Factors influencing eHealth adoption by Dutch hospitals: An empirical study

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Abstract – **This study aims at understanding the factors influencing the organisational adoption of eHealth by Dutch hospitals. This study proposes a model for organisational eHealth adoption based on the Technological-Organisational-Environmental (TOE) framework and elements of the Diffusion of Innovations (DOI) theory. The following factors were identified and included in the model for examining their influence on organisational eHealth adoption: centralisation, size, organisational readiness, top management support, and absorptive capacity. A cross-sectional survey was developed and distributed to hospitals in the Netherlands. Data analysis was performed using the Partial Least Squares-Structural Equation Modelling (PLS-SEM) approach. The study's findings indicate that size, organisational readiness and top management support significantly influence the organisational adoption of eHealth by Dutch hospitals. The findings of this study can be used to derive organisational strategies or governmental policies to foster the organisational adoption of eHealth.**

Keywords: *eHealth, organisational innovation adoption, Technological-Organisational-Environmental (TOE) framework, healthcare, Diffusion of Innovations (DOI), Dutch hospitals*

1. Introduction

In a time in which the Dutch healthcare system has been put 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* – is seen as a promising solution in sustaining the Dutch healthcare system.

Nowadays, eHealth is gaining ground. At both European and national level, policy makers are convinced of the possibilities eHealth promises to offer in sustaining the healthcare system. It seems everything and everyone is ready to embed eHealth: "finances demand it, citizens expect it, and technology is ripe" [4]. Nevertheless, the ground is still weak. Recent studies point out that eHealth's potential is not fully deployed in hospitals across Europe, including Dutch hospitals [5], [6]. However, as a growing number of eHealth technologies are becoming available in cure, hospitals need to come up with innovation strategies to successfully introduce eHealth in their organisations [7]. To do so, more insight is needed into the factors influencing the organisational adoption[1] of eHealth by Dutch hospitals.

This study aims to provide an understanding in the factors influencing the adoption of eHealth by Dutch hospitals by answering the following research question: *What are the relevant factors that influence the organisational adoption of eHealth by Dutch hospitals?*

[1] Organisational adoption is defined as the acceptance and incorporation of eHealth into an organisation's every day practice [11].

The remainder of this article is structured as follows: the next section provides the theoretical background of the study. In section 3, the conceptual model including its hypotheses will be presented. Section 4 describes the methodology of the study. The results of the analysis will be 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 and directions for future research.

2. Theoretical background

This section aims at providing an understanding in the concepts in the domain of eHealth and organisational innovation.

Information and Communication Technologies (ICT) are regarded as a promising source to put forward innovative solutions in order to sustain the Dutch healthcare system. The use of ICT in healthcare, nowadays, is often referred to as eHealth. In literature, eHealth is defined in a variety of ways. For the purpose of this study, the following (delineated) definition of eHealth is adopted [8]: *eHealth is the use of emerging 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.*

Organisational innovation have generally be defined as "the development (generation) and/or use (adoption) of new ideas or behaviours" [9], [10]. In line with this definition, Damanpour (2006) distinguished two dimensions of the organisational innovation process: 1) generation, and 2) adoption. This study will focus on the latter. Additionally, the idea or behaviour may pertain to a product, service, technology, system, or practice [9], [11] 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 an organisational population (i.e. an industry), or to the entire world [10]. For the purpose of this research, the following definition of innovation will be used [12]: *An eHealth application that is perceived as new by an adopting hospital organisation, discontinuous with previous practice and which is intentionally introduced and directed at improving health outcomes.*

Despite the fact that much has been written about the process of innovation adoption [13], there is little information concerning the process of innovation adoption in hospitals [14]. For the purpose of this study, the hospital innovation adoption process is largely drawn upon the *IT implementation model* of Cooper and Zmud (1990); an innovation adoption model that is most widely used in IT studies. The model has been slightly adjusted by dividing the initiation stage into awareness, interest and evaluation – consistent with the model of Fichman and Kemerer (1997) – in order to capture more detail in the pre-adoption stage. This study assumes that innovations typically move 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.

Table 1) Stages of organisational innovation adoption

Stage	Description
Aware	*Key decision makers are aware of the innovation.*
Interest	*The organisation is committed to actively learning more about the innovation.*
Evaluation	*The organisation as initiated 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 widely available for use in the organisation.*
Acceptance	*The innovation is employed in organisational work; members are committed to using the innovation.*
Routinization	*Usage of the innovation is encouraged as a normal activity in the organisation; the innovation is no longer perceived as something out of the ordinary.*
Infusion	*The innovation is used within the organisation to its fullest potential; in a comprehensive and sophisticated manner.*

Several theories and models on innovation adoption have been identified in the Information System (IS) literature and have been applied under different conditions [17]. At organisational level, *Diffusion of Innovation*

(DOI) and the *Technological-Organisational-Environmental (TOE) framework* are most widely used [18]. This study adopts the TOE framework and elements of the DOI theory in developing the conceptual model for the organisational adoption of eHealth by Dutch hospitals. Rogers' theory of Diffusion of Innovation (DOI) provides a fundamental theoretical base of innovation adoption research in many disciplines and has been a dominant theory used to examine organisational adoption of IS over the prior two decades [18], [19]. The TOE framework, as presented by Tornatzky and Fleischer (1990), extends the DOI theory by identifying three aspects of the organisation's context that influence the adoption of an innovation: the *technological context*, the *organisational context*, and the environmental context.

