# Factors influencing eHealth adoption by Dutch hospitals

An empirical study

Building a better working world

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# Preface

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In this section I would like to take the opportunity to thank everyone that has in some way contributed in the completion of my Master of Science program Systems Engineering, Policy Analysis, and Management at the faculty of Technology, Policy and Management (TPM) at the Technological University of Delft.

First of all, I would like to thank my family, girlfriend and friends for their loving support in times I needed it the most. In particular I like to thank my dad for connecting me to various hospital organisations. Next, I would like to thank the faculty of TPM for giving me the opportunity to enrich myself in many different TPM-related fields. In particular I would like to thank Marina van Geenhuizen as a motivating first supervisor who challenged me to take things one step further. I also like to thank Mark de Reuver as a fantastic second supervisor with whom I felt very comfortable discussing several methodical issues of my thesis. Next I like to thank Marijn Janssen as for being my chair, but foremost I like to thank him for inspiring me in the field of ICT throughout the master's program. As I did my thesis at EY, I also would like to thank EY for this opportunity, and especially I would like to thank Maarten Muurling and Koen van Boggelen for being fantastic coaches throughout the execution of my thesis at EY. Finally, I like to thank all participating hospitals which made the execution of this study possible.

Sander Faber
Delft, 29-10-2014

# Summary

# Summary


## Research problem
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 (Ernst & Young, 2013a; European Commission, 2012; Ewijk, Horst, & Besseling, 2013; World Economic Forum, 2013), 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" (Nijland, 2011). 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 (European Commission, 2011; Krijgsman et al., 2013). 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 (de Veer, Fleuren, Bekkema, & Francke, 2011; Fleuren, Wiefferink, & Paulussen, 2004b). 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 of the organisational adoption of eHealth by identifying 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?*

## Theoretical background
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 (Eng, 2001): *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" (Damanpour & Wischnevsky, 2006; Zaltman, Duncan, & Holbek, 1973). In line with this definition, Damanpour (2006) distinguished two dimensions of the 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 (Cooper & Zmud, 1990; Rogers, 1995; Zaltman et al., 1973) 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 (Damanpour & Wischnevsky, 2006). For the purpose of this research, the following definition of innovation will be used (Robert, Greenhalgh, MacFarlane, & Peacock, 2009):


[1] Organisational adoption is defined as the acceptance and incorporation of eHealth into an organisation's every day practice (Rogers, 1995).

*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 (i.e. (Cooper & Zmud, 1990; Fichman & Kemerer, 1997; Frambach & Schillewaert, 2002; Gallivan, 2001; Kwon & Zmud, 1987a; Meyer & Goes, 1988; Rogers, 1995; Tornatzky, Fleischer, & Chakrabarti, 1990; Zaltman et al., 1973; K. Zhu, Kraemer, & Xu, 2006)), there is little information concerning the process of innovation in hospitals (Omachonu & Einspruch, 2010). For the purpose of this study, the hospital innovation adoption process is largely drawn upon the *IT implementation model* of Cooper and Zmud (1990) and the model of Fichman and Kemerer (1997). 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 (the adoption decision). |
| 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 (Wolfe, 1994). At organisational level, *Diffusion of Innovation* (DOI) and the *Technological-Organisational-Environmental (TOE) framework* are most widely used (Oliveira, Martins, & Lisboa, 2011). This study adopts the TOE framework and elements of the DOI theory in developing the conceptual model for the 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 (Hsu, Kraemer, & Dunkle, 2006) and has been a dominant theory used to examine organisational adoption of IS over the prior two decades (Hsu et al., 2006; Oliveira et al., 2011). 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*.

Consistent with the TOE framework, this study's conceptual model in Figure 1 (including hypotheses) posits factors, identified in the literature review, within a hospital's contexts (technological, organisational and environmental) influencing the organisational adoption of eHealth. Although this conceptual model provides the bigger picture of a hospital's contexts, this study this study's primarily focus on the organisational context. This particular context is chosen to be included because CIOs and management have most control over the factors within this context. Hence, the organisational context is the most relevant context to consider from a hospital CIO's perspective.

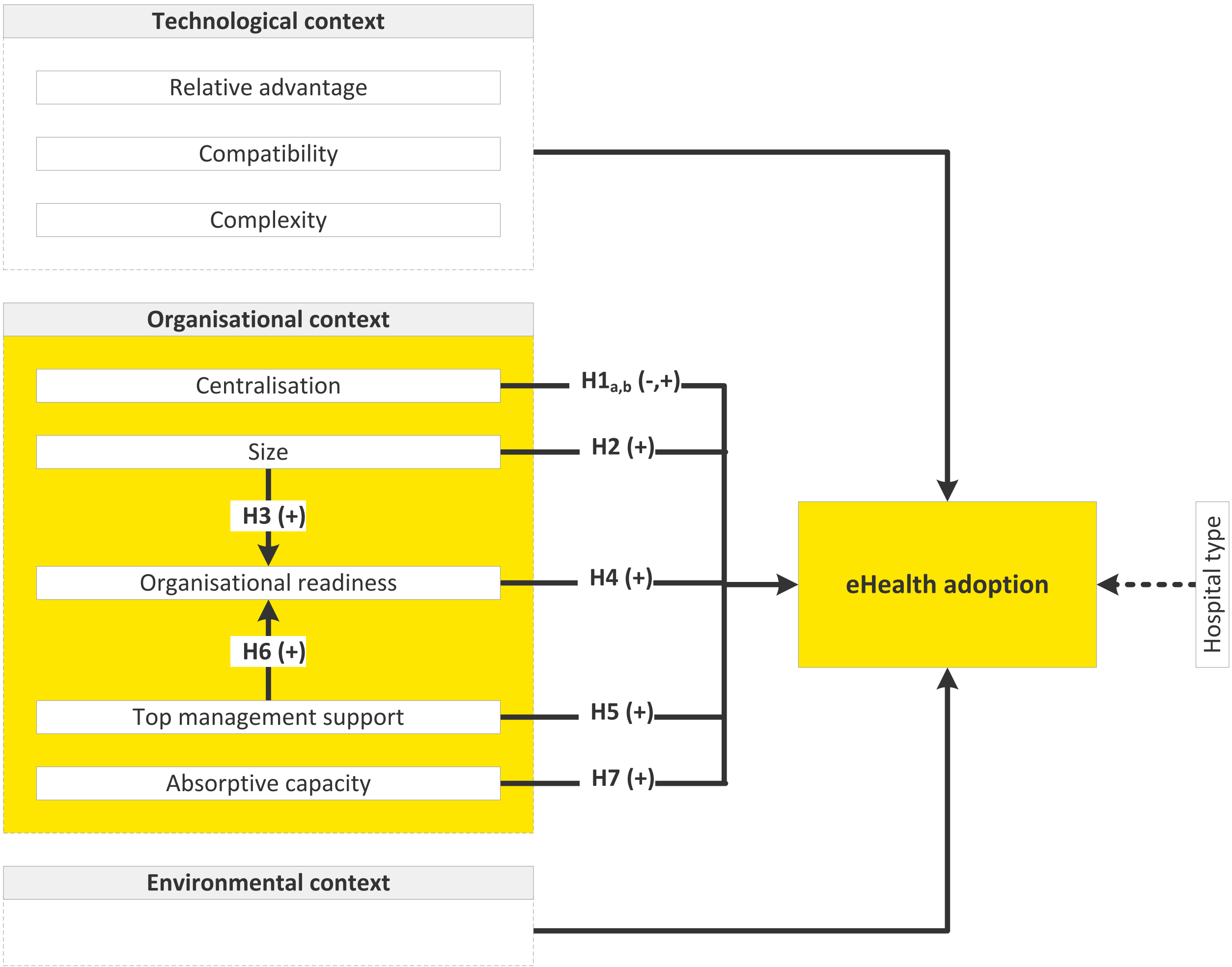
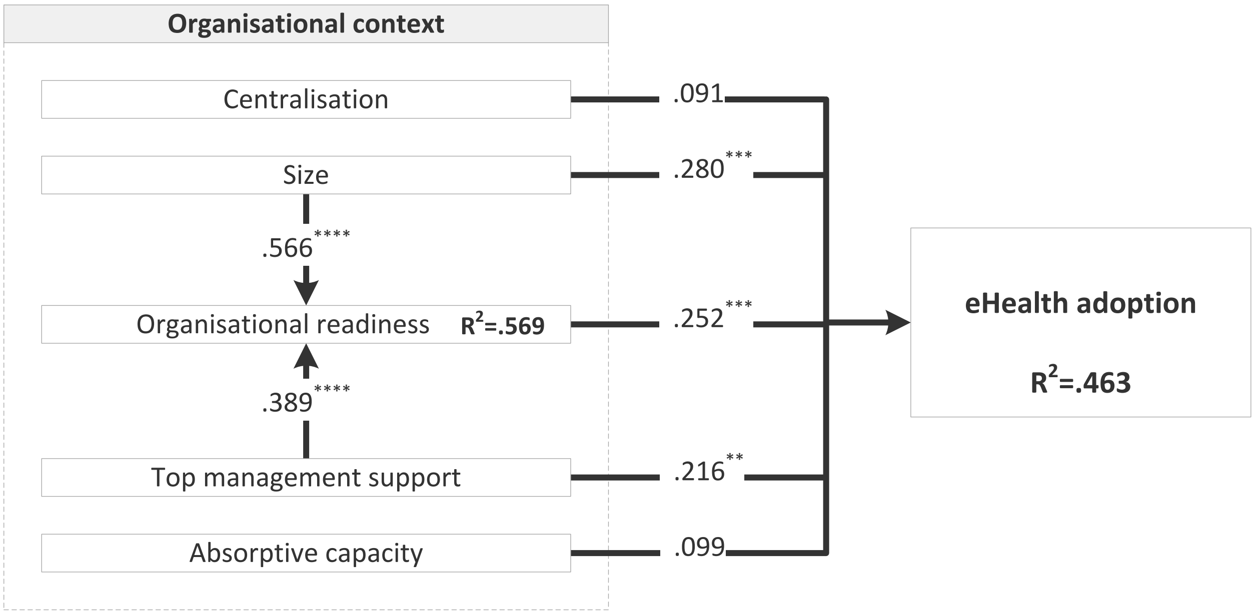



Figure 1) Conceptual model for eHealth adoption by hospital organisations

## Analysis and results

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 that has been administered to a specific population of Dutch hospitals to collect information at one point in time, over a period of 2 months.

The measurement model and structural model were tested using a Partial Least Squares Structural Equation Modelling (PLS-SEM) approach through WarpPLS4.0. Figure 2 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 (Chin, 1998; Vinzi, Chin, Henseler, & Wang, 2010).




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

**Figure 2) Structural model with path coefficients (without control variable)**

As presented in Table 2, the final model partially supports the hypothesis of this study. 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. Although no formal hypotheses were proposed for the sub-constructs of organisational readiness, technological and financial readiness equally determine organisational readiness to adopt eHealth significantly. Furthermore, 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).

**Table 2) 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*

## Discussion and conclusions

The aim of this study was to provide an understanding of the organisational adoption of eHealth by identifying the factors influencing the 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?*

*Main findings*
First of all, the literature review as part of this study revealed that eHealth is a broad dynamic domain which needs to be structured prior to analysing it. Accordingly, eHealth was structured along the following three dimensions: 1) technology, 2) healthcare use context, and 3) healthcare function (prevention, care, or cure) (see chapter 2). Second, the survey findings of this study provide an adequate picture of the current state of eHealth adoption by hospitals in the Netherlands. The results from the survey confirmed that, in general, Dutch hospitals fall short in realising eHealth's full potential (see section 5.1). Third, this study focuses on the organisational context influencing the organisational adoption of eHealth. The organisational context includes five factors that may influence 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 (see section 5.2).

*Theoretical implications (see section 6.2)*
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. 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 (Fichman, 2001; Jeyaraj, Rottman, & Lacity, 2006), this study also take into account the pre-adoption and post-adoption stages of organisational innovation adoption process. 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) 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.

***Societal contributions (see section** Error! Reference source not found.**)***
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.

***Limitations and future research (see section** Error! Reference source not found.* ***and 6.5)***
This study includes a few limitations and directions for future research. 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. 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. Second, 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. Third, 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. In order to overcome this bias 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. Fourth, developing solid instruments is still an ongoing procedure of development, testing, and refinement (S. MacKenzie, Podsakoff, & Podsakoff, 2011). 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 (MacCallum, 1992). 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. 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. Future studies can gather longitudinal data to examine the causality and interrelationships between variables that are important to the organisational adoption of eHealth.

Finally, 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. 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.

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# Chapter 1
# Introduction

# 1 Introduction

This chapter outlines the current trends in the Dutch healthcare system and its major challenge of ensuring affordable, accessible and high quality healthcare in the long term (section 1.1). Besides, this chapter stresses eHealth's potential in ensuring the long term sustainability of the Dutch healthcare system (section 1.2 and 1.3). Sections 1.4 to 1.6 describe the purpose and significance of this study, including its scope and research questions to be answered. Finally, section 1.7 includes the research approach and structure of the remaining chapters of this report.

## 1.1 *Trends in the Dutch healthcare system*

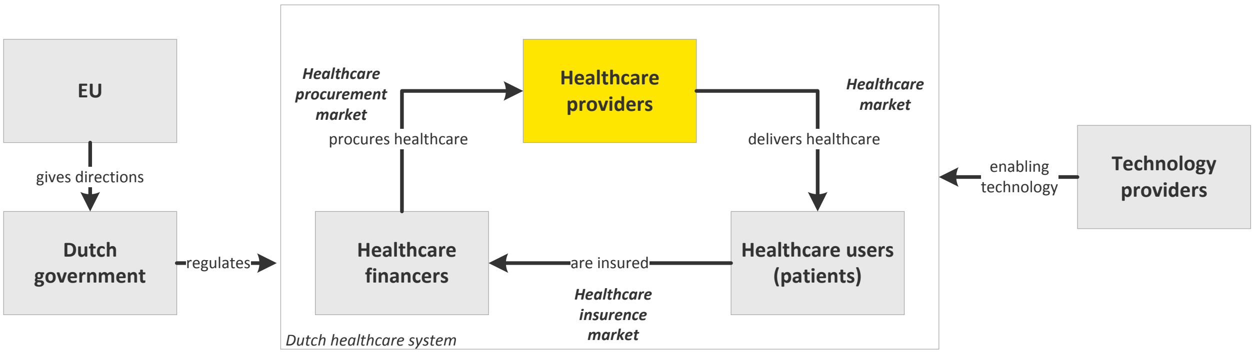
Healthcare is regarded as an important determinant of national well-being (Mackenbach & Maas, 2008; van der Horst, van Erp, & de Jong, 2011). In order to achieve high national well-being, affordable, accessible and high quality healthcare is important. Healthcare in the Netherlands belongs to the top healthcare systems in the world and has recently ranked first in the Euro Health Consumer Index (Commonwealth Fund, 2010; Health Consumer Powerhouse, 2013). However, the Dutch healthcare system has been put under pressure as healthcare expenditures are expected to rise significantly in the coming years, mainly due to an increase in overall healthcare consumption (De Nationale Denktank, 2013; Economist Intelligence Unit, 2011; Ernst & Young, 2013a, 2013c; European Commission, 2012; Smit, 2013; van Ewijk, van der Horst, & Besseling, 2013; World Economic Forum, 2013). According to the CPB (Netherlands Bureau for Economic Policy Analysis), if we do not intervene, healthcare expenditures in the Netherlands will rise to 22-31% of the country's GDP in 2040 compared to 15.3% 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 (van der Horst et al., 2011; van Ewijk et al., 2013). See appendix A. for a detailed overview of the trends in the Dutch healthcare system.

The abovementioned trends make healthcare expenditure an important topic of debate among all parties involved in the Dutch healthcare system and ask for innovative solutions to ensure its the long-term sustainability.

## 1.2 *Embedding eHealth in the Dutch healthcare system*

Although there is no agreement on the best solution among stakeholders, Information and Communication Technologies (ICT) are regarded as a promising source to put forward innovative solutions (Commission, 2011a; eHealth Task, 2012; Ernst & Young, n.d., 2013a, 2013c; European Commission, n.d., 2012; Gaddi & Capello, 2014; Krijgsman et al., 2013; Stroetmann, Jones, Dobrev, & Stroetmann, 2006). In the same way as the potential of ICT have been experienced in other service sectors like e-banking, e-government, and e-business (eHealth Task, 2012; Gaddi & Capello, 2014; Mannan, Murphy, & Jones, 2006), it is expected that **eHealth – *the use of emergent ICT to improve health and healthcare*** – will play a key role in sustaining the Dutch healthcare system.

Nowadays, eHealth is gaining ground in the Dutch healthcare system. At both European and national level, policy makers are convinced of the possibilities eHealth can offer to strengthen the healthcare system. Recently, the European Commission published "*eHealth Action Plan 2012-2020 - Innovative healthcare for the 21st century*" that presents and consolidates actions to deliver the opportunities that eHealth promises offer (European Commission, 2011, 2012). At national level, a recent report by the Dutch Government "*De maatschappij verandert. Verandert de zorg mee?*" sets a 5 year target for providing online access to medical data to at least 80% of chronically ill patients and elderly people, and to at least 40% of the remaining citizens. In addition, it sets a 2020 deadline for offering telemonitoring for diabetes and COPD to at least 75% of chronically ill patients (Rijksoverheid, 2014; Schippers & Rijn, 2014a, 2014b). Furthermore, healthcare insurers gradually impose healthcare providers to use eHealth in the healthcare process (Zorgvisie, 2014). Moreover, current demands made by (e-)patients to manage their own health and well-being may be well met by eHealth technologies (Brabers, Rooijen, & Jong, 2012; Nijland, 2011; E. Wilson, Wang, & Sheetz, 2014). Healthcare consumers increasingly search the Internet for healthcare related information and expect healthcare providers to use means of communication that are most appropriate, including the Internet (Krijgsman et al., 2013, 2014; Rijen, Lint, & Ottes, 2002). Besides, half of the healthcare consumers wish to have online access to their medical record (Krijgsman et al., 2014). Meanwhile, there is a growing ecosystem of entrepreneurs and start-ups in healthcare in which a growing number of eHealth technologies are becoming available (Aitken, 2013; Fleuren, Wiefferink, & Paulussen, 2004a; Fox & Duggan, 2012; P. Wilson & Leitner, 2004). See Figure 3 for a systematic overview of the Dutch healthcare system including its key players.




*Adapted from:* (Grundmeijer, Reenders, & Rutten, 2009; Jacobs et al., 2011; Mackenbach & Maas, 2008)

**Figure 3) Layout of the Dutch healthcare system including its key players**

## 1.3 *Problem statement*

The National eHealth Monitor 2014 revealed that the Netherlands are doing well in eHealth compared to other countries and that the expectations of eHealth's potential are favourable (Krijgsman et al., 2014). It seems everything and everyone is ready to embed eHealth in the Dutch healthcare system: "finances demand it, citizens expect it, and technology is ripe" (Nijland, 2011). 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 (Ernst & Young, 2013b; European Commission, 2011; Krijgsman et al., 2013). As a growing number of eHealth applications are becoming available in cure, hospitals need to come up with innovation strategies to successfully introduce eHealth in their organisations (de Veer et al., 2011; Fleuren et al., 2004a; Van Dyk, 2014). But are they *ready* to leverage the full potential that eHealth promises to offer? To date, Dutch hospitals fall short in realizing eHealth's full potential. Despite many eHealth projects have been initiated, their implementation is often too fragmented and their impact is rather isolated (Ernst & Young, 2013b; Krijgsman et al., 2013, 2014; Ossebaard & Gemert-Pijnen, 2013; Van Dyk, 2014). The eHealth monitor 2014 indicated four underlying explanations for the under deployment of eHealth: 1) eHealth in the workplace is not always a matter of plug and play, 2) process innovation is not a trivial task, 3) healthcare users and providers experience insufficient added value in using certain eHealth applications, and 4) intended users are not always aware of the possibilities of eHealth (Krijgsman et al., 2014). Clearly, introducing eHealth in hospitals is not a trivial task and persons responsible for eHealth implementation are seeking for frameworks that provide them guidance when introducing eHealth technologies in their organisation (Van Dyk, 2014).

## 1.4 *Research aim and research questions*

In response to the above, this study aims to provide an understanding of the *organisational* adoption of eHealth by identifying the factors influencing the organisational adoption[2] of eHealth by Dutch hospitals. Based on the problem statement in section 1.3 and the aim of this study, the following research questions have been formulated:

"

***What are the relevant factors that influence the organisational adoption of eHealth by Dutch hospitals?***

"

The main question is decomposed into the following sub questions:

1. *What is eHealth?*
2. *What is the current situation regarding the organisational adoption of eHealth by Dutch hospitals?*
3. *What are the factors that influence the organisational adoption of eHealth by Dutch hospitals?*
4. *What strategies can be derived to foster the organisational adoption of eHealth by Dutch hospitals?*

## 1.5 *Research relevance*

Due to the fact that healthcare is a major determinant for national well-being, any step forward in sustaining the Dutch healthcare system by fully exploiting eHealth's potential is of societal relevance. In particular the focus on hospitals which are most dominant in modern healthcare: central in healthcare regions, most visible, and the most expensive. The results of this study help in understanding the factors influencing the adoption of eHealth from which strategies can be derived to foster the successful adoption of eHealth by Dutch hospitals.

The scientific relevance of this study lies in investigating the factors that influence the organisational adoption of eHealth. To my best knowledge, this is the first study empirically investigating the adoption of eHealth within the relatively small research domain of organisational innovation adoption. Moreover, most of this research is qualitative not quantitative.

## 1.6 *Research scope*

The scope of this study is limited to the investigation of innovation adoption at organisational level by studying the adoption of eHealth by general and academic hospitals in the Netherlands. eHealth applications within the scope of this research are limited to state-of-the-art eHealth applications that are used in cure, in the interaction between patients and healthcare professionals. Furthermore, this study assumes that eHealth applications are developed outside the adopting hospital and that all hospitals go through a similar sequence of stages in adopting eHealth applications.

[2] Organisational adoption is defined as: the acceptance and incorporation of eHealth into an organisation's every day practice (Rogers, 1995).

## 1.7 *Research approach and structure*

The structure of this study reflects the logical flow of activities from the research problem exploration, the development of the conceptual model based on insights from literature, the collection and analysis of data, the testing of hypotheses, to the final reporting and evaluation activities. The study may be divided into six phases as presented in Figure 4:

| Problem definition | Theoretical background | Model construction and instrument devopment | Data collection | Model validation | Interpretation |
|---|---|---|---|---|---|
| Chapter 1 | Chapter 2 and 3 | Chapter 4 | Chapter 4 | Chapter 5 | Chapter 6 |

Figure 4) Research approach

**Phase 1: Problem definition**
Chapter 1 justifies the need for the research problem, as expressed specifically in the purpose statement and the research questions for the study. The problem definition also includes a clear specification of the level of analysis and scope.

**Phase 2: Theoretical background**
In advanced multivariate analyses like PLS-SEM, the theoretical foundation is particularly relevant (Urbach & Ahlemann, 2010). In phase 2, theories that may serve as a starting point for the model development are identified and useful construct definitions are provided. To this end, a literature review was performed to understand the domain of eHealth (Chapter 2) and the phenomenon of organisational innovation adoption (Chapter 3). The literature review was performed by making use of scientific literature databases Google Scholar and Scopus. Keywords used for searching include: *organisational innovation, innovation and diffusion of innovations, innovation assimilation, IT innovation in organisations, organisational change, innovation adoption and implementation*. The keywords have been combined with the term "eHealth" or "healthcare" in order to narrow the search results to the domain of this study.

**Phase 3: Model construction and instrument development**
Even though a thorough literature review may provide researchers with a number of building blocks for their model construction, it is very likely that certain constructs will require new or adapted measurement approaches (Urbach & Ahlemann, 2010). Chapter 4 describes the methodology used to empirically test the conceptual model in this study. It includes the research design and the development of the survey instrument.

**Phase 4: Data collection**
Before starting with the model validation, the quality of empirical data gathered during the data collection phase needs to be verified (Urbach & Ahlemann, 2010). To this end, chapter 4 include a description of the data collection procedure, the population, and the results of data screening. In addition, the presence of possible common method bias is assessed.

**Phase 5: Model validation**
Model validation denotes the process of systematically evaluating whether the hypotheses expressed by the structural model are supported by the data or not. To this end, this study adopted a two-step

validation approach assessing 1) the measurement models and 2) the structural model as presented in chapter 5 (Urbach & Ahlemann, 2010; Vinzi et al., 2010).

### Phase 6: Interpretation

In phase 6, the parameter estimates are interpreted on the basis of the structural equation model's theoretical foundation. Consequently, the hypotheses expressed by the structural model can be regarded as either confirmed or rejected (Urbach & Ahlemann, 2010). Finally, based on the study's empirical findings the research questions are answered, conclusions are drawn, implications are derived for theory and practice, and the need for future research is identified.

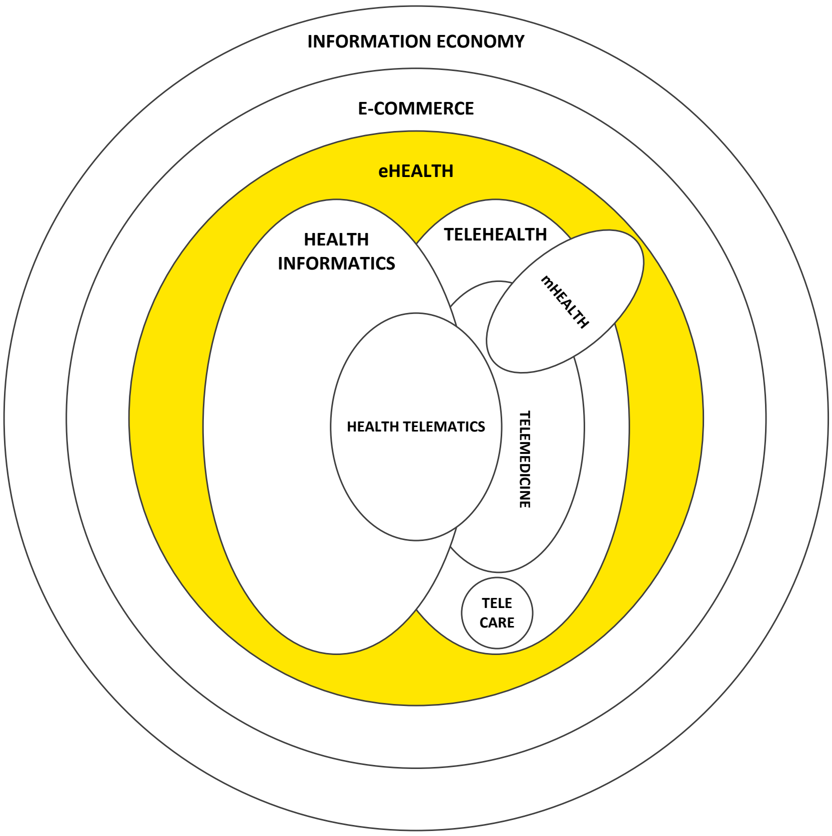
# Chapter 2
## The eHealth domain

# 2 The eHealth domain

In this chapter, the eHealth domain will be explored by answering the following research sub question: *"What is eHealth?"* First, an overview will be provided with several definitions of eHealth in literature (section 2.1). Thereafter, the broad definition of eHealth will be narrowed down by structuring the eHealth domain (section 2.2). This will result in a working definition of eHealth including some state-of-the-art eHealth applications that will be studied in the survey.

## 2.1 *What is eHealth?*

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. However, the use of ICT in healthcare is, among others, also known as *telemedicine*, *mHealth*, *telecare*, *telehealth*, and *health informatics*. This large and ever-changing number of terms reflects the field's dynamic nature and continual evolution (Maheu, Whitten, & Allen, 2002). Yet, it may also result in confusion. Figure 5 gives an overview of relationships between these terms. The focus of this study is indicated in yellow in Figure 5. Appendix B. provides a short overview of eHealth related terms including some examples.




*Adapted from:* (John Mitchell, 1999)

Figure 5) Relationships between terms

According to Mitchell (1999), who first coined the term eHealth in 1999, eHealth can be considered to be the health industry's component *of e-commerce*. Specifically, the prefix "e", standing for "electronic", in the term eHealth is used in line with other "e-words" such as e-banking, e-learning, e-government, and so on, in an attempt to convey the *notion of digital data*, including its promises, principles and excitement to the health arena, and to give an account of the new possibilities the Internet is opening up to the area of healthcare (Eysenbach, 2001; International Telecommunication Union, 2008).

The term eHealth has emerged and is increasingly used as a "umbrella" term encompassing various telehealth and health informatics activities for healthcare delivery both at distance as well as locally (see Appendix B. ) (John Mitchell, 1999; Van Dyk, 2014). In literature, many definitions of eHealth can be found. Some definitions of eHealth are presented in Table 3.

**Table 3) Definitions of eHealth**

| Definition | Source |
|---|---|
| eHealth is an **emerging** field in the intersection of medical informatics, public health and business, referring to **health services** and **information** delivered or enhanced through the **Internet** and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology. | (Eysenbach, 2001) |
| eHealth is the use of **emerging** Information and Communication Technologies (**ICT**), especially the **Internet**, to **improve** or **enable health** and **healthcare**. | (Eng, 2001; Krijgsman et al., 2014) |
| eHealth is the use of **ICT** in health products, services and processes combined with **organisational change** in healthcare systems and **new skills**, in order to **improve** health of citizens, efficiency and productivity in healthcare delivery, and the economic and social value of health. eHealth covers the interaction between **patients and health-service providers**, **institution-to-institution** transmission of data, or peer-to-peer communication between **patients and/or health professionals**. | (European Commission, 2012) |
| eHealth encompasses the use of **emerging** information and communications technology (**ICT**), especially the **Internet**, to **improve health** and **healthcare**, and to enable "**patient empowerment**". | (Ernst & Young, 2013b) |

The term eHealth is fairly broad and encompasses a set of various concepts, including health, technology, and commerce. In addition, many definitions note the varying stakeholders, the attitudes encompassed, the role of place and distance, and the real or potential benefits to be expected from eHealth (Oh, Rizo, Enkin, & Jadad, 2005). It is wise to emphasize that eHealth is mainly defined how it is used; the definition cannot be pinned down, as it is a dynamic environment, constantly moving (Eysenbach, 2001). As pointed out in *eHealth, Care and Quality of Life, "eHealth should be seen as a key component part of health and healthcare. As technology advances and it becomes even more embedded within our day-to-day lives, the distinct term eHealth will gradually fade into insignificance, as the terms e-commerce and e-banking have done previously"* (Gaddi & Capello, 2014; Hilbert, 2012). Finally, many definitions note the real or potential benefits to be expected from eHealth. However, evidence of its potential benefits is still lacking. Nevertheless, there are indications to believe eHealth can bring real benefits to healthcare (Al-Shorbaji, 2013; European Commission, 2012; Stroetmann et al., 2006).

### 2.1.1 Conclusions

In this study the term "eHealth" is preferred to describe the use of ICT in healthcare. Although eHealth is a fairly broad term encompassing various concepts, it suits the dynamic nature of the domain. According to Mitchell (1999), because of the convergence of technologies and the increased ability to perform multiple functions with those technologies it is unwise to solely emphasise the distance factor in telehealth. In other words, many eHealth applications that are available today do not just fit in one of the abovementioned subcategories. Besides, using the term eHealth is in line with international and national reports discussing the use of ICT in healthcare (Krijgsman et al., 2014)

However, the broad nature of the term eHealth makes it difficult to study and asks for a further structuring, as for instance CIOs or top-level ICT managers may have slightly different interpretations of eHealth. The next section will determine the scope of eHealth applications included in this study by structuring the eHealth domain along three dimensions.

## 2.2 *Structuring the eHealth domain*

A major risk of using a broad definition of eHealth is that it may lead to miscommunication among stakeholders. To prevent this to happen, it is useful to delineate the eHealth domain by structuring it along three dimensions, namely: 1) technology, 2) users and their interactions, and 3) type of healthcare (prevention, cure or care).

### 2.2.1 State-of-the-art technology

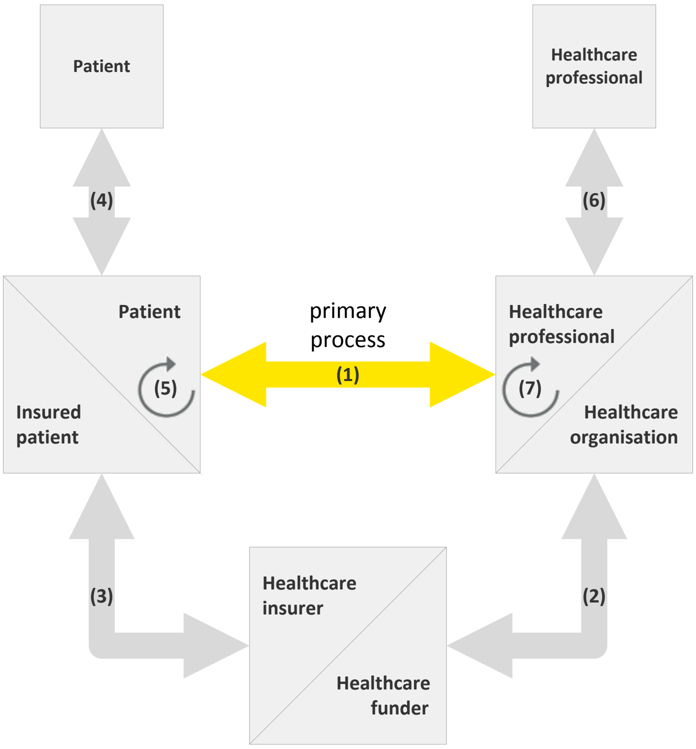
As it is impossible to keep the list of technologies up-to-date since the break-through rate of new technology is high and complex modifications combine two or more technologies (John Mitchell, 1999; Ossebaard & Gemert-Pijnen, 2013). Therefore, the focus in this study will be on state-of-the-art technologies which can be defined as "*the highest level of development, as of a device, technique, or scientific field, achieved at a particular time*" (Houghton Mifflin Company, 2000).

