MASTER'S THESIS

Agility through Patient Knowledge

Leveraging IT Ambidexterity in Healtcare

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Leveraging IT Ambidexterity in Healthcare

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Abstract

The capability of hospitals to sense and response to a changing environment, also known as its patient agility, is regarded as a higher order dynamic capability that may be influenced by lower order IT capabilities according to the dynamic capabilities' view (DCV). This research has investigated how such IT capabilities, namely the balanced exploitation and exploration of IT resources or IT ambidexterity, influence this agility and how this relation is mediated by patient knowledge processes. Also, the moderating role of process complexity is evaluated.

A partial least squares structured equation modeling (PLS-SEM) analysis shows that IT ambidexterity positively impacts patient agility and that this impact is mediated by patient knowledge processes. A moderating effect of process complexity has not been found. A multi-group analysis further indicated that the mediating effect is greater for non-academic, non-top-clinical hospitals.

The results are based on a relatively small sample size (*N* = 95) and even though current findings indicate that hospital can increase their patient agility and leverage their IT investments by a structured, timely, systematic and cross-functional application of process knowledge processes, further research extending the targeted response group is recommended.

Key terms

IT ambidexterity, patient knowledge processes, patient agility, process complexity, PLS-SEM, hospitals, dynamic capabilities' view (DCV)

Summary

Like in other parts of society Information Technology (IT) has gradually become more important in the support and execution of patient care processes in hospitals. At the same time patient demands are constantly changing and hospitals are challenged to keep track of those demands and act on them in an effective and efficient matter.

The simultaneous and balanced exploitation of existing IT and exploration of new IT is known as IT ambidexterity. In line with the dynamic capabilities' view (DCV) this IT ambidexterity can be regarded as a lower order function that enables a higher order dynamic capability agility. Two important components of agility are sensing changing needs and responding to those changing needs. Patient knowledge processes play a role in registering, processing and disclosing patient care related information thereby enabling patient care related agility, or patient agility. Those processes in turn are enabled by the balanced exploration and exploitation of IT resources or IT ambidexterity.

This research has examined the effect of IT ambidexterity on patient agility including the role of patient knowledge processes as a mediator. Additionally, it investigated whether process complexity moderates the relation between patient knowledge processes and patient agility.

A survey under Dutch hospitals resulted in a dataset of 95 observations on IT ambidexterity, patient knowledge processes, patient agility and process complexity. All observations consist of scores on a 7-point Likert scale. Partial Least Squares - Structured Equation Modelling (PLS-SEM) was used to analyze these scores.

The measurement model was validated based on the internal consistency reliability, convergent validity and discriminant validity. Values for Cronbach's alpha and composite reliability indicated internal consistency reliability. Convergent validity was established by assessing the outer loadings and average variance extracted (AVE). To show the measurement model has sufficient discriminant validity the outer loadings were evaluated as well as the Fornell-Larcker criterion and the heterotrait-monotrait ratio (HTMT). All obtained values indicated a valid measurement model.

To validate the structural model the explained variance (R^2), the effect size (f^2), the predictive relevance (Q^2) and the size and significance of the path coefficients of the model were evaluated. IT ambidexterity and patient agility are second order formative constructs consisting of respectively exploitation and exploration capabilities and sensing and responding capabilities. To validate patient agility collinearity was examined as well. IT ambidexterity was operationalized using the item-level interaction terms of IS exploitation and IS exploration,

The results show valid second order constructs as well as significant path coefficients and R^2 values for the paths from the first order construct to the second order constructs and for the path from IT ambidexterity to patient knowledge processes, from IT ambidexterity to patient agility and from patient knowledge processes to patient agility. The moderator role of process complexity is not significant.

The path coefficients vary in their strength, but all significant paths have adequate effect size and predictive relevance. These findings confirm the first three hypotheses of this thesis:

1. *IT ambidexterity has a positive impact on patient agility.*
2. *IT ambidexterity has a positive impact on patient knowledge processes.*

3. *Patient knowledge processes mediate the positive relationship between IT ambidexterity and patient agility.*

The forth hypothesis: *The relation between patient knowledge processes and patient agility is stronger in an environment with more complex processes,* cannot be accepted based on the results of the analysis.

Additionally, a multi-group analysis was performed to find out whether the hypotheses that were confirmed for the group of hospitals as a whole would also hold for subgroups bases on hospital type, function, department age and department size (in number of patients). Results of this analysis show that the mediating role of patient knowledge processes in the relation between IT ambidexterity and patient agility is significantly stronger for non-academic and non-top-clinical hospitals.

The multi-group analysis was also used to further investigate a possible moderating effect of process complexity, but this effect has not been found. Finally, the multi-group analysis was applied to validate that no statistical differences exist in the early responses and late responses, to prevent bias stemming from different data collection methods. This shows no significant differences in path coefficients between the early and late responses.

This research contributes to existing literature with regards to the role of dynamic capabilities and research on the relation between IT ambidexterity and firm performance as well as to earlier research on the role of IT ambidexterity as enabler of patient knowledge processes and the role of patient knowledge processes as enabler of agility.