The TOE framework has been used successfully by IS researchers to understand key contextual elements that determine IT innovation adoption at the organisational level. This is also the case for Health Information Systems [13], [18].

3. Conceptual model and hypotheses

This study primarily focusses on the organisational context as this is the most relevant context to consider from a hospital CIO's perspective. Within the organisational context, the following factors have been included:

Centralisation

Centralisation refers to "the extent to which decision making authority is dispersed or concentrated in an organisation" [11]. In centralised decision-making the decision-making autonomy is centralised at the top of the organisation hierarchy (top-down), whereas in decentralised decision-making the decision-making authority is distributed throughout a larger group within the organisation (bottom-up). Centralisation has usually been found to be negatively associated with innovativeness; that is, the more power is concentrated in an organisation, the less innovative that organisation tends to be [11], [21], [22]. 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 [11], [13], [21]. In this study, the following hypothesis is proposed:

$H1_a$: Centralisation has a negative influence on eHealth adoption.

$H1_b$: Centralisation has a positive influence on eHealth adoption.

Size

Size refers to the size of the hospital organisation. DOI theory suggests that a greater organisational size has been most consistently related to an organisation's propensity to adopt any innovation [11]. Size is one of the best three predictors of IT adoption by organisations according to a literature review by Jeyaraj et al. (2006).This association of size and innovation adoption is typically explained as that larger organisations posits greater slack in resources and are therefore able to allocate greater organisational resources (i.e. financial, technical, and human resources) to the adoption an innovation [23]. Therefore, this study also assumes a link between size and organisational readiness (see next factor). In this study, the following hypotheses are proposed:

H2: Size has a positive influence on eHealth adoption.

H3: Size has a positive influence on organisational readiness.

Organisational readiness

From a resource-based perspective [13], organisation readiness has been defined as "the availability of the needed organisational resources for adoption" [25]. Implementing an innovation in organisation that is more *ready* is more likely to be successful [11], [22]. According to Iacovou et al., (1995), organisational readiness comprises two primary dimensions: *technological readiness* and *financial readiness*.

Technological readiness has been conceptually proposed by Kwon and Zmud (1987) and has been supported by a number of empirical studies on organisational IT innovation adoption [25], [27]. The technological readiness refers to the level of sophistication of IT usage and IT management, which reflects the level of requisite technological resources that the organisation possesses in order to adopt and

implement IT innovation. These technological resources include both tangible resources as well as intangible resources [25]. In this study, technological readiness comprises the following four dimensions: 1) IT infrastructure, 2) IT human resources (support), 3) IT governance, and 4) IT security. The latter two are developed and included in this study as part of technological readiness because it is expected to be an important concern in the adoption of eHealth applications.

Financial readiness refers to the level of financial resources available to an organisation to pay for the innovation adoption potential or expected expenditures [25]. In this study, the following hypothesis is proposed:

H4: Organisational readiness has a positive influence on eHealth adoption.

Top management support

Top management support and commitment refers to the extent of commitment and resource support given by the top management for adopting eHealth innovation and change in the organisation [28]. According to a recent IT adoption literature review by Jeyaraj et al. (2006), top management support is one of the three best predictors for IT innovation adoption by organisations. The positive influence of top management support on IT innovation adoption has been explained in two ways. First, top management support ensures that there is a commitment to resourcing the implementation of an innovation. Secondly, top management can stimulate change (or overcome resistance) by communicating and reinforcing values through an articulated vision for the organisation, and by that, play a crucial role in influencing other organisational members accepting an innovation [21], [23]. As the first explanation suggests, this study assumes a link from top management support to organisational readiness. In this study, the following hypotheses are proposed:

H5: Top management support has a positive influence on eHealth adoption.

H6: Top management support has a positive influence on organisational readiness.

Absorptive capacity

Absorptive capacity (often referred to as organisational learning ability) 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, they enable organisations to systematically identify, capture, interpret, share, re-frame, and re-codify new knowledge, to link it with its own existing knowledge base, and to put it to appropriate use, resulting in an improved ability to assimilate innovations [21], [29]–[31]. Thus, an organisation's absorptive capacity is positively associated with adoption [21], [22], [31], [32]. In this study, the following hypothesis is proposed:

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

The abovementioned factors identified from literature to influence the organisational adoption of eHealth by Dutch hospitals are conceptually presented in Figure 1.