### 2.2.2 Users and their interactions

A second classification can be made by distinguishing several types of users and the possible interactions between them. Identification of the users involved is an important step in studying the adoption of innovations. Besides, the user and his setting determine for a large part the type of eHealth application being used (Ossebaard & Gemert-Pijnen, 2013). As described in section 1.2 the healthcare system can be seen as a combination of three actors: the healthcare provider (i.e. healthcare professional or hospital), the healthcare user (patient), and the healthcare financer (usually a healthcare insurer). Figure 6 presents an overview with possible users and the possible interactions between them. The following informational and technological interactions are possible (Krijgsman & Wolterink, 2012; Ossebaard & Gemert-Pijnen, 2013):

1) Use by healthcare professionals to communicate with patients (the *primary process* in healthcare), e.g., access to EHRs, appointment systems, electronic consultation, video-conferencing.
2) Use by the healthcare organisation to communicate with external others (i.e. healthcare insurer), e.g., to order medical equipment or to submit health insurance declarations.
3) Use by patients to communicate with external others, e.g., to consult comparative choice information, benchmarks or educational materials.
4) Use by patients to communicate with each other, e.g., online peer support.
5) Use by patients within their personal context, e.g., self-assessments, self-measurements or self-management in a personalized application.

6) Use by healthcare professionals to communicate with other healthcare professionals, e.g., the exchange of medical data, electronic referral or inter-professional consultation.
7) Use by healthcare professionals within their professional context, e.g., electronic health records (EHRs).




*Adapted from:* (Krijgsman & Wolterink, 2012; Mackenbach & Maas, 2008)

**Figure 6) Interactions in healthcare**

Given the aim of this study, the focus will be on the primary process in healthcare; the interaction between patient and healthcare professional. The *eHealth monitor 2013 and 2014* describes this category as "*Communication between healthcare provider and user*". This category includes eHealth applications such as "making appointments online", "asking questions to healthcare professional online", "online access to the electronic health records", "online treatment" and "telemonitoring" (Krijgsman et al., 2013, 2014).

## 2.2.3 Prevention, cure and care

In healthcare the following overall functions can be distinguished: *prevention* (stay healthy), *cure* (recovery), and *care* (independent living with disease or disability). However, this distinction is not always clear and overlap often occurs (Caris, 2007; Grundmeijer et al., 2009; Mackenbach & Maas, 2008; Raad voor Volksgezondheid & Zorg, 2001). For instance, a patient with rheumatoid arthritis needs permanent medication to control pain and inflammation (cure). But that same patient might also requires help from, for instance, a physiotherapist and other tools to adapt to the limitations of the chronic disease (care) (Grundmeijer et al., 2009). In general, the nature of a disease determines the type(s) of healthcare provided (Grundmeijer et al., 2009). A third classification of eHealth applications is based on this division and is described below.

***Prevention*** is defined as the total of measures, both within and outside the health sector, aimed at the protection and enhancement of health by preventing diseases and health problems to occur. Within this category a distinction is made between primary prevention (aimed at preventing new diseases to occur and therefore aimed at eliminating or reducing the causes of a condition), secondary prevention (aimed at discovering a disease at the earliest possible stage so that early treatment is possible to prevent serious illness), and tertiary prevention (aimed at preventing or limiting the effects of an already diagnosed condition) (Caris, 2007; Mackenbach & Maas, 2008). Thus, eHealth applications in the category prevention typically aim at or support in the prevention, the early detection, or the prevention of the effects of an already diagnosed condition (Haaker et al., 2013).

Curative care (***cure***) is aimed at curing a disease. The primary purpose is to recover ill people that suffer from acute or chronic conditions, to relieve their pain, and when full recovery is not possible, to slow down the disease process. Main activities in cure are the provision of healthcare in the case of minor ailments, in the case of life-threatening diseases (acute care), and in the case of (chronic) diseases (non-acute care) (Mackenbach & Maas, 2008). Cure activities also include activities such as guidance and support that are often associated with care (Caris, 2007; Grundmeijer et al., 2009; Mackenbach & Maas, 2008; Raad voor Volksgezondheid & Zorg, 2001). Thus, eHealth applications in the category cure typically aim at or support in patient recovery (Haaker et al., 2013).

***Care*** is aimed at supporting people in (independent) living with an illness or disability (Caris, 2007; Haaker et al., 2013; Mackenbach & Maas, 2008; Raad voor Volksgezondheid & Zorg, 2001). A first category is care of long-term illnesses. People with disabilities due to illness may appeal to care that aims to eliminate the underlying disorder or disability (see cure), but if that does not work, they are mostly dependent on care and nursing (care). To illustrate, when a person has a chronic disease, that person is not always chronically ill. Most people with a chronic disease function normally and are independent. About 10% of the Dutch population suffer from one or more chronic diseases. Most patients are in the age category between 55 and 80 years. About 4% of that category needs serious care (Grundmeijer et al., 2009). The other 86% are typically dependent on (long-term) permanent treatment in cure (Raad voor Volksgezondheid & Zorg, 2001). A second category is the care of people with disabilities. In this category, people with mental, physical or sensory disabilities are provided with guidance, care and nursing (Mackenbach & Maas, 2008). Thus, eHealth applications in the category care typically aim at or support in patient independent living with a disease of condition without treatment of the disease or condition itself (Haaker et al., 2013).

Given the aim of this study and the focus on hospitals (as described in 1.4), this study focuses on eHealth applications within *cure,* including activities such as guidance and support.

### 2.2.4 Conclusions

The following applications fall within the delineated definition of eHealth (please note that some degree of overlap exists, i.e. telemonitoring can also be seen as a form of online treatment):

Table 4) Potential eHealth applications in this study

| eHealth application | Description |
|---|---|
| e-Intake | Online consultation preparation (e.g. questionnaire about patient history). |
| e-Consult | Online consulting a medical professional (possibly including video and audio). |
| Telemonitoring | Remotely monitor the patient based / generated information provided by the patient (possibly automated). |
| Online access to EHR | Consult online medical information by the patient. |

| | |
|---|---|
| Online information | Offering advice and information about health, illness and treatment methods on the Internet. |
| Social media | All forms of Internet communication with the patient (e.g. Facebook, MSN, YouTube, Chat Sites, Blogs and Twitter). |
| e-Communication | Digital contact between patient and caregiver (e.g. e-mail or instant contact such as Skype). |
| Online treatment | Internet therapies and treatment methods. |

To describe the use of different eHealth applications in the current situation (see section 5.1), this study will investigate which of the above eHealth applications are in use by Dutch hospitals. In addition, some applications will be studied in detail, namely:

- Telemonitoring in heart failure: *remotely monitor the patient with heart failure.*
- Telemonitoring in diabetes: *remotely monitor the patient with diabetes.*
- Online access to EHR: *access to online medical information by the patient.*

The three abovementioned eHealth applications are particularly interesting to study in detail as these applications are one of the main priorities in the EU/NL agenda (Commission, 2011b) and the National Implementation Agenda (NIA) of eHealth (Nationale Implementatie Agenda, 2012). Moreover, at national level, a recent report by the Dutch Government "*De maatschappij verandert. Verandert de zorg mee?*" sets the following 2020 targets with respect to telemonitoring and online access to EHR (Rijksoverheid, 2014; Schippers & Rijn, 2014a, 2014b):

1) 40% of Dutch and 80% of the chronically ill have direct access to certain medical data and can use it in mobile apps or web applications.
2) 75% of the chronically ill and frail elderly, who are willing and able to, can perform independent measurements, often in combination with telemonitoring.

## 2.3 *Conclusion*

This chapter argued that the broad nature of the term eHealth makes it difficult to study and asks for a further structuring prior to analysing it, as for instance CIOs or top-level ICT managers may have slightly different interpretations of eHealth. In order to mitigate this potential bias, the questionnaire included a clear *delineated* definition of eHealth and descriptions of the three applications. Structuring eHealth along the following three dimensions: 1) technology, 2) healthcare use context, and 3) healthcare function (prevention, care, or cure) has found to be useful, resulting in the following definition of eHealth, including a clear delineation of the eHealth domain to be used in this study (Eng, 2001; Krijgsman et al., 2014):

*"eHealth is the use of emerging Information and Communication Technology (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."*

# Chapter 3
## Literature review

# 3 Theoretical background

This section partially answers the following research sub question "*What are the factors that influence the organisational adoption of eHealth by Dutch hospitals?*" by identifying relevant factors from literature. In this chapter, relevant literature concerning the adoption of eHealth in healthcare organisations is explored. This chapter begins with a clarification of the relevant key concepts in innovation literature for this study (section 3.1). Thereafter, this section reviews literature on the following topics: the domain of organisational innovation, theories and models on IT innovation adoption, and theories and models on IT adoption in healthcare (section 3.2). Section 3.3 identifies the factors from literature that will be included in the conceptual model for this study.

## 3.1 *Key concepts in innovation literature*

Innovation has been studied in various disciplines (sociology, engineering, economics, marketing and psychology), for different stages of innovation (generation of innovation or adoption of innovation), at different levels of analysis (individual, subunit, organisational, industrial, national or the innovation itself), and for different types of innovation (technical/ administrative, radical/incremental or product/process) (Damanpour & Schneider, 2008; Damanpour & Wischnevsky, 2006; Gopalakrishnan & Damanpour, 1997; Read, 2000). As a result, many theories and models have been developed that aim at explaining organisational and human behaviour in respect to innovation adoption, and there have been several past studies that investigated factors and processes that influence innovation adoption in various contextual settings (Hecht, Maier, Seeber, & Waldhart, 2011). Yet, this broad variety of innovation studies also resulted in distinctions between definitions, reflecting differences in fundamental assumptions and viewpoints of researchers (Makkonen, 2007; Robert et al., 2009). As has been argued by Greenhalgh (2004) "*there is not, nor there will ever be, a consensus on terminology in the field of innovation studies.*" Therefore, this chapter begins with an overview of the definitions of key concepts in innovation research that are used in this study. Particularly, this study focusses on innovation through eHealth at the organisational level.

### 3.1.1 Innovation in organisations

In literature, the term "*innovation*" has been defined in a variety of ways (Hameed, Counsell, & Swift, 2012; Hameed, 2012; Orlando & Renzi, 2013; Read, 2000). Although prior research has not yielded a generally accepted definition for innovation (Makkonen, 2007), most of the widely used definitions of innovation focus on novelty and newness (Johannessen, Olsen, & Lumpkin, 2001; Makkonen, 2007; Read, 2000). In general, innovation has been conceived in two distinct ways, namely, as a process "*the process of introducing something new*" and as an outcome "*a new idea, system, practice, product, or technology*" (Crossan & Apaydin, 2009; Gopalakrishnan & Damanpour, 1997; Postema, 2012; Read, 2000).

Organisational innovation has generally be defined as "*the development (generation) and/or use (adoption) of new ideas or behaviours.*" The idea or behaviour may pertain to a product, service, technology, system, or practice (Damanpour & Schneider, 2008; Damanpour & Wischnevsky, 2006; Hameed et al., 2012; Orlando & Renzi, 2013; Zaltman et al., 1973). In line with this definition, Damanpour (2006) distinguished two dimensions of the organisational innovation process: 1) generation, and 2) adoption.

The generation of an innovation typically takes place in innovation-generating organisations and can be described as a process (consisting of recognition of opportunity, research, design, commercial development, and marketing and distribution) that results in an outcome that is new to at least one organisational population (Damanpour & Gopalakrishnan, 1998; Damanpour & Wischnevsky, 2006). The outcome of the generation process is a new idea, system, practice, product or technology. Thus, innovation as an outcome can be defined as *"an idea, system, practice, product or technology that is perceived as new by an adopting organisation."* (Cooper & Zmud, 1990; Rogers, 1995; Zaltman et al., 1973). An innovation may be new to the 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 (Damanpour & Wischnevsky, 2006; Orlando & Renzi, 2013). Consequently, innovation has been studied at various levels (Damanpour, 1991). As was earlier mentioned, this study focusses on innovation through eHealth at the organisational level.

When an innovation of the generation process is acquired by another organisation, that second organisation goes through another process: the innovation adoption process (Damanpour & Gopalakrishnan, 1998). Innovation adoption will be elaborated in the next section.

To conclude, as argued by Damanpour (1998) *"innovation can be seen as both a process and an outcome; the generation process results in innovation as an outcome for the generating organisation, while the adoption process delineates how that outcome is assimilated in the adopting organisation."*

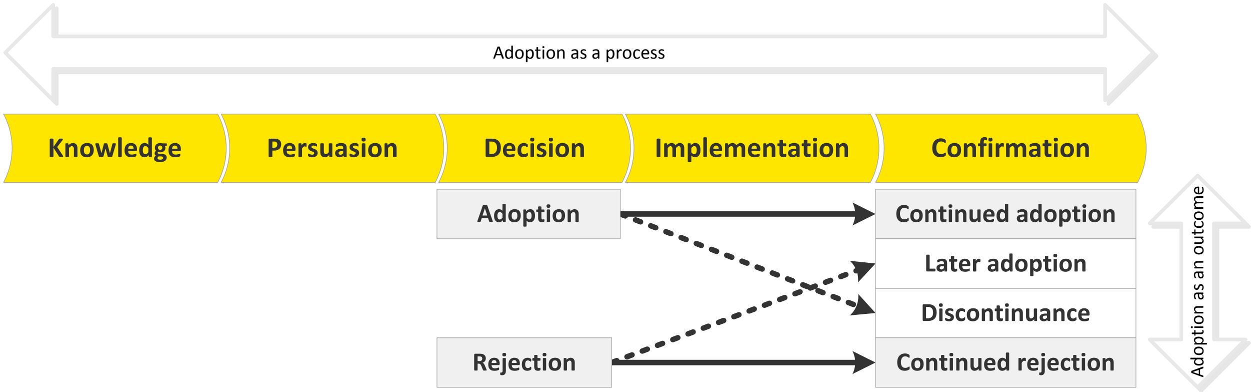
Following the above, the following definition of innovation will be used in this study (Robert et al., 2009):

*"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."*

### 3.1.2 Organisational innovation adoption

Similar to innovation, *adoption* of an innovation has been conceived as both an outcome *"the decision to adopt"* as well as a process *"the innovation adoption process"* and has been studied at various levels by various researchers (Gopalakrishnan & Damanpour, 1997; Makkonen, 2007; Postema, 2012).

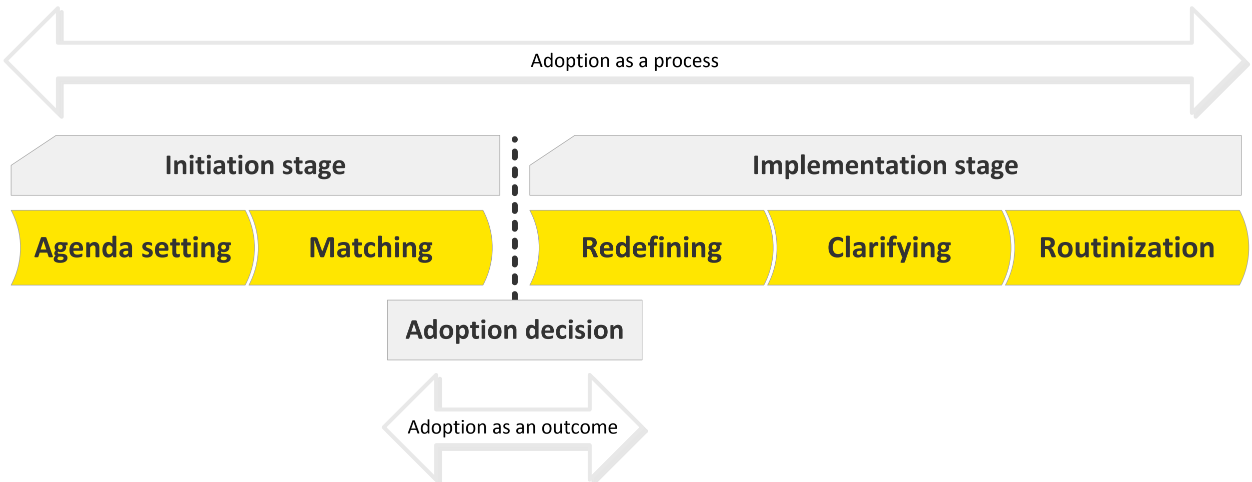
From an individual perspective, Rogers (1995) described innovation adoption as *''the process through which an individual (or another decision making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision.''* The process that individuals (or another decision making unit) go through in adopting an innovation is described in Rogers' *innovation-decision model* as presented in Figure 7 consisting of five sequential stages that lead to an outcome: the adoption (or rejection) of an innovation (Rogers, 1995). Accordingly, Rogers (1995) defines adoption as an outcome as *"a decision to continue full-scale use of an innovation."*




*Adapted from:* (Rogers, 1995)

Figure 7) Innovation-decision process

With respect to organisational innovation adoption, commonly two main stages (consisting of different substages) may be distinguished: initiation and implementation. The adoption decision takes place in between these stages (Damanpour & Wischnevsky, 2006; Rogers, 1995; Zaltman et al., 1973). See Figure 8. Most of the organisational innovation adoption models proposed by other authors are variations of the above, with greater or lesser gradations between stages. All definitions are consistent with the pre-adoption, adoption-decision and post-adoption categorisation in Information Systems (IS) literature (Kouki, Poulin, & Pellerin, 2006). See Appendix C. for an overview. During the initiation stage, the organisation recognises a need, becomes aware of an innovation, forms an attitude towards it, and evaluates the innovation (Frambach & Schillewaert, 2002; Gopalakrishnan & Damanpour, 1997; Rogers, 1995). The initiation stage generally encompasses substages of awareness, consideration, and intention (Frambach & Schillewaert, 2002). During the implementation stage, the organisation decides to purchase and make use of the innovation (Frambach & Schillewaert, 2002; Gopalakrishnan & Damanpour, 1997; Rogers, 1995). Yet, the ***organisational*** adoption decision is only the beginning of implementation (Frambach & Schillewaert, 2002) as wide spread usage is not a certainty (K. Zhu et al., 2006).

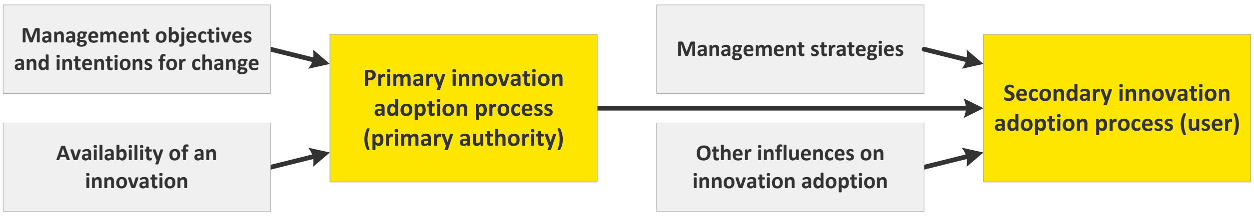



*Adapted from:* (Rogers, 1995)

Figure 8) Stages in the organisational innovation adoption process

*Contingent adoption decisions in hospital organisations*

Many IT innovations in organisations involve a two-part adoption decision process. First, a formal adoption decision is made to purchase, adopt, and acquire an innovation by an organisation, to make that innovation available to the organisation and is then followed by local adoption decisions by the intended users about whether to actually use the innovation, and how (Fichman, 2000; Gallivan, 2001; Greenhalgh, Robert, Bate, et al., 2004; Klein & Sorra, 1996) (see Figure 9). Rogers (1983, 1995) refers to this as *contingent innovation-decisions* in which decisions to adopt or reject only can be made after a prior innovation adoption decision. In the case of a hospital, a healthcare professional's decision to adopt (make use of) a new eHealth technology can be made only after the hospital has made an organisational adoption decision to purchase that eHealth technology. More specifically, this example illustrates an *optional adoption decision* (made by an individual independent of the decisions of other members of a system) or *authority adoption decision* (made by a relatively few individuals in a system who possess power, status, technical expertise) that follows a *collective adoption decision* (made by consensus among members of a system) (Rogers, 1995).




*Adapted from:* (Gallivan, 2001)

Figure 9) Contingent innovation-decisions

*Implications for innovation adoption studies*

According to Zhu et al. (2006), organisational adoption (decision) does not always results in widespread usage of an innovation in an organisation; after it is adopted, acceptance and/ or assimilation within the organisation becomes important (Frambach & Schillewaert, 2002; Vaidyanathan, 2004). Generally, the innovation process can only be considere a succes to the extent that the innovation is accepted and integrated into the organisation (Gopalakrishnan & Damanpour, 1997; Hameed, 2012; Rogers, 1995; Zaltman et al., 1973). During the implementation stage, targeted organisational members (in this case: healthcare professionals) ideally become increasingly skillful, consistent and commited in their use of an innavation (Klein & Sorra, 1996). Thus, implementation can be considered as the critical gateway between an organisation's decision to adopt the innovation and the regular use of the innovation within that organisation (Klein & Sorra, 1996; Postema, 2012).

In the field of Information Systems (IS), assimilation is considered to be a central objective and an essential outcome of the innovation adoption process (Armstrong & Sambamurthy, 1999; Damanpour & Schneider, 2008; William H Delone & Mclean, 1992; Kouki et al., 2006; Orlando & Renzi, 2013; Pudjianto, 2012). As is argued by Gallivan (2001), *"it is not innovation use or user adoption per se that matters as the outcome of interest, but rather how extensively the innovation is used and how deeply the organisation's use of the innovation alters processes, structures, and organisational culture."* In literature, there exist a variety of definitions of assimilations. Assimilation can be conceived as an outcome *"the extent (breadth and depth) to which the innovation used in a comprehensive and integrated way and becomes routinized and embedded in the organisation's work processes and value chain activities"* as well as a process designating one, to several, or all stages of the organisational innovation adoption process (Kouki et al., 2006). When assimilation is designated to all stages of the organisational innovation adoption process, innovation adoption is often referred to as/ renamed as innovation assimilation.

As argued by Fichman (2000), "*the two-part decision process means that the latter stages of the organisational adoption (assimilation) process – from formal adoption to full institutionalisation – become especially worthy of focused study*". Accordingly, he suggests that richer models of the intra-organisational processes of innovation need to be developed. In addition, he suggests the following design elements (Fichman, 2000):

- Use measures that capture rich differences in post-adoption outcomes. Instead of static indicators, more dynamic indicators are increasingly used in research to measure successful innovation adoption, including aggregated adoption, assimilation stage achieved, and extent of implementation (Postema, 2012);
- Focus attention on elements that have disproportionate influence on the latter stages of assimilation, such as factors associated with the delivery system (i.e. top management support, champions, training) and the process model supporting implementation; (see section 3.3)
- Consider individual technology acceptance, and the factors that affect it, as key elements of the implementation process (i.e. Perceived Innovation Characteristics and Individual Technology Acceptance). (see section 6.5)

#### 3.1.2.1 *Stages of organisational innovation adoption*

Despite the fact that much has been written about the process of innovation in organisations, there is little information concerning the process of innovation in hospitals (Omachonu & Einspruch, 2010). For the purpose of this study, the hospital innovation adoption process is largely drawn upon the IT implementation model of Cooper and Zmud (1990) because it 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 variance in the initiation stage. The reason to do so is because eHealth is a relatively new phenomenon which may result in that many hospitals are concentrated in the initiation stage with respect to a particular innovation. Below, the stages of hospital innovation are described. Although the process of innovation typically is not linear (van de Ven, Polley, Garud, & Venkataraman, 2008), the majority of innovations go through several stages before the innovation is used within the organisation to its fullest potential (Damanpour & Wischnevsky, 2006; Greenhalgh, Robert, Bate, et al., 2004). Stage-based models have had their success in identifying several stages in the process of organisational innovation adoption (Greenhalgh, Robert, Bate, et al., 2004). This study assumes that innovations typically move through a number of common, sequenced stages (as outlined in Table 5) leading to their eventual use in an organisation and that specific organisational variables (i.e. size or features of the organisational structure) are associated with higher or lower levels of adoption.

**Table 5) 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 (the adoption decision). |
| 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. |

*Adapted from:* (Cooper & Zmud, 1990; Fichman & Kemerer, 1997)

### 3.1.3 Conclusions

Innovation can be viewed from different levels and perspectives. For the purpose of this study, eHealth is regarded as an innovation to an adopting hospital organisation. Thus, innovation at the ***organisational level***. An organisational innovation adoption framework is constructed in the next section, based on two theories on organisational innovation adoption found in literature.

## 3.2 *Theories on organisational innovation adoption (theoretical framework)*

According to Fichman and Wolfe, there seems no single theory of innovation and it seems unlikely that one will emerge (Fichman, 2000; Wolfe, 1994). As a result, researchers should (and have) develop(ed) theories of the middle range that are tailored to specific classes of technologies or to particular adoption contexts (Fichman, 2000). Consequently, several theories and models on innovation have been identified in the Information System (IS) literature and have been applied under different conditions (Wolfe, 1994). Major differences can be observed with respect to the level of analysis (i.e. individual level versus organisational-level), unit of analysis (i.e. an individual versus the innovation versus the organisation), and the outcome variable (i.e. use versus adoption versus success versus impact).

### 3.2.1 Selection of theory

Given the aim of this study, several theoretical models have been assessed on their applicability in investigating factors influencing the organisational adoption of eHealth.  A number of theoretical models have been proposed in literature to facilitate the understanding of factors affecting the adoption and acceptance of information technologies. In general, innovation adoption has largely been studied at two levels: the individual and the organisation. However, much of the IT adoption research has focused on the individual by explaining what influences their decision to use a particular technology (user adoption and acceptance). Relatively fewer studies have focused on organisational-level adoption by understanding the adoption and diffusion process of an adopting organisation.

At the individual level, *Technology Acceptance Models (TAM)* (Davis, 1989), *Theory of Planned Behaviour (TPB)* (Ajzen, 1991), *Unified Theory of Acceptance and Use of Technology (UTAUT)* (V Venkatesh, Thong, & Xu, 2012; Viswanath Venkatesh, Morris, Davis, & Davis, 2003) and Rogers' early Diffusion of Innovation theory (Rogers, 1995) are dominantly used (Oliveira et al., 2011). Despite their value, these models concentrate rather strongly on user (individual-level) and technological attributes, neglecting attributes of the organisation (Wolfe, 1994). In particular the first three theoretical models can only be used at individual-level (Viswanath Venkatesh et al., 2003), whereas DOI theory can be used at individual-level as well as at organisational-level (Damanpour, 1991; Gopalakrishnan & Damanpour, 1997). Another frequently used theoretical models to study IS innovation is the *IS success* model (W. H. Delone & McLean, 2003; William H Delone & Mclean, 1992). Although this model also take into account the organisation (in terms of organisational impact), the strong focus on IT and information quality does not help explain why the same innovation can be adopted in different ways, and with different effects, in various settings. Hence, it does not consider the organisational context. In the healthcare domain, the

"*Fit between Individuals, Task and Technology (FITT)*" framework has been introduced recently to better understand ICT adoption. Central to the FITT model is the idea that IT adoption in a clinical environment depends on the fit between the attributes of the users (e.g. computer literacy, motivation), of the attributes of the technology (e.g. usability, performance), and of the attributes of the clinical tasks and processes (e.g. task complexity) (Ammenwerth, Iller, & Mahler, 2006; Tsiknakis & Kouroubali, 2009). The FITT framework is an enhancement influenced by some existing models like the *TAM* (Davis, 1989), the *Task-Technology-Fit (TTF)* model (DL Goodhue & Thompson, 1995) and the *IS success* model (W. H. Delone & McLean, 2003; William H Delone & Mclean, 1992). Consideration of the interaction of user and task is the decisive new element. However, organisational aspects in this model are either part of the individual aspect (individual-level) (individuals work in various roles and various groups in an organization), or they are considered in the task aspect (the clinical tasks and processes are organized in a given way, with defined responsibilities). The model has a great overlap with Rogers' compatibility and complexity innovation attributes, however, it also neglects the organisational context. Thus, as this study's focus is on innovation adoption at the organisational level, except for DOI theory, the above theories and models can not considered applicable for the aim of this study.

In response to the lack of a unifying framework of organisational innovation adoption, numerous studies have tried to include as many of the distinctive characteristics of context as possible in the development of an organisational innovation adoption theory. A number of researchers have attempted to identify these contexts (see Table 6).

**Table 6) Contexts in organisational innovation adoption models**

| Contexts | Researcher |
|---|---|
| 1) individual, 2) structural, 3) technical, 4) task-related factors, and 5) environmental factors. | (Kwon & Zmud, 1987a) |
| 1) characteristics of the leaders of organisations, 2) characteristics of the organisation, and 3) characteristics of the environment | (Kimberly & Evanisko, 1981) |
| 1) individual, 2) task, 3) innovation/technology, 4) organisation, and 5) environment | (Premkumar, 2003) |
| 1) individual leader characteristics, 2) internal organisational structural characteristics, and 3) external organisational characteristics | (Rogers, 1995) |
| 1) technological context, 2) organisational context, and 3) environmental context | (Tornatzky et al., 1990) |

In the healthcare domain, Yusof et al. (2008) recently developed a new framework based on *Human, Organization and Technology-fit* (HOT-fit) after having conducted a critical appraisal of the findings of existing HIS evaluation studies. This framework has great overlap with the TOE framework, except that it does not take into account the environmental context. Although this framework does include the organisational context, there are several studies in all industries that point out the importance of the environmental context upon the adoption of information technology (Damanpour & Gopalakrishnan, 1998; Oliveira et al., 2011; Tornatzky et al., 1990). On the other hand, the TOE framework does not have an explicit category "human". However, this category may be included in the organisational context of the TOE framework (see section 6.5).

From the abovementioned organisational adoption theoretical models, *Diffusion of Innovation* (DOI) theory (Rogers, 1995) and the *Technology-Organisation-Environment framework* (TOE) (Tornatzky et al., 1990) are most widely used (Oliveira et al., 2011). DOI theory has been frequently employed to investigate drivers of innovation adoption, since it can be used at individual-level as well as at organisational-level (Damanpour, 1991; Gopalakrishnan & Damanpour, 1997). The TOE framework has received more attention and acceptance from diverse fields of study as it makes Rogers' DOI theory better able to explain organisational innovation adoption by including a new and important component: the environmental context (Hsu et al., 2006; Oliveira et al., 2011). The TOE framework has been empirically tested by many studies and has been found useful in understanding the adoption of technological innovations (Dwivedi, Wade, & Schneberger, 2012; Oliveira et al., 2011). A significant number of previous studies based on the TOE framework have already explored the critical factors for information systems adoption. This is also the case for different health information systems (Dwivedi et al., 2012; Oliveira et al., 2011; Yang, Kankanhalli, Ng, & Lim, 2013). However, given that technology adoption is complex and context sensitive, different factors in the TOE framework may vary across different innovation and adoption contexts (Dwivedi et al., 2012; Tornatzky et al., 1990). Consequently, even though there were some studies adopted TOE framework for investigating organisational adoption of health information system, this framework has not been utilized to the domain of eHealth adoption and in particular not the adoption by Dutch hospitals.

The next sections will further elaborate on DOI theory and the TOE framework as they are considered best applicable given the aim of this study.

### 3.2.2 Diffusion of Innovation

Rogers' theory of Diffusion of Innovation (DOI) provides a fundamental theoretical base of innovation adoption research in many disciplines (Hsu et al., 2006) and has been a dominant theory used to examine organisational adoption of IS over the prior two decades (Hsu et al., 2006; Oliveira et al., 2011). DOI theory posits that an organisation's adoption of innovations is influenced by innovation characteristics and organisational characteristics (Hsu et al., 2006; Rogers, 1995).

Rogers' *early* research primarily focuses on explaining adoption rates and patterns of innovation adoption by individuals from early to late adopters. DOI theory sees innovations as being communicated through certain channels over time and within a particular social system in which individuals are seen as possessing different degrees of willingness to adopt innovations. According to Rogers (1995), the rate of adoption of innovations is impacted by five factors: *relative advantage*, *compatibility*, *trialability*, *observability*, and *complexity*. The first four factors are generally positively correlated with rate of adoption while the last factor, complexity, is generally negatively correlated with rate of adoption. Thus, innovations that possesses these five attributes or characteristics will be adopted smoothly and diffuse faster (Rogers, 1995). Although Roger's early DOI theory was originally developed to explain the behaviour of individuals, it has also been extensively applied to organisations (Damanpour, 1991; Gopalakrishnan & Damanpour, 1997).

**Table 7) Innovation characteristics**

| Construct | Definition |
|---|---|
| Relative advantage | The degree to which an innovation is perceived as being better than the idea it supersedes. |
| Compatibility | The degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. |
| Complexity | The degree to which an innovation is perceived as relatively difficult to understand and use. |
| Trialability | The degree to which an innovation may be experimented with on a limited basis. |
| Observability | The degree to which the results of an innovation are visible to others. |

*Adapted from:* (Rogers, 1995)

In addition to the above contribution, based on studies of organisational innovativeness (the degree to which an organisation is relatively earlier in adopting a new innovation as compared with other organisations), DOI theory identifies several organisational characteristics influence the adoption of innovations (Hsu et al., 2006; Rogers, 1995; Vaidyanathan, 2004; Wolfe, 1994). According to the DOI theory, innovativeness is influenced by factors such as individual (leader) characteristics (leader's attitude towards change), internal organisational structural characteristics (centralisation, complexity, formalisation, interconnectedness, organisational slack, size), and external characteristics of the organisation (system openness) (Rogers, 1995).

**Table 8) Organisational characteristics**

| Construct | Definition |
|---|---|
| Individual leader characteristics | |
| Attitude toward change | |
| Internal characteristics of organisational structure | |
| Centralisation | The degree to which power and control in a system are concentrated in the hands of relatively few individuals. |
| Complexity | The degree to which an organization's members possess a relatively high level of knowledge and expertise, usually measured by the members' range of occupational specialties and their degree of professionalism expressed by formal training. |
| Formalisation | The degree to which an organization emphasizes following rules and procedures in the role performance of its members. |
| Interconnectedness | The degree to which the units in a social system are linked by interpersonal networks. |
| Organisational slack | The degree to which uncommitted resources are available to an organization. |
| Size | |
| External characteristics of organisational structure | |
| System openness | |

*Adapted from:* (Rogers, 1995)

Although Rogers' DOI theory seems to be quite applicable to an investigation of innovation adoption by organisations, researchers continue to search other contexts influencing organisational innovativeness and combine them with Rogers' theory to provide a richer and potentially more explanatory model (Hsu et al., 2006). For instance, the *Technology-Organisation-Environment* framework that will be discussed in the next section.

### 3.2.3 Technological-Organisational-Environmental (TOE) framework

The TOE framework, as presented by Tornatzky and Fleischer (1990), provides a useful analytical framework that can be used for studying the organisational adoption (assimilation) of different types of innovations (Oliveira et al., 2011). The framework identifies three aspects of the organisation's context that influence the adoption of an innovation: the *technological context*, the *organisational context*, and the *environmental context*. Together they present both constraints and opportunities for technological innovation and therefore influence the way an organisation sees the need for, searchers for, and adopts new technology (Oliveira et al., 2011; Tornatzky et al., 1990).

