Scholarship*, 2011, pp. 1–27.

[41] B. Ramdani, P. Kawalek, and O. Lorenzo, “Predicting SMEs’ adoption of enterprise systems,” *J. Enterp. Inf. Manag.*, vol. 22, no. 1/2, pp. 10–24, 2009.

[42] T. C. Flatten, A. Engelen, S. a. Zahra, and M. Brettel, “A measure of absorptive capacity: Scale development and validation,” *Eur. Manag. J.*, vol. 29, no. 2, pp. 98–116, Apr. 2011.

[43] P. Ifinedo, “Internet/e-business technologies acceptance in Canada’s SMEs: an exploratory investigation,” *Internet Res.*, vol. 21, no. 3, pp. 255–281, 2011.

[44] X. Duan, H. Deng, and B. Corbitt, “What Drives the Adoption of Electronic Markets in Australian Small-and- Medium Sized Enterprises? – An Empirical Study,” in *Australasian Conference on Information Systems (23rd : 2012 : Geelong, Victoria)*, 2012.

[45] T. S. H. Teo and Y. Pian, “A Contingency Perspective on Internet Adoption and Competitive Advantage,” *Eur. J. Inf. Syst.*, vol. 12, no. 2, pp. 78–92, 2003.

[46] C. P. Armstrong and V. Sambamurthy, “Information Technology Assimilation in Firms: The Influence of Senior Leadership and IT Infrastructures,” *Inf. Syst. Res.*, vol. 10, no. 4, pp. 304–327, 1999.

[47] G. Cepeda-Carrion, J. Gabriel, and C. Navarro, “Improving the absorptive capacity through unlearning context: an empirical investigation in hospital-in- the-home units,” *Serv. Ind. J.*, vol. 32, no. 9, pp. 1551–1570, 2012.

[48] J. J. P. Jansen, F. a. J. Van Den Bosch, and H. W. Volberda, “Managing Potential and Realized Absorptive Capacity: How Do Organizational Antecedents Matter?,” *Acad. Manag. J.*, vol. 48, no. 6, pp. 999–1015, 2005.

[49] V. E. Vinzi, W. Chin, J. Henseler, and H. Wang, Eds., *Handbook of partial least squares: Concepts, methods and applications*. Heidelberg: Springer Science and Business Media, 2010.

[50] R. Fichman, “The Role of Aggregation in the Measurement of IT-Related Organizational Innovation,” *Mis Q.*, vol. 25, no. 4, pp. 427–455, 2001.

[51] R. M. Baron and D. a Kenny, “The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations,” *J. Pers. Soc. Psychol.*, vol. 51, no. 6, pp. 1173–82, 1986.

[52] N. Kock, “One-tailed or two-tailed P values in PLS-SEM?” TX: ScriptWarp Systems, Laredo, 2014.

[53] N. Urbach and F. Ahlemann, “Structural Equation Modeling in Information Systems Research Using Partial Least Squares,” *J. Inf. Technol. Theory Appl.*, vol. 11, no. 2, pp. 5–40, 2010.

[54] W. Chin, “The partial least squares approach to structural equation modeling,” in *Modern Methods for Business Research*, G. A. Marcoulides, Ed., Erlbaum, London, 1998, pp. 295–336.

[55] C. Fornell and D. Larcker, “Evaluating Structural Equation Models with Unobservable Variables and Measurement Error,” *J. Mark. Res.*, vol. 18, no. 1, pp. 39–50, 1981.

[56] J. F. Hair, C. M. Ringle, and M. Sarstedt, “Partial Least Squares Structural Equation Modeling: Rigorous Applications, Better Results and Higher Acceptance,” *Long Range Plann.*, vol. 46, no. 1–2, pp. 1–12, 2013.

[57] A. Diamantopoulos, P. Riefler, and K. P. Roth, “Advancing formative measurement models,” *J. Bus. Res.*, vol. 61, no. 12, pp. 1203–1218, 2008.

[58] D. Gefen and E. E. Rigdon, “An Update and Extension to SEM Guidelines for Administrative and Social Science Research,” *MIS Q.*, vol. 35, no. 2, pp. iii–xiv, 2011.