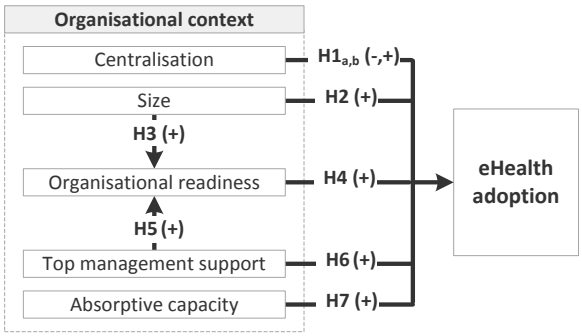


Figure 1) Conceptual model for organisational eHealth adoption

Non-linear relationships

As argued by Kock (2013), the vast majority of relationships between variables, in investigations of both natural and behavioural phenomena, are non-linear and usually take the form of U-shaped and S-shaped. Likewise, the process of innovation typically is not linear [34]. 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 [35], [36]. Consequently, although linear techniques have served researchers well, results obtained from a non-linear technique may be more complete or provide different insights into the phenomena under study [37].

4. Research method

Given the purpose and research questions of this study, this present study is of quantitative nature adopting a cross-sectional survey research design, using an online questionnaire.

4.1. Data collection

As there was no readily available measurement instrument that was entirely applicable for the purpose of this study, a measurement instrument was developed based on several existing surveys in literature. A questionnaire was designed that was comprehensible and easy to answer for Chief Information Officer (CIO) or top-level ICT manager of Dutch hospitals. It covered all constructs of the conceptual model for eHealth adoption. Consequently, the conceptual model was used as structuring instrument for the survey. Items for measuring the constructs are mainly adaptations of instruments used in prior IT innovation adoption studies.

The data used to test the conceptual model was collected using a cross-sectional survey questionnaire and a secondary source[2]. The questionnaire was used to collect most of the data, while a secondary data source was only used to collect data regarding hospital size and type. The online questionnaire was distributed to and collected from one CIO or top-level ICT manager at each hospital in the sample, from the 15th of June 2014 to the 25th of August 2014.

A total of 85 questionnaires were distributed to hospitals in the population with the request to get these filled in from a CIO or top-level ICT manager having knowledge of eHealth in the organisation. About 68% of these hospitals responded to the survey, resulting in an initial dataset containing a total of 58 unique (based on IP-address) responses. However, incomplete responses were deleted list-wise, resulting in a dataset of 30 usable responses (35% of the accessible population), as presented in Table 2. The sample is representative for the entire population of general and academic hospitals with respect to the hospital type, size and annual turnover.

Table 2) Composition of the sample

Type of hospital	Amount
Academic	N=2 (6.67%)
General, *of which:*	N=28 (93.33%)
STZ[3]	*N=10 (35.71%)*
SAZ[4]	*N=12 (42.86%)*
Other	*N=6 (21.43%)*
Total	**N=30 (100%)**

4.2. Operationalization of constructs

This subsection describes how the constructs were operationalised in the measurement model[5]. The measures were mainly adaptations of existing measures that were used in prior IT innovation adoption studies. The measurement instrument was evaluated by an expert group, a cognitive interview, and field testing.

Dependent variable: eHealth adoption

The dependent variable is measure as the sum of the standardized extent of adoption of three eHealth applications (telemonitoring in heart failure, telemonitoring in diabetes, and online access to Electronic Health Record) measured on an eight-point scale corresponding to the stages of the organisation innovation adoption process as described in section 2 [38]. Figure 2 shows the extent of adoption per eHealth application according to the stages of organisational innovation adoption process as described in section 2. It is notable that most hospitals (about 60%) show interest in all three eHealth applications, but did not take any further steps in adopting the innovation at this moment. Currently, 7 to 23% of the Dutch hospitals have adopted the three eHealth applications. Specifically, 23% of the Dutch hospitals have adopted telemonitoring in heart failure, 7% have adopted telemonitoring in diabetes, and 23% have adopted online access to EHR. Fewer hospitals make actual use of the three applications (3-20%). To illustrate,

[2] https://www.jaarverslagenzorg.nl/

[3] Samenwerkende topklinische opleidingsziekenhuizen

[4] Samenwerkende algemene ziekenhuizen

[5] The measurement model defines the relations between the latent variables (constructs) and the observed indicators (manifest variables or items) [39].

telemonitoring in heart failure is used by 20% of the Dutch hospitals, telemonitoring in diabetes is only used by 3%, and online access to EHR is used by 13% of the Dutch hospitals.