The TOE framework is largely consistent with the DOI theory. In addition to the technological and organisational contexts, that are parallel to the two categories in Rogers' model, the TOE framework also includes a new and important component: the environmental context. The TOE framework makes Rogers' DOI theory better able to explain organisational innovation adoption (Hsu et al., 2006; Oliveira et al., 2011).

Prior research has demonstrated the broad applicability and explanatory power of the TOE framework. The framework has been used to explain the adoption of interorganisational systems, e-business, electronic data interchange, open systems, enterprise systems, and a broad spectrum of general IS applications. However, each study used slightly different factors as measures for each of the framework's contexts (Dwivedi et al., 2012).

### 3.2.4 Conclusions

From this literature review, the TOE framework model and elements of the DOI theory are the basis for this study in developing the conceptual model. As discussed earlier, the TOE framework 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*. Consequently, the TOE framework compared to other adoption theories is a more relevant tool to classify all determinants of IT innovation adoption according to the three contexts and to explain organisational innovation adoption (Hsu et al., 2006; Tornatzky et al., 1990).

The TOE perspective 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 (Dwivedi et al., 2012; Oliveira et al., 2011; Yang et al., 2013).

## 3.3 *Factors influencing the innovation adoption process*

Consistent with the TOE framework, factors are categories in three contexts. Factors within each context are identified based on the literature review of organisational innovation adoption literature and prior studies on innovation (eHealth and IT) adoption by (healthcare) organisations.

### 3.3.1 Technological context

The *technological context* includes the internal and external technologies that are relevant to the organisation and typically refers to the innovation's characteristics that affect innovation adoption. Technologies may include both equipment as well as processes (Oliveira et al., 2011; Tornatzky et al., 1990). This study considers three innovation characteristics of eHealth applications: *relative advantage*, *compatibility* and *complexity*. The factors are identified based on the DOI theory and prior IT innovation adoption studies. According to Rogers (1995), the rate of adoption of innovations is impacted by five characteristics: *relative advantage*, *compatibility*, *complexity*, *trialability* and *observability*. However, because prior IT innovation adoption studies suggest that the latter two characteristics are found to be insignificant influencing IT innovation adoption (Tornatzky & Klein, 1982), they will be excluded in the conceptual model. The technological context will be described in section 5.1, with respect to three eHealth applications telemonitoring in heart failure, telemonitoring in diabetes, and online access to EHR.

#### Relative advantage

Relative advantage refers to "*the degree to which an innovation is perceived as being better than either the status quo or its precursor*" (Rogers, 1995). DOI theory suggest that the relative advantage of an innovation positively influences an organisation's propensity to adopt the innovation (Rogers, 1995). For effective adoption, relative advantage of an innovation must be recognised by key stakeholders of the organisation. If stakeholders perceive a clear advantage in using the innovation, it is more likely the innovation adoption will be successful (Fichman, 2000; Greenhalgh, Robert, Bate, et al., 2004; Rogers, 1995). According to a literature review by Jeyaraj et al. (2006), relative advantage is the most frequently used predictor of IT adoption by organisations.

**Compatibility**
Compatibility refers to *"the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential units of adoption"* (Rogers, 1995). In other words, compatibility refers the organisational fit of the innovation with current work procedures and needs of the organisation (Kamal, 2006). DOI theory suggest that compatibility of an innovation with values, experiences, and needs has a positive relationship with innovation adoption (Rogers, 1995). The necessity that a technology be compatible with the organisation and its tasks is one of the more consistent findings in the innovation adoption literature (Cooper & Zmud, 1990; Jeyaraj et al., 2006).

**Complexity**
Complexity refers to *"the degree to which an innovation is perceived as relatively difficult to understand and use"* (Rogers, 1995). It is the opposite of the innovation's "ease of use" in the IT adoption literature (Fichman, 2000). Innovation's complexity as perceived by the organisation or healthcare professional can have a negative impact on the innovation adoption (Kamal, 2006). Organisations who perceive an innovation as complex are tend to adopt it slowly and in limited capacity (Bradford & Florin, 2003). In addition, innovations that are perceived as "easy to use" (i.e. no additional skills required for innovation use) are more likely to be used by the intended users (de Veer et al., 2011; Fleuren et al., 2004a; Meyer & Goes, 1988). Thus, as DOI theory suggest, innovation's complexity has a negative relationship with innovation adoption (Rogers, 1995). According to a literature review by Jeyaraj et al. (2006), complexity is one of the five most frequently used predictor of IT adoption by organisations.

### 3.3.2 Organisational context

According to the TOE framework, organisational adoption of innovation can be influenced by the organisational context, which refers to the characteristics and resources of the organisation (Oliveira et al., 2011; Tornatzky et al., 1990). As this study's focus will be on the organisational context of a hospital, hypotheses have been developed for the theoretical constructs bellow.

**Organisational structure**
Relevant factors are identified based on the DOI theory's early studies of organisational innovativeness and prior IT innovation adoption studies. Based on DOI theory at organisational level (Rogers, 1995), innovativeness is partly influenced by the internal organisational structural characteristics, including *centralisation*, *complexity*, *formalisation*, *interconnectedness*, *organisational slack* and *size* (Oliveira et al., 2011; Rogers, 1995). This study considers two characteristics of the organisational structure, namely: *centralisation* and *size*.

***Centralisation***
Centralisation refers to *"the extent to which decision-making authority is dispersed or concentrated in an organisation"* (Rogers, 1995). 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 (Rogers, 1995). In a centralised organisation, top leaders are poorly positioned to identify operational problems, or to suggest relevant innovations to meet these needs (Fichman, 2000; Rogers, 1995). In addition, Greenhalgh et al., (2004) state that an organisation will adopt and assimilate innovations more readily if it has decentralised decision-making structures that involve participation of the user in the decision to adopt the innovation and devolved decision making to frontline teams (Damanpour, 1991; Greenhalgh, Robert, Bate, et al., 2004; Klein & Sorra, 1996). Although the initiation of innovations in a centralised organization is usually less frequent than in a decentralised organisation, the centralisation may actually encourage the implementation of innovations, once the innovation decision has been made (Dwivedi et al., 2012; Fichman, 2000; Fleuren, Wiefferink, & Paulussen, 2004c; Rogers, 1995). 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 (Rogers, 1995). Moreover, 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 by 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 of eHealth (Premkumar & Roberts, 1999). Therefore, this study assumes also 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 (Dwivedi et al., 2012), organisation readiness has been defined as *"the availability of the needed organisational resources for adoption"* (Iacovou, Benbasat, & Dexter, 1995; Ramdani & Kawalek, 2007). Implementing an innovation in organisation that is more *ready* is more likely to be successful (Damanpour, 1991; Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidou, 2004; Robert et al., 2009; Rogers, 1995). According to Iacovou et al., (1995), organisational readiness comprises two primary dimensions: *technological readiness* and *financial readiness*. In this study, the following hypothesis is proposed:

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

***Technological readiness***

Technological readiness has been conceptually proposed by Kwon and Zmud (1987) and has been supported by a number of empirical studies on IT innovation adoption (Armstrong & Sambamurthy, 1999; Iacovou et al., 1995; K. Zhu et al., 2006). As argued by Zhu and Kraemer (2005), technological readiness is an important factor for successful IT adoption. 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 (Hsu et al., 2006; Iacovou et al., 1995). These technological resources include both *tangible resources* (comprising the physical IT infrastructure components such as IT infrastructure and hardware) and *intangible resources* (human IT resources comprising the technical and managerial IT skills such as IT knowledge of management and employees, experience and technical skills) (Iacovou et al., 1995). Thus, technological readiness "*is reflected not only by physical assets, but also by human resources that are complementary to physical assets*" (K. Zhu et al., 2006). Technology infrastructure establishes a platform on which eHealth can be build, while IT human resources provide the knowledge and skills to implement eHealth. Additionally, the constructs IT governance and IT security are developed and included in this study as part of technological readiness because they are expected to be an important concern in the adoption of eHealth applications.

*IT infrastructure*
IT infrastructure refers to the physical technologies that enable eHealth applications (K. Zhu et al., 2006). The technology infrastructure establishes a foundation on which eHealth can build. In line with the resource-based theory, tangible resources, such as the physical technology infrastructure, enable organisations to adopt innovations more quickly (Jie, Seeforf, & Lowrey, 2013).

*Human IT resources (support)*
Human IT resources refer to IT professionals possessing the knowledge and skills to implement eHealth applications (Fleuren et al., 2004a; K. Zhu et al., 2006). Besides, assistance in innovation use (i.e. helpdesks) increases the acceptance of users because of the innovation may be perceived to use more easily (Broens et al., 2007; de Veer et al., 2011; Klein & Sorra, 1996). Various researchers argue that sufficient skilled staff available will positivity influence the uptake of new technologies (de Veer et al., 2011; Fleuren et al., 2004c).

*IT governance*
IT governance is also included as a resource since many organisations including the healthcare industry adopted IT governance to ensure that IT is aligned with organisational goals and objectives (Cater-Steel & Tan, 2005). In order to sustain the use of innovation, there is a necessity establishing some order and control in the management of IT resources (Cater-Steel & Tan, 2005; Chen & Tsou, 2007; Sulaiman & Wickramasinghe, 2010).

*IT security*
IT security refers to the degree to which an adequate level of IT security is ensured by the organisation. Especially because the deployment of eHealth is primarily through the support of Internet and other communication technologies, the guarantee of the security of the information flows is an important concern in the adoption decision among adopters. The organisation's ability to provide an adequate level of IT security is therefore relevant to the adoption of eHealth (Broens et al., 2007; Van Dyk, 2014; Wu & Chuang, 2010).

***Financial readiness***
Financial readiness refers to the level of financial resources available to an organisation to pay for the innovation adoption potential or expected expenditures (Iacovou et al., 1995; Oliveira & Martins, 2009). Financial readiness is found to influence IT innovation adoption (Greenhalgh,

Robert, Bate, et al., 2004; Iacovou et al., 1995; Rogers, 1995). According to various researchers, sustainable funding (including funding plans) available for implementing and continuing (after pilot stage) an innovation is one of the strongest predictors for successful adoption and implementation (Broens et al., 2007; de Veer et al., 2011; Fleuren et al., 2004c; Kamal, 2006; Van Dyk, 2014).

*Top management support*

Top management support refers to the extent of commitment and resource support given by the top management for adopting eHealth innovation and change in the organisation (Premkumar, 2003). 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 (Bradford & Florin, 2003; Fichman, 2000; Fleuren et al., 2004c; Gallivan, 2001; Jie et al., 2013; Premkumar & Roberts, 1999; Susanto, 2008). 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*" (Zahra & George, 2002). 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 (Cohen & Levinthal, 1990; Fichman, 2000; Greenhalgh, Robert, Macfarlane, et al., 2004; Jie et al., 2013; Zahra & George, 2002). Thus, an organisation's absorptive capacity is positively associated with adoption (Cohen & Levinthal, 1990; Fichman, 2000; Frambach & Schillewaert, 2002; Greenhalgh, Robert, Bate, et al., 2004). In this study, the following hypothesis is proposed:

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

### 3.3.3 Environmental context

According to the TOE framework, factors that pertain to the environmental context influence organisational adoption of technological innovations. The environmental context is the environment in which the organisation conducts its business. It includes the organisation's industry, competitors, macroeconomic context, and regulatory environment (Hsu et al., 2006; Oliveira et al., 2011; Tornatzky et al., 1990). According to Meyer and Goes (1988), hospitals transact with their environments to acquire inputs such as patients, capital funds, and legitimacy. As this study is limited to hospital organisations within the Netherlands, the environmental context is rather homogeneous. Therefore, the environmental context will fall outside the scope of this study.

### 3.3.4 Control variable

Studies employing surveys should include control variables to ensure that the variances observed can be attributed to only the theoretical constructs included in the study. The type of hospital is taken into consideration in this study as control variable that could explain the variation of the dependent variable eHealth adoption.

### 3.3.5 Non-linear relationships

Although linear techniques have served researchers well, some phenomena under investigation may not behave linearly (Brewster, 2011). 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 (Carver & Scheier, 1998; Kiel, 1995). Investigation of non-linear dynamic systems has shown that the behaviour of systems (whether simple or complex) are frequently nonlinear and/or discontinuous (Barton, 1994; Guastello, 2002). 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 (van de Ven et al., 2008). As a result, at best the findings from linear techniques are not as strong as they could be if a non-linear technique was available and applied appropriately. Results obtained from a non-linear technique may be more complete or provide different insights into the phenomena under study (Brewster, 2011). However, non-linear analysis should follow non-linear theorizing; a relatively unexplored area. Nevertheless, in his DOI theory, Rogers (Rogers, 1995) noted that the relationships of socioeconomic status (and perhaps other independent variables) with innovativeness should not be assumed to be linear. Likewise, Gulati (1996) suggest that the relationship between innovation and organisational slack is curvilinear, or inverse U-shaped. He argues that slack promotes greater experimentation and the pursuit of new projects but also promotes diminishing levels of discipline. Since adequate levels of both experimentation and discipline are requisites for innovation, it is expected slack to have a nonlinear influence on innovation (Gulati, 1996).

## 3.4 *Conclusion*

Consistent with the TOE framework, this study's conceptual model in Figure 10 (and corresponding hypotheses in Table 9) posits factors identified in the literature review within a hospital's contexts (technological, organisational and environmental) influencing the organisational adoption of eHealth. Although this conceptual model provides the bigger picture of a hospital's contexts, this study this study's primarily focus on the organisational context mainly due to restrictions on the amount of constructs that were allowed to be included in the model with respect to the small sample size. This particular context is chosen to be included because CIOs and management have most control over the factors within this context. Hence, the organisational context is the most relevant context to consider from a hospital CIO's perspective.

**Table 9) Overview of proposed hypotheses in this study**

| Hypotheses | |
|---|---|
| $H1_a$ | Centralisation has a negative influence on eHealth adoption. |
| $H1_b$ | Centralisation has a positive influence on eHealth adoption. |
| H2 | Size has a positive influence on eHealth adoption. |
| H3 | Size has a positive influence on organisational readiness. |

| | |
|---|---|
| H4 | Organisational readiness has a positive influence on eHealth adoption. |
| H5 | Top management support has a positive influence on eHealth adoption. |
| H6 | Top management support has a positive influence on organisational readiness. |
| H7 | Absorptive capacity has a positive influence on eHealth adoption. |

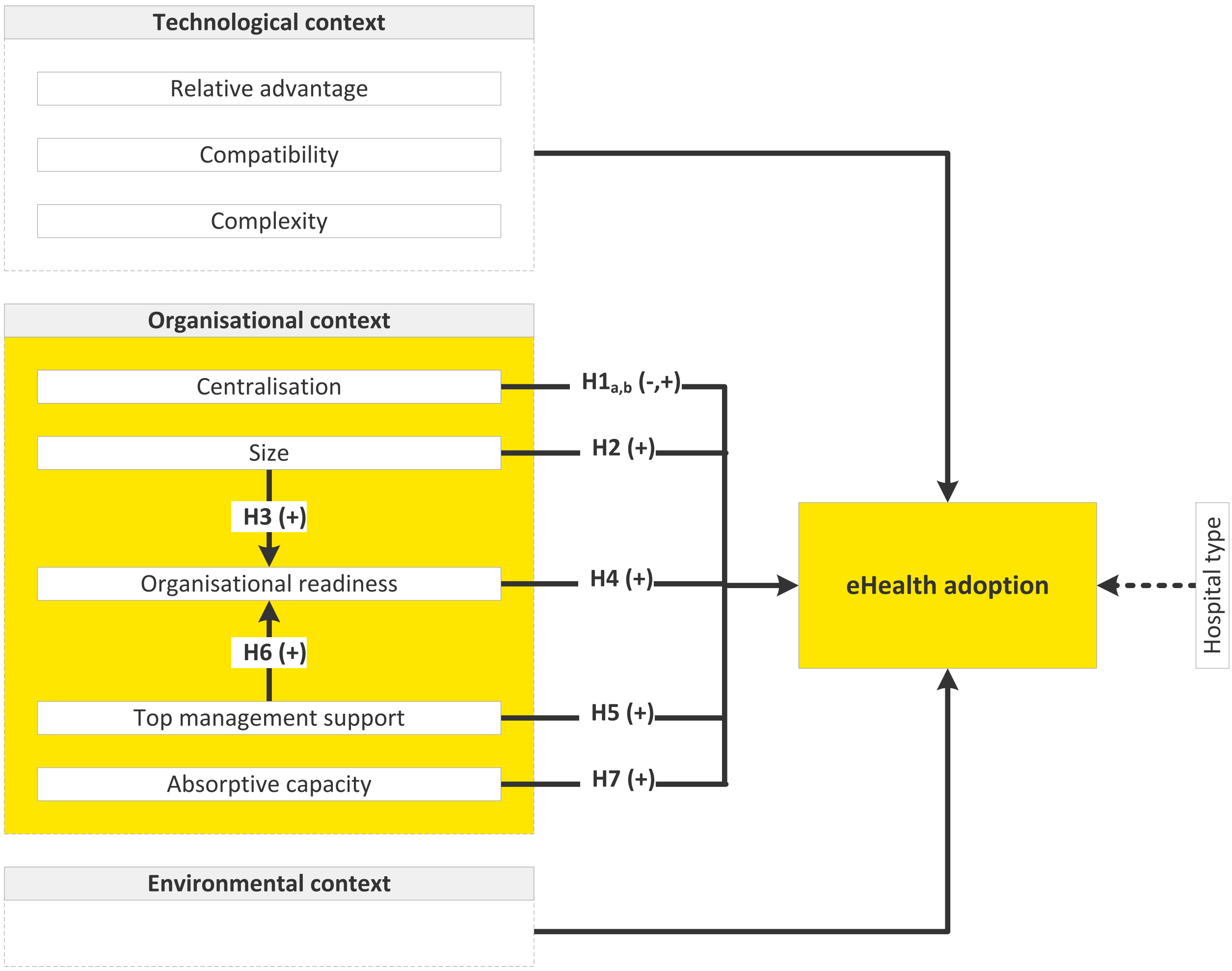



Figure 10) Conceptual model for eHealth adoption by hospitals

# Chapter 4
## Methodology

# 4 Methodology

This chapter describes the design adopted by this study to achieve the aim of this study, namely, to identify the factors influencing the adoption and implementation of eHealth technologies and to synthesise them into a new framework for the successful adoption of eHealth technologies by Dutch hospitals. Section 4.1 describes the research design choice made in this study. Section 4.2 details the participants in this study including an explanation of the sampling procedure. Section 4.3 describes the procedure in designing the instrument to be used in the study and justifies its use. Section 4.4 outlines the procedure for collecting the data. Section 4.5 discusses how the data will be analysed.

## 4.1 *Research design*

Having identified the factors in the problem situation and developed a conceptual model in the previous chapters, the next step is to design the research in a way that the requisite data can be gathered and analysed to arrive at a solution (Sekaran, 2003). Research designs are plans and the procedures for research that span the decisions from broad assumptions to detailed methods of data collection, analyses and interpretation (Creswell & Clark, 2011; Creswell, 2009, 2012). The choices made in constructing the research design for this study are presented in Figure 11 and discussed below.

| | | | | |
|---|---|---|---|---|
| ***Paradigm*** | **Postpositivism** | Constructivism | Pragmatism | Advocacy |
| ***Approach*** | **Deductive** | Inductive | | |
| ***Nature*** | **Quantitative** | Qualitative | Mixed | |
| ***Methodology (Design)*** | Experimental | Case studies | Sequental | |
| | **Non-experimental** | Narratives | Concurrent | |
| | ***Survey design*** | Grounded theory | Transformative | |
| | | Ethnography | | |
| | | Phenomenologies | | |
| ***Timeframe*** | **Cross-sectional** | | | |
| | Longitudinal | | | |
| ***Unit of analysis*** | Individual | | | |
| | **Organisation** | | | |
| | Community | | | |

Figure 11) Elements of the research design

According to Wahyuni (2012), research aim and questions are the suggested starting points to develop a research design because they provide important clues about the substance that a researcher is aiming to assess. Given the purpose and research questions of this study (as described in section 1.4), this present study is of quantitative nature. Quantitative research is a means for testing objective theories by examining the relationship among variables, and is generally based on the logic of deduction as the main variables are specified in advance of data collection and are tested rationally (Bahari, 2012; Creswell, 2009). According to Creswell (2003), in quantitative research the investigator primarily uses postpositivist claims for developing knowledge, employs strategies of inquiry (sometimes called: research methodologies) such as experiments and surveys, and collects data on predetermined instruments that yield statistical data. A quantitative approach has been chosen on three counts. First, a quantitative approach allows for empirical generalisations of the study's findings. Second, most of the constructs were already developed in other studies using the TOE framework. And third, at the time this study was conducted, the opportunity came to combine it with the EY's annual ICT benchmark among hospitals in the Netherlands.

Moreover, this present research can be categorised as a non-experimental design because it aims at identifying the factors influencing the adoption of eHealth by Dutch hospitals and does not require control over behavioural events. A widely used non-experimental strategy of inquiry to identify attitudes, beliefs, opinions, and other types of information is the survey research design. According to Yin (2014), a survey research design is particularly useful when attempting to answer research questions in the form of: "*what*", "*who*", "*where*", "*how much*" or "*how many*". Therefore, since the research question in this study is in the form of "*what*", the most appropriate strategy of inquiry will be a survey research design. Survey research designs include cross-sectional and longitudinal studies using questionnaires or structured interviews for data collection, with the intent of generalising from a sample to a population (Creswell, 2003). Most research studies are cross-sectional, mainly because of the pressure of time and resources (Gray, 2013). For these same reasons, this present research adopted a cross-sectional survey research design, using an online questionnaire that has been administered to a specific population of Dutch hospitals to collect information at one point in time, over a period of 2 months (Sekaran, 2003).

## 4.2 *Population*

### 4.2.1 Unit of analysis

Given the research aim and questions (as described in section 1.4), the population of interest (the target population) is finite and comprises all hospitals in the Netherlands. Consequently, the unit of analysis is the (hospital) organisation.

Hospitals are perhaps most dominant in modern healthcare. Currently, the Netherlands counts 85 hospital organisations (general and academic hospitals) distributed over 131 locations (Nationale Atlas Volksgezondheid, 2013). A hospital can be described as a specialised medical centre, with a concentration of facilities for diagnosis, treatment and care. For emergency situations, they also feature a first aid facility (Mackenbach & Maas, 2008). In general we distinguish three main categories of hospitals: General hospitals (mainly for patient care, but also contribute to training of doctors, specialists and nurses), Academic hospitals (for education, research and patient care) and Categorical hospitals (intended for the treatment of a particular category of patients) (Mackenbach & Maas, 2008). General hospitals can be further divided into "*Samenwerkende Topklinische opleidingsZiekenhuizen*" (STZ), "*Samenwerkende Algemene Ziekenhuizen*" (SAZ) and "*others*" (Bijlsma, 2013; Dutch Hospital Data, 2013). In addition to hospitals, there are also many independent treatment centres and private clinics. Independent treatment centres are relatively small treatment centres offering certain treatments, such as the treatment of cosmetic problems or varicose veins (Mackenbach & Maas, 2008). Currently, an increase in the amount of private clinics can be observed (Bijlsma, 2013; Dutch Hospital Data, 2013).

### 4.2.2 Sample

Due to practical reasons, however, it is not possible to include the entire population of interest in this study as the three eHealth applications – *online access to patient health record, telemonitoring in heart failure*, and *telemonitoring in diabetes* – studied in this survey research are mainly used in the provision of general healthcare. Studying a Cancer Treatment Centre (categorical hospital) in respect to telemonitoring in heart failure, for instance, would result in biased outcomes. Therefore, the sample frame was limited to hospitals for the provision of general healthcare by excluding categorical hospitals, rehabilitation centres, independent treatment centres, and private clinics. Consequently, the accessible population of this study entails all general and academic hospitals in the Netherlands (see Table 10).

**Table 10) Composition of the accessible population**

| Type of hospital | Amount |
|---|---|
| Academic | N=8 (9.41%) |
| General, *of which:* | N=77 (90.59%) |
| *STZ* | *N=26 (33.77%)* |
| *SAZ* | *N=37 (48.05%)* |
| *Other* | *N=14 (18.18%)* |
| **Total** | **N=85 (100%)** |

Due to dynamics in the Dutch hospital landscape (mergers and bankruptcies), there was no up-to-date list of all general and academic hospitals in the Netherlands available prior to this study. Therefore, an up-to-date list has been constructed based on four sources that were found on the Internet and one source of EY. The network of EY was used to obtain contact information of 30 hospitals. For the other hospitals, contact information in the form of e-mail addresses of Chief Information Officers (CIOs) or ICT managers was supplemented by to the following procedure: 1) LinkedIn was used to find the right persons to fill in the survey (CIO or ICT manager), 2) telephone numbers of each hospital was gathered, and 3) all hospitals were called following the protocol in Appendix F. to obtain e-mail addresses. In Appendix D. the sample frame is presented. Because of privacy concerns, contact information is not included in this report.

The survey was distributed to 85 hospital organisations in the Netherlands. 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). The final sample size consisted of respondents from 30 hospital organisations (general and academic hospitals) located in different parts of the Netherlands. As can be seen in Table 11, 93% of the sample was general hospitals compared to 7% academic hospital organisations. More specifically, of the general hospitals, 36% were STZ, 43% were SAZ, and "other" general hospitals accounted for 22%.

**Table 11) Composition of the sample**

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

A $Chi^2$ has been performed to test whether the sample composition is representative for the composition of the real population. A p-value of .608 indicates that the composition of the sample is equal to the population. In addition, two *one-sample t-tests* have been performed on the variables [SIZE] and [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] and p-value=.707 for [TURNOVER]). Thus, the above results suggest that the sample is representative for the real population of general and academic hospitals with respect to the hospital type, size and annual turnover.

## 4.3 *Instrumentation*

Because there was no readily available measurement instrument that was entirely applicable for the purpose of this study, an instrument was developed based on several existing surveys in literature. The entire survey can be found in Appendix N. Note, however, that only a part of the questions in the survey was used in this study.

### 4.3.1 Instrument development

A questionnaire was designed that was comprehensible and easy to answer for CIOs or top-level ICT managers of Dutch hospitals. It covered all constructs of the conceptual model for organisational eHealth adoption in Figure 10. 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 measurement instrument was evaluated by means of three survey testing methods. First, an expert group was composed of experts in the field of healthcare and innovation, having prior experience in designing questionnaires (see Table 12). Expert group testing was conducted through a not formally structured discussion on each question. The expert group did not involve the respondent. Second, the questionnaire has been tested by means of a cognitive interview, resulting in qualitative information on how the questions are understood and answered. In a think aloud interview an expert in Health Information Systems described his thoughts while answering the survey questions. This think aloud session was used to identify difficulties in question comprehension, misperceptions of the response task, types of recall strategies used and reactions to sensitive questions. Third, the questions were tested in the field along with the instructions. An ICT manager was asked to provide feedback on the survey in terms of comprehension and time to complete the survey.

**Table 12) Instrument testing group**

| Expertise | Organisation |
|---|---|
| Expert group | |
| Professor at faculty TPM | Delft University of Technology |
| Assistant professor at faculty TPM | Delft University of Technology |
| Manager EY: IT Healthcare | EY |
| Senior auditor EY | EY |
| Cognitive interview | |
| Hospital Information Systems (HIS) specialist | Carestream Health |
| Field testing | |
| ICT Manager | Nij Smellinghe and Zorggroep Pasana |

### 4.3.2 Operationalization of constructs

This subsection describes how the constructs were operationalised in the measurement model[3]. This study designed a mixed measurement model in which most of the constructs were reflectively measured, except from the construct *organisational readiness,* which was formatively measured[4]. The measures were mainly adaptations of existing measures that were used in prior IT innovation adoption studies.

#### 4.3.2.1 *Dependent variable: eHealth adoption*

Dependent variables used in previous organisational innovation adoption studies were very different. There is no consistent approach to measuring innovation adoption. Most of the organisational innovation adoption research is concentrated on the adoption stage, including measures such as the earliness of adoption and frequency of adoption (e.g. the number of adoptions across a set of innovations) (Fichman, 2001; Jeyaraj et al., 2006).

Significantly less attention has been paid to post-adoption stages, which occur after the adoption the decision has been made (Hsu et al., 2006) (see section 3.1.2.1 for the innovation adoption process in organisation). Nevertheless, Fichman and Postema (2000; Postema) see that more dynamic indicators are increasingly used in research to measure successful innovation adoption, including aggregated adoption, assimilation stage achieved, and extent of implementation. Existing measures that do take into account the post-adoption stages can be roughly categorised in two groups (Hsu et al., 2006):

1) Based on Kwon and Zmud's (1987) six-stage model of IT innovation adoption (including initiation, adoption, adaption, acceptance, routinization, and infussion) the dependend variable of innovation adoption is measured from 1 to 6 according to the six stages.
2) Innovation use is measured based on Massetti and Zmud's (1996) four dimensions of IT innovation use measurement: volume, diversity, breadth, and depth.

This study measures succesful adoption of eHealth in the following way, as proposed by (Fichman, 2001):

1) The *aggregated extent of adoption (which aggregates across innovations and across stages)*: was created by summating the standardized[5] extent of adoption (to mean of zero with unit variance) of three eHealth applications measured from 1-8 according to the stages of the organisation innovation adoption process as described in section 3.1.2.1 [DV1_t_1]. Respondents were asked to indicate the extent of adoption of three eHealth applications by dragging each innovation to the corresponding stage of adoption, measured on a 8 point-scale according to the stages of the organisation innovation adoption process.

Fichman (2001) argued that a measure obtained by aggregating the adoption stages of organisational innovation would better explain the organisational innovation adoption process as it combines different kinds of innovation behaviour – such as propensity to adopt innovation, propensity to adopt them earlier

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[3] The measurement model defines the relations between the latent variables (constructs) and the observed indicators (manifest variables or items) (Vinzi et al., 2010).

[4] Three measurement models can be distinguished: 1) a reflective model when the observed indicators are assumed to be the reflex of the latent variables, 2) a formative model when the observed indicators are assumed to cause or form the latent variables, and 3) a mixed model when some of the latent variables use a formative model, while others adopt a reflective model (Vinzi et al., 2010).

[5] According to Fichman (2001) this is the same approach that has been used previously to create aggregated measures, except for the use of standardized variables. While averaging raw scores can lead to composite variables that have more descriptive meaning, it leaves the composite vulnerable to being biased toward technologies that have larger variances.

and the propensity to implement them in a more rapid and sustained fashion – in one single measure. Moreover, as argued by Fichman (2001), aggregating across as few as three innovations lead to much stronger results in terms of predictive validity than for any single innovation model. Besides, since theoretical models of innovation are often developed with the intention of generalising to broader classes of technologies (as is the case in this study), it appears that aggregation within a class of technologies can substantially reduce the possibility of Type II errors for generalisations at these broader levels (Fichman, 2001).

#### 4.3.2.2 *Independent variables measures*

As Table 13 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], the respondents were asked to indicate whether the statements were applicable to the situation within their hospital organisation, measured on a Likert seven-point scale (strongly disagree – strongly agree).

With regard to the higher-level constructs, Jarvis (2003) argues that four main types can be derived from the fact that (a) a lower-order construct can have either formative or reflective indicators, and (b) those lower-order constructs can, themselves, be either formative or reflective indicators of an underlying higher-order construct. Consequently, the following combinations can be distinguished: 1) reflective (lower-order)-reflective (higher-order) (type I), 2) reflective-formative (type II), 3) formative-reflective (type III), and 4) formative-formative (type IV). In addition, it is also possible for a model to contain a mixture of formative and reflective indicators. According to Jarvis (2003), "mixed models could result either because some of the first-order dimensions are formative indicators of the second-order construct and some are reflective indicators of the second-order construct or because some of the first-order dimensions themselves have formative indicators and some have reflective indicators." In this study, "organisational readiness" can be classified as a mixed formative model that is formed by the formatively measured construct "technological readiness" and the reflectively measured construct "financial readiness". "Technological readiness" can be classified as a *reflective-formative type II model*, in which the lower-order constructs (IT infrastructure, IT human resources, IT governance, and IT security) are reflectively measured that do not share a common cause but rather form general concept that fully mediates the influence on subsequent endogenous variables (Becker, Klein, & Wetzels, 2012; Chin, 1998; Jarvis et al., 2003).

See Section 5.2.1 for the outcomes of the measurement model assessment are presented.