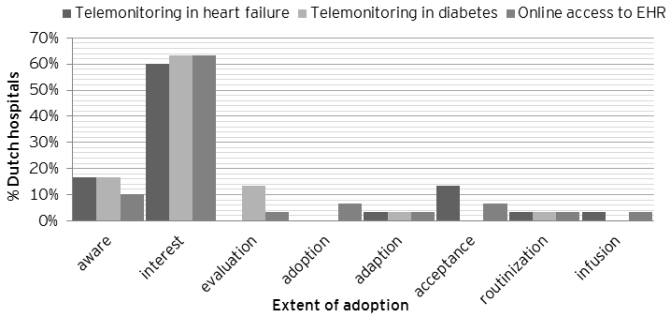


Figure 2) Extent of adoption per eHealth application (N=30)

Independent variable measures

Most of the constructs were reflectively measured, except from the construct organisational readiness, which was formatively measured[6]. The measures were mainly adaptations of existing measures that were used in prior IT innovation adoption studies. As Table 5 in the appendix indicates, each construct was measured by three to five corresponding indicators. For all measures, except the dependent variables and independent variable [IT_budget_t_1], respondents were asked to indicate whether the statements were applicable to the situation within their organisation, measured on a Likert seven-point scale (strongly disagree – strongly agree). Table 3 provide descriptive statistics of reflectively measured constructs used in the analysis.

Table 3) Descriptive statistics of model constructs

Construct	#	Mean	Std. deviation
eHealth adoption	3	2.66	1.23
Centralisation	2	5.08	1.20
Size	1	508.93	235.88
IT infrastructure	4	4.27	1.43
IT human resources	2	2.67	1.24
IT governance	3	5.18	1.50
IT security	3	4.10	1.23
Financial readiness	1	6838458.98	4104765.71
TMS[a]	5	2.89	1.31
Absorptive Capacity	5	4.01	1.18

#=number of items in Likert-scale; The average sum of the items was calculated for each construct; [a]Top Management Support

[6] In a reflective model the observed indicators are assumed to be the reflex of the latent variables, whereas in a formative model the observed indicators are assumed to cause or form the latent variables [39].

5. Data analysis and results

The measurement model and structural model were tested using a Partial Least Squares – Structural Equation Modelling (PLS-SEM) approach through WarpPLS4.0. The choice for PLS-SEM through WarpPLS was 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 [33], [39].

As for the last count, according to Kock (2011), the vast majority of relationships between variables, in investigations of both natural and behavioural phenomena, are non-linear and usually take the form of U-shaped and S-shaped. Therefore, the Warp3[7] PLS regression algorithm was selected in which the relationships between constructs take the form of S-curves; defaulting to U-curves or lines, if the relationship follow U-curve patters or are linear, respectively [33]. Mediation effects were assessed by using Baron & Kenny's (1986) criterion. As suggested by Kock (2013), the "Stable"[8] method for p-value estimation was employed, as resampling methods (such as bootstrapping and jack-knifing) tend to yield unstable standard errors at very small sample sizes. In addition, all hypotheses were tested using one-tailed t-tests since all hypotheses in this study are one-directional [42].

[7] The Warp3 algorithm, the default algorithm used by the software, tries to identify relationships among latent variables defined by functions whose first derivatives are U-curves. These types of relationships follow a pattern that is more similar to an S-curve (or a somewhat distorted S-curve). An S-curve can be seen as a combination of two connected U-curves, one of which is inverted. Examples of S-curve functions are the sigmoid, hyperbolic sine and hyperbolic tangent. The logistic function is a type of sigmoid function, and thus is also an example of S-curve function [33].

[8] With the "Stable" method, the software's default, p-values are calculated through nonlinear fitting of standard errors to empirical standard errors generated with the other resampling methods available. In other words, the stable method could be viewed as a quasi-parametric method that yields p-values that approximate the "average" p-values generated by the software's other resampling methods [33].

5.1. Measurement model assessment

To assess the measurement model, it is necessary to distinguish between reflective and formative models [43], [44]. The measurement model was first assessed for reliability, convergent validity and discriminant validity for its reflective measures. Secondly, the measurement model was assessed for indicator validity and discriminant validity for its formative measures.

Reflective measurement model assessment

Table 6 in the appendix shows that indicator reliability is acceptable, with all construct's items loading significant at the .05 level with a loading higher than .7, except for the construct IT infrastructure (lowest item loading .653). However, values as low as .5 are acceptable for initial construct development [44]. Furthermore, internal consistency reliability is acceptable, with composite reliability measures exceeding .6 and Cronbach's Alpha 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 .5 for all constructs [45].

Discriminant validity was assessed by comparing the square root of AVE for each construct to the correlation of that construct with other constructs. Table 7 in the appendix indicates that discriminant validity is acceptable, as the lowest square root of AVE (Organisational readiness) was higher than the highest correlation among all construct pairs [44], [45]. In addition, cross-loadings were assessed to ascertain discriminant validity. To confirm discriminant validity, the loading of each indicator is higher for its designated construct than for any other of the constructs, and each of the constructs loads highest with its own items [44]. Following this guideline, three items ([AC_4], [AC_6], [AC_7]) have been eliminated sequentially from the final measurement model as they had unacceptable cross-loadings on other constructs. Sequential elimination from the measurement model resulted in an acceptable discriminant validity for the final measurement.

Formative measurement model assessment

Following Henseler et al. (2009), the validity of formative constructs is assessed at two levels: the indicator level and the construct level.

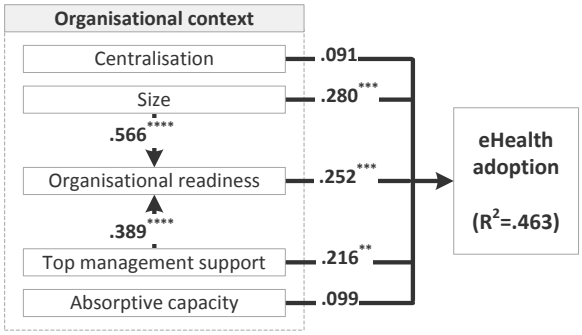
Table 7 in the appendix shows that indicator validity is acceptable as indicator weight's significance exceeds .05 significance level for all formative constructs [44]. Moreover, indicator validity is confirmed as the VIF values are below 3.3 [39], [47].

Discriminant validity is assessed by testing the inter-construct correlations between formative constructs and all other constructs as well. Table 8 in the appendix indicates that discriminant validity is acceptable, with inter-correlations of less than .7 for all constructs [48], [49].

5.2. Structural model assessment

The structural model was evaluated by assessing the amount variance explained and the path coefficients between constructs including their significance.

Figure 3 presents the final structural model, including standardised path coefficients, their significance, and the amount of variance explained (R^2). The model's R^2 of .463 demonstrates that the model explains a good amount of variance for eHealth adoption by Dutch hospitals [39]. As presented in Table 4, the final model partially supports the hypothesis of this study.



*Levels of significance: *p<.1, **p<.05, ***p<.01, ****p<.001*

Figure 3) Structural model with path coefficients

In addition, significant paths from hospital size to organisational readiness (β=.566, *p*-value=<.001, f^2=.368) and top management support to organisational readiness (β=.389, *p*-value=<.001, f^2=.200) indicates the presence of mediation. The significance of this mediating effect is tested by using Baron and Kenny's (1986) criteria, and found to be significant.

Since organisational readiness is a higher-level formative construct and has a significant positive association with eHealth adoption, the

weights of the sub constructs were examined to assess the significance of their impact on eHealth adoption. Although no formal hypotheses were proposed for the sub-constructs of organisational readiness, Table 8 in the appendix includes the weights of each sub-construct including their significance. Remarkably, technological and financial readiness equally determine organisational readiness to adopt eHealth significantly. Furthermore, technological readiness is formed by IT infrastructure, IT human resources (support), IT governance, and IT security. IT governance and IT security are the dominant factors in determining technological readiness as they posits higher weights than IT infrastructure and IT human resources (support).

The results from this study found non-linear relationships between constructs that take the form of S-curves. This non-linear relationship is not entirely surprising as the vast majority of relationships between variables, in investigations of both natural and behavioural phenomena, are non-linear and usually take the form of U-shaped and S-shaped (see section 2) [33].

5.3. Hypotheses testing

With respect to hospital size, the results from the analysis are consistent with Diffusion of Innovations (DOI) theory that suggests a greater organisational size has been most consistently related to an organisation's propensity to adopt any innovation [11], [24]. In addition, the significant association between size and organisational readiness is consistent with the theoretical explanation that a larger organisation posits a greater slack in resources which can be allocated to the adoption of an innovation [23].

Organisational readiness is found to be significantly influencing the organisational 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 [11], [12], [30]. Besides, the outcomes of the model measurement assessment confirmed the positive influence of technological and financial readiness on organisational readiness as proposed by Iacovou et al., (1995). Moreover, technological readiness, as conceptually proposed by Kwon and Zmud (1987) and supported by a number of empirical studies on IT innovation adoption [25], [27], has been successfully extended with IT governance and IT security. The four dimensions determine an organisation's technological readiness to adopt eHealth. 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 technologies.

The extent of eHealth adoption was found to be higher where top management support was higher. This finding is consistent with prior organisational innovation studies of which top management support was one of the three best predictors [24]. In addition, a positive effect of top management support on organisational readiness was found, which is consistent with the theoretical explanation that top management support ensures the allocation of requisite resources for the implementation of an innovation.

On the other hand, centralisation and absorptive capacity were not found to significant influence organisational eHealth adoption.

With regard to centralisation, the empirical results of this study could not confirm either of the two hypotheses. However, the results tend to be more in support of (yet not significantly) the hypothesis that centralisation has usually been found to be negatively associated with innovativeness [11], in contrast to other research suggesting that a greater centralisation may actually encourage the implementation of innovations, once the innovation decision has been made [11], [21].

Finally, the results of this study could not significantly support the hypothesis that a greater absorptive capacity is associated with a greater extent of eHealth adoption. However, the empirical results tend support this hypothesis as the relationship between absorptive capacity and the extent of eHealth adoption is positive, yet not significantly. This may be an implication of the small sample size, and it may be that a greater sample size would

have led to a significant positive relationship between the two constructs.