**Table 13) Overview of constructs and their operationalisation**

| Construct | Operationalization (items) | Code | Sources |
|---|---|---|---|
| Technological context | | | |
| Relative advantage (R) | [eHealth application] stelt uw organisatie in staat efficiëntere zorg te verlenen. (Question 4, 18, 32) | [RA_1] | (Ifinedo, 2011; Moore & Benbasat, 1991; Ramamurthy, Premkumar, & Crum, 1999; Ramdani, Kawalek, & Lorenzo, 2009) |
| | [eHealth application] stelt uw organisatie beter in staat aan patiëntbehoeften te voldoen. (Question 5, 19, 33) | [RA_2] | |
| | [eHealth application] stelt uw organisatie in staat doelmatiger zorg te leveren. (Question 6, 20, 34) | [RA_3] | |
| Compatibility (R) | [eHealth application] komt helemaal overeen met de behoeften en prioriteiten van uw organisatie. (Question 7, 21, 35) | [OC_1] | (Moore & Benbasat, 1991; Ramamurthy et al., 1999; Ramdani et al., 2009) |
| | [eHealth application] vergt geen verandering van waarden, normen en cultuur van uw organisatie. (Question 8, 22, 36) | [OC_2] | |

| | | | |
|---|---|---|---|
| | [eHealth application] sluit goed aan bij de huidige werkwijze in de zorg. (Question 9, 23, 37) | [OC_3] | |
| Complexity (R) | [eHealth application] is zeer eenvoudig te gebruiken door de medisch professionals (reversed). (Question 10, 24, 38) | [CO_1_r] | (Moore & Benbasat, 1991; Ramamurthy et al., 1999; Ramdani et al., 2009) |
| | [eHealth application] vereist extra vaardigheden van de medisch professionals. (Question 11, 25, 39) | [CO_2] | |
| | [eHealth application] is moeilijk te implementeren. (Question 12, 26, 49) | [CO_3] | |
| Organisational context | | | |
| Centralisation (R) | De structuur van uw organisatie is in sterke mate gedecentraliseerd (reversed). (Question 69) | [CE_1_r] | (Covin & Slevin, 1991; Jaworski & Kohli, 1993) |
| | Besluiten over het implementeren van nieuwe IT worden centraal genomen. (Question 70) | [CE_2] | |
| Size (R) | The number of beds[6], using a logarithmic transformation to adjust for curvilinearity. | [SIZE_t_1] | (Greenhalgh, Robert, Macfarlane, et al., 2004; Meyer & Goes, 1988) |
| Organisational readiness (F) | A higher level formative construct consisting of two dimensions: 1) Technological readiness and 2) Financial readiness. (see below) | | (Grandon & Pearson, 2004; Iacovou et al., 1995; Ramdani et al., 2009; Ramdani & Kawalek, 2007; Teo & Pian, 2003) |
| 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) | | (Armstrong & Sambamurthy, 1999; Hsu et al., 2006; Iacovou et al., 1995; Kwon & Zmud, 1987b; Teo & Pian, 2003; K. Zhu et al., 2006) |
| IT infrastructure (R) | De IT infrastructuur in uw organisatie is toereikend voor eHealth. (Question 46) | [IT_1] | (Armstrong & Sambamurthy, 1999; Hsu et al., 2006; Iacovou et al., 1995; Kwon & Zmud, 1987b; Teo & Pian, 2003; K. Zhu et al., 2006) |
| | Wireless Internet is overal te allen tijde beschikbaar binnen uw organisatie voor de medisch professionals. (Question 47) | [IT_2] | |
| | Wireless Internet is overal te allen tijde beschikbaar binnen uw organisatie voor patiënten. (Question 48) | [IT_3] | |
| | Uw organisatie faciliteert het gebruik van Bring Your Own Device (BYOD) door de medisch professionals. (Question 49) | [IT_4] | |
| IT human resources (support) (R) | Bij de implementatie van een eHealth toepassing beschikt uw organisatie over voldoende ondersteunend personeel. (Question 102) | [HR_1] | (Armstrong & Sambamurthy, 1999; Hsu et al., 2006; Iacovou et al., 1995; Kwon & Zmud, 1987b; Teo & Pian, 2003; K. Zhu et al., 2006) |
| | Bij de implementatie van een eHealth toepassing beschikt uw organisatie over voldoende ondersteuning op het gebied van training. (Question 103) | [HR_2] | |
| | In uw organisatie is een helpdesk aanwezig voor technische ondersteuning bij de implementatie en toepassing van eHealth. (Question 105) | [HR_3] | |

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| | | | |
|---|---|---|---|
| IT governance (R) | IT Strategie is opgesteld en bekrachtigd door het bestuur. (Question 71) | [IG_1_t] | Self-developed |
| | Er is een korte termijn (1 à 2 jaar) visie met betrekking tot IT beleid opgesteld. (Question 72) | [IG_2_t] | |
| | Er is een lange termijn (5 jaar) visie met betrekking tot IT beleid opgesteld. (Question 73) | [IG_3] | |
| IT security (R) | Uw organisatie maakt gebruik van DigiD. (Question 58) | [SE_1] | Self-developed |
| | Uw organisatie voldoet aan alle eisen voor een Goed Beheerd Zorgsysteem. (Question 59) | [SE_2] | |
| | Uw organisatie voldoet aan alle eisen van de NEN7513 (2010). (Question 60) | [SE_3] | |
| | Uw organisatie voldoet aan alle eisen van de NEN7510 (2011). (Question 61) | [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] | (Kevin Zhu & Kraemer, 2005) |
| Top management support and commitment (R) | Het management beloont personeel voor eHealth innovatie en creativiteit. (Question 98) | [MS_1] | (Duan, Deng, & Corbitt, 2012; Ifinedo, 2011; Premkumar & Roberts, 1999; Ramdani et al., 2009; Yap, James, & K. S., 1994) |
| | Het management stimuleert sterk het gebruik van eHealth. (Question 99) | [MS_2] | |
| | Het management stelt voldoende middelen (tijd en geld) beschikbaar voor eHealth. (Question 100) | [MS_3] | |
| | Het bestuur heeft een visie ontwikkeld over eHealth. (Question 90) | [MS_4] | |
| | Evaluatie tussen het management en medisch professionals over de effecten van eHealth vindt plaats op regelmatige basis. (Question 97) | [MS_5] | |
| Absorptive capacity (R) | Uw organisatie is goed in staat nieuwe eHealth toepassingen te identificeren. (Question 77) | [AC_1] | (Cepeda-Carrion, Gabriel, & Navarro, 2012; Flatten, Engelen, Zahra, & Brettel, 2011; Jansen, Van Den Bosch, & Volberda, 2005) |
| | Het zoeken naar nieuwe eHealth mogelijkheden is een alledaagse bezigheid in uw organisatie. (Question 78) | [AC_2] | |
| | Uw organisatie bezoekt met enige regelmaat bijeenkomsten om nieuwe kennis over eHealth te verwerven. (Question 79) | [AC_3] | |
| | Medisch professionals worden regelmatig bijgeschoold en voorgelicht over nieuwe ontwikkelingen in eHealth. (Question 104) | [AC_4] | |
| | In uw organisatie is een goede communicatie tussen medische professionals en IT professionals. (Question 80) | [AC_5_t] | |
| | Uw organisatie kent goed georganiseerde communicatiekanalen voor het uitwisselen en delen van kennis en ideeën. (Question 81) | [AC_6] | |
| | Uw organisatie is in staat nieuwe eHealth kennis in te zetten voor het ontwikkelen van nieuwe (verbeterde) zorgdiensten. (Question 82) | [AC_7] | |
| | Uw organisatie gaat voortdurend na hoe nieuwe IT kennis beter benut kan worden. (Question 83) | [AC_8] | |
| *Items in grey were removed from final measurement model, (R) = reflectively measured, (F) = formatively measured* | | | |

#### 4.3.2.3 *Control variable*

Two types of hospital organisations fall insight the scope of this study: general hospitals and academic hospitals. In order to control for the type of hospital, the variable is included in the model. For that to work, type of hospital has been included in the dataset as a dummy variable: 1 for academic hospitals and 2 for general hospitals. Consequently, the variable will essentially measure "the degree of generalness" of each hospital. As we have more than two endogenous variables (organisational readiness and eHealth adoption), the controls were added to both of them (Kock, 2011b). See Appendix L. for the model including the control variable.

## 4.4 *Data collection procedure*

The data used to test the research model was collected using a cross-sectional survey questionnaire and a secondary source[7]. The questionnaire was used to collect most of the data, while a secondary data source was only used to collect data regarding a hospital's size and type. For the latter, respondents had to fill in the name of their organisation. In return a personal benchmark report was offered.

An online questionnaire was distributed to and collected from one Chief Information Officer (CIO) or top-level ICT manager at each hospital in the sample, from the 15th of June 2014 to the 25th of August 2014. The questionnaire was distributed via e-mail, including a cover letter and instructions. Both, the e-mail and the first page of the online questionnaire, included a cover letter in which the purpose of the research was explained, the average completion time of the questionnaire was given, confidentiality statements were made, and a personal benchmark was offered as a return for filling in the questionnaire (see Appendix N. and O. ). The questionnaire was confidential, but respondents were offered a personal benchmark report for which they had to fill in the name of their organisation. Therefore, anonymity in this report as well as in the benchmark was promised and respected, and all data were handled in confidence. Instructions were provided per question for the purpose of clarification.

A total of 85 questionnaires were distributed to hospitals with the request to get these filled in from a CIO or top-level ICT manager having knowledge of eHealth in the organisation. The first reminder was sent after 10 days from the first e-mail followed by multiple reminders every 10 days, until the sample was sufficient for the intended analyses and with respect to the time available for this study. In between the reminders, hospitals were contacted by telephone to ascertain the survey was arrived to the right person. Some of the hospital's CIOs or top-level ICT managers were very enthusiastic about filling in the questionnaire, while for other hospitals e-mail and telephone was extensively used to make them understand the purpose of this study and that the data provided will be used for academic research.

The online questionnaire was created and conducted using "*Collector – software for demanding and innovative online surveys*". This particular software offered all functionalities required for the purpose of this study's questionnaire, including conditional routing, all of the current question-types in market, recruitment via e-mail, e-mail invitation with corporate identity layout, importation of email addresses, reminders, results in real time, data-export to excel and SPSS, and the possibility of anonymous handling (Survalyzer AG, 2011).

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## 4.5 *Data processing and analysis*

### 4.5.1 Data preparation and screening

Prior to performing the data analysis, it is necessary to assure that the conditions of the data are theoretically appropriate and statistically adequate. Following recommendations by (Joseph F. Hair, Black, Babin, & Anderson, 2010) the data were screened on missing values, outliers, normality and homoscedasticity.

First of all, variables were relabelled to reflect an abbreviation of the construct being measured and 6 variables were reverse coded into new variables. Next, data screening is performed in SPSS22.0.

The initial dataset contained a total of 58 unique (based on IP-address) responses. According to (Joseph F. Hair et al., 2010), cases with a minimum of 15% or more missing data are candidates for deletion. Following this rule of thumb, 28 incomplete cases were deleted. Furthermore, there were a few cases that had 1 or 2 missing values. The *Extraction-Maximization* method was used to replace these missing values. Besides, in three cases a hospital has been recently merged with another hospital. As secondary data was only available for each independent hospital, variables such as [SIZE] and [REVENUE] were calculated by summating the values of each of the two hospitals. Additionally, hospital's websites were used for validation. Outliers were tested univariatly by examining the distribution of observations for each variable in the analysis. First, the data was converted to z-scores. Second, cases with standard scores of 2.5 or greater were defined as outliers (Joseph F. Hair et al., 2010). However, since the majority of the questions have a 7 point Likert scale, it is hard to say whether differences between cases are indeed outliers. Therefore, they cannot be removed. Although the initial response rate was 68% (58/85), after the removal of missing data and outliers, 30 cases remained resulting in a response rate of 35% (30/85).

Normality is the most fundamental assumption in multivariate analysis, referring to the shape of the data distribution of an individual metric variable and its correspondence to the normal distribution. If the variation from the normal distribution is sufficiently large, all resulting statistical tests are invalid, because normality is required to use the F and t-statistics. Moreover, normality can have serious effects in small samples (N<50) (Joseph F. Hair et al., 2010). With regard to the small sample size of this study, normality was assessed by examination of skewness and kurtosis values, and the examination of the normality plot (which compares the cumulative distribution of actual data values with the cumulative distribution of a normal distribution) of each variable. As a result, 15 variables showed a high level of skewness and kurtosis. In addition, the visual review did confirm the normality assumption being violated for these variables. In order to meet the normality assumption, these variables have been transformed as follows: $Log_{10}$ transformation for positively skewed variables and square root transformation for negatively skewed variables.

Homoscedasticity refers to the assumption that dependent variable(s) exhibit equal variance across the range of predictor variables (Joseph F. Hair et al., 2010). Homoscedasticity was checked by examining the outcomes of the Levene's test for two predictor variables (size and hospital type). In terms of homoscedasticity, the results of the Levene's test depicted that the homogeneity of variance assumption was not violated (p-value=>.5).

Finally, the data was loaded into WarpPLS4.0 which conducted an additional check on the data. The assessment of the output in Appendix H. did not found any errors.

### 4.5.2 Exploratory Factor Analysis (EFA)

EFA was used to assess the presence of common method bias and unidimensionality of reflective measurement models.

#### 4.5.2.1 *Common method bias*

Common method bias occurs when a significant amount of spurious covariance shared among variables is attributable to the common method used for collecting data (Malhotra, Kim, & Patil, 2006; Urbach & Ahlemann, 2010). In other words, common method bias refers to the condition in which variance observed is a result of the method of the data collection rather than what the measurement is intended to assess. Because in this study most data was collected through self-report surveys in which the same respondent responds to the items in a single questionnaire at the same point of time, the data are likely to be susceptible to common method bias (Malhotra et al., 2006). In order to test the presence of common method bias, Harman's single-factor test was conducted. To this end, all items used in the study are subject to an exploratory factor analysis. The unrotated factor solution is investigated to determine the number of factors that are necessary to account for the variance in the items. Common method bias is assumed to exist, if "1) a single factor emerges from unrotated factor solutions," or "2) a first factor explains the majority of the variance in the variables" (Malhotra et al., 2006). Results from EFA (see Appendix G. ) suggest that the data is free from common method bias because seven factors emerged from the unrotated factor solution. Besides, the first factor only explains 33% of the variance in the variables.

#### 4.5.2.2 *Unidimensionality*

Unidimensionality refers to a latent variable (or reflectively measured construct) having each of its measurement items relate to it better than to any others (Urbach & Ahlemann, 2010). Following the guidelines of Vinzi et al. (2010), the reflective measurement models should be tested at unidimensionality as the PLS approach assume that a latent construct, reflected by manifest variables, satisfies the assumption of unidimensionality. Unidimensionality was assessed based on the Kaiser's rule (a block may be considered unidimensional if the first eigenvalue of its correlation matrix is higher than 1, while the others are smaller) and item loadings of >.5 to their corresponding construct (Urbach & Ahlemann, 2010). In case unidimensionality was rejected, eventual groups of unidimensional sub-blocks were identified by referring to patterns of variable-factor correlations displayed on the loading plots (Vinzi et al., 2010). Because the unidimensionality procedure cannot be conducted directly from PLS-SEM (Mohamad, Bin, & Afthanorhan, 2014; Urbach & Ahlemann, 2010), EFA was conducted using the Principle Components Analysis[8] (PCA) method with Varimax rotation. Because the sample was quite small (N<50), Regular Exploratory Factor Analysis[9] (REFA) method was used with Varimax rotation. As the REFA method may result in fewer salient item loadings, the results provide a more cautious analysis of the data compared to those of a PCA (Jung, 2013). Items that did not meet the generally excepted thresholds were removed sequentially (final results can be found in Appendix G. ). In total, two items were removed from two constructs ([HR_3], [SE_2]). In the case of the higher-order formative construct (multidimensional construct) "Technological readiness", unidemsionality was rejected. Hence, four

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[8] Principle Components Analysis (PCA) is statistically considered as a way to explore structures in multivariate data by reducing the dimensionalities of the data.

[9] Regularized Exploratory Factor Analysis (REFA) is a factor extraction method that is designed for small sample sizes. REFA was developed by combining a class of noniterative estimations of unique variances and three widely used estimation methods: Maximum Likelihood, Generalized Least Squares, and Unweighted Least Squares. Because REFA is not available yet in statistical software such as SPSS, factor extraction was calculated with MATLAB R2011a using a program provided by Sunho Jung (Jung & Lee, 2011; Jung & Takane, 2008; Jung, 2013)

unidemensional sub-constructs were identified in the factor matrix, referring to the reflective constructs of the higher-order formative construct: IT infrastructure, IT human resources (support), IT governance, and IT security.

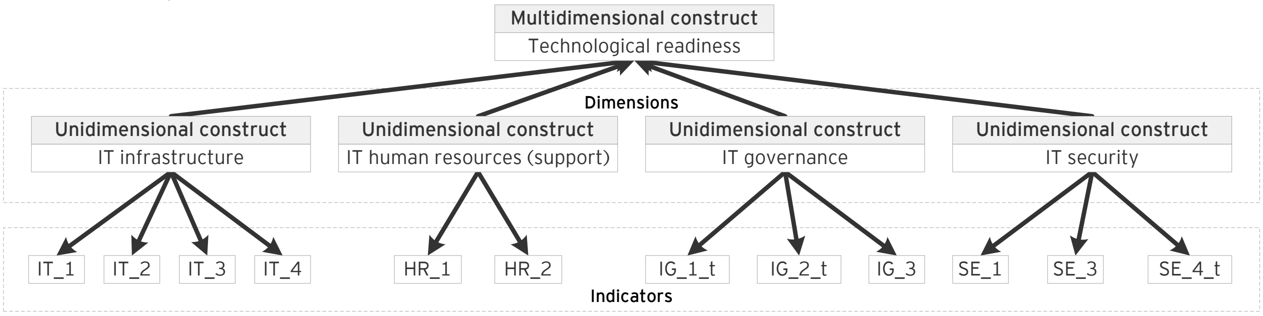



**Figure 12) Multidimensional construct: technological readiness**

In order to assess the unidimensionality of the constructs within the technological context, all corresponding items were included in an EFA. In total, three items were removed ([OC_1], [CO_2], [CO_3]). Despite it was expected to retrieve three factors (relative advantage, compatibility, complexity), only two unidemensional sub-constructs were identified in the factor matrix, referring to relative advantage and compatibility.

### 4.5.3 Partial Least Squares - Structural Equation Modelling (PLS-SEM)

Currently, there are two general approaches to SEM: 1) covariance-based structural equation modelling (CB-SEM) as implemented in LISREL, AMOS, EQS, SEPATH, and RAMONA and 2) the component-based approach PLS-SEM (Urbach & Ahlemann, 2010). Table 14 summarizes the characteristics of the PLS-SEM and compares it with CB-SEM.

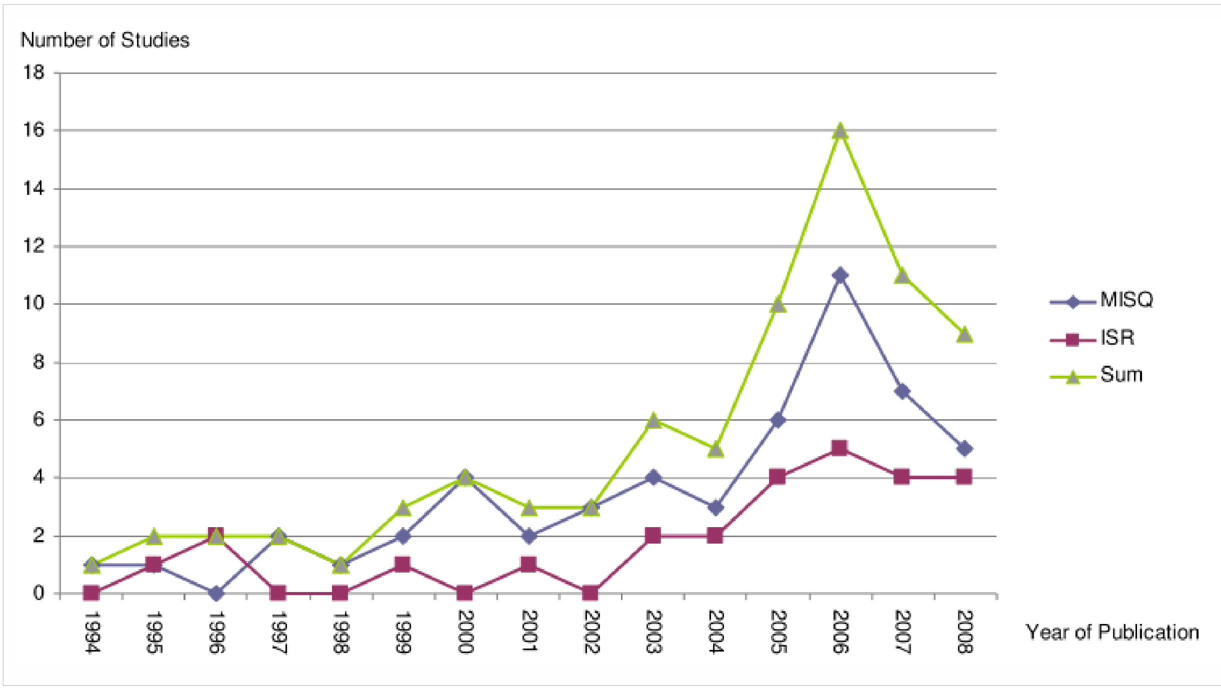
**Table 14) PLS-SEM versus CB-SEM**

| Criteria | PLS-SEM | CB-SEM |
|---|---|---|
| Objective | Prediction-oriented | Parameter-oriented |
| Approach | Variance-based | Covariance-based |
| Assumption | Predictor specification (nonparametric) Consistent | Typically multivariate normal distribution and independent observations (parametric) |
| Parameter estimates | Consistent as indicators and sample size increase (i.e., consistency at large) | Consistent |
| Latent variable scores | Explicitly estimated | Indeterminate |
| Epistemic relationship between an LV and its measures | Can be modelled in either formative or reflective mode | Typically only with reflective indicators. However, the formative mode is also supported. |
| Implications | Optimal for prediction accuracy | Optimal for parameter accuracy |
| Model complexity | Large complexity (e.g., 100 constructs and 1,000 indicators) | Small to moderate complexity (e.g., less than 100 indicators) |
| Sample size | Power analysis based on the portion of the model with the largest number of predictors. Minimal recommendations range from 30 to 100 cases. | Ideally based on power analysis of specific model—minimal recommendations range from 200 to 800. |

| | | |
|---|---|---|
| Type of optimization | Locally iterative | Globally iterative |
| Significance tests | Only by means of simulations; restricted validity | Available |
| Availability of global Goodness of Fit (GoF) metrics | Are currently being developed and discussed (however, WarpPLS4.0 is the first who provides this functionality, see section 4.5.3.2) | Established GoF metrics available |

*Adapted from:* (Chin, 2010; Urbach & Ahlemann, 2010)

This study adopts Partial Least Squares – Structural Equation Modelling (PLS-SEM) "soft modelling" approach through WarpPLS 4.0 (Kock, 2010, 2013; Vinzi et al., 2010). Partial least squares structural equation modelling (PLS-SEM) approach and the advanced PLS-SEM algorithms have enjoyed steady popularity as a key multivariate analysis method in management information systems (MIS) research (Gefen & Rigdon, 2011; Urbach & Ahlemann, 2010). Urbach et al., (2010) conducted a systematic literature review demonstrating the increasing popularity of PLS in IS research by analysing all research articles that appeared in two prestigious international IS journals, namely *Information Systems Research (ISR)* and *Management Information Systems Quarterly (MISQ)*, during a period of fifteen years (from 1994 until 2008). Figure 13 shows the distribution of empirical research articles that used PLS-SEM over time. For one, it is apparent that the use of PLS-SEM has increased over time. Furthermore, their analysis indicate that in the empirical studies published in the two journals investigated, PLS has been used even more frequently than the covariance-based approaches. Moreover, their findings are in line with the findings of (Dale Goodhue, 2006), who discovered that "PLS has been wholeheartedly accepted as an important statistical method in the MIS field."




*Adapted from:* (Urbach & Ahlemann, 2010)

**Figure 13) Distribution of studies using PLS-SEM over time**

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, minimal demands on measurement scales, and a relatively small sample size is acceptable. Third, WarpPLS is unique among PLS-SEM software in computing nonlinear relationships between constructs (Kock, 2013; Vinzi et al., 2010). The abovementioned advantages reflect most of PLS-SEM's strengths. However, some of the characteristics have to be treated with caution (DL Goodhue, 2013; Joe F Hair, Sarstedt, Ringle, & Mena, 2012; Henseler & Dijkstra, 2014; Ringle & Sarastedt, 2012; Rönkkö & Evermann, 2013; Urbach & Ahlemann, 2010).

#### 4.5.3.1 *PLS-SEM approach*

PLS-SEM works by "simultaneously assessing the reliability and validity of the measures of theoretical constructs (confirmatory factory analysis (CFA) and estimating the relationships among these constructs (path modelling)". Accordingly, a Structural Equation Model with latent constructs has two components (Vinzi et al., 2010): 1) the outer model (the *measurement model* including the unidirectional predictive relationships between each construct and its associated observed indicators), and 2) the inner model (the structural model showing the relationships (paths) between constructs). Appendix I. shows the steps taken during the model construction.

In contrast to EFA, PLS-SEM performs a CFA in which the pattern of loadings of the measurement items on the reflective constructs is specified explicitly in the model. Then, the fit of this pre-specified model is examined to determine its convergent and discriminant validities (Vinzi et al., 2010). The higher level constructs, organisational readiness and technological readiness, were modelled using the two-step approach in which the lower-order construct scores are initially estimated in a model without higher-order constructs. Then, the lower-construct scores are used as indicators in a separate higher-order structural model analysis. This approach is particularly advantageous when estimating higher-order models with formative indicators and in the case of small sample sizes (Becker et al., 2012; Ciavolino & Nitt, 2009; Vinzi et al., 2010; B. Wilson & Henseler, 2007).

The structural model was tested using a PLS-SEM approach through WarpPLS4.0. As suggested by Kock (2013), the "Stable"[10] method for p-value estimation was employed, as resampling methods (such as bootstrapping and jackknifing) 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 (Kock, 2014). 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 (see section 3.3.5). Therefore, the Warp3[11] PLS regression algorithm was selected in which the relationships between constructs take the form of S-curves;

[10] 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 (Kock, 2013).

[11] 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 (Kock, 2013).

defaulting to U-curves or lines, if the relationship follow U-curve patters or are linear, respectively (Kock, 2013). Mediation effects were assessed by using Baron & Kenny's (1986) criterion.

#### 4.5.3.2 *WarpPLS 4.0*

WarpPLS[12] is SEM software that is able to identify nonlinear (or "warped") relationships among constructs and corrects the values of path coefficients accordingly. According to Kock (2010, 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. The underlying algorithm employed by WarpPLS is Partial Least Squares (PLS) regression, whose main characteristic is its ability to minimize multicollinearity among constructs; even in the presence of overlapping manifest variables (or indicators). The WarpPLS regression algorithm is fundamentally like other PLS algorithms as it calculates weights, loadings, and variable scores. However, WarpPLS distinct itself from other PLS algorithms in that "*warping*" is performed at the path coefficient level, and after the estimation of all weights and loadings in the model, using a Robust Path Analysis technique. Furthermore, this software provides users with a wide range of features, for instance, the automatically estimation of p-values for path coefficients, several model fit indices (which have been designed to be meaningful in the context of PLS-based SEM analyses), calculations of variance inflation factor (VIF) coefficients for construct predictors associated with each construct criterion that allow users to check whether some predictors should be removed due to multicolinearity. Moreover, all of the features provided have been extensively tested with both real data as well as simulated data generated through Monte Carlo procedures (Kock, 2010, 2013).

[12] http://www.scriptwarp.com/warppls/

# Chapter 5

## Analysis and results

# 5 Analysis and results

This chapter answers the following research sub questions: "*What is the current situation regarding the organisational adoption of eHealth by Dutch hospitals?*" and "*What are the factors that influence the organisational adoption of eHealth by Dutch hospitals?*". In this chapter, the results of data analyses of the survey study are presented. Specifically, section 5.1 provides an overview of the current eHealth adoption by Dutch hospitals and section 5.2 presents and evaluates the results of the PLS-SEM.

## 5.1 *Current state of eHealth adoption by Dutch hospitals*

The aim of this subsection is to provide an overview of the current situation regarding eHealth adoption by Dutch hospitals, and by that answering the following research sub question: "*What is the current situation regarding eHealth adoption by Dutch hospitals?*". In the same period this study was conducted, the eHealth monitor 2014 (Krijgsman et al., 2014) – initiated by Minister Schippers (VWS) – was conducted by Nictiz and NIVEL. The eHealth monitor 2014 obtained results on the adoption of telemonitoring and online access to EHR by surveying Dutch healthcare providers (general practitioners, healthcare professionals[13] and nurses) and healthcare consumers[14]. In this section, the results from the eHealth monitor 2014 will be presented along with the results from this study in order to provide a richer overview of the current state of eHealth adoption by Dutch hospitals.

***Differences in eHealth adoption between Dutch hospitals***

Despite on average CIOs and top-level managers of Dutch hospitals indicate to be quite ready (53%) to successfully introduce eHealth in their organisations (see Table 15), Dutch hospitals fall short in realising eHealth's full potential.

**Table 15) Perceived eHealth readiness**

| | N | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| eHealth readiness | 30 | 52.17% | 19.23% | 10% | 80% |
| eHealth readiness | 58 | 53.38% | 25.40% | 0% | 100% |

This study observed that there are major differences between Dutch hospitals in the organisational adoption of eHealth (see Table 16 and Figure 15). In general, a difference in eHealth adoption can be observed between academic and general hospitals. A one-way between subjects ANOVA was conducted to compare the effect of hospital type (academic and general hospitals) on the organisational adoption of eHealth. Results suggest a significant effect of type of hospital on organisational eHealth adoption at the $p<.5$ level ($F[1, 28]=6.49$, $p=.017$). On average, academic hospitals (Mean=3.57, N=2) are further in the adoption of eHealth than general hospitals (Mean=-.26, N=28) (see Appendix J. ).

***Differences in the adoption of various eHealth applications***

In line with the findings of the eHealth monitor 2014, results from this study also indicate that there are major differences in the adoption of various eHealth applications. Whereas some eHealth applications

[13] The sample medical specialists, 188 panelists (response rate=6%), is representative to medical specialty, age and sex (Krijgsman et al., 2014).

[14] The sample healthcare consumers, 754 panel members (response rate 50%), is representative to the general population aged 18 years and older in the Netherlands with respect to age and sex, based on data from the Central Bureau of Statistics (CBS) (Krijgsman et al., 2014).

are broadly used (i.e. online information), other eHealth applications remain unexploited (i.e. online treatment) (Krijgsman et al., 2014). To illustrate, Figure 14 presents eHealth applications (as described in section 2.2.4) that are currently in significant use by Dutch hospitals (N=51). The top three is formed by online information (57%), social media (47%), and e-Intake (27%). Remarkably, telemonitoring (22%) and online access to EHR (16%) are only in significant use by less than 22% of the Dutch hospitals, while these applications are one of the main priorities in the EU/NL agenda (Commission, 2011b) and the National Implementation Agenda (NIA) of eHealth (Nationale Implementatie Agenda, 2012). Moreover, at national level, a recent report by the Dutch Government "*De maatschappij verandert. Verandert de zorg mee?*" sets the following 5 year targets with respect to telemonitoring and online access to EHR (Rijksoverheid, 2014; Schippers & Rijn, 2014a, 2014b):

3) 40% of Dutch and 80% of the chronically ill have direct access to certain medical data and can use it in mobile apps or web applications.
4) 75% of the chronically ill and frail elderly, who are willing and able to, can perform independent measurements, often in combination with telemonitoring.

With regard to these objectives, it can be argued that there is still a lot to gain and healthcare providers are to move (Krijgsman et al., 2014). The next section provides a more detailed insight into the organisational adoption of telemonitoring and online access to EHR as these applications are used for measuring organisational eHealth adoption by Dutch hospitals (see section 4.3.2.1).

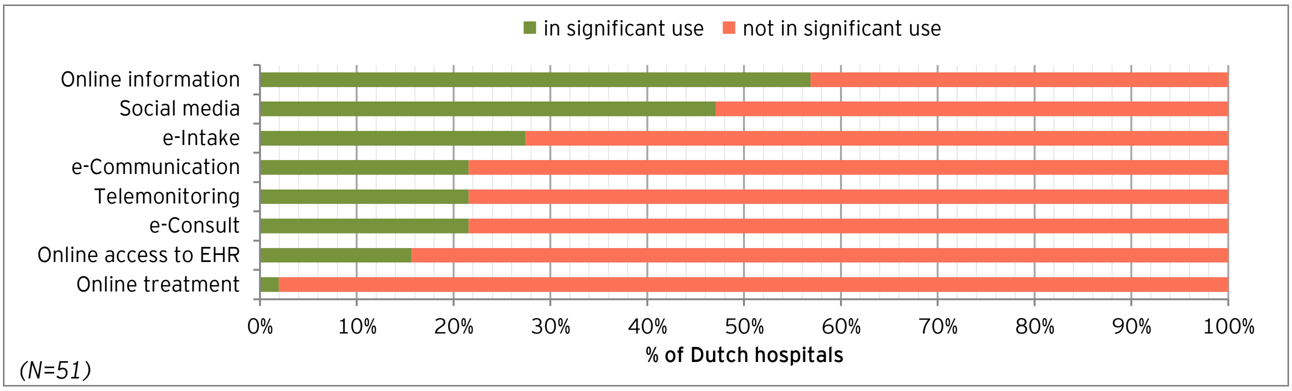



**Figure 14) eHealth applications currently in use by Dutch hospitals (within study's scope)**

***Organisational adoption of telemonitoring and online access to EHR***

A more detailed insight in the adoption of telemonitoring in heart failure, telemonitoring in diabetes, and online access to EHR by Dutch hospitals is provided in Figure 15 (N=30). Figure 15 shows the extent of adoption per eHealth application according to the stages of organisational innovation adoption process as described in section 3.1.2.1. 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, 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. On average, telemonitoring in heart failure and online access to EHR have the greatest extent of adoption by Dutch hospitals (Mean= 2.80 which corresponds to the late stage of "interest") compared to telemonitoring in diabetes (Mean=2.23 which corresponds to the early stage of "interest").

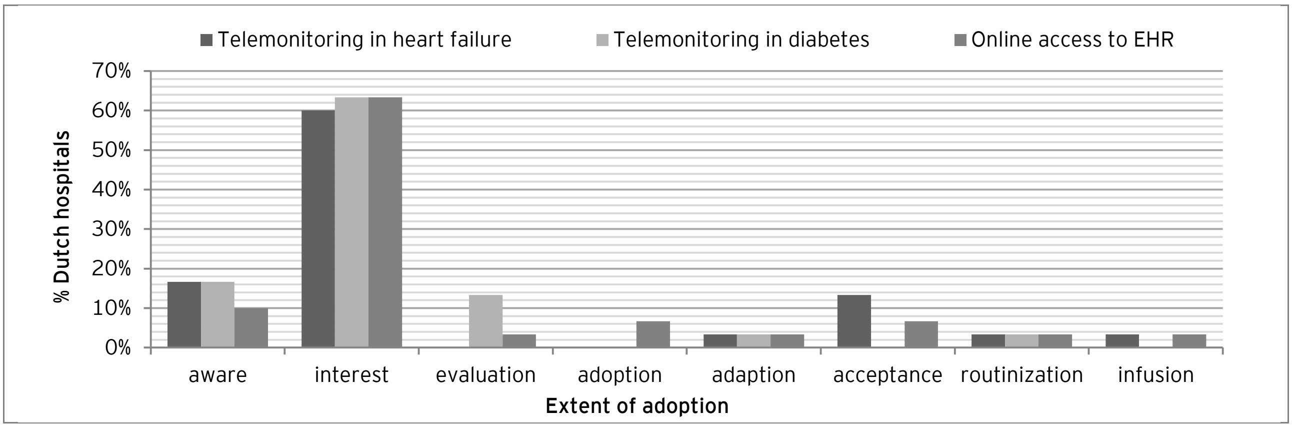


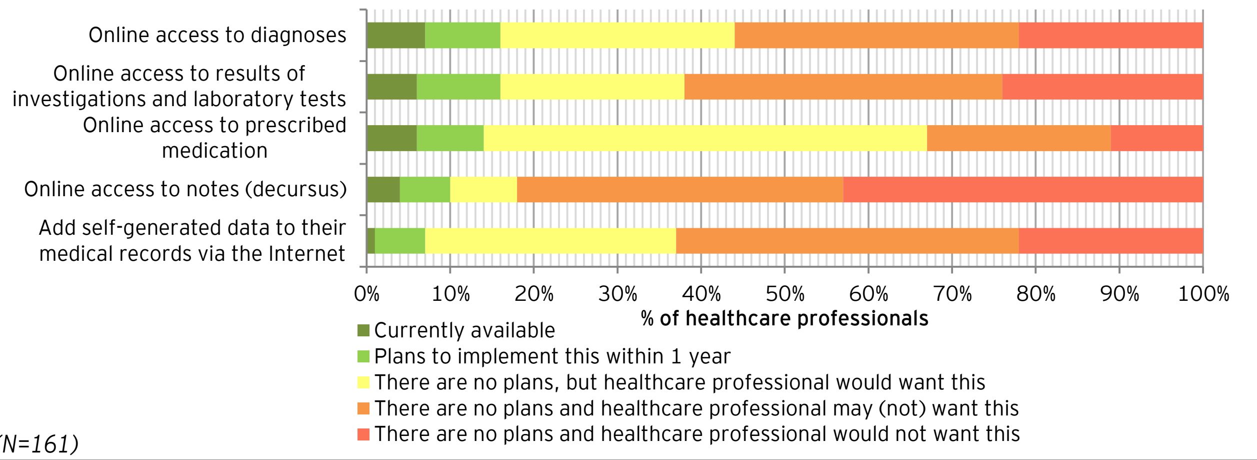

**Figure 15) The extent of adoption per eHealth application**

According to the eHealth monitor 2014, healthcare professionals for whom telemonitoring in heart failure is relevant (N=22), 23% (N=8) indicated to make use of telemonitoring in heart failure. Besides, telemonitoring in diabetes is used by 40% (N=14) of the healthcare professionals for whom telemonitoring in diabetes is relevant (N=35). Only 3% of the healthcare consumers indicated to use telemonitoring (Krijgsman et al., 2014).