Table 4) Overview of hypotheses

Hypotheses		
H1 $_a$	*Centralisation has a negative influence on eHealth adoption.*	Not supported
H1 $_b$	*Centralisation has a positive influence on eHealth adoption.*	Not supported
H2	*Size has a positive influence on eHealth adoption.*	Supported ***
H3	*Size has a positive influence on organisational readiness.*	Supported ****
H4	*Organisational readiness has a positive influence on eHealth adoption.*	Supported ***
H5	*Top management support has a positive influence on eHealth adoption.*	Supported **
H6	*Top management support has a positive influence on organisational readiness.*	Supported ****
H7	*Absorptive capacity has a positive influence on eHealth adoption.*	Not supported

*Levels of significance: *p<.1, **p<.05, ***p<.01, ****p<.001*

6. Discussion and conclusion

The aim of this paper was to provide an understanding in the factors influencing the organisational adoption of eHealth by Dutch hospitals by answering the following research question: *What are the relevant factors that influence the adoption of eHealth by Dutch hospitals?*

6.1. Main findings

This study focuses on the organisational context influencing the organisational adoption of eHealth. The organisational context includes five factors that may influence organisational eHealth adoption by Dutch hospitals: centralisation, size, organisational readiness, top management support, and absorptive capacity. Among these factors, size, organisational readiness, and top management support have found to be significant influencing eHealth adoption by Dutch hospitals.

6.2. Theoretical implications

This study makes several contributions to existing literature on organisational innovation adoption. First of all, the *empirical* study of the organisational adoption of eHealth by Dutch hospital provides an increased understanding of organisational innovation adoption by hospital organisations and can be seen as a "case" within the broader organisational innovation adoption research domain. Second, this study provides evidence for the applicability of the TOE framework in the domain of eHealth. In addition, findings have shown the relevance of several existing TOE framework factors from literature in explaining the organisational adoption of eHealth by Dutch hospitals. Third, different than the literature that examined IT innovation adoption with an adoption versus non-adoption focus [24], [38], this study also take into account the pre-adoption and post-adoption stages of organisational innovation adoption process as suggested by Fichman (2001). Fourth, several constructs have been developed or extended, including eHealth adoption and organisational readiness. Finally, 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 increased popularity of PLS-SEM in IS research. In addition, the use of WarpPLS allowed for analysing non-linear relationships between organisational eHealth adoption and the factors influencing it which fits well with the usual non-linear nature of natural and behavioural phenomena.

6.3. Societal contributions

Prior to this study, there was little understanding in the factors influencing the organisational adoption of eHealth by Dutch hospitals. This study provides an understanding in the factors influencing the eHealth adoption based on theories and empirical results. With this understanding, practical guidelines can be derived for designing strategies geared towards enhancing the effectiveness and availability of those significant factors.

The empirical results of the survey revealed that a larger hospitals size is associated with higher levels of eHealth adoption, mainly explained in that larger hospitals posit greater slack resources that can be allocated to eHealth as compared to smaller hospitals. Therefore, smaller hospitals should find out existing obtainable external aid and incentives provided by government, advisors, vendors, and other hospitals, in adopting eHealth. Accordingly, governmental assistance policies (i.e. subsidies) may be needed for smaller hospitals to keep up with larger hospitals. In addition, smaller

hospitals are recommended to explore opportunities for (enhanced) collaboration with other hospitals in their region when implementing eHealth initiatives.

As was found in the survey, organisational readiness is important to the organisational adoption of eHealth. Organisational readiness is expressed in the availability of the requisite organisational resources for eHealth adoption. Having sufficient organisational resources is an important precondition for successful eHealth adoption. Therefore, hospital CIOs and management should pay great attention to the availability of the organisational resources (i.e. financial, technical, and human) needed for the implementation and sustained use of eHealth. To this end, CIOs and management should 1) be *aware* of the resources that a particular eHealth application requires, and 2) be *certain* that these requisite resources can be allocated, prior to adoption.

This study also found that top management support and commitment is imperative to organisational eHealth adoption. Therefore, top management should ensure the support and commitment that is needed for eHealth to be deployed successfully by ensuring that there is a commitment to resourcing the implementation of an eHealth application and stimulating change (and overcoming resistance) in the adoption of eHealth.

6.4. Limitations

It is important to evaluate the study's results and contributions in light of its limitations. Therefore, this section reflects on the study in terms of generalizability, methodological and theoretical limitations.

Two limitations have been identified concerning this study's generalizability. First of all, it has to be noted that all of the empirical studies were conducted with specific subjects (i.e. general and academic hospitals) from 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, and economic settings. In addition, as this study focused on cure, generalisations to healthcare institutions that are concerned with the provision of healthcare other than cure (i.e. care) should be treated with caution. Finally, this study assumes homogeneity of three eHealth applications that are used in the interaction between healthcare professional and patients by aggregating them into a composite score of eHealth adoption. As a result, this study fails to differentiate between factors that influence each of the applications. Besides, as only three eHealth applications in the interaction between healthcare professional and patient (primary process) are studied, caution is preferred when generalising the outcomes to eHealth applications other than included in this study or eHealth applications that are used in other contexts than the primary process.