With regard to the use of online access to EHR, the eHealth monitor 2014 investigated online access to the following parts of the EHR as provided by the healthcare professional (N=161) (Krijgsman et al., 2014): 1) diagnoses, 2) prescribed medications, and 3) results of investigations and laboratory tests, and 4) notes (decursus). For each part of the EHR as listed above, only 4 to 7% percent of the healthcare professionals indicated that online access for patients is possible (see Figure 16). Remarkably, a majority of the healthcare consumers (45-51%) wish to have online access to their EHR. However, only 1-2% of healthcare consumers have accessed their EHR online more than once in the past year (Krijgsman et al., 2014).

Although it would be interesting to compare the results of this study with the results of the eHealth monitor 2014, this is impossible to do because it is unclear what hospitals correspond to the healthcare professionals surveyed by the eHealth monitor 2014. Consequently, the results of the eHealth monitor 2014 should be treated with caution as it is unclear whether the healthcare professionals surveyed are coming from different hospitals representative to the entire population of Dutch hospitals. To illustrate, when most healthcare professionals surveyed come from hospitals that are further in the adoption of eHealth, this would result in biased results, and vice versa. Nevertheless, both studies conclude that although the expectations of eHealth applications that can promote self-management are high, there is an overall low extent of adoption for all three eHealth applications.

**Online access to the following parts of the EHR as provided by healthcare professionals:**




*(N=161)*

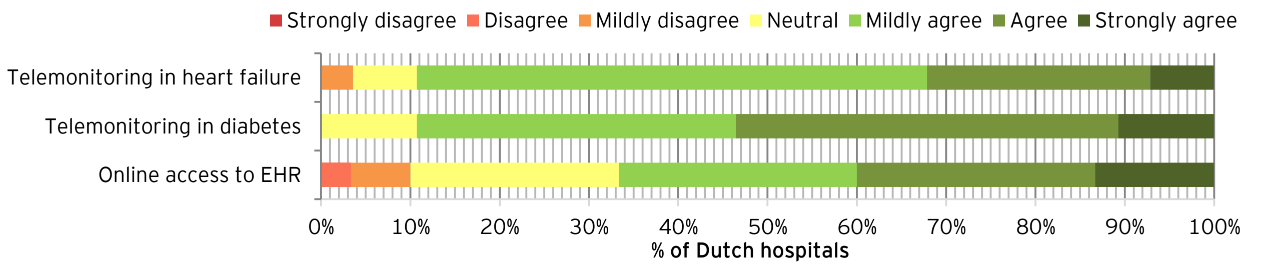
*Adapted from:* (Krijgsman et al., 2014)

**Figure 16) Percentage of healthcare professionals providing online access to EHR**

***Perceived relative advantage of telemonitoring and online access to EHR***

In general, results from this study suggest that most hospitals perceive advantages in using all three eHealth applications. Relative advantage refers to "the degree to which an innovation is perceived as being better than either the status quo or its precursor" (Rogers, 1995). DOI theory suggest that the relative advantage of an innovation positively influences an organisation's propensity to adopt the innovation (Rogers, 1995). The most relative advantage is perceived for telemonitoring in diabetes (Mean=5.62), followed by telemonitoring in heart failure (Mean=5.27). Compared to telemonitoring, online access to EHR is perceived to offer less relative advantage (Mean=5.08).

**The following eHealth applications offer a relative advantage to the hospital:**




*Telemonitoring in heart failure (N=28); Telemonitoring in diabetes (N=28); online access to EHR (N=30)*

**Figure 17) Perceived relative advantage**

***Perceived compatibility of telemonitoring and online access to EHR***

Despite the perception of Dutch hospitals that eHealth can offer benefits, results from this study also suggest that most hospitals perceive that the three applications are not compatible with the organisation. Compatibility refers to *"the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential units of adoption"* (Rogers, 1995). In other words, compatibility refers the organisational fit of the innovation with current work procedures and needs of the organisation (Kamal, 2006). DOI theory suggest that compatibility of an innovation with values, experiences, and needs has a positive relationship with innovation adoption (Rogers, 1995). Telemonitoring in diabetes (Mean: 3.76) is perceived most compatible with the existing values, past experiences, and needs of the hospital, followed by telemonitoring in heart failure (Mean: 3.46). Compared to telemonitoring, online access to EHR is perceived to be least compatible (Mean: 3.38).

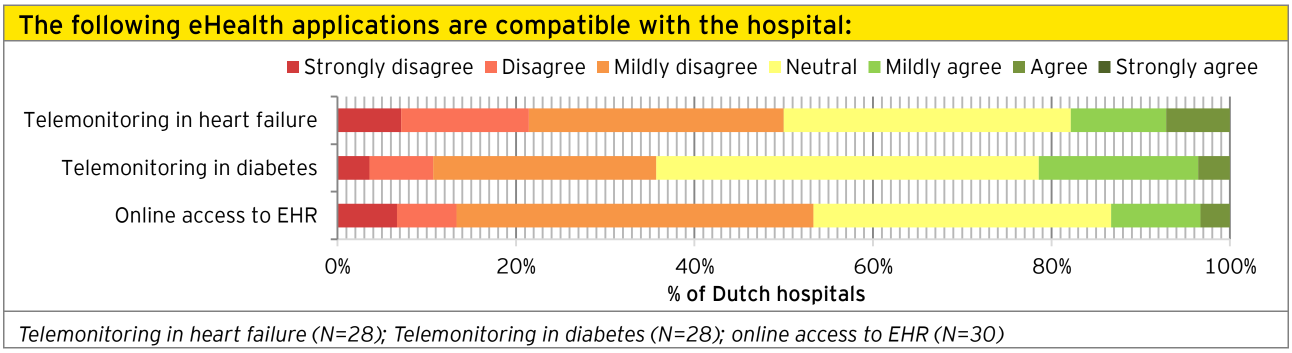



Figure 18) Perceived compatibility

*Barriers in the implementation of eHealth*

Besides that the three eHealth applications are perceived to be not compatible with the organisation, there are several other possible explanations for the overall low extent of adoption for all three eHealth applications by Dutch hospitals. This study investigated barriers in the implementation of eHealth by asking respondents (CIOs or high-level ICT managers of Dutch hospitals) – who have implemented one or more of the three eHealth applications (N=12) in their organisation – to select the barriers they experienced in the implementation of the three eHealth applications. Barriers that may have inhibited the eHealth adoption are listed in Figure 19. Most frequently mentioned as barrier to implementation the three eHealth applications were 1) too strict regulation (8 times), 2) technical issues (6 times), 3) lack of funding (6 times), 4) lack of healthcare professional support (6 times), and 5) lack of security (5 times). In turn, healthcare professionals have mentioned 1) unclear regulation (37%), 2) lack of financing (48%), and 3) lack of security (39%) most frequently as barrier to adopt the three eHealth applications as indicated by the eHealth monitor 2014 (Krijgsman et al., 2014). Least frequently mentioned barriers were 1) lack of patients support, and 2) lack of government support (0 times). Similarly, the eHealth monitor 2014 indicated that patient resistance in the case of online access to EHR was least frequently mentioned as barrier by healthcare professionals (1%) (Krijgsman et al., 2014).

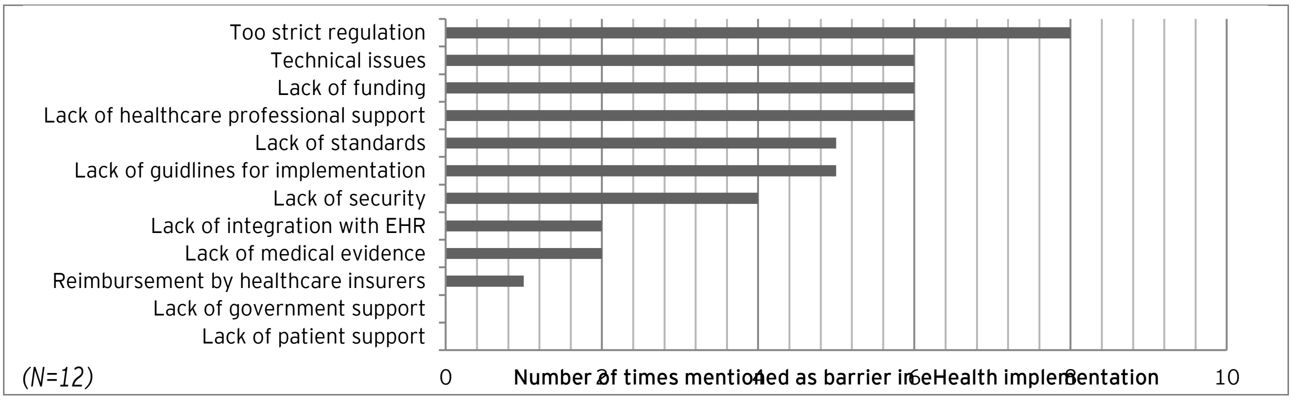


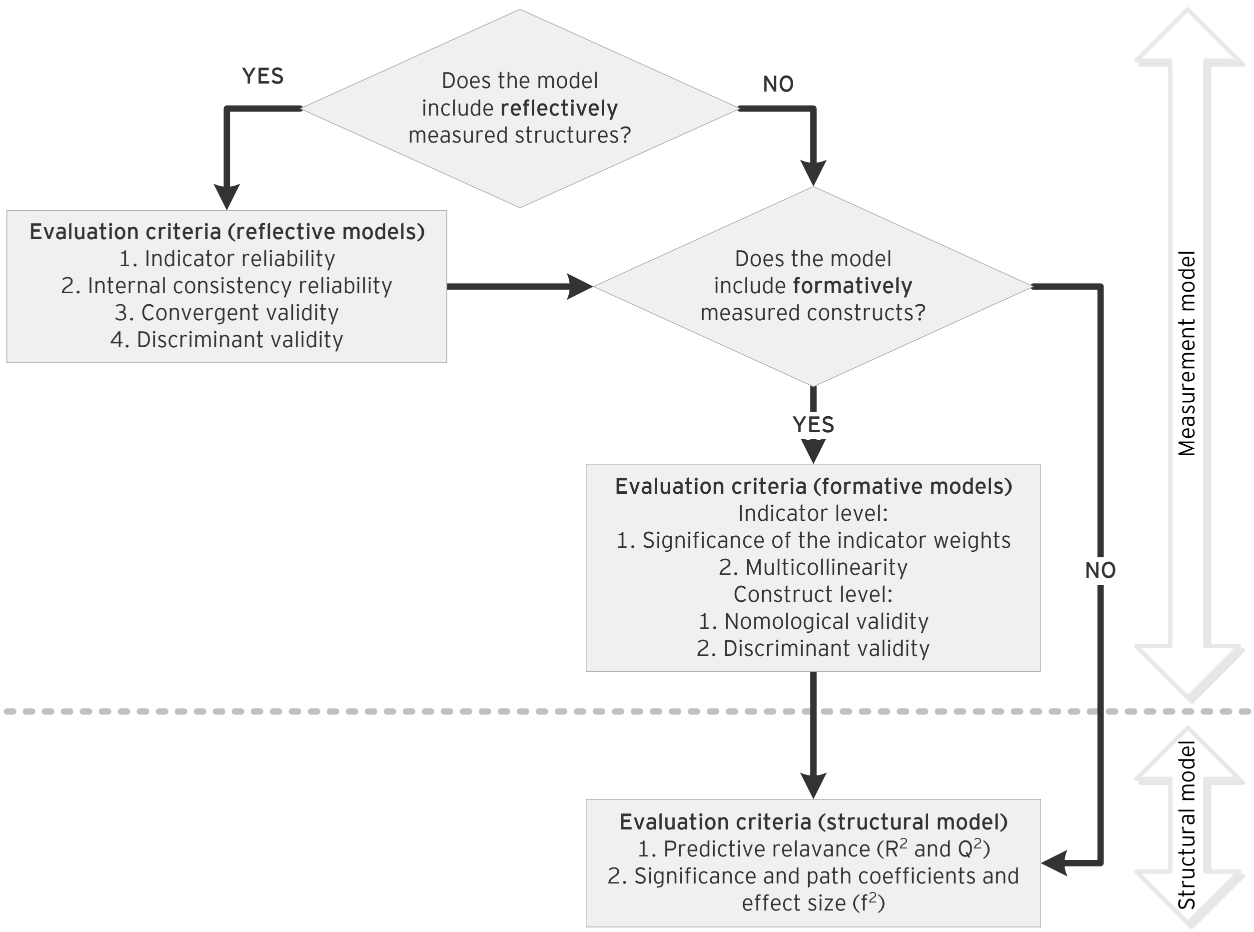

Figure 19) Barriers in eHealth implementation

## 5.2 *Explanatory analysis: PLS-SEM*

A PLS-SEM is usually analysed and interpreted in two sequential stages to ensure the reliability and validity of the measures prior the attempt in making and drawing the conclusion on the structural model (Vinzi et al., 2010). In this study the PLS-SEM model is evaluated in two stages:

1) Assessment and refinement of adequacy of the **measurement model** (section 5.2.1);
2) Assessment and evaluation of the **structural model** (section 5.2.1).

Following the reporting guidelines of Chin (2010), results from the explanatory analysis are reported also in two stages, corresponding to the evaluation stages as discussed above. First, the results of the measurement model assessment will be presented, including the reliability and validity of the item measures used. Second, then the validity and results of the structural model are presented. See Figure 20 for the PLS-evaluation stages.




*Adapted from:* (Sarstedt, Ringle, Smith, Reams, & Hair, 2014)

Figure 20) PLS-SEM evaluation stages

In order to provide descriptive statistics of reflectively measured constructs used in the analysis, the average sum of the items was calculated for each construct. Table 16 provides the mean, standard deviation, minimum and maximum for each construct in the PLS-SEM.

**Table 16) Descriptive statistics of model constructs**

| Construct | # items | Mean | Std. deviation | Min | Max |
|---|---|---|---|---|---|
| eHealth adoption | 3 | 2.66 | 1.23 | 1.00 | 6.33 |
| Centralisation | 2 | 5.08 | 1.20 | 2.50 | 7.00 |
| Size | 1 | 508.93 | 235.88 | 196 | 1042 |
| IT infrastructure | 4 | 4.27 | 1.43 | 1.00 | 7.00 |
| IT human resources | 2 | 2.67 | 1.24 | 1.00 | 5.50 |
| IT governance | 3 | 5.18 | 1.50 | 1.67 | 7.00 |
| IT security | 3 | 4.10 | 1.22 | 2.00 | 6.33 |
| Financial readiness | 1 | 6838458.98 | 4104765.71 | 1500000 | 15000000 |
| Top management support | 5 | 2.89 | 1.31 | 1.00 | 5.60 |
| Absorptive capacity | 5 | 4.01 | 1.18 | 1.80 | 6.20 |
| *(N=30)* | | | | | |

### 5.2.1 Measurement Model assessment

To assess the measurement model, it is necessary to distinguish between reflective[15] and formative measurement models as they require a different evaluation approach (Sarstedt et al., 2014; Urbach & Ahlemann, 2010).

**Reflective measurement model assessment**

Reflective measurement models are tested for indicator reliability, internal consistency reliability, convergent validity, and discriminant validity (Urbach & Ahlemann, 2010).

Indicator reliability describes the extent to which an item or set of items is consistent regarding what it intends to measure (Urbach & Ahlemann, 2010). Results in Table 17 show 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 (Chin, 1998).

Internal consistency reliability refers to the degree to which a set of items are internally consistent, that is, having the same range and meaning. According to the results in Table 17, internal consistency reliability is acceptable, with composite reliability measures exceeding .6 for all constructs (Urbach & Ahlemann, 2010). Moreover, the above is confirmed with Cronbach's Alpha exceeding .6 for all constructs (Cronbach, 1951).

Convergent validity involves the degree to which individual items reflecting a construct converge in comparison to items measuring different constructs (Urbach & Ahlemann, 2010). Table 17 shows that 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 (Fornell & Larcker, 1981).

15 Measurement models of constructs using secondary data (i.e [SIZE_t_1] and [IT_BUDGET_t_1]) or categorical/binary scale estimates (modelled as reflective mesures) do not need to be evaluated (Joseph F. Hair et al., 2013).

Table 17) Assessment of reflective construct internal reliability and convergent validity

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

*Levels of significance: *p<.1, **p<.05, ***p<.01, ****p<.001*
*AVE=Average Variance Extracted, CR=Composite Reliability, CA=Cronbach's Alpha*

Discriminant validity concerns the degree to which the measures of different constructs differ from one another (Urbach & Ahlemann, 2010). Discriminant validity was assessed by comparing the square root of AVE for each construct to the correlation of that construct with other constructs. Table 18 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 (Chin, 1998; Fornell & Larcker, 1981). 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 (Chin, 1998). According to Kock and Lynn (2012), cross-loadings greater than .5 are signs of possible collinearity, as they reflect high correlations among a latent variable score and indicators that are not supposed to "belong" with that latent variable. 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 model (see Appendix K. ).

Table 18) Assessment of discriminant validity

| Construct | eHA | CE | SIZE | OR | TMS | ACAP |
|---|---|---|---|---|---|---|
| eHealth adoption (eHA) | **1.000** | | | | | |
| Centralisation (CE) | .060 | **.889** | | | | |
| Size (SIZE) | .478*** | -.167 | **1.000** | | | |
| Organisational readiness (OR) | .526*** | .045 | .614**** | **.758** | | |
| Top management support (TMS) | .342* | .249 | .221 | .355* | **.846** | |
| Absorptive capacity (ACAP) | .303 | .078 | .139 | .346* | .702**** | **.808** |

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

### Formative measurement model assessment

In contrast to reflective measurement models, conventional validity assessments do not apply to formative measurement models (Sarstedt et al., 2014; Urbach & Ahlemann, 2010). Henseler et al. (2009) suggest assessing the validity of formative constructs at two levels: the indicator level and the construct level.

Indicator validity is evaluated by assessing the significance of the indicator weights. Table 19 shows that indicator validity is acceptable as indicator weight's significance exceeds .05 significance level for all formative constructs (Chin, 1998). In addition, the degree of mutlicollinearity among the formative indicators is assessed by calculating the Variance Inflation Factor (VIF) which indicates how much of an indicator's variance is explained by other indicators of the same construct. Indicator validity is confirmed as the VIF values are below 3.3 (Joseph F. Hair, Ringle, & Sarstedt, 2013; Vinzi et al., 2010).

Construct validity is evaluated in terms of nomological validity and discriminant validity. Nomological validity is acceptable as the formative construct behaves as expected in the net of hypotheses (Henseler et al., 2009). Secondly, discriminant validity is assessed by testing the interconstruct correlations between formative constructs and all other constructs as well. Table 18 indicates that discriminant validity is acceptable, with intercorrelations of less than .7 for all constructs (Bruhn, Georgi, & Hadwich, 2008; Diamantopoulos, Riefler, & Roth, 2008; S. B. MacKenzie, Podsakoff, & Jarvis, 2005).

Table 19) Assessment of formative construct indicator 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 |

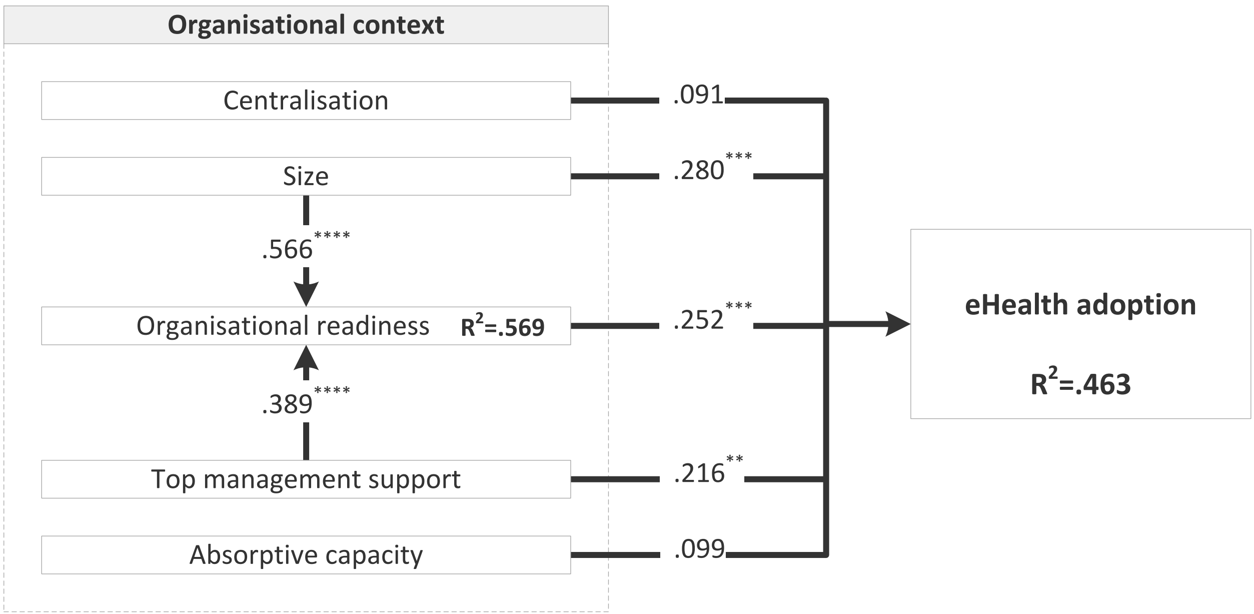
*Levels of significance: *p<.1, **p<.05, ***p<.01, ****p<.001*
*SE=Standard Error; VIF=Variance Inflation Factor; WLS=Weight-Loading Sign (-1 = Simpson's paradox in l.v.); ES=Effect Size*

#### 5.2.1.1 *Conclusions*

In summary, based on the test above, it can be concluded that in terms of the measures used the model presents acceptable reliability and validity, and is free from multicollinearity. Based on these results, it can be expected that the results of the path analysis are generally unbiased.

### 5.2.2 Structural Model assessment

The outcomes of the structural model were evaluated by assessing the amount variance explained for each endogenous construct and the pathcoeffients between constructs including their significance. As the control variable did not significantly affect the path coefficients between the independent variables and the dependent variable, and as there was only a .013 difference in $R^2$ value of the dependent variable between the model with control variable ($R^2$=.476) and without ($R^2$=.463), the control variable was excluded in the structural model presented in this chapter[16].




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

Figure 21) Structural model with path coefficients (without control variable)

Figure 21 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 in eHealth adoption by Dutch hospitals (Chin, 1998; Vinzi et al., 2010). In addition, a $R^2$ of .549 demonstrates that the model explains a good amount of variance for Organisational Readiness. Moreover, the model's predictive relevance ($Q^2$) is assessed with a nonparametric Stone-Geisser test. Predictive relevance for both endogenous constructs is confirmed as the $Q^2$>0 ($Q^2_{\text{eHealth adoption}}$=.489 and $Q^2_{\text{Organisational Readiness}}$=.572) (Urbach & Ahlemann, 2010). In addition, WarpPLS4.0 conducts a model fitness test as part of its structural model analysis. The model satisfies all criteria available for model fit and model quality. An overview of the model fit and quality indices is presented in Table 20.

[16] Results of the structural model with control variable can be found in Appendix L.

Table 20) Overview of model fit and quality indices (without control variable)

| Measure | Value |
|---|---|
| Average path coefficient | .271*** |
| Average R-squared | .516**** |
| Average adjusted R-squared | .444**** |
| Average block VIF | 1.454, acceptable if <= 5, ideally <= 3.3 |
| Average full collinearity VIF | 1.843, acceptable if <= 5, ideally <= 3.3 |
| Tenenhaus GoF | .638, small >= .1, medium >= .25, large >= .36 |
| Sympson's paradox ratio | 1.000, acceptable if >= .7, ideally = 1 |
| R-squared contribution ratio | 1.000, acceptable if >= .9, ideally = 1 |
| Statistical suppression ratio | 1.000, acceptable if >= .7 |
| Nonlinear bivariate causality direction ratio | 1.000, acceptable if >= .7 |
| *Levels of significance: *p<.1, **p<.05, ***p<.01, ****p<.001* | |

#### 5.2.2.1 ***Findings***

The final model partially supports the hypothesis of this study. Table 21 presents a detailed overview of the results of the PLS-SEM analysis, including the pathcoefficients of direct, indirect and total paths between constructs, and the weights of the subconstructs which form formative higher order constructs. Because PLS-SEM estimates the measurement model and the relationships between constructs simultaneously, the significance of weights of the sub-constructs display significance of their impact on eHealth adoption only if their associated formative higher-order constructs are found to be significant. These weights can be interpreted similarly to the beta coefficients from a multiple regression analysis.

According to the model outcomes, support is found for the following hypotheses:

- H2: Size has a positive influence on eHealth adoption (β=.280, *p*-value=.003, $f^2$=.156).
- H3: Size has a positive influence on organisational readiness (β=.566, *p*-value=<.001, $f^2$=.368).
- H4: Organisational readiness has a positive influence on eHealth adoption (β=.252, *p*-value=.007, $f^2$=.141).
- H5: Top management support has a positive influence on eHealth adoption (β=.216, *p*-value=.016, $f^2$=.100).
- H6: Top management support has a positive influence on organisational readiness. (β=.389, *p*-value=<.001, $f^2$=.200).

As indicated by the $f^2$ coefficients (measure for the practical impact of an independent construct on a dependent construct), the associations of hypotheses 3 and 6 have a large effect size, the association of hypothesis 2 and 4 indicates a medium effect size, and the association of hypothesis 5 has a low to medium effect size (Chin, 1998; Urbach & Ahlemann, 2010).

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 & Kenny's (1986) criteria, and found to be significant. Moreover, it concerns a partial mediating effect as the paths from hospital size to eHealth adoption and top management support to eHealth adoption are found to be significant.

According to the model outcomes, the following hypotheses are *not* supported:

- $H1_{a,b}$: Centralisation has a negative/ positive influence on eHealth adoption (β=.091, *p*-value=.176, $f^2$=.030).
- H7: Absorptive capacity has a positive influence on eHealth adoption (β=.099, *p*-value=.156, $f^2$=.035).

**Table 21) Detailed overview of SEM results (without control variable)**

| Association | Path coefficient | Weight |
|---|---|---|
| Centralisation → eHealth adoption | .091 | |
| Size → eHealth adoption | .280***a<br>.422****b | |
| Size → Organisational readiness | .566**** | |
| Size → Organisational readiness → eHealth adoption | .143**c | |
| Organisational readiness (third order) → eHealth adoption | .252*** | |
| Technological readiness (second order) → Organisational readiness | | .659**** |
| IT infrastructure → Technological readiness | | .341**** |
| IT human resources → Technological readiness | | .362**** |
| IT governance → Technological readiness | | .409**** |
| IT security → Technological readiness | | .433**** |
| Financial readiness → Organisational readiness | | .659**** |
| Top management support → eHealth adoption | .216**a<br>.389****b | |
| Top management support → Organisational readiness | .389**** | |
| Top management support → Organisational readiness → eHealth adoption | .098* c | |
| Absorptive capacity → eHealth adoption | .099 | |
| *Levels of significance: *p<.1, **p<.05, ***p<.01, ****p<.001*<br>*[a]direct effect, [b]total effect, [c]indirect effect* | | |

Since organisational readiness is a higher-order formative construct and has a significant positive association with eHealth adoption, the weights of the subconstructs were examined to assess the significance of their impact on eHealth adoption. Although no formal hypotheses were proposed for the subconstrucs of organisational readiness, Table 21 includes the weights of each subconstruct including their significance. The weights reveal the relative importance in determining organisational readiness to adopt eHealth. 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. As Table 21 reveals, 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).

Table 22 provides a summary of the hypotheses in this study.

**Table 22) Summary 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* | | |

***Non-linear relationships***

In order to identify relationships between constructs, the Warp3 PLS regression algorithm (see section 4.5.3) 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 (Kock, 2013). The results from this study found non-linear relationships between constructs that take the form of S-curves (see Appendix M. ). 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 3.3.5) (Kock, 2013).

### 5.2.3 Limitations

The assessment of the outer and inner model took place in two distinct phases. The outer model was evaluated following two different techniques: EFA and CFA. The inner model was evaluated using the PLS-SEM technique. The repeated inspection of the same dataset with different techniques where the next analysis is modified according to the results from the previous analysis could lead to the problem of capitalization on chance. According to MacCallum (1992), this problem exist regardless of the type of search strategy used and regardless of the nature of the initial model and purpose of the research. Many different data-driven search strategies can be defined, all of which are inherently susceptible to this problem. For instance, alternative strategies could define different priorities to what aspects of a model should be considered for modification first (e.g. measurement model versus structural model or the Warp3 PLS regression algorithm searching for the best fitted relationship as described above). Especially when sample size is small; this is the case in this study. Consequently, as this study's 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 (MacCallum, 1992).

# Chapter 6

# Discussion and conclusions

# 6 Discussion and conclusions

This final chapter of this report discusses and concludes the results of the study findings by utilizing the descriptive statistics and structural equation modelling techniques outlined in section 5. The significant theoretical implications of the study finding are also discussed in this chapter. Societal contributions of the study findings will be provided in the form of recommendations and answers the following research sub question: *"What strategies can be derived to foster the organisational adoption of eHealth by Dutch hospitals?"* Furthermore, the limitations of this study will be discussed, followed by directions for future research. Finally, a brief personal reflection will be provided on the research process.

## 6.1 *Main findings*

The aim of this study was to provide an understanding in the organisational adoption of eHealth by Dutch hospitals by identifying the factors influencing the organisation adoption of eHealth. The following research question has been formulated: *"What are the relevant factors influencing the organisational adoption of eHealth by Dutch hospitals?"* The findings of this study serve to answer the research questions will be outlined below.

First of all, the literature review as part of this study revealed that eHealth is a broad dynamic domain which needs to be structured prior to analysing it. Accordingly, eHealth was structured along the following three dimensions: 1) technology, 2) healthcare use context, and 3) healthcare function (prevention, care, or cure). In this study, eHealth has been defined as: *"the use of emerging Information and Communication Technology (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."*

Second, the survey findings of this study provide an adequate picture of the current state of eHealth adoption by hospitals in the Netherlands. The results from the survey confirmed that, in general, Dutch hospitals fall short in realising eHealth's full potential. With respect to the three eHealth applications studied (telemonitoring in heart failure, telemonitoring in diabetes, and online access to EHR), only 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, 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.

Third, the empirical results from the study found that there are several factors within the organisational context of Dutch hospitals influencing the organisational adoption of eHealth. The organisational context studied in this study 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. Below these organisational factors are discussed in more detial.

***Size***

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 (Jeyaraj et al., 2006; Rogers, 1995). 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 (Premkumar & Roberts, 1999).

*Organisational readiness*

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 (Damanpour, 1991; Greenhalgh, Robert, Macfarlane, et al., 2004; Robert et al., 2009; Rogers, 1995). 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 (Armstrong & Sambamurthy, 1999; Iacovou et al., 1995; K. Zhu et al., 2006), 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.

*Top management support*

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 (Jeyaraj et al., 2006). 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.

*Centralisation*

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 (Rogers, 1995), in contrast to other research suggesting that a greater centralisation may actually encourage the implementation of innovations, once the innovation decision has been made (Fichman, 2000; Fleuren et al., 2004c; Rogers, 1995).

*Absorptive capacity*

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.

## 6.2 *Theoretical implications*

This study makes several contributions to existing literature on organisational innovation adoption. First of all, this *empirical* study of 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, several theoretical models have been assessed on their applicability in investigating factors influencing the organisational adoption of eHealth. By adopting the Technological-Organisational-Environmental (TOE) framework including parts of the DOI theory as theoretical model, this study provides evidence for the applicability of the TOE framework in the domain of eHealth. In addition, findings have shown the significant relevance of several existing TOE framework factors from literature in explaining the organisational adoption of eHealth by Dutch hospitals, for instance: size, organisational readiness, and top management support. Moreover, this study has shown the usefulness of the TOE framework for identifying factors that influence organisational adoption of eHealth as the TOE framework compared to other adoption theories is a more relevant tool to classify all determinants of innovation adoption according to the three contexts and to explain organisational innovation adoption. Third, different than the literature that examined IT innovation adoption with an adoption versus non-adoption focus (Fichman, 2001; Jeyaraj et al., 2006), this study also take into account the pre-adoption and post-adoption stages of organisational innovation adoption process as suggested by Fichman (2001). This approach results in richer results since different factors may influence organisational innovation adoption in different stages of the organisational innovation process. Fourth, several constructs have been developed or extended, including eHealth adoption and organisational readiness. eHealth adoption has been measured as the aggregated extent of adoption (which aggregates across innovation and across stages), as proposed by Fichman (2001). The extent of adoption is measured on a 1-8 scale corresponding to the hospital innovation adoption process which has been largely drawn from the IT implementation model of Cooper and Zmud (1990). The initiation stage has been slightly adjusted by dividing it into awareness, interest and evaluation – consistent with the model of Fichman and Kemerer (1997) – in order to capture more variance in the initiation stage. This adjustment has proven its value since the organisational eHealth adoption by Dutch hospitals was largely concentrated in the early stages of the hospital innovation adoption process. Technological readiness, initially conceptualized in Kwon and Zmud (1987), was extended with IT governance and IT security that have found to be significantly contributing to organisational readiness. This inclusion of IT governance and IT security thus contribute in better explaining organisational eHealth adoption by Dutch hospitals. The measurement instrument have passed various reliability and validity tests, and they could be used in future organisational IS adoption research. 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 in IS research. Especially, PLS-SEM offers potential for future studies as it has lesser restrictions on sample size compared to other techniques. This is particularly useful in research domains characterised by a small population, for instance, the population hospitals in the Netherlands. In addition, the use of WarpPLS allowed for analysing non-linear relationships between organisational eHealth adoption and the factors influencing it. This non-linear estimation 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. The study provide an understanding in the factors influencing organisational eHealth adoption based on several theories and empirical results from the survey. In order to foster the organisational adoption of eHealth, there is a need to design organisational strategies or governmental policies that are geared towards enhancing the effectiveness and availability of those significant factors positively associated with eHealth adoption. Any step forward in sustaining the Dutch healthcare system by fully exploiting eHealth's potential by Dutch hospitals (which are most dominant in modern healthcare) is of societal relevance.

### 6.3.1 Recommendations to hospitals

This study offers a useful framework for hospital CIOs and management to assess and enhance the conditions under which eHealth is launched in order to achieve successful adoption. Empirical results from the survey study found that specific organisational conditions are associated with higher or lower levels of eHealth adoption. Specifically, empirical findings revealed that a hospital's level of eHealth adoption is significantly influenced by its size, availability of organisational resources, and level of top management support. With this understanding, strategies can be derived geared toward improving these factors associated with organisational eHealth adoption. The strategies described below represent a few directions that hospitals may take in order to achieve successful adoption of eHealth. However, as Klein and Sorra (Klein, Conn, & Sorra, 2001) argue, "the influence of implementation policies and practices is cumulative, compensatory, and equifinal". In other words, the influence of numerous implementation policies and practices is cumulative; more is better. Consequently, several of these strategies may be deployed at the same time within the same hospital organisation.

*Size*

The empirical results of the survey revealed that a larger hospitals size is associated with higher levels of eHealth adoption. This relationship is largely 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. Smaller hospitals are recommended to explore opportunities for (enhanced) collaboration with other hospitals in their region when implementing eHealth initiatives. Lorenzi and Riley (2003) define collaboration as the ability of organisations to create relatively unique organisational forms that meet their particular needs. In a collaboration partnership the hospital and its partners share a common mission and vision organized as one greater entity that manages the operations.

*Organisational readiness*

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 needed for the implementation and sustained use of eHealth. To this end, prior to adoption, 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.

Thus, hospitals need to developing strategies to evaluate the availability of existing organisational resources. This study offers a useful (personal) benchmark[17] to hospitals by which they can assess their current state of eHealth adoption and related organisational factors as compared to other hospitals. In addition, the personal benchmark allow hospitals to assess how they have improved compared to last

[17] The benchmark report is not included in this report as it has become part of the EY's annual ICT benchmark 2014.

year. It thus provides a useful instrument in identifying potential areas of improvement, specific to their organisation.

Moreover, the empirical results from the survey provide useful starting points for hospitals to improve their organisational readiness. In particular, empirical results revealed that both financial and technological resources are of great importance to organisational readiness. Therefore, hospitals need to ensure sustainable financial resources in terms of IT budget in order to facilitate eHealth implementation and sustained use. In addition, the survey found that technological resources can be improved in four different areas:

- *IT infrastructure*
  Results from this study indicated that IT infrastructure are important technological resources in a hospital. Therefore, hospitals need to ensure the IT infrastructure is adequate for the use of eHealth as it establishes the foundation on which eHealth can build. For instance, as many eHealth applications require data exchange through the Internet (i.e. in online access to EHR and in telemonitoring), healthcare professionals and patients should have reliable (wireless) access to the Internet within the hospital. Implementing an eHealth application that is not compatible with the existing IT infrastructure is likely to fail. It is thus important to be certain whether the IT infrastructure is adequate for a particular eHealth application prior to implementation.

- *IT human resources (support)*
  Whereas technology infrastructure establishes a platform on which eHealth can be build, IT human resources provide the knowledge and skills to implement eHealth. Results from this study indicate that IT human resources are important technological resources in achieve organisational readiness. Therefore, hospitals need to ensure sufficient IT professionals possessing the knowledge and skills to implement eHealth applications. To this end, hospital could think of the establishment of teams dedicated to the implementation of eHealth. On the other hand, hospitals lacking sufficient internal IT human resources could also build on IT-related assistance received from outside the organisation. Besides, as many eHealth applications demand a new way of working, training and support should be available to the intended users during the implementation and use of a particular application in order to achieve user acceptance. Staff training initiatives may help to increase healthcare professionals' knowledge, skills, and abilities that are necessary to make use of eHealth's full potential.

- *IT governance*
  The results from the survey indicated that IT governance is an important technological resource of a hospital in achieving organisational readiness for eHealth adoption. In order to sustain the use of eHealth, hospitals need to ensure IT is aligned with organisational goals and objectives. To establish an adequate IT governance, there are several supporting frameworks/references available (i.e. COBIT) that can provide useful guidance to the implementation (or enhancement) of IT governance.

- *IT security*
  IT security was found to be an important aspect of a hospital's technological resources. Particularly, hospitals need to ensure an adequate level of IT security is provided as the deployment of eHealth is primarily through the support of the Internet and other communication technologies. Adequate security measures need to be in place in order to guarantee a secure information flow between healthcare professional and patient. To this end, the hospital's IT department plays a major role in drafting and implementing the hospital's information security policy (Jong, 2012). It should at minimum addresses the safe storage of information, secure information exchange and authorisation,

and other aspects of information security. In designing an information security policy, guidelines such as the NEN7513[18] and NEN7510[19] can provide useful guidance as well as the use of authentication standards such as DigiD. In addition, it is recommended to involve IT auditors and security officers in designing the information security policy, and to perform a security audit to test its effectiveness.

*Top management support*

This study 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. The support and commitment from the top management is particularly reflected in:

- *Ensuring that there is a commitment to resourcing the implementation of an eHealth application*
  In the allocation of sufficient resources, top management can play an important role in devoting resources ( as described in the previous section) needed for the implementation and sustained use of eHealth.

- *Stimulating change (and overcoming resistance) to adopt and use eHealth.*
  Top manager support and commitment can stimulate change (or overcome resistance), and by that, influence the acceptance among healthcare professional to adopt and use eHealth. To this end, top management is advised to organize appropriate change management, communicate a long-term eHealth vision for the organisation, strongly encouraging the use of eHealth (i.e. transformational leadership style), reward healthcare professionals for eHealth innovation (i.e. extrinsic incentives such as goal-sharing awards, performance reviews, promotions, and raises in salary, as well as intrinsic incentives such as recognition, increased stature or respect), and offer informational feedback about eHealth effects on a regular basis to the healthcare professionals.

## 6.3.2 Recommendations to government

The findings from this study also offers recommendations to government in designing policies directed at fostering the uptake of eHealth. Such policies could for instance include financial support, technological support as well as educational support. In order to foster the adoption of eHealth by Dutch hospitals, the Dutch government have recently set the following 2020 objectives with respect to telemonitoring and online access to EHR (Rijksoverheid, 2014; Schippers & Rijn, 2014a, 2014b):

1) 40% of Dutch and 80% of the chronically ill have direct access to certain medical data and can use it in mobile apps or web applications.
2) 75% of the chronically ill and frail elderly, who are willing and able to, can perform independent measurements, often in combination with telemonitoring.

In addition to this objective, the government announced to take adequate measures to overcome barriers in the adoption and implementation of eHealth.

[18] The NEN7513 standard specifies the data necessary to fulfill the information need of interested parties and gives causes for data recording.This standard gives also indications for use to the care providers and the use of logging. It specifies requirements for datasystems.

[19] The NEN7510 standard provides guidelines and basic principles for the determining, establishing and maintaining of measures which an organisation in the health care has to take to secure the provision of information.

*Overcome barriers in implementation*
The results of the survey identified several barriers in the implementation of eHealth (see section 5.1, Figure 19). Despite that these barriers were identified by a limited number of 12 hospitals, these results provide a useful starting points for designing government policies directed at overcoming these barriers.

- *Too strict regulation*
  In the survey, too strict regulation has been most frequently mentioned as barrier in eHealth implementation. This finding suggests that the government should evaluate existing regulations on eHealth and possibly relax regulation where this is demanded.

- *Lack of funding*
  Another frequently mentioned barrier in eHealth implementation was the lack of funding. Due to current regulations, health insurers do not yet reimburse all eHealth applications. However, there are positive signs that this regulation is about to change as eHealth applications are going to be included in the current DBC-funding system.

- *Lack of standards*
  Lack of standards is another frequently mentioned as a barrier in the implementation of eHealth in which the government can play an important role overcoming this barrier. Because regulations on technical standards are lacking, developers of eHealth applications determine which standards are used, resulting in lacking interoperability between different eHealth (related) systems. The government should act as a facilitator in bringing public and private players in the Dutch healthcare system together aimed at creating acceptance about the necessary standards. Creating a mandate of key players of the healthcare system is important to eventually enforce standards.

*Assistance to the small*
Generally, organisational resources have found to influence the organisational adoption of eHealth. As smaller hospitals tend to have less resources available needed for the implementation of eHealth, governmental assistance policies (i.e. subsidies) may be needed for smaller hospitals to keep up with larger hospitals and to achieve the 2020 targets as set by the Dutch government.

## 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.

*Generalizability*
Three 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, since the healthcare industry is a very institutionalised environment (Mohr, 1992), 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. Second, a sample size of 30 usually is not favourable to draw generalisations about the entire population. However, representativity tests in section 4.2.2 suggest that the sample is representative for the real population with respect to hospital type, size and annual turnover. 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 (see section 4.3.2.1). 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 (see section 2.2.4), 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 (i.e. eHealth applications in the interaction between healthcare professionals like teleconsulting). Nevertheless, as argued by Fichman (2001), aggregating across as few as three innovations lead to much stronger results in terms of predictive validity than for any single innovation model. Besides, since theoretical models of innovation are often developed with the intention of generalizing to broader classes of technologies (as is also the case in this study), it appears that aggregation within a class can substantially reduce the possibility of Type II errors for generalizations at these broader levels.

***Methodological***

Four methodological limitations have been identified for this study. First of all, although PLS-SEM is better able to perform analysis with small sample sizes, low sample sizes tend to deflate statistical power, especially when the outer model quality is poor and data are highly skewed (Joseph F. Hair, Sarstedt, Pieper, & Ringle, 2012). However, in this study the outer-model has been thoroughly assessed (see section 5.2.1) and data that was highly skewed was transformed prior to the PLS-SEM analysis (see section 4.5.1). Second, 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. Hence, this study is aware that within the hospital there may be differences in perception other than this study presents. 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. However, Weill and Olson (1989) found that self-report performance figures provided by managers were strongly correlated with corresponding objective measures. Therefore, this study assumes that the received responses are valid. Third, developing solid instruments is an ongoing procedure of development, testing, and refinement (S. MacKenzie et al., 2011). 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 (MacCallum, 1992). 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. A more comprehensive evaluation of the innovation process in healthcare organisations would require a longitudinal approach or case studies over time which was not possible in this study due to the relatively short time period of a Master's thesis.

***Theoretical***

Two theoretical limitations have been identified for this study. First of all, mainly due to restrictions on the amount of constructs that were allowed to be included in the model with respect to the small sample size, this study did not include other factors have been identified as potential influencers in organisational adoption research. For instance, within the organisational context the degree of formalisation may influence the organisational adoption of eHealth. 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. Nevertheless, the model found relevant factors explaining 46% of variance in organisational eHealth adoption by Dutch hospitals. Finally, this study considers the organisational innovation adoption process consisting of linear and sequential stages. Although stage models have had their success in identifying several stages in the process of adoption and implementation of an innovation in organisations, critics asserted that the linear and sequential stage models do not adequately represent the process of innovation (Greenhalgh, Robert, Bate, et al., 2004; van de Ven et al., 2008). Nevertheless, the stages describe critical milestones in the innovation adoption process that can be easily identified during eHealth implementation exercises. Moreover, as this research is only interested in studying the factors that influence the organisational adoption of eHealth rather than studying the innovation process within an organisation. Therefore, it is assumed that considering the organisational innovation adoption process consisting of linear and sequential stages does not impact this study's findings.

## 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. It is suggested to shorten the questionnaire by only including the questions that have passed the reliability and validity tests in this study. 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. Besides, the TOE framework can easily supplemented by other theories (i.e. Resource Based View theory, Institutional Theory, and others) as have been done in other studies (Dwivedi et al., 2012). Combining different theories can potentially better explain organisational innovation adoption. 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. In addition, a cross-country approach allows assessing the influence of the environmental context on the organisational eHealth adoption. 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 first 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 utilising 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.

## 6.6 Personal reflection on research process

In this section I will provide a brief personal reflection on the research process. First, I will describe the choices I made in searching, selecting and using the literature. Second, I will describe my choices with regard to methodology and analysis used. Finally, I will reflect on the interpretation phase of this study.

*Literature*

eHealth (including the the Dutch healthcare system) and organisational innovation adoption were relatively new fields of study me. Consequently, a lot of effort was put in acquiring sufficient relevant knowledge about the two domains and transform this knowledge into a good survey instrument to measure relevant factors for organisational eHealth adoption. To this end, an extensive literature study was performed in both fields. At the very start of this study, the focus was quite broad, entailing all kinds of eHealth applications and many theories in the field of innovation. During the research effort, important choices were made in delineating the study's scope. In the process of identifying relevant factors, the TOE framework provided me useful guidance in categorising all identified factors. Due to great enthusiasm, however, I ended up with a comprehensive multi-level framework including many factors that literature suggested to influence the adoption of eHealth. Consequently, a selection had to be made on what factors to include in the survey. In this selection process, the main trade off was the amount of factors to be included in the survey versus the acceptable survey length in order to achieve sufficient response.

*Methodology and analysis*

For the purpose of this research I choose a quantitative approach. I experienced some difficulties in the data collection. A cross-sectional survey was distributed to 85 hospitals in the Netherlands. Some of the hospital's CIOs or top-level ICT managers were very enthusiastic about filling in the questionnaire, while for other hospitals e-mail and telephone was extensively used to make them understand the purpose of this study and that the data provided will be used for academic research. Lots of effort (including the backing of EY) resulted in a final sample of 30 hospitals (35% response rate). For future studies – similar to this study – it may be useful to adopt another data collection method, for instance, structure interviews in order to increase the response rate. Eventually, since eHealth is still in an early development stage, qualitative studies may have helped to generate ideas and concepts related to the context of eHealth adoption within organisations. Finally, due to the small sample size of this study I was limited in the methods I could use in analysing the data. Consequently, I pro-actively searched for methods that were suitable for small sample size. After experimentation with several modelling software packages, I choose to use WarpPLS4.0; a Partial Least Squares Structural Equation Modelling software package. However, as I had no knowledge and experience about this software package and the data analysis technique, a lot of effort was put in learning and understanding the modelling technique and software.

*Interpretation*

This study provides a useful understanding in the organisational factors influencing the adoption of eHealth from which strategies can be derived to foster the organisational adoption of eHealth. However, I experienced some difficulties in translating these findings into useful strategies for CIOs and management due to a lack of practical knowledge. For future studies – similar to this study – it may be useful to perform qualitative research (i.e. interviews) as it may help in an enhanced interpretation of the findings from this study.

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# Appendices

# A. Trends in the Dutch healthcare system

The Dutch healthcare system has been put under pressure as healthcare expenditures are expected to rise significantly in the coming years, mainly due to an increase in overall healthcare consumption (De Nationale Denktank, 2013; Economist Intelligence Unit, 2011; Ernst & Young, 2013a, 2013c; European Commission, 2012; Smit, 2013; van Ewijk et al., 2013; World Economic Forum, 2013). Several developments, on both the demand and supply side, can be identified that underpin this increase in healthcare expenditures. The impact of these developments may differ for the type of healthcare: *cure* and *care*. Figure 22 gives a schematic overview of the forces at play in the Dutch healthcare system. It is important to mention that the developments are not exhaustive and may mutually affect each other to a certain extent.

On the demand side, the expected increase in healthcare expenditures is mainly driven by an increasing number of chronically ill patients, an increasing number of patients with comorbidity, an increasing number of diseases related to unhealthy lifestyles, an aging population and more demanding patients (CPB, 2007; Scholte & Kok, 2013; van der Horst et al., 2011; van Ewijk et al., 2013; World Economic Forum, 2013). The amount of chronically ill patients is expected to rise with 16% in 2030 compared to 2011. In the same period, the amount of patients with comorbidity is expected to grow with over 30% (Kiwa Prismant, 2012). In 2011, already 15% of the total costs of healthcare are subscribed to the treatment of chronic diseases (including cardiovascular disorders, cancer, diabetes, asthma / Chronic Obstructive Pulmonary Disease (COPD), depression and rheumatic diseases). The expected growth in the number of chronically ill patients and patients with comorbidity can be partly explained by an aging population and as a result of unhealthy lifestyles (van der Horst et al., 2011; World Economic Forum, 2013). In the period 2011 and 2030 the percentage of people aged over 65 will increase from 17% to 25% of the total population (Kiwa Prismant, 2012; van Ewijk et al., 2013). This demographical development affects healthcare expenditure because the last year of life is associated with high healthcare expenditures. Especially in costs concerned with care, the aging population will have a significant impact (CPB, 2007; Scholte & Kok, 2013; World Economic Forum, 2013). Another development that drives the increase in healthcare expenses is a more demanding population, as a result of better informed patients and an increased welfare (Scholte & Kok, 2013; World Economic Forum, 2013).

On the supply side, increasing healthcare expenditures are mainly driven by advancements in medical technology and treatments, the sluggish growth in productivity and unopposed volume incentives for healthcare providers. Advancements in medical technology and treatments generally impact the expenses of healthcare in the following ways: First of all, currently hard to diagnose diseases may become better traceable in the future. This may even lead to overdiagnosis: a side effect of screening for early forms of diseases which may turn people into patients unnecessarily, since the disease will never cause symptoms or death during a patient's lifetime. Secondly, as diseases become more manageable we may live for a longer period of time while carrying one or more diseases with us (Scholte & Kok, 2013). The above will result in an increased consumption of healthcare. Thirdly, the benefits medical innovations bring for health often diminish due to a higher price for treatment. Often, new methods will not entirely substitute existing methods for treatment, resulting in an increased amount of diagnoses and operations per disease, accompanied by an increase in costs (CPB, 2007; World Economic Forum, 2013). Another development that contributes to an increase in healthcare expenditure is concerned with labour productivity in the healthcare sector. Healthcare, especially long-term care is a highly labour intensive sector in which labour productivity growth is low. These characteristics may result in a higher price of healthcare, and therefore an increase in healthcare expenditures, when salaries in healthcare rise in response to rising salaries in other sectors that did experience labour productivity growth. It increases the cost of healthcare without quality or quantity of profits is made. This is called the 'Baumol effect' (Scholte & Kok, 2013; van der Horst et al., 2011). Finally, in the current healthcare system, healthcare providers are being rewarded for increases in expenditure or volume (World Economic Forum, 2013).

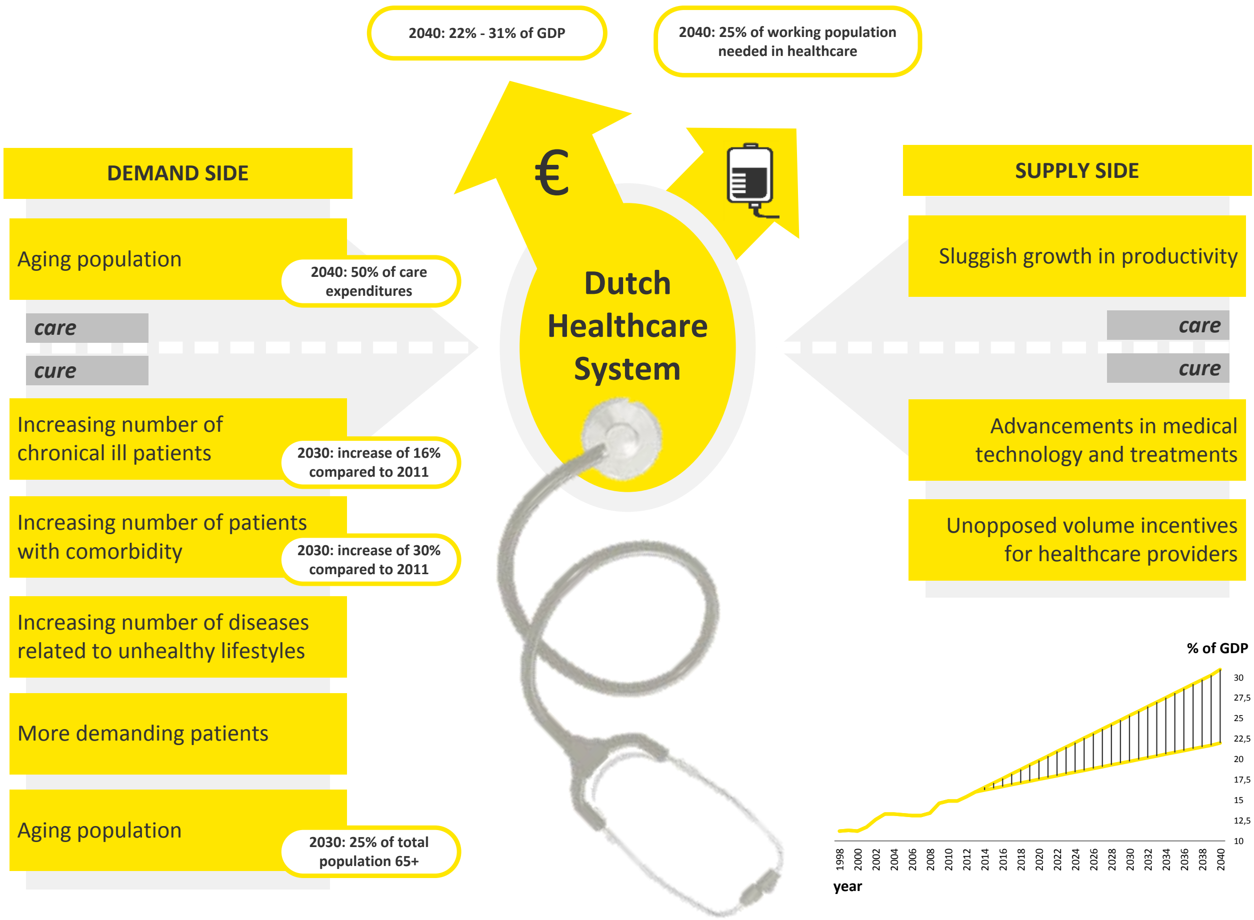



Figure 22) Overview trends in Dutch healthcare system

# B. eHealth related terms

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. However, the use of ICT in healthcare is, among others, also known as *telemedicine*, *mHealth*, *telecare*, *telehealth*, and *health informatics*. This appendix provides a short overview of eHealth related terms.

## B.1 *Health informatics*

The health informatics category is more oriented towards information technologies than telecommunication technologies as it deals with the collection, storage, retrieval, communication and optimal use of health related data, information and knowledge (Beekens, 2011; John Mitchell, 1999). Examples that fit in this category are the Electronic Health Record (EPD), Picture Archiving and Communication System (PACS), and provision of healthcare related information on the Internet for patients and interested parties (Beekens, 2011).

## B.2 *Telehealth*

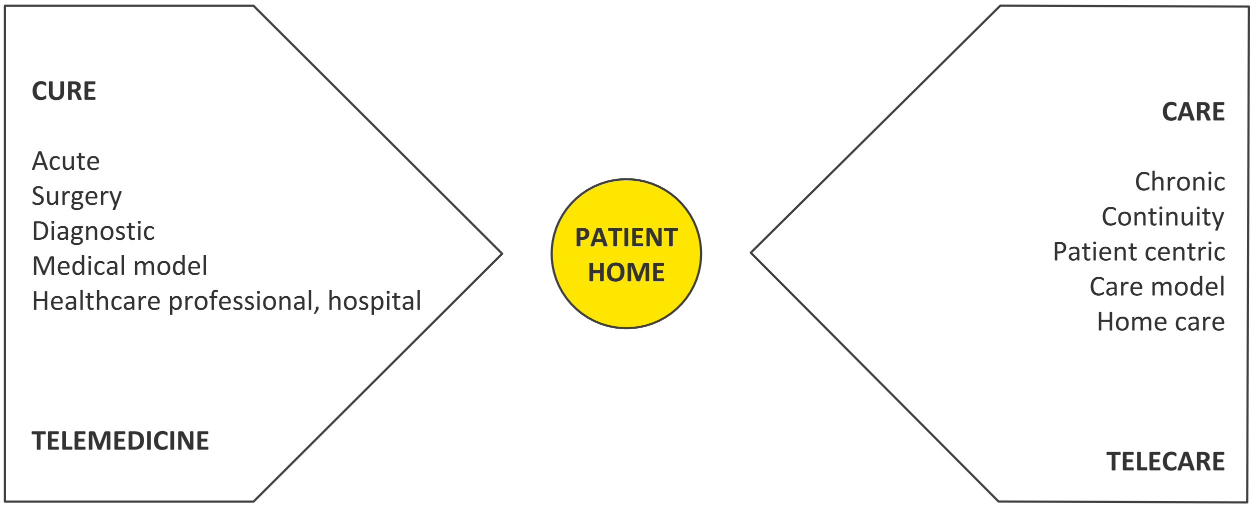
The telehealth category is more oriented towards telecommunication technologies than information technologies as it deals with the provision of healthcare at distance through the use of telecommunication technologies (Beekens, 2011; John Mitchell, 1999; Van Dyk, 2014). The term was first coined in 1978 by Bennet et al. to extend the scope of telemedicine (see below) and incorporate a broader set of activities, including patient and provider education (Van Dyk, 2014). Specifically, telehealth includes preventative, promotive, as well as curative aspects of the field, whereas telemedicine has a narrower focus on the curative aspect (Maheu et al., 2002; Van Dyk, 2014). Yet, telehealth is often interchangeable used with telemedicine because the similarities between them are greater than the differences (see below) (Maheu et al., 2002).

## B.3 *Telemedicine*

As mentioned above, telemedicine can been regarded as a subset of telehealth with a narrower focus on the curative aspect (Van Dyk, 2014). Telemedicine is a term to describe the use of telecommunication technologies for the provision of medical services to distant locations, and existed along before the Internet (Maheu et al., 2002; Van Dyk, 2014). Its main focus is on enabling the communication between people in healthcare (Beekens, 2011). To date, this communication is still largely doctor-to-doctor (including hospital-to-hospital) and typically involves consultation with specialists at distance, with the patient being examined or otherwise somewhere in the system. Yet, recent developments involve doctor-to-patients communications (i.e. consultations) through the use of the Internet (Telecare Aware Group, 2012). Examples that fit in this category are services like video-monitoring by home care nurses, email-consult services with general practitioners (GP's), and self-measuring services for e.g. blood pressure and diabetes where patients afterwards send their information to the doctor (Beekens, 2011).

## B.4 *Telecare*

Telecare describes *"the continuous, automatic and remote monitoring of real time emergencies and lifestyle changes over time in order to manage the risks associated with independent living"* (Telecare Aware Group, 2012). As the definition indicates, telecare is mainly associated with "care" or "lifestyle monitoring". Telecare is based on the idea that people should be able to participate in the community as much as, and for as long as, possible (Doughty, Monk, & Bayliss, 2007). Because of this preventive character, telecare is within the scope of telehealth, but not within the scope of telemedicine (that is associated with cure) (Van Dyk, 2014). See Figure 23. Examples that fit in this category are alarms (including a range of sensors), monitoring (such as care station/ care kiosk, domestic task/ ADL performance, lifestyle/ behaviour measurements, movement measurements) and advice/ feedback (such as TV/ audio device, video therapy) (Doughty et al., 2007).




*Adapted from:* (Vlaskamp & Webers, 2001)

**Figure 23) Difference between telemedicine and telecare**

## B.5 *mHealth*

mHealth refers to the use of eHealth applications that are executed with the help of mobile technology (i.e. smartphones and tablets) (Van Dyk, 2014). In broad, it is defined as the use of portable devices with the capability to create, store, retrieve, and transmit data in real time between end users for the purpose of improving healthcare safety and outcomes, whereas reducing costs (Akter & Ray, 2010; Yu, Wu, Yu, & Xiao, 2006). mHealth is often regarded as a subset of eHealth applied within telehealth and telemedicine domain with a focus on the role of mobility and related technology in the delivery of healthcare (Van Dyk, 2014; Yu et al., 2006). Examples that fit in this category are new communication with patients, access to Web resources, personal health record-on-the-phone and point-of-care documentation, communication-based disease management, on-the-phone educational programs, professional networking, administrative applications, financial applications, emergency medical services/ emergency department services, public health, pharmaceutical research, body area networks, and implanted and wearable devices for information capture and monitoring (Liebert, 2010).

## B.6 *Health telematics*

Health Telematics is "a composite term for health-related activities, services and systems, carried out over a distance by means of information and communications technologies, for the purposes of global health promotion, disease control, and healthcare, as well as education, management, and research for health". Very often and very common health telematics is called eHealth to show the importance of e-technologies for healthcare (Pfeiffer, 2009). It differs from eHealth in that it has a narrow focus on the distance aspect, whereas eHealth also include local use of ICT in healthcare.

# C. Organisational innovation adoption process: An overview

With respect to organisational innovation adoption, commonly two main stages (consisting of different substages) may be distinguished: initiation and implementation. The adoption decision takes place in between these stages (Damanpour & Wischnevsky, 2006; Rogers, 1995; Zaltman et al., 1973). Most of the organisational innovation adoption models proposed by other authors are variations of the above, with greater or lesser gradations between stages. All definitions are consistent with the pre-adoption, adoption-decision and post-adoption categorisation in Information Systems (IS) literature as presented in Table 23 (Kouki et al., 2006).

**Table 23) Overview of organisational innovation adoption models**

| References | Stages/phases | | | | | |
|---|---|---|---|---|---|---|
| | *Two-stage models* | | | | | |
| (Zaltman et al., 1973) | Primary adoption | Secondary adoption | | | | |
| | *Three-stage models* | | | | | |
| (Lewin, 1952) | Unfreezing | Change | Refreezing | | | |
| (Grover & Goslar, 1993) | Initiation | Adoption | Implementation | | | |
| (Gallivan, 2001) | Primary authority adoption decision | Secondary adoption and organisational assimilation | Organisational acceptance and consequences | | | |
| (K. Zhu et al., 2006) | Initiation | Adoption | Routinization | | | |
| (Meyer & Goes, 1988) | Knowledge-awareness | Evaluation-choice | Adoption-implementation | | | |
| (Wu & Chuang, 2010) | Adoption | Implementation | Assimilation | | | |
| | *Four-stage models* | | | | | |
| (Swanson & Ramiller, 2004) | Comprehension | Adoption | Implementation | Assimilation | | |
| (Fleuren et al., 2004c) | Dissemination | Adoption | Implementation | Continuation | | |
| | *Five-stage models* | | | | | |
| (Rogers, 1995) | Agenda setting | Matching | Redefining | Clarifying | Routinization | |
| (Robert et al., 2009) | Initiation | Adoption | Implementation | Assimilation | Consequences | |
| (Tornatzky et al., 1990) | Awareness | Selection | Adoption | Implementation | Routinization | |
| (Zaltman et al., 1973) | Knowledge awareness | Attitudes formation | (adoption) Decision | Initial implementation | Continued-sustained implementation | |
| | *Six-stage models* | | | | | |
| (Cooper & Zmud, 1990) | Initiation | Adoption | Adaption | Acceptance | Routinization | Infusion |
| (Fichman & Kemerer, 1997; Fichman, 2000) | Awareness | Interest | Evaluation/ Trial | Commitment | Limited deployment | General deployment |
| (Kwon & Zmud, 1987a) | Initiation | Adoption | Adaptation (development/ installation) | Acceptance | Use | Incorporation |
| (Frambach & Schillewaert, 2002) | Awareness | Consideration | Intention | Adoption | Continuous use | User acceptance |

# D. Sampling frame

Due to dynamics in the Dutch hospital landscape (mergers and bankruptcies), there was no up-to-date list of all general and academic hospitals in the Netherlands available prior to this study. Therefore, an up-to-date list has been constructed based on four sources that were found on the Internet and one source of EY. The sample frame used in this study is presented in Table 24. Because of privacy concerns, contact information is not included in this report.