Three methodological limitations have been identified for this study. First, all data were collected from a single respondent from each hospital surveyed. As a result, the analysis may not fully capture the perceptions of the entire organisation. Nevertheless, as the respondents were CIOs or top-level ICT managers, critical decision makers in the innovation adoption process who are familiar with eHealth and related concepts within their organisations, it is expected that their responses sufficiently represent their hospital organisations. Related to this limitation is that this study employed a self-report survey. As a result, respondents may inflate the benefits they perceive from eHealth implementation in order to protect the hospital image. Second, developing solid instruments is still an ongoing procedure of development, testing, and refinement [50]. Although reliability and validity were empirically tested in the data set, new or extended constructs, such as organisational readiness, could be further refined. Moreover, as this study's (measurement) model was modified to its fit to one sample, the generalizability of those modifications to other sample and to the population remains to be determined [51]. Finally, because the study is of cross-sectional nature, it is not possible to analyse how patterns of organisational adoption change over time. Hence, the empirical results only show that statistical relationships exist among organisational adoption of eHealth and factors. However, causal relationships can be derived from the theoretical arguments.

The following theoretical limitation has been identified for this study. This study did not include other factors that have been identified as potential influencers in organisational

adoption research. Besides, this study focussed only on the organisational context while the TOE framework suggest that the organisational adoption of eHealth is also influenced by the technological and environmental contexts including their factors which are not included in the final model of this study.

6.5. Future research

The abovementioned findings and limitations suggest some important directions for future research in the domain of organisational innovation adoption. First of all, it would be interesting to re-examine the relationships between factors and organisational eHealth adoption with a greater sample size for an improved statistical power and generalizability to the entire population. Second, it would be interesting to also test other factors that have not been included in this study. In addition, including the technological and environmental contexts in the model is believed to lead to richer results. Third, in response to this study's limited focus on the Dutch healthcare system it would be interesting to conduct the study cross-country and evaluate differences in relationships between factors and organisational eHealth adoption between countries in order to investigate whether or not this study framework can be generalized and the study's empirical findings are applicable in different healthcare industries. Fourth, in order to overcome the bias due to a single respondent it would be interesting to explore the possibility to include the healthcare professional in the study. In this way, a multi-level model can be constructed including the CIO as key decision maker and the healthcare professionals as intended users. It is suggested to add a new context into the organisational context of the TOE framework, including factors influencing individual innovation acceptance. Fifth, future research is needed to further refine the measurement instrument and to determine whether modifications to the measurement model are generalizable to the entire population. Sixth, as this is one of the early studies employing PLS-SEM in analysing the organisational adoption, future research should further explore the possibilities PLS-SEM has to offer particularly in this study's domain. Seventh, it would be interesting to examine how the impact of various contextual factors on the organisational adoption of eHealth changes over time. Future studies can gather longitudinal data to examine the causality and interrelationships between variables that are important to the organisational adoption of eHealth. Eight, this study provides a useful understanding in the organisational factors influencing the adoption of eHealth. From this understanding, strategies can be derived that aim at improving these factors. However, future research is needed to assess the effectiveness of different strategies in improving these factors. Finally, although the quantitative approach in this study has proved its value, future research utilizing a qualitative approach are also needed to help understand organisational eHealth adoption better. Especially, since eHealth is still in an early development stage, qualitative studies will help to generate ideas and concepts related to the context of eHealth adoption within organisations as well as qualitative research (i.e. interviews) may help in an enhanced interpretation of the findings from this study.

Appendix

Table 5) Operationalization of constructs

Construct	Operationalization (items)	Code	Sources
Centralisation (R)	De structuur van uw organisatie is in sterke mate gedecentraliseerd (reversed).	[CE_1_r]	[52], [53]
	Besluiten over het implementeren van nieuwe IT worden centraal genomen.	[CE_2]	
Size (R)	The number of beds[9], using a logarithmic transformation to adjust for curvilinearity.	[SIZE_t_1]	[30], [54]
Organisational readiness (F)	A higher level formative construct consisting of two dimensions: 1) Technological readiness and 2) Financial readiness. (see below)		[25], [55]–[58]

[9] https://www.jaarverslagenzorg.nl/

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)		[19], [25], [27], [58]–[60]
IT infrastructure (R)	De IT infrastructuur in uw organisatie is toereikend voor eHealth.	[IT_1]	[19], [25], [27], [58]–[60]
	Wireless Internet is overal te allen tijde beschikbaar binnen uw organisatie voor de medisch professionals.	[IT_2]	
	Wireless Internet is overal te allen tijde beschikbaar binnen uw organisatie voor patiënten.	[IT_3]	
	Uw organisatie faciliteert het gebruik van Bring Your Own Device (BYOD) door de medisch professionals.	[IT_4]	
IT human resources (support) (R)	Bij de implementatie van een eHealth toepassing beschikt uw organisatie over voldoende ondersteunend personeel.	[HR_1]	[19], [25], [27], [58]–[60]
	Bij de implementatie van een eHealth toepassing beschikt uw organisatie over voldoende ondersteuning op het gebied van training.	[HR_2]	
	In uw organisatie is een helpdesk aanwezig voor technische ondersteuning bij de implementatie en toepassing van eHealth.	[HR_3]	
IT governance (R)	IT Strategie is opgesteld en bekrachtigd door het bestuur.	[IG_1_t]	Self-developed
	Er is een korte termijn (1 à 2 jaar) visie met betrekking tot IT beleid opgesteld.	[IG_2_t]	
	Er is een lange termijn (5 jaar) visie met betrekking tot IT beleid opgesteld.	[IG_3]	
IT security (R)	Uw organisatie maakt gebruik van DigiD.	[SE_1]	Self-developed
	Uw organisatie voldoet aan alle eisen voor een Goed Beheerd Zorgsysteem.	[SE_2]	
	Uw organisatie voldoet aan alle eisen van de NEN7513 (2010).	[SE_3]	
	Uw organisatie voldoet aan alle eisen van de NEN7510 (2011).	[SE_4_t]	
Financial readiness (R)	The IT budget of the healthcare organisation, using a logarithmic transformation to adjust for curvilinearity.	[IT_BUDGET_t_1]	[61]
Top management support and commitment (R)	Het management beloont personeel voor eHealth innovatie en creativiteit.	[MS_1]	[23], [56], [62]–[64]
	Het management stimuleert sterk het gebruik van eHealth.	[MS_2]	
	Het management stelt voldoende middelen (tijd en geld) beschikbaar voor eHealth.	[MS_3]	
	Het bestuur heeft een visie ontwikkeld over eHealth.	[MS_4]	
	Evaluatie tussen het management en medisch professionals over de effecten van eHealth vindt plaats op regelmatige basis.	[MS_5]	
Absorptive capacity (R)	Uw organisatie is goed in staat nieuwe eHealth toepassingen te identificeren.	[AC_1]	[65]–[67]
	Het zoeken naar nieuwe eHealth mogelijkheden is een alledaagse bezigheid in uw organisatie.	[AC_2]	
	Uw organisatie bezoekt met enige regelmaat bijeenkomsten om nieuwe kennis over eHealth te verwerven.	[AC_3]	
	Medisch professionals worden regelmatig bijgeschoold en voorgelicht over nieuwe ontwikkelingen in eHealth.	[AC_4]	
	In uw organisatie is een goede communicatie tussen medische professionals en IT professionals.	[AC_5_t]	
	Uw organisatie kent goed georganiseerde communicatiekanalen voor het uitwisselen en delen van kennis en ideeën.	[AC_6]	
	Uw organisatie is in staat nieuwe eHealth kennis in te zetten voor het ontwikkelen van nieuwe (verbeterde) zorgdiensten.	[AC_7]	
	Uw organisatie gaat voortdurend na hoe nieuwe IT kennis beter benut kan worden.	[AC_8]	

Items in grey were removed from final measurement model, (R) = reflectively measured, (F) = formatively measured

Table 6) Reflective measurement validity

Construct	Item	Loading	AVE	CR	CA
Centralisation	CE_1_r	.889****	.791	.883	.736
	CE_2	.889****			
IT infrastructure	IT_1	.643****	.626	.867	.790
	IT_2	.928****			
	IT_3	.897****			
	IT_4	.652****			
IT human resources	HR_1	.962****	.926	.962	.920
	HR_2	.962****			
IT governance	IG_1_t	.815****	.764	.906	.844
	IG_2_t	.904****			
	IG_3	.900****			
IT security	SE_1	.752****	.610	.823	.677
	SE_3	.728****			
	SE_4_t	.856****			
Top management support	MS_1	.832****	.716	.926	.900
	MS_2	.804****			
	MS_3	.892****			
	MS_4	.867****			
	MS_5	.832****			
Absorptive capacity	AC_1	.850****	.653	.904	.866
	AC_2	.810****			
	AC_3	.781****			
	AC_5_t	.739****			
	AC_8	.855****			

*Levels of significance: *p<.1, **p<.05, ***p<.01, ****p<.001*

AVE=Average Variance Extracted, CR=Composite Reliability, CA=Cronbach's Alpha

Table 7) Discriminant validity

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

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

Table 8) Formative measurement model validity

Indicator	Technological readiness	Organisational readiness	SE	VIF	WLS	ES
Second order formative construct (Technological readiness)						
IT infrastructure	.341****		.096	1.023	1	.193
IT human resources	.362****		.096	1.023	1	.217
IT governance	.409****		.096	1.023	1	.278
IT security	.433****		.096	1.023	1	.311
Third order formative construct (Organisational readiness)						
Technological readiness		.659****	.096	1.023	1	.500
Financial readiness		.659****	.096	1.023	1	.500

*Levels of significance: *p<.1, **p<.05, ***p<.01, ****p<.001; SE=Standard Error; VIF=Variance Inflation Factor; WLS=Weight-Loading Sign (-1 = Simpson's paradox in I.v.); ES=Effect Size*

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