**Table 24) Sampling frame**

| |
|---|
| **Universitaire Medische Centra** |
| 1. (1) Academisch Medisch Centrum |
| 2. (2) Academisch Ziekenhuis Maastricht |
| 3. (3) Erasmus MC |
| 4. (4) Leids Universitair Medisch Centrum (LUMC) |
| 5. (5) Universitair Medisch Centrum Groningen |
| 6. (6) Universitair Medisch Centrum St. Radboud (UMCN) |
| 7. (7) Universitair Medisch Centrum Utrecht |
| 8. (8) VU Medisch Centrum |
| **Algemene Ziekenhuizen** |
| *Samenwerkende Topklinische opleidingsZiekenhuizen (STZ)* |
| 9. (1) Albert Schweitzer Ziekenhuis |
| 10. (2) Amphia Ziekenhuis |
| 11. (3) Atrium Medisch Centrum Parkstad |
| 12. (4) Cansisius-Wilhelmina Ziekenhuis |
| 13. (5) Catharina Ziekenhuis |
| 14. (6) Deventer Ziekenhuis |
| 15. (7) Gelre Ziekenhuis |
| 16. (8) HagaZiekenhuis (Stichting Reinier Haga Groep) |
| 17. (9) Isala Klinieken |
| 18. (10) Jeroen Bosch Ziekenhuis |
| 19. (11) Kennemer Gasthuis – Spaarne Ziekenhuis (fuserend) |
| 20. (12) Maasstad Ziekenhuis |
| 21. (13) Martini Ziekenhuis (Algemeen Christelijk Ziekenhuis Groningen) |
| 22. (14) Máxima Medisch Centrum |
| 23. (15) MCA Gemini Groep |
| 24. (16) Meander Medisch Centrum |
| 25. (17) Medisch Centrum Haaglanden |
| 26. (18) Medisch Centrum Leeuwarden (Zorgpartners Friesland) |
| 27. (19) Medisch Spectrum Twente |
| 28. (20) Onze Lieve Vrouwe Gasthuis – St. Lucas Andreas Ziekenhuis |
| 29. (21) Reinier de Graaf Groep (Stichting Reinier Haga Groep) |
| 30. (22) Rijnstate (Alysis Zorggroep) |
| 31. (23) St. Antonius Ziekenhuis |
| 32. (24) St. Elisabeth Ziekenhuis |
| 33. (25) St. Franciscus/ Vlietland Groep |
| 34. (26) VieCuri Medisch Centrum |
| *Samenwerkende Algemene Ziekenhuizen (SAZ)* |

| |
|---|
| 35. (1) Antonius Zorggroep |
| 36. (2) BovenIJ Ziekenhuis |
| 37. (3) Bronovo-Nebo Ziekenhuis Bronovo |
| 38. (4) Diaconessenhuis Leiden |
| 39. (5) Cura Mare, Het Van Weel-Bethesda Ziekenhuis |
| 40. (6) Elkerliek Ziekenhuis |
| 41. (7) Franciscus Ziekenhuis Roosendaal |
| 42. (8) Havenziekenhuis en Instituut voor Tropische Ziekten B.V. |
| 43. (9) IJsselland Ziekenhuis |
| 44. (10) LangeLand Ziekenhuis |
| 45. (11) Laurentius Ziekenhuis |
| 46. (12) Lievensberg Ziekenhuis |
| 47. (13) MC Groep (IJsselmeer Ziekenhuizen) |
| 48. (14) Nij Smellinghe – Zorggroep Pasana |
| 49. (15) Ommelander Ziekenhuis Groep |
| 50. (16) Pantein |
| 51. (17) Refaja Ziekenhuis |
| 52. (18) Rivas Zorggroep (Beatrixziekenhuis) |
| 53. (19) Rode Kruis Ziekenhuis |
| 54. (20) Saxenburgh Groep |
| 55. (21) SJG Weert (St. Jans Gasthuis) |
| 56. (22) Slingeland Ziekenhuis |
| 57. (23) Spijkenisse Medisch Centrum |
| 58. (24) St. Anna Zorggroep |
| 59. (25) St. Jansdal Ziekenhuis (Christelijk Algemeen Ziekenhuis Noordwest-Veluwe) |
| 60. (26) Tjongerschans Ziekenhuis Heerenveen (Zorgpartners Friesland) |
| 61. (27) Waterland Ziekenhuis |
| 62. (28) Wilhelmina Ziekenhuis Assen |
| 63. (29) Zaans Medisch Centrum |
| 64. (30) Ziekenhuis Amstelland |
| 65. (31) Ziekenhuis Bernhoven |
| 66. (32) Ziekenhuis Rivierenland |
| 67. (33) Ziekenhuisvoorzieningen Oost-Achterhoek (Streekziekenhuis Koningin Beatrix) |
| 68. (34) Zorgcombinatie Noorderboog (Diaconessenhuis Meppel) |
| 69. (35) Zorggroep Leveste Middelveld (Ziekenhuis Bethesda) |
| 70. (36) ZorgSaam Zeeuws-Vlaanderen |
| 71. (37) Zuwe Hofpoort Ziekenhuis |
| *Overige* |
| 72. (1) Admiraal de Ruyter Ziekenhuis |
| 73. (2) Diakonessenhuis Utrecht |
| 74. (3) Flevoziekenhuis |
| 75. (4) Groene Hart Ziekenhuis |
| 76. (5) Ikazia Ziekenhuis |
| 77. (6) Medisch Centrum Amstelveen |
| 78. (7) Orbis Medisch Centrum |
| 79. (8) Rijnland Ziekenhuis |
| 80. (9) Slotervaart Ziekenhuis |
| 81. (10) Tergooiziekenhuizen |

| |
|---|
| 82. (11) TweeSteden Ziekenhuis |
| 83. (12) Westfries Gasthuis (Stichting Algemeen Ziekenhuis) |
| 84. (13) Ziekenhuis Gelderse Vallei |
| 85. (14) Ziekenhuisgroep Twente |

*Adapted from:* (Dutch Hospital Data, 2013; KPMG, 2013; Nationale Atlas Volksgezondheid, 2013) *and https://www.jaarverslagenzorg.nl/*

# E. Representativity of sample

A Chi[2] has been performed to test whether the sample composition is representative for the composition of the real population. A p-value of .608 indicates that the composition of the sample is equal to the population. In addition, two *one-sample t-tests* have been performed on the variables [SIZE] and [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] and p-value=.707 for [TURNOVER]).

Table 25) Chi-Square on sample composition

| | Observed N | Expected N | Residual |
|---|---|---|---|
| Academic | 2 | 2.8 | -.8 |
| General | 28 | 27.2 | .8 |

| | Observed N |
|---|---|
| Chi-Square | .263[a] |
| Df | 1 |
| Asymp. Sig. | .608 |

*[a]1 cells (50%) have expected frequencies less than 5. The minimum expected cell frequency is 2.8*

Table 26) One-Sample test of size

| Test Value = 512.5176 | | | | | 95% Confidence Interval of the Difference | |
|---|---|---|---|---|---|---|
| | t | df | Sig. (2-tailed) | Mean Difference | Lower | Upper |
| Size | -.083 | 29 | .934 | -3.587 | -91.665 | 84.492 |

Table 27) One-Sample test of annual turnover

| Test Value = 253588871.7 | | | | | 95% Confidence Interval of the Difference | |
|---|---|---|---|---|---|---|
| | t | df | Sig. (2-tailed) | Mean Difference | Lower | Upper |
| Annual turnover | -.380 | 29 | .707 | -12991686.010 | -82874440.548 | 56891068.528 |

# F. Call protocol

Contact information in the form of e-mail addresses of Chief Information Officers (CIOs) or ICT managers was supplemented by to the following procedure: 1) LinkedIn was used to find the right persons to fill in the survey (CIO or ICT manager), 2) telephone numbers of each hospital was gathered, and 3) all hospitals were called following the protocol as outlined below.

Goedendag,

U spreekt met Sander Faber en ik ben op zoek naar het "Hoofd ICT" van het [ziekenhuis], [de heer/ mevrouw] [achternaam].

== doorverbonden ==

Goedendag,

U spreekt met Sander Faber en ik bel u namens de Technische Universiteit Delft. Klopt het dat ik ben doorverbonden met het "Hoofd ICT" van het [ziekenhuis]?

Op dit moment ben ik bezig met mijn afstudeeronderzoek bij EY (Ernst & Young) naar de adoptie en implementatie van eHealth in Nederlandse ziekenhuizen. Daarvoor wil ik bij de ICT managers van alle Nederlandse Ziekenhuizen een enquête van 15 minuten afnemen via het Internet en mij vraag is of u hieraan zou willen meewerken. Als tegenprestatie worden de resultaten van het onderzoek aan u ter beschikking gesteld in de vorm van een persoonlijk benchmarkrapport in het najaar van 2014. In dit rapport wordt uw zorginstelling afgezet tegen andere zorginstellingen op het gebied van eHealth.

[Indien: ja]
Wat is uw e-mailadres?

[Indien: nee]
Is er wellicht een ander persoon binnen de organisatie die hiervoor tijd zou kunnen vrijmaken en die op de hoogte is van eHealth ontwikkelingen binnen de organisatie?

Hartelijk dank voor uw tijd/ medewerking.

Tot ziens.

# G. Exploratory Factor Analysis results

EFA used to assess the presence of common method bias and unidimensionality of reflective measurement models.

## G.1 *Common method bias*

Harman's single-factor test was conducted to test the presence of common method bias. All items used in the study are subject to an exploratory factor analysis. Common method bias is assumed to exist, if "1) a single factor emerges from unrotated factor solutions," or "2) a first factor explains the majority of the variance in the variables".

Table 28) EFA Common Method Bias

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | **8.023** | 33.430 | 33.430 | 8.023 | **33.430** | 33.430 |
| 2 | **2.876** | 11.983 | 45.413 | 2.876 | 11.983 | 45.413 |
| 3 | **2.561** | 10.672 | 56.084 | 2.561 | 10.672 | 56.084 |
| 4 | **1.902** | 7.925 | 64.010 | 1.902 | 7.925 | 64.010 |
| 5 | **1.564** | 6.515 | 70.524 | 1.564 | 6.515 | 70.524 |
| 6 | **1.340** | 5.585 | 76.109 | 1.340 | 5.585 | 76.109 |
| 7 | **1.027** | 4.278 | 80.387 | 1.027 | 4.278 | 80.387 |
| 8 | .786 | 3.277 | 83.664 | | | |
| 9 | .700 | 2.915 | 86.578 | | | |
| 10 | .535 | 2.229 | 88.807 | | | |
| 11 | .466 | 1.941 | 90.748 | | | |
| 12 | .411 | 1.714 | 92.462 | | | |
| 13 | .381 | 1.586 | 94.048 | | | |
| 14 | .376 | 1.565 | 95.613 | | | |
| 15 | .306 | 1.275 | 96.888 | | | |
| 16 | .202 | .842 | 97.729 | | | |
| 17 | .149 | .622 | 98.352 | | | |
| 18 | .113 | .472 | 98.823 | | | |
| 19 | .083 | .346 | 99.169 | | | |
| 20 | .070 | .290 | 99.460 | | | |
| 21 | .053 | .223 | 99.683 | | | |
| 22 | .041 | .172 | 99.854 | | | |
| 23 | .028 | .115 | 99.969 | | | |
| 24 | .007 | .031 | 100.000 | | | |
| *Extraction Method: Principal Component Analysis.* | | | | | | |

## G.2 *Unidimensionality*

Unidimensionality refers to a latent variable (or reflectively measured construct) having each of its measurement items relate to it better than to any others. Unidimensionality was assessed based on the Kaiser's rule (a block may be considered unidimensional if the first eigenvalue of its correlation matrix is higher than 1, while the others are smaller) and item loadings of >.5 to their corresponding construct (Urbach & Ahlemann, 2010). EFA was conducted using the Principle Components Analysis (PCA) method with Varimax rotation. Because the sample was quite small (N<50), Regular Exploratory Factor Analysis (REFA) method was used with Varimax rotation.

Table 29) EFA: Technological context - Telemonitoring in heart failure

| (N=28) | REFA - *Varimax* | | PCA - *Varimax* | |
|---|---|---|---|---|
| Item | Factor 1 | Factor 2 | Factor 1 | Factor 2 |
| RA_3_A_t | .894 | -.101 | .939 | -.089 |
| RA_1_A | .742 | .103 | .826 | .115 |
| RA_2_A_t | .737 | -.228 | .802 | -.212 |
| CO_1_A_r | .075 | -.731 | .078 | -.831 |
| OC_2_A | -.045 | .671 | -.033 | .796 |
| OC_3_A | -.039 | .648 | -.041 | .779 |
| Eigenvalues | 1.902 | 1.462 | 2.217 | 1.997 |
| % of variance | 31.703 | 24.373 | 36.942 | 33.280 |
| Reliability | .815 | .724 | .815 | .724 |

Table 30) EFA: Technological context - Telemonitoring in diabetes

| (N=28) | REFA - *Varimax* | | PCA - *Varimax* | |
|---|---|---|---|---|
| Item | Factor 1 | Factor 2 | Factor 1 | Factor 2 |
| RA_1_B | .768 | .077 | .874 | -.076 |
| RA_3_B | .801 | .174 | .851 | -.198 |
| RA_2_B_t | .690 | -.037 | .804 | .092 |
| OC_3_B | -.016 | -.782 | .013 | .884 |
| CO_1_B_r | -.013 | .683 | .007 | -.751 |
| OC_2_B | -.161 | -.542 | -.149 | .716 |
| Eigenvalues | 1.734 | 1.410 | 2.156 | 1.913 |
| % of variance | 28.900 | 23.508 | 35.941 | 31.879 |
| Reliability | .787 | .692 | .787 | .692 |

Table 31) EFA: Technological context – Online access to EHR

| (N=30) | REFA - *Varimax* | | PCA - *Varimax* | |
|---|---|---|---|---|
| Item | Factor 1 | Factor 2 | Factor 1 | Factor 2 |
| RA_3_C | -.928 | -.136 | .936 | .147 |
| RA_1_C | -.916 | -.192 | .925 | .182 |
| RA_2_C_t | -.717 | .047 | .846 | -.148 |
| CO_1_C_r | -.044 | .718 | .050 | -.843 |
| OC_3_C | -.039 | -.724 | .067 | .799 |
| OC_2_C_t_1 | -.188 | -.336 | .095 | .609 |
| Eigenvalues | 2.252 | 1.209 | 2.465 | 1.795 |
| % of variance | 37.534 | 20.163 | 41.077 | 29.914 |
| Reliability | .886 | .595 | .886 | .595 |

Table 32) EFA: Centralisation

| (N=30) | REFA - *Varimax* | PCA - *Varimax* |
|---|---|---|
| Item | Factor 1 | Factor 1 |
| CE_1_r | 0.763 | .889 |
| CE_2 | 0.763 | .889 |
| Eigenvalues | 1.163 | 1.582 |
| % of variance | 71.493 | 79.084 |
| Reliability | .883 | .883 |

Table 33) EFA: Technological readiness

| (N=30) | REFA - *Varimax* | | | | PCA - *Varimax* | | | |
|---|---|---|---|---|---|---|---|---|
| Item | Factor 1 (IT governance) | Factor 2 (IT infrastructure) | Factor 3 (IT security) | Factor 4 (IT human resources) | Factor 1 (IT governance) | Factor 2 (IT infrastructure) | Factor 3 (IT security) | Factor 4 (IT human resources) |
| IG_1_t | .848 | -.168 | .019 | .044 | .893 | .230 | .062 | -.099 |
| IG_3 | .770 | .217 | .243 | -.306 | .796 | -.183 | .174 | .361 |
| IG_2_t | .708 | .076 | .383 | -.215 | .745 | -.102 | .349 | .260 |
| IT_2 | -.205 | -.877 | .324 | -.009 | -.274 | .839 | .341 | .046 |
| IT_1 | .232 | -.650 | -.264 | -.075 | .238 | .800 | -.236 | .006 |
| IT_3 | -.205 | -.839 | .389 | -.134 | -.273 | .784 | .422 | .157 |
| IT_4 | .318 | -.475 | .151 | -.257 | .305 | .570 | .086 | .332 |
| SE_3 | .017 | -.083 | .749 | .028 | -.040 | .059 | .810 | .028 |
| SE_4_t | .283 | -.193 | .574 | -.037 | .275 | .189 | .741 | .008 |
| SE_1 | .267 | -.060 | .400 | -.047 | .307 | .028 | .612 | -.017 |
| HR_1 | .131 | -.099 | .030 | -.917 | .136 | .101 | .033 | .927 |
| HR_2 | .100 | -.137 | -.003 | -.896 | .084 | .146 | -.030 | .926 |
| Eigenvalues | 2.278 | 1.879 | 2.232 | 1.606 | 2.481 | 2.452 | 2.096 | 2.062 |
| % of variance | 18.982 | 15.657 | 18.603 | 13.387 | 2.677 | 2.431 | 17.467 | 17.182 |
| Reliability | .906 | .867 | .823 | .962 | .906 | .867 | .823 | .962 |

Table 34) EFA: Top Management Support

| (N=30) | REFA - *Varimax* | PCA - *Varimax* |
|---|---|---|
| **Item** | **Factor 1** | **Factor 1** |
| MS_3 | -.881 | .892 |
| MS_4 | -.858 | .867 |
| MS_1 | -.766 | .832 |
| MS_5 | -.773 | .832 |
| MS_2 | -.729 | .804 |
| **Eigenvalues** | 3.228 | 3.579 |
| **% of variance** | 68.453 | 71.581 |
| **Reliability** | .926 | .926 |

Table 35) EFA: Absorptive Capacity

| (N=30) | REFA - *Varimax* | PCA - *Varimax* |
|---|---|---|
| **Item** | **Factor 1** | **Factor 1** |
| AC_1 | .813 | .845 |
| AC_8 | .786 | .809 |
| AC_2 | .748 | .799 |
| AC_5_t | .737 | .747 |
| AC_3 | .688 | .725 |
| AC_7 | .665 | .718 |
| AC_4 | .584 | .655 |
| AC_6 | .542 | .550 |
| **Eigenvalues** | 4.337 | 4.337 |
| **% of variance** | 54.213 | 54.213 |
| **Reliability** | .904 | .904 |

## H. Pre-processing results

Data was loaded into WarpPLS4.0 which conducted an additional check on the data. Below an overview of the checks is presented.

```
Pre-processing data results:
-----------------------------------------------------------

Checking for and correcting missing values ...
  No missing values found.

Checking for and correcting zero variance problems ...
  No columns with zero variance found.

Checking for and correcting identical column names ...
  No identical column names found.

Checking for rank problems ...
  The data may be rank deficient, which may lead to misleading results.
  The number of data columns is 34.
  The number of data rows (usually called the "sample size") is 30.
  Yet, the maximum number of independent data rows or columns is only 30.
  This problem can often be avoided by having a much larger number of data
rows than columns.

Standardizing data ...
   All columns (indicators) standardized.
```

# I. Model construction

PLS-SEM works by "simultaneously assessing the reliability and validity of the measures of theoretical constructs (confirmatory factory analysis (CFA) and estimating the relationships among these constructs (path modelling)". Generally, a Structural Equation Model with latent constructs has two components (Vinzi et al., 2010): 1) the outer model (the *measurement model* including the unidirectional predictive relationships between each construct and its associated observed indicators), and 2) the inner model (the structural model showing the relationships (paths) between constructs). In contrast to EFA, PLS-SEM performs a CFA in which the pattern of loadings of the measurement items on the reflective constructs is specified explicitly in the model. Then, the fit of this pre-specified model is examined to determine its convergent and discriminant validities (Vinzi et al., 2010). The higher level constructs, organisational readiness and technological readiness, were modelled using the two-step approach in which the lower-order construct scores are initially estimated in a model without higher-order constructs. Then, the lower-construct scores are used as indicators in a separate higher-order structural model analysis. Below the steps in the model constructions are provided.

1. Construction of the first-order reflective constructs to obtain the LV scores:


Figure 24) Higher-order construct build-up step 1

2. Construction of second order formative construct to obtain the LV score:

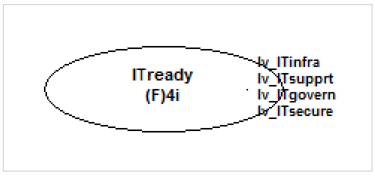



Figure 25) Higher-order construct build-up step 2

3. Construction of the complete model (the control variable is connected to all endogenous variables):

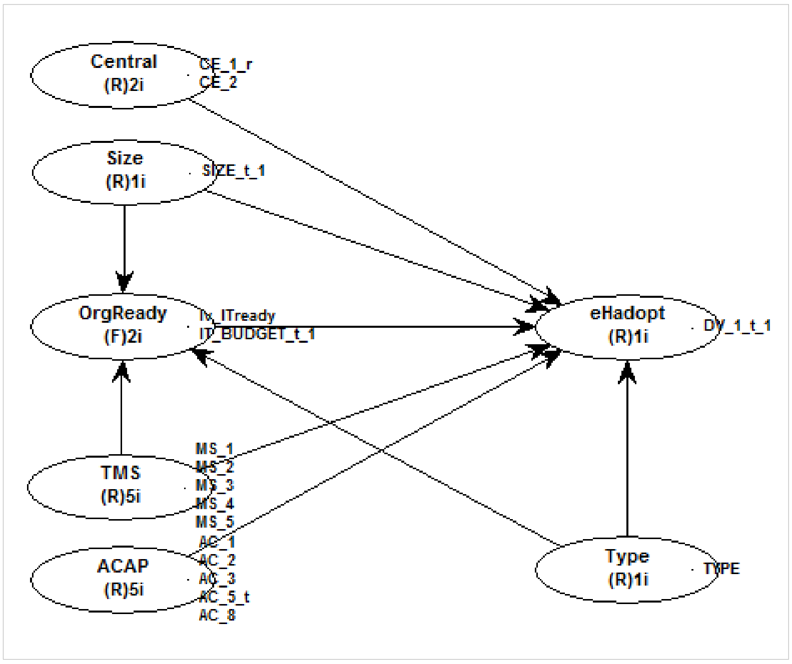



Figure 26) Complete model in WarpPLS 4.0

4. Construction of the final model (control variable is excluded):

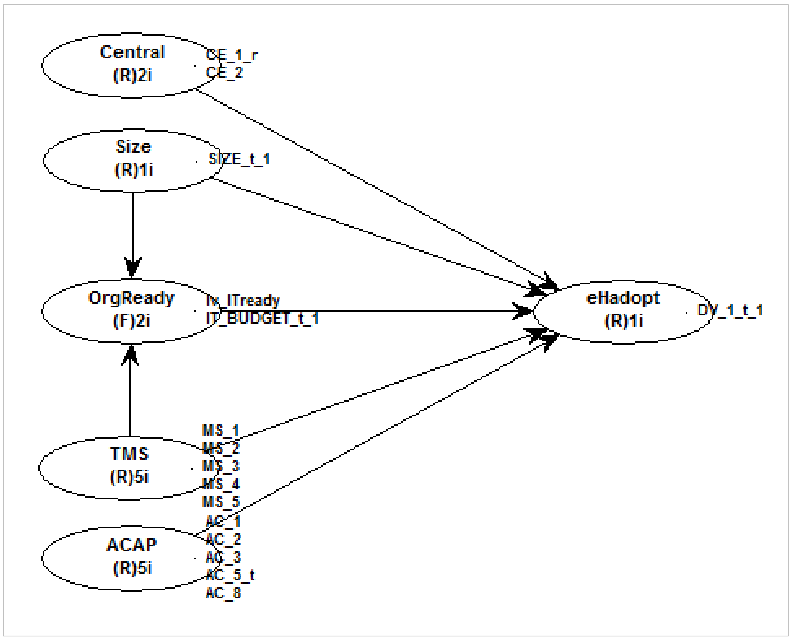



Figure 27) Final model in WarpPLS 4.0

# J. Academic versus general hospital adoption

A one-way between subjects ANOVA was conducted to compare the effect of hospital type (academic and general hospitals) on the organisational adoption of eHealth. Results suggest a significant effect of type of hospital on organisational eHealth adoption at the $p<.5$ level ($F[1, 28]=6.49$, $p=.017$). On average, academic hospitals (Mean=3.57, N=2) are further in the adoption of eHealth than general hospitals (Mean=-.26, N=28).

Table 36) ANOVA: academic versus general hospital

| | Sum of squares | df | Mean square | F | Sig. |
|---|---|---|---|---|---|
| **Between groups** | 27.266 | 1 | 27.266 | 6.488 | 0.017 |
| **Within groups** | 117.662 | 28 | 4.202 | | |
| **Total** | 144.928 | 29 | | | |

# K. Cross-loadings

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 (Chin, 1998). According to Kock and Lynn (2012), "cross-loadings greater than .5 are signs of possible collinearity, as they reflect high correlations among a latent variable score and indicators that are not supposed to "belong" with that latent variable".

Table 37) Cross-loadings first order constructs of second-order construct

| | IT infrastructure | IT human resources | IT governance | IT security |
|---|---|---|---|---|
| IT_1 | .643 | -.060 | .266 | -.361 |
| IT_2 | .928 | -.080 | -.230 | .150 |
| IT_3 | .897 | .067 | -.283 | .272 |
| IT_4 | .652 | .081 | .454 | -.232 |
| HR_1 | -.033 | .962 | .005 | .047 |
| HR_2 | .033 | .962 | -.005 | -.047 |
| IG_1_t | .232 | -.257 | .815 | -.115 |
| IG_2_t | -.060 | .062 | .904 | .130 |
| IG_3 | -.150 | .171 | .900 | -.027 |
| SE_1 | -.136 | .053 | .043 | .752 |
| SE_3 | .051 | -.047 | -.126 | .728 |
| SE_4_t | .076 | -.007 | .070 | .856 |

*Loadings are unrotated and cross-loadings are oblique-rotated*

*All loadings are significant at the level of <.001*

Table 38)Table 30) Cross-loadings of reflective constructs in final model

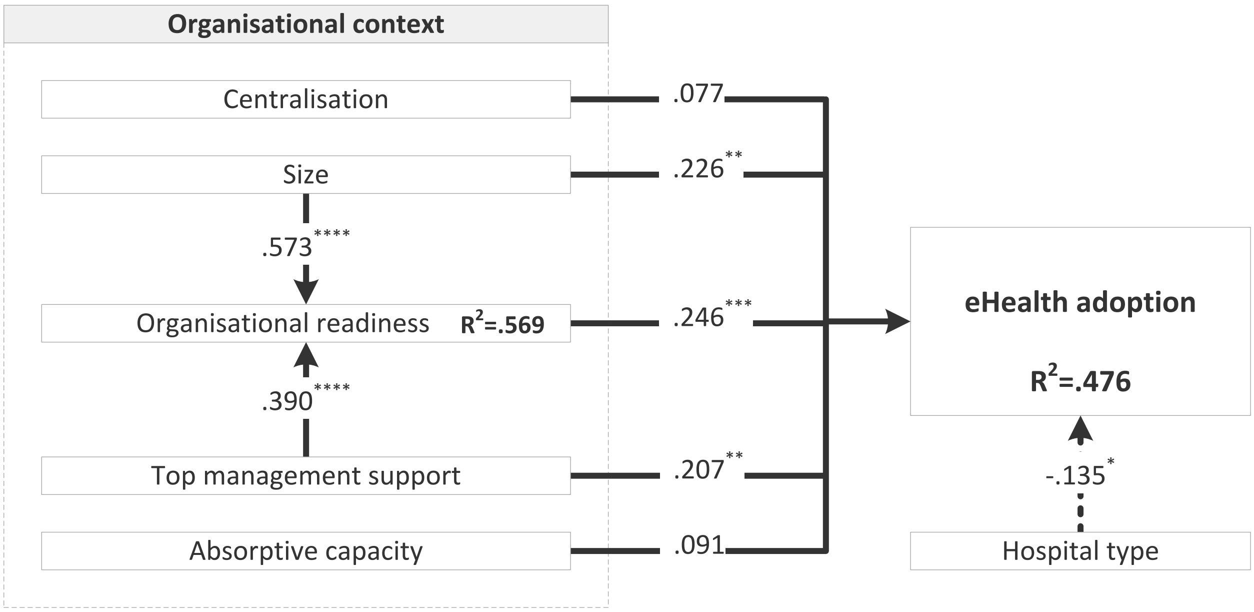
| | Centralisation | Top management support | Absorptive capacity |
|---|---|---|---|
| CE_1_r | .889 | -.063 | .012 |
| CE_2 | .889 | .063 | -.012 |
| MS_1 | .022 | .832 | -.133 |
| MS_2 | .026 | .804 | -.049 |
| MS_3 | -.025 | .892 | .174 |
| MS_4 | .075 | .867 | .246 |
| MS_5 | -.099 | .832 | -.263 |
| AC_1 | .056 | -.169 | .850 |
| AC_2 | -.104 | .346 | .810 |
| AC_3 | .083 | -.066 | .781 |
| AC_5_t | .068 | -.228 | .739 |
| AC_8 | -.092 | .097 | .855 |

*Loadings are unrotated and cross-loadings are oblique-rotated*

*All loadings are significant at the level of <.001*

# L. Structural model with control variable

Figure 28 presents the structural model with control variable, including standardised path coefficients, their significance, and the amount of variance explained ($R^2$).




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

**Figure 28) Structural model with path coefficients (with control variable)**

WarpPLS 4.0 conducts a model fitness test as part of its structural model analysis. The model satisfies all criteria available for model fit and model quality. An overview of the model fit and quality indices is presented in the following table:

**Table 39) Overview of model fit and quality indices (with control variable)**

| Measure | Value |
|---|---|
| Average path coefficient | .218*** |
| Average R-squared | .522**** |
| Average adjusted R-squared | .429**** |
| Average block VIF | 1.483, acceptable if <= 5, ideally <= 3.3 |
| Average full collinearity VIF | 1.843, acceptable if <= 5, ideally <= 3.3 |
| Tenenhaus GoF | .654, small >= .1, medium >= .25, large >= .36 |
| Sympson's paradox ratio | 0.889, acceptable if >= .7, ideally = 1 |
| R-squared contribution ratio | 0.995, acceptable if >= .9, ideally = 1 |
| Statistical suppression ratio | 1.000, acceptable if >= .7 |
| Nonlinear bivariate causality direction ratio | 1.000, acceptable if >= .7 |
| *Levels of significance: *p<.1, **p<.05, ***p<.01, ****p<.001* | |

A detailed overview of the PLS-SEM results with control variable are displayed in the following table:

**Table 40) Detailed overview of SEM results (with control variable)**

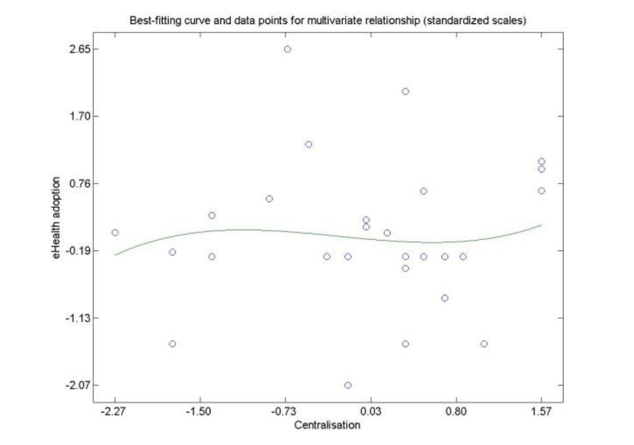
| Association | Path coefficient | Weight |
|---|---|---|
| Centralisation → eHealth adoption | .077 | |
| Size → eHealth adoption | .226$^{**a}$<br>.367$^{****b}$ | |
| Size → Organisational readiness | .573$^{****}$ | |
| Size → Organisational readiness → eHealth adoption | .141$^{**c}$ | |
| Organisational readiness (third order) → eHealth adoption | .246$^{***}$ | |
| Technological readiness (second order) → Organisational readiness | | .659$^{****}$ |
| IT infrastructure → Technological readiness | | .341$^{****}$ |
| IT human resources → Technological readiness | | .362$^{****}$ |
| IT governance → Technological readiness | | .409$^{****}$ |
| IT security → Technological readiness | | .433$^{****}$ |
| Financial readiness → Organisational readiness | | .659$^{****}$ |
| Top management support → eHealth adoption | .207$^{**a}$<br>.303$^{****b}$ | |
| Top management support → Organisational readiness | .390$^{****}$ | |
| Top management support → Organisational readiness → eHealth adoption | .096$^{*c}$ | |
| Absorptive capacity → eHealth adoption | .091 | |
| Type → eHealth adoption | -.135$^{*}$ | |
| Type → Organisational readiness | .017 | |

*Levels of significance: *p<.1, **p<.05, ***p<.01, ****p<.001*
*[a]direct effect, [b]total effect, [c]indirect effect*

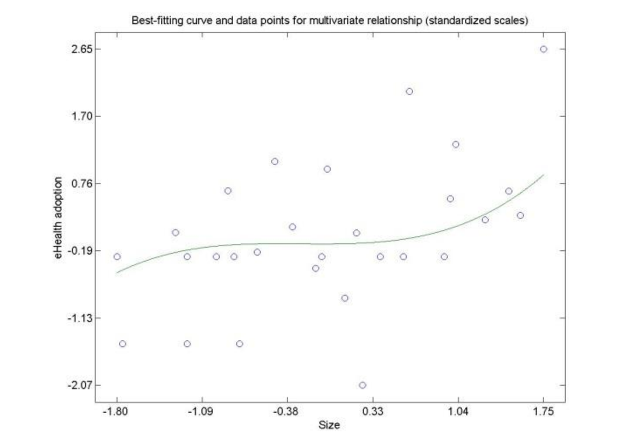
# M. Multivariate relationship plots

In order to identify relationships among constructs, the Warp3 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 (Kock, 2013). The results from this study found non-linear relationships between constructs that take the form of S-curves as can be seen in Figure 29 below.

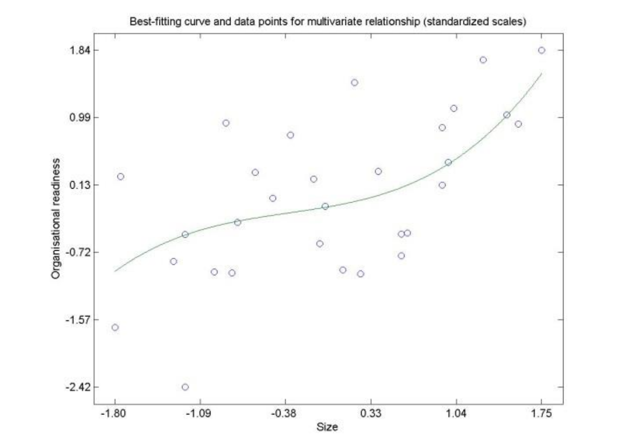
**Centralisation and eHealth adoption**



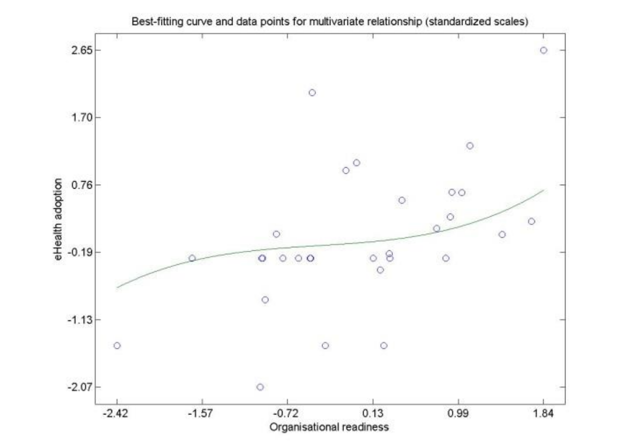

**Size and eHealth adoption**




**Size and organisational readiness**

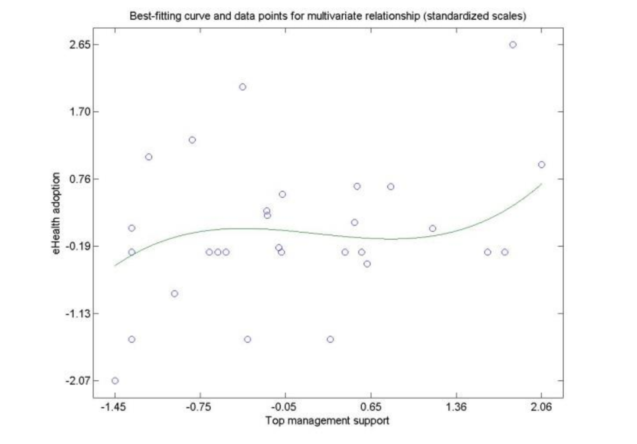


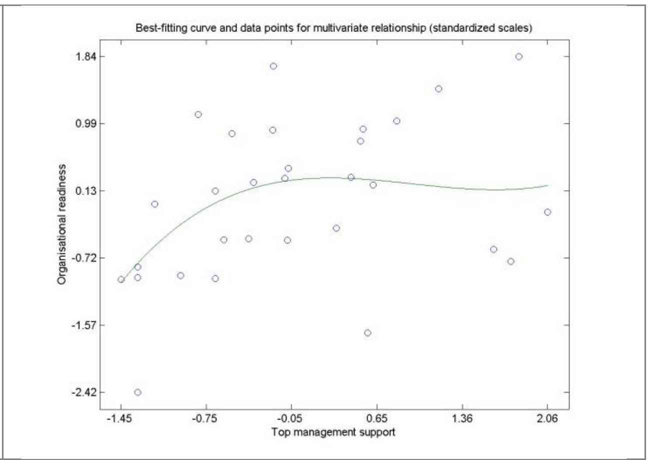

**Organisational readiness and eHealth adoption**




**Top management support and eHealth adoption**

**Top management support and org. readiness**




absorptive capacity and eHealth adoption

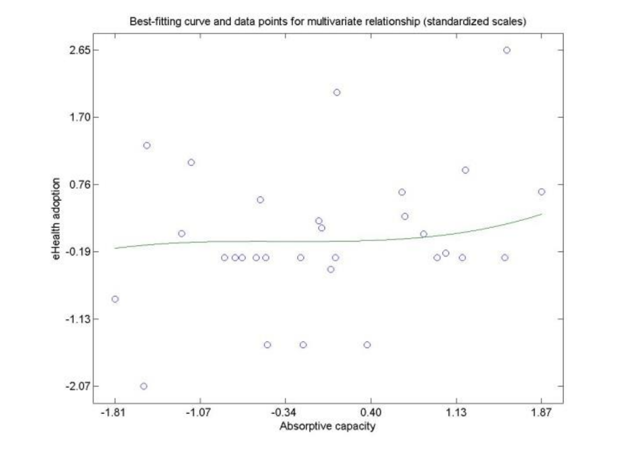



Figure 29) Multivariate relationship plots

# N. Survey

Because there was no readily available measurement instrument that was entirely applicable for the purpose of this study, a measurement instrument (questionnaire) was developed based on several existing surveys in literature. Note that only a part of the questions in the survey was used in this study. Below, the questionnaire is presented.

## eHealth in uw zorginstelling: bent u er klaar voor?

### *EY ICT benchmark 2014*

*Recente onderzoeken laten zien dat de kansen van eHealth nog niet volledig worden benut in Nederlandse zorginstellingen. De vraag is hoe dat komt:* ***Is uw zorginstelling eigenlijk wel klaar voor eHealth?***

Om antwoord te geven op deze vraag doet EY, in samenwerking met de faculteit Techniek, Bestuur en Management van de TU Delft, onderzoek naar de adoptie en implementatie van eHealth in Nederlandse zorginstellingen. Graag nodigen wij u uit om voor dit onderzoek deze enquête in te vullen.

Het invullen van deze enquête kost u ongeveer 15 minuten. De gegeven antwoorden worden op basis van volledige anonimiteit gerapporteerd en in vertrouwelijkheid verwerkt.

De resultaten van het onderzoek worden aan u ter beschikking gesteld in de vorm van **een persoonlijk benchmarkrapport**. In dit rapport wordt uw zorginstelling afgezet tegen andere zorginstellingen op het gebied van eHealth.

Voor vragen over de enquête of het onderzoek kunt u contact opnemen met Sander Faber (MSc Student SEPAM ICT, TU Delft en Graduate Intern EY) via e-mail op sander.faber@nl.ey.com of telefonisch op het nummer +31 (0) 88 407 91 32.

Hartelijk dank voor uw medewerking,

Ir. J.G.G.V. van den Boom RE
Partner IT Risk and Assurance EY

Prof.dr. M.S. van Geenhuizen
Faculteit Techniek, Bestuur en Management
Technische Universiteit Delft

# eHealth toepassingen

## *Definitie van eHealth:*

*eHealth betreft het gebruik van **nieuwe informatie- en communicatietechnologieën** ter **ondersteuning of verbetering** van de gezondheid en de gezondheidzorg.*

1. **In hoeverre is uw organisatie klaar voor gebruik van eHealth?** (%)
   [0-100]

2. **Welke vormen van eHealth zijn op dit moment binnen uw organisatie in gebruik?**

   - ☐ **e-Intake;** online consultvoorbereiding (denk aan vragenlijst voor bijvoorbeeld anamnese).
   - ☐ **e-Consult;** online raadplegen van een medisch professional (eventueel inclusief beeld en geluid).
   - ☐ **Teleconsultatie;** online raadplegen van een collega (consultatie tussen medisch professionals).
   - ☐ **Telemonitoring;** *op afstand toezicht houden op de patiënt op basis van door patiënt verstrekte/ gegenereerde informatie (eventueel geautomatiseerd).*
   - ☐ **e-Inzage;** *online raadplegen van medische gegevens door de patiënt.*
   - ☐ **e-Afspraak;** de patiënt kan online afspraken maken, wijzigen en annuleren.
   - ☐ **e-Notification;** de patiënt ontvangt een herinnering via e-mail of SMS.
   - ☐ **Online informatie;** aanbieden en raadplegen van informatie over ziekte, gezondheid en behandelmethoden op het Internet.
   - ☐ **Sociale media;** alle vormen van Internetcommunicatie met de patiënt (denk aan Facebook, MSN, Youtube, Chatsites, Twitter en Weblogs).
   - ☐ **Online zelftesten**; online testen of vragenlijsten via het Internet die zonder tussenkomst van een professional te gebruiken zijn.
   - ☐ **e-Communicatie;** digitaal contact tussen patiënt en zorgverlener (denk aan e-mail of chatcontact (bijvoorbeeld Skype)).
   - ☐ **Online behandeling;** Internet therapieën en behandelmethoden.

# eHealth toepassingen (vervolg)

*In deze enquête staan **drie** innovatieve eHealth toepassingen centraal, te weten:*

- ***Telemonitoring bij hartfalen;*** *op afstand toezicht houden op de patiënt met hartfalen.*
- ***Telemonitoring bij diabetes;*** *op afstand toezicht houden op de patiënt met diabetes.*
- ***e-Inzage****; online raadplegen van medische gegevens door de patiënt.*

3. Kunt u in de onderstaande tabel aangeven in welke fase de betreffende eHealth toepassing zich in uw organisatie bevindt?
Sleep de eHealth toepassing naar de bijbehorende fase.

*U kunt de positie per toepassing resetten door 1 keer op de toepassing te klikken.*

***Voorbeeld:***
*Uw organisatie maakt regelmatig gebruik van telemonitoring bij hartfalen. Dit geeft u als volgt aan:*

| | (actief) **meer leren/ interesse** | begonnen met **testen en evalueren** | ***besluiten over imple-mentatie*** | begonnen met **imple-mentatie** | wordt **regelmatig gebruikt** | gebruik **niet langer als ongewoon beschouwd** | in een **uitgebreide en verfijnde** manier gebruikt **(volledige potentie)** |
|---|---|---|---|---|---|---|---|
| Telemonitoring bij **hartfalen** | ☐ | ☐ | ☐ | ☐ | ☒ | ☐ | ☐ |

| | *(actief)* ***meer leren/ interesse*** | *begonnen met* ***testen en evalueren*** | ***besluiten*** *over imple-mentatie* | *begonnen met* ***imple-mentatie*** | *wordt* ***regelmatig gebruikt*** | *gebruik* ***niet langer als ongewoon beschouwd*** | in een **uitgebreide en verfijnde** manier gebruikt **(volledige potentie)** |
|---|---|---|---|---|---|---|---|
| *Telemonitoring bij* ***hartfalen*** | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| *Telemonitoring bij* ***diabetes*** | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| *e-Inzage* | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

Indien het bovenstaande niet van toepassing is:

| | *Onbekend met de toepassing* | *(nog)* ***geen interesse*** | *besloten* ***niet*** *te* ***implementeren*** | *gebruik* ***beëindigd*** |
|---|---|---|---|---|
| *Telemonitoring bij* ***hartfalen*** | ☐ | ☐ | ☐ | ☐ |
| *Telemonitoring bij* ***diabetes*** | ☐ | ☐ | ☐ | ☐ |
| *e-Inzage* | ☐ | ☐ | ☐ | ☐ |

## Telemonitoring bij hartfalen

*Onderstaand zijn een aantal stellingen over telemonitoring bij hartfalen opgenomen.* ***Kunt u per stelling aangeven in hoeverre deze van toepassing is op uw organisatie?***

| | Telemonitoring bij hartfalen | Geheel oneens | | | | | | Geheel eens |
|---|---|---|---|---|---|---|---|---|
| 4. | stelt uw organisatie in staat efficiëntere zorg te verlenen (tijd en geld). | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5. | stelt uw organisatie beter in staat aan patiëntbehoeften te voldoen. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6. | stelt uw organisatie in staat doelmatiger zorg te leveren. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7. | komt helemaal overeen met de behoeften en prioriteiten van uw organisatie. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 8. | vergt geen verandering van waarden, normen en cultuur van uw organisatie. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9. | sluit goed aan bij de huidige werkwijze in de zorg. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10. | is zeer eenvoudig te gebruiken door de medisch professionals. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11. | vereist extra vaardigheden van de medisch professionals. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12. | is moeilijk te implementeren. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13. | heeft een direct waarneembaar positief effect op de zorgverlening. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14. | kan niet op kleine schaal worden getest (bv. een pilot). | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

*Onderstaand volgen een aantal open vragen over telemonitoring bij hartfalen.* ***Kunt u per stelling zo nauwkeurig mogelijk antwoorden?***

15. **Wanneer heeft uw organisatie, bij benadering, (formeel) besloten telemonitoring bij hartfalen te implementeren?** [maand/jaar]
16. **Wanneer is/was telemonitoring bij hartfalen, bij benadering, binnen uw organisatie klaar voor gebruik?** [maand/jaar]
17. **Welke van de onderstaande barrières bent u tegengekomen in de implementatie van telemonitoring bij hartfalen?** (meer dan 1 antwoord mogelijk)

- ☐ Tekort aan financiering
- ☐ Onveilig
- ☐ Geringe medical evidence
- ☐ Gebrek aan framework voor implementatie
- ☐ Onvoldoende steun patiënten
- ☐ Geen
- ☐ Te strikte wet- en regelgeving
- ☐ Technische problemen
- ☐ Gebrek aan standaarden
- ☐ Onvoldoende steun professionals
- ☐ Onvoldoende steun overheid
- ☐ Anders, namelijk…

## Telemonitoring bij diabetes

*Onderstaand zijn een aantal stellingen over telemonitoring bij diabetes opgenomen.* ***Kunt u per stelling aangeven in hoeverre deze van toepassing is op uw organisatie?***

| | Telemonitoring bij diabetes | Geheel oneens | | | | | | Geheel eens |
|---|---|---|---|---|---|---|---|---|
| 18. | stelt uw organisatie in staat efficiëntere zorg te verlenen (tijd en geld). | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19. | stelt uw organisatie beter in staat aan patiëntbehoeften te voldoen. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 20. | stelt uw organisatie in staat doelmatiger zorg te leveren. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 21. | komt helemaal overeen met de behoeften en prioriteiten van uw organisatie. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 22. | vergt geen verandering van waarden, normen en cultuur van uw organisatie. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 23. | sluit goed aan bij de huidige werkwijze in de zorg. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 24. | is zeer eenvoudig te gebruiken door de medisch professionals. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 25. | vereist extra vaardigheden van de medisch professionals. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 26. | is moeilijk te implementeren. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 27. | heeft een direct waarneembaar positief effect op de zorgverlening. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 28. | kan niet op kleine schaal worden getest (bv. een pilot). | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

*Onderstaand volgen een aantal open vragen over telemonitoring bij diabetes.* ***Kunt u per stelling zo nauwkeurig mogelijk antwoorden?***

29. **Wanneer heeft uw organisatie, bij benadering, (formeel) besloten telemonitoring bij diabetes te implementeren?** [maand/jaar]
30. **Wanneer is/was telemonitoring bij diabetes, bij benadering, binnen uw organisatie klaar voor gebruik?** [maand/jaar]
31. **Welke van de onderstaande barrières bent u tegengekomen in de implementatie van telemonitoring bij diabetes?** (meer dan 1 antwoord mogelijk)

- ☐ Tekort aan financiering
- ☐ Onveilig
- ☐ Geringe medical evidence
- ☐ Gebrek aan framework voor implementatie
- ☐ Onvoldoende steun patiënten
- ☐ Geen
- ☐ Te strikte wet- en regelgeving
- ☐ Technische problemen
- ☐ Gebrek aan standaarden
- ☐ Onvoldoende steun professionals
- ☐ Onvoldoende steun overheid
- ☐ Anders, namelijk…

## e-Inzage door patiënten

*Onderstaand zijn een aantal stellingen over e-inzage door patiënt opgenomen.* ***Kunt u per stelling aangeven in hoeverre deze van toepassing is op uw organisatie?***

| | e-Inzage | Geheel **on**eens | | | | | | Geheel eens |
|---|---|---|---|---|---|---|---|---|
| **32.** | stelt uw organisatie in staat efficiëntere zorg te verlenen (tijd en geld). | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **33.** | stelt uw organisatie beter in staat aan patiëntbehoeften te voldoen. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **34.** | stelt uw organisatie in staat doelmatiger zorg te leveren. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **35.** | komt helemaal overeen met de behoeften en prioriteiten van uw organisatie. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **36.** | vergt geen verandering van waarden, normen en cultuur van uw organisatie. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **37.** | sluit goed aan bij de huidige werkwijze in de zorg. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **38.** | is zeer eenvoudig te gebruiken door de medisch professionals. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **39.** | vereist extra vaardigheden van de medisch professionals. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **40.** | is moeilijk te implementeren. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **41.** | heeft een direct waarneembaar positief effect op de zorgverlening. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **42.** | kan niet op kleine schaal worden getest (bv. een pilot). | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

*Onderstaand volgen een aantal open vragen over e-inzage.* ***Kunt u per stelling zo nauwkeurig mogelijk antwoorden?***

**43.** **Wanneer heeft uw organisatie, bij benadering, (formeel) besloten e-inzage te implementeren?** [maand/jaar]

**44.** **Wanneer is e-inzage, bij benadering, binnen uw organisatie klaar voor gebruik?** [maand/jaar]

**45.** **Welke van de onderstaande barrières bent u tegengekomen in de implementatie van e-inzage?** (meer dan 1 antwoord mogelijk)

- ☐ Tekort aan financiering
- ☐ Onveilig
- ☐ Geringe medical evidence
- ☐ Gebrek aan framework voor implementatie
- ☐ Onvoldoende steun patiënten
- ☐ Geen
- ☐ Te strikte wet- en regelgeving
- ☐ Technische problemen
- ☐ Gebrek aan standaarden
- ☐ Onvoldoende steun professionals
- ☐ Onvoldoende steun overheid
- ☐ Anders, namelijk…

## ICT randvoorwaarden

*Onderstaand zijn een aantal stellingen over de IT infrastructuur en informatiebeveiliging in uw organisatie opgenomen.* ***Kunt u per stelling aangeven in hoeverre deze van toepassing is op uw organisatie?***

| | | Geheel **on**eens | | | | | | Geheel eens |
|---|---|---|---|---|---|---|---|---|
| 46. | De IT infrastructuur in uw organisatie is toereikend voor eHealth. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 47. | Wireless Internet is overal te allen tijde beschikbaar binnen uw organisatie voor de medisch professionals. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 48. | Wireless Internet is overal te allen tijde beschikbaar binnen uw organisatie voor patiënten. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 49. | Uw organisatie faciliteert het gebruik van "*Bring Your Own Device*" (BYOD) door de medisch professionals. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 50. | Het technisch IT beheer is uitbesteed (aan externe organisatie). | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 51. | Het functioneel IT beheer is uitbesteed (aan externe organisatie). | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 52. | Werkplekbeheer is uitbesteed (aan externe organisatie). | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 53. | Uw organisatie kent een interne Service Desk. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 54. | Het serverbeheer is uitbesteed (aan externe organisatie). | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 55. | "*Service Level Agreements*" (SLA's) en overige IT afspraken met externe IT dienstverleners worden periodiek (jaarlijks) geëvalueerd. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 56. | Uitbestede processen worden voorzien van een onafhankelijke verklaring (bv ISAE 3402) over de kwaliteit van de externe dienstverlener. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 57. | Uw organisatie laat geregeld een "Legal Hack" uitvoeren. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 58. | Uw organisatie maakt gebruik van DigiD. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 59. | Uw organisatie voldoet aan alle eisen voor een Goed Beheerd Zorgsysteem (GBZ). | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 60. | Uw organisatie voldoet aan alle eisen van de NEN7513 (2010) (het loggen/ vastleggen van acties op het EPD) . | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 61. | Uw organisatie voldoet aan alle eisen van de NEN7510 (2011). | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**Indien niet volledig wordt voldaan aan alle eisen van de NEN7510:**

| | | Ja | Nee |
|---|---|---|---|
| **62.** | Heeft uw organisatie in de afgelopen twee jaar een risicoanalyse uitgevoerd gericht op de betrouwbaarheid, continuïteit en beveiliging van IT? | ☐ | ☐ |
| **63.** | Heeft uw organisatie formele IT-beheerprocedures ingericht voor de back-up en recovery? | ☐ | ☐ |
| **64.** | Heeft uw organisatie een proces geïmplementeerd voor continuïteitsbeheer om verstoringen als gevolg van calamiteiten en beveiligingsincidenten tot een aanvaardbaar niveau te beperken? | ☐ | ☐ |
| **65.** | Heeft uw organisatie een formele IT-beheerprocedure voor wijzigingen ingericht? | ☐ | ☐ |
| **66.** | Beschikt uw organisatie over iemand die verantwoordelijk is voor informatiebeveiliging? | ☐ | ☐ |
| **67.** | Heeft uw organisatie procedures ingericht om informatiebeveiligingsincidenten (anoniem) te melden? | ☐ | ☐ |

## Kenmerken van uw organisatie

*Onderstaand zijn een aantal stellingen over de kenmerken van uw organisatie opgenomen.* ***Kunt u per stelling aangeven in hoeverre deze van toepassing is op uw organisatie?***

| | | Geheel **on**eens | | | | | | Geheel eens |
|---|---|---|---|---|---|---|---|---|
| 68. | Medisch professionals zijn betrokken in de IT strategie ontwikkeling. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 69. | De structuur van uw organisatie is in sterke mate gedecentraliseerd. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 70. | Besluiten over het implementeren van nieuwe IT technologieën worden centraal genomen. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 71. | IT Strategie is opgesteld en bekrachtigd door het bestuur. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 72. | Een korte termijn (1 à 2 jaar) visie met betrekking tot IT beleid is opgesteld. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 73. | Een lange termijn (5 jaar) visie met betrekking tot IT beleid is opgesteld. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 74. | De CIO (Chief Information Officer) is binnen uw organisatie een formele functie. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 75. | Uw organisatie maakt veelvuldig gebruik van zorgpaden. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 76. | eHealth is binnen de zorgpaden geïntegreerd. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 77. | Uw organisatie is goed in staat nieuwe eHealth toepassingen te identificeren. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 78. | Het zoeken naar nieuwe eHealth mogelijkheden is een alledaagse bezigheid in uw organisatie. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 79. | Uw organisatie bezoekt met enige regelmaat bijeenkomsten om nieuwe kennis over eHealth te verwerven (denk aan beurzen, congressen, etc.). | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 80. | In uw organisatie is een goede communicatie tussen medische professionals en IT professionals. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 81. | Uw organisatie kent goed georganiseerde communicatiekanalen voor het uitwisselen en delen van kennis en ideeën. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 82. | Uw organisatie is in staat nieuwe eHealth kennis in te zetten voor het ontwikkelen van nieuwe (verbeterde) zorgdiensten. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 83. | Uw organisatie gaat voortdurend na hoe nieuwe IT kennis beter benut kan worden. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 84. | Een zorgproces dat goed werkt gaan wij niet verbeteren met eHealth. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 85. | Uw organisatie accepteert geen risico in het gebruik van innovatieve eHealth toepassingen. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 86. | Uw organisatie heeft een sterke voorkeur voor bewezen technologieën. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

## eHealth strategie en management

*Onderstaand zijn een aantal stellingen over de eHealth strategie en management van uw organisatie opgenomen.* ***Kunt u per stelling aangeven in hoeverre deze van toepassing is op uw organisatie?***

| | | Geheel **on**eens | | | | | | Geheel eens |
|---|---|---|---|---|---|---|---|---|
| 87. | In uw organisatie is men sterk van mening dat de huidige werkwijze kan worden verbeterd met eHealth. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 88. | Uw organisatie ziet niets in eHealth. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 89. | In uw organisatie heerst een sterk gevoel van urgentie over de invoering van eHealth. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 90. | Het bestuur heeft een visie ontwikkeld over eHealth. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 91. | Medisch professionals begrijpen en ondersteunen de eHealth visie. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 92. | De eHealth visie is geformaliseerd en bekrachtigd. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 93. | Uw organisatie heeft een strategie met haalbare doelstellingen voor het realiseren van de eHealth visie. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 94. | Uw organisatie beschikt over een eHealth meerjarenplan. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 95. | Een systeem is ingesteld om eHealth implementatie te monitoren. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 96. | De implementatie van eHealth toepassingen worden conform een duidelijk implementatieplan uitgevoerd. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 97. | Evaluatie tussen het management en medisch professionals over de effecten van eHealth vindt plaats op regelmatige basis. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 98. | Het management beloont personeel voor eHealth innovatie en creativiteit. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 99. | Het management stimuleert sterk het gebruik van eHealth. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 100. | Het management stelt voldoende middelen (tijd en geld) beschikbaar voor eHealth. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 101. | Uw organisatie beschikt over reservemiddelen (slack resources) die direct inzetbaar zijn voor eHealth. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 102. | Bij de implementatie van een eHealth toepassing beschikt uw organisatie over voldoende ondersteunend personeel. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 103. | Bij de implementatie van een eHealth toepassing beschikt uw organisatie over voldoende ondersteuning op het gebied van training. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 104. | Medisch professionals worden regelmatig bijgeschoold en voorgelicht over nieuwe ontwikkelingen in eHealth. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 105. | In uw organisatie is een helpdesk aanwezig voor technische ondersteuning bij de implementatie en toepassing van eHealth. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 106. | Uw organisatie kent duidelijke protocollen voor het afhandelen van technische fouten tijdens het gebruik van eHealth. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | |
|---|---|---|
| **107.** | In uw organisatie zijn champions* aanwezig die hun collega's sterk aanmoedigen in eHealth innovatie en gebruik. | ☐ ☐ ☐ ☐ ☐ ☐ ☐ |
| **108.** | Bij de implementatie van een eHealth toepassing wordt een medisch professional als champion aangewezen. | ☐ ☐ ☐ ☐ ☐ ☐ ☐ |

* *Champion = een bekwaam persoon met toewijding tot het aanmoedigen en doorvoeren van innovaties binnen de organisatie*

**109. Wat is het huidige IT budget van de organisatie? (inclusief personeel)**
[€]

## Uw zorginstelling

*Hartelijk dank voor uw medewerking aan de IT benchmark 2014 – eHealth. De resultaten van dit onderzoek* worden aan u ter beschikking gesteld in de vorm van *een persoonlijk benchmarkrapport*. In dit rapport wordt uw zorginstelling afgezet tegen andere zorginstellingen op het gebied van eHealth.

Hiervoor graag de naam van uw zorginstelling invullen in het onderstaande veld.

110. Naam van uw zorginstelling:

111. Heeft u nog aanvullende opmerkingen of suggesties naar aanleiding van deze enquête?

# Bedankt voor uw medewerking

Hartelijk dank voor uw medewerking aan de EY ICT benchmark 2014 – Health. U kunt de webbrowser sluiten.

EY
Ir. J.G.G.V. van den Boom RE
Partner IT Risk and Assurance EY

**Technische Universiteit Delft**
Prof.dr. M.S. van Geenhuizen
Faculteit Techniek, Bestuur en Management

# O. Invitations and reminders

A total of 85 questionnaires were distributed to hospitals in the sample with the request to get these filled in from a CIO or top-level ICT manager having knowledge of eHealth in the organisation. The first reminder was sent after 10 days from the first e-mail followed by multiple reminders every 10 days, until the sample was sufficient for the intended analyses and with respect to the time available for this study. In between the reminders, hospitals were contacted by telephone to ascertain the survey was arrived to the right person.

## O.3 *First invitation*

### O.3.1 EY focus

Geachte [!AANHEF!] [!TUSSENVOEGSEL!] [!ACHTERNAAM!],

Al enkele jaren wordt door EY jaarlijks de ICT benchmark bij zorginstellingen afgenomen. Graag nodigen wij u uit om aan de ICT benchmark van 2014 deel te nemen. Deze deelname is geheel kosteloos en vergt enkel 15 minuten van uw tijd.

De ICT benchmark van 2014 heeft als thema: *eHealth in uw zorginstelling, bent u er klaar voor?* Om antwoord te geven op deze vraag doet EY, in samenwerking met de faculteit Techniek, Bestuur en Management van de TU Delft, onderzoek naar de adoptie en implementatie van eHealth in Nederlandse zorginstellingen. Het invullen van de enquête voor de ICT benchmark 2014 kost u ongeveer 15 minuten. De gegeven antwoorden worden op basis van volledige anonimiteit gerapporteerd en in vertrouwelijkheid verwerkt.

De resultaten van het onderzoek worden aan u in het najaar van 2014 ter beschikking gesteld in de vorm van een **persoonlijk benchmarkrapport**. In dit rapport wordt uw zorginstelling afgezet tegen andere zorginstellingen op het gebied van eHealth.

Voor inhoudelijke vragen over de enquête of het onderzoek kunt u contact opnemen met Sander Faber via e-mail op sander.faber@nl.ey.com of telefonisch op het nummer +31 (0) 88 407 91 32.

**Klik hier om naar de enquête te gaan:**
[!LINK!]
**of voor de iOS versie:**
[!LINK!]

Hartelijk dank voor uw medewerking!
Met vriendelijke groet,

Sander Faber | Graduate Intern
Ernst & Young Advisory
Wassenaarseweg 80, 2596 CZ Den Haag, Netherlands
Mobile: +31 (0) 6 28618097 | Office: +31 (0) 88 - 40 79132 |
sander.faber@nl.ey.com
Website: http://www.ey.com

### 0.3.2 **TU Delft (personal) focus**

Geachte [!AANHEF!] [!TUSSENVOEGSEL!] [!ACHTERNAAM!],

[Naar aanleiding van ons telefoon gesprek mail ik u hierbij de enquête toe.]

Al enkele jaren wordt door EY jaarlijks de ICT benchmark bij zorginstellingen afgenomen. De ICT benchmark van 2014 heeft als thema: *eHealth in uw zorginstelling, bent u er klaar voor?* Om antwoord te geven op deze vraag doet EY, in samenwerking met de faculteit Techniek, Bestuur en Management van de TU Delft, onderzoek naar de adoptie en implementatie van eHealth in Nederlandse zorginstellingen.

Mijn naam is Sander Faber en ik ben samen met EY op dit moment bezig met mijn afstudeeronderzoek aan de faculteit Techniek, Bestuur en Management van de TU Delft. De ICT benchmark 2014, inclusief de gegeven antwoorden in de enquête, zijn een belangrijk onderdeel van mijn afstudeeronderzoek.
Graag nodigen ik u uit om aan de ICT benchmark van 2014 deel te nemen. Deze deelname is geheel kosteloos en vergt enkel 15 minuten van uw tijd.

**Klik hier om naar de enquête te gaan:**
[!LINK!]
**of voor de iOS versie:**
[!LINK!]

De resultaten van het onderzoek worden aan u in het najaar van 2014 ter beschikking gesteld in de vorm van een **persoonlijk benchmarkrapport**. In dit rapport wordt "[!INSTELLING!]" afgezet tegen andere zorginstellingen op het gebied van eHealth. De gegeven antwoorden worden op basis van volledige anonimiteit gerapporteerd en in vertrouwelijkheid verwerkt.

Voor inhoudelijke vragen over de enquête of het onderzoek kunt u contact met mij opnemen via e-mail op sander.faber@nl.ey.com of telefonisch op het nummer +31 (0) 88 407 91 32.

Hartelijk dank voor uw medewerking!
Met vriendelijke groet,

Sander Faber | Graduate Intern
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Mobile: +31 (0) 6 28618097 | Office: +31 (0) 88 - 40 79132 | sander.faber@nl.ey.com
Website: http://www.ey.com

## O.4 *First reminder*

Geachte [!AANHEF!] [!TUSSENVOEGSEL!] [!ACHTERNAAM!],

Enkele dagen geleden hebben wij u uitgenodigd om deel te nemen aan de ICT benchmark 2014 met als specifiek onderwerp eHealth. De ICT benchmark wordt dit jaar in samenwerking met de Technische Universiteit Delft uitgevoerd om de status van de adoptie en implementatie van eHealth te onderzoeken. Mijn naam is Sander Faber en ik ben samen met EY op dit moment bezig met mijn afstudeeronderzoek aan de faculteit Techniek, Bestuur en Management van de TU Delft. De ICT benchmark 2014, inclusief de gegeven antwoorden in de enquête, zijn een belangrijk onderdeel van mijn afstudeeronderzoek.

Indien u de enquête nog niet (volledig) hebt ingevuld wil ik u alsnog 15 minuten van uw tijd vragen om de (resterende) vragen te beantwoorden. Hiervoor klikt u op één van de onderstaande links:

**Klik hier om naar de enquête te gaan:**
[!LINK!]
**of voor de iOS versie:**
[!LINK!]

De resultaten van het onderzoek worden aan u in het najaar van 2014 ter beschikking gesteld in de vorm van een **persoonlijk benchmarkrapport**. In dit rapport wordt "[!INSTELLING!]" afgezet tegen andere zorginstellingen op het gebied van eHealth. De gegeven antwoorden worden op basis van volledige anonimiteit gerapporteerd en in vertrouwelijkheid verwerkt.

Voor inhoudelijke vragen over de enquête of het onderzoek kunt u contact met mij opnemen via e-mail op sander.faber@nl.ey.com of telefonisch op het nummer +31 (0) 88 407 91 32.

Hartelijk dank voor uw medewerking!

Heeft u reeds de enquête ingevuld? Dat kunt u melden via de onderstaande link:
[!UITSCHRIJVEN!]

Met vriendelijke groet,

Sander Faber | Graduate Intern
Ernst & Young Advisory
Wassenaarseweg 80, 2596 CZ Den Haag, Netherlands
Mobile: +31 (0) 6 28618097 | Office: +31 (0) 88 - 40 79132 |
sander.faber@nl.ey.com
Website: http://www.ey.com

## O.5 *Second reminder*

Geachte [!AANHEF!] [!TUSSENVOEGSEL!] [!ACHTERNAAM!],

Enkele dagen geleden hebben wij u uitgenodigd om deel te nemen aan de ICT benchmark 2014 met als specifiek onderwerp: *eHealth in uw zorginstelling, bent u er klaar voor?* Om antwoord te geven op deze vraag doet de Technische Universiteit Delft, in samenwerking met EY, onderzoek naar de adoptie en implementatie van eHealth in Nederlandse zorginstellingen.

Indien u de enquête nog niet (volledig) hebt ingevuld willen wij u alsnog 15 minuten van uw tijd vragen om de (resterende) vragen te beantwoorden. Als tegenprestatie worden de resultaten van het onderzoek aan u ter beschikking gesteld in de vorm van een **persoonlijk benchmarkrapport** in het najaar van 2014. In dit rapport wordt uw zorginstelling afgezet tegen andere zorginstellingen op het gebied van eHealth. De gegeven antwoorden worden op basis van volledige anonimiteit gerapporteerd en vertrouwelijkheid verwerkt.

**Klik hier om naar de enquête te gaan:**
[!LINK!]
**of voor de iOS versie:**
[!LINK!]

Voor inhoudelijke vragen over de enquête of het onderzoek kunt u contact opnemen met Sander Faber via e-mail op sander.faber@nl.ey.com of telefonisch op het nummer +31 (0) 88 407 91 32.

Hartelijk dank voor uw medewerking!

**Technische Universiteit Delft**
Prof.dr. M.S. van Geenhuizen
Faculteit Techniek, Bestuur en Management

**EY**
Ir. J.G.G.V. van den Boom RE
Partner IT Risk and Assurance EY

Heeft u reeds de enquête ingevuld? Dat kunt u melden via de onderstaande link:
[!UITSCHRIJVEN!]

## O.6 *Third reminder*

**Subject:** Is [!VOORNAAM!] klaar voor eHealth?

Geachte [!AANHEF!] [!TUSSENVOEGSEL!] [!ACHTERNAAM!],

Enkele weken geleden hebben wij u uitgenodigd om deel te nemen aan de ICT benchmark 2014 met als specifiek onderwerp: ***eHealth in uw zorginstelling, bent u er klaar voor?*** Om antwoord te geven op deze vraag doet EY, in samenwerking met de Technische Universiteit Delft, onderzoek naar de adoptie en implementatie van eHealth in Nederlandse zorginstellingen.

Indien u de enquête nog niet (volledig) hebt ingevuld willen wij u alsnog 15 minuten van uw tijd vragen om de (resterende) vragen te beantwoorden. U heeft hiervoor nog tot 25 augustus 2014.

Bij deelname worden de resultaten van het onderzoek aan u ter beschikking gesteld in de vorm van **een persoonlijk benchmarkrapport** in het najaar van 2014. In dit rapport wordt uw ziekenhuis afgezet tegen **nu al 33 andere ziekenhuizen** op het gebied van eHealth.

**Klik hier om naar de enquête te gaan:**
[!LINK!]
**of voor de iOS versie:**
[!LINK!]

Voor inhoudelijke vragen over de enquête of het onderzoek kunt u contact opnemen met Sander Faber via e-mail op sander.faber@nl.ey.com of telefonisch op het nummer +31 (0) 88 407 91 32.

Hartelijk dank voor uw medewerking!

**Technische Universiteit Delft**
Prof.dr. M.S. van Geenhuizen
Faculteit Techniek, Bestuur en Management

**EY**
Ir. J.G.G.V. van den Boom RE
Partner IT Risk and Assurance EY

Heeft u reeds de enquête ingevuld? Dat kunt u melden via de onderstaande link:
[!UITSCHRIJVEN!]

# Factors influencing eHealth adoption by Dutch hospitals
# An empirical study

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