Because of the relatively small sample size (N = 95) and because the survey addresses topics both in the area of IT processes and patient care processes follow-up research is advised. A matched pair research setup where an IT knowledgeable person is paired with a person with knowledge of patient care processes might be suitable for this. Since the current results are based on Dutch hospitals the generalizability of this research is limited to the Netherlands. Future research may include hospitals outside the Netherlands.

Hospitals can use these finding to evaluate their patient knowledge processes to see if a more structured, systematic, timely and cross-functional approach to these processes may increase their patient agility. Also, these findings may be used to leverage the demand for investments in IT capabilities, both exploitative and explorative, to increase patient agility.

Contents

1. Introduction

1.1. Background

As in many organizations, the amount of Information Technology (IT) in hospitals has increased continuously over the last 60 years or so. A study by Haux shows how IT developed from a nice-to-have discipline to a '*discipline dedicated to the systematic processing of data, information and knowledge in medicine and health care (p. 600)*' that is essential for organizations in healthcare (Haux, 2010). Haux identifies the progress in information processing methodology and information and communication technology as one of the driving forces that influence medical informatics, as well as the changes in needs, requirements and expectations of societies. While the latter are related to the output of a healthcare process, the first one is related to the toolset being used (among others) in the healthcare process.

Healthcare organizations need to balance continuous quality improvement, through exploring new ways, with cost rationalization, and through effectively exploiting their existing resources (Gastaldi, Appio, Corso, & Pistorio, 2018). A striking example is the implementation of electronic health records that leads to improved efficiency through reduction of redundancy and improved quality through a reduction of medical errors caused by the unavailability of critical clinical information in a paper-based system for medical records (Agarwal, Gao, DesRoches, & Jha, 2010).

When it comes to responding to changing customer needs organizations can possibly benefit from a sense-and-respond strategy where processes are in place to collect, process and respond to those customer needs (Jayachandran, Hewett, & Kaufman, 2004; Roberts & Grover, 2012a). The capability to respond to changing conditions is also referred to as an organizations' agility (Chen et al., 2014; Lee, Sambamurthy, Lim, & Wei, 2015).

Hospitals can be characterized as knowledge intensive organizations because of their need to integrate disciplines such as clinics, prescriptions and patient relationships among others (Wu, Hu, & National Chung Cheng University, 2012). While Raschke recognizes the important role that processes play in the relation between IT ambidexterity and an organizations' agility (Raschke, 2010) and Jayachandra et al. identify knowledge processes as an important capability for agility (Jayachandran et al., 2004) there exists scarce literature on the mediating role of knowledge processes in the relation between IT ambidexterity and agility.

Of interest in this context is the possible role of process complexity. Research conducted by Chen et al. shows a possible strengthening effect of environmental complexity in the mediating role that business process agility has on organization performance (Chen et al., 2014). Higher process complexity increases the demand for information processing capabilities in hospitals (Preuss, 2003). Thus, the role of process complexity as moderator in the relation between knowledge processes and patient agility may be relevant.

This research aims to provide insight in the mediating role that patient knowledge processes play in the relation between IT ambidexterity and patient agility, and the moderating effect of process complexity in this relation.

1.2. Exploration of the topic

An organizations' capability to respond to change, also referred to as agility, can be regarded as a dynamic capability (Eisenhardt & Martin, 2000; Raschke, 2010). Regarding processes as invaluable as enabler voor agility is in line with the Resource Based View (RBV) of organizations where the IT infrastructure that supports those processes is regarded an asset. Capabilities and assets form the resources of an organization (Wade & Hulland, 2004).

Lee et al. (2015) put IT ambidexterity in relation to dynamic capabilities by defining IT ambidexterity as '*a firm's ability to simultaneously pursue exploration and exploitation in their management of IT resources and practices (p. 400)*', and they propose that IT ambidexterity, as a lower-order functional capability, would be an antecedent of organizational agility, a higher-order dynamic capability.

Knowledge processes are defined by Jayachandran et al. as those activities within an organization that are focused on the generation, analysis, and dissemination of customer-related information for the purpose of strategy development and implementation (Jayachandran et al., 2004). Viewing knowledge processes as business processes is in line with Trkmans' (2010) definition of business processes as '*a complete, dynamically coordinated set of activities or logically related tasks that must be performed to deliver value to customers or to fulfil other strategic goals (p. 125)*'.

Recent research has shown that IT ambidexterity plays a role in the relation between IT and an organizations' performance where business processes have a mediating role (Ferraris, Monge, & Mueller, 2018; Lee et al., 2015). IT is thus regarded as an enabler for business processes in line with the RBV. A more direct relation between IT ambidexterity and agility has been found in literature as well (Heckmann & Maedche, 2018; Lee et al., 2015; Tallon, Queiroz, Coltman, & Sharma, 2018) and more fundamentally, using exploration and exploitation of resources to be able to respond to changing markets has also been the topic of research (Sambamurthy, Bharadwaj, & Grover, 2003).

The mediating role of process knowledge processes seems to be likely also given the existing research on the enabling role IT ambidexterity has for process performance (Ferraris et al., 2018; van de Wetering, Versendaal, & Walraven, 2018) and research describing the mediating role of knowledge processes in the relation between IT competency and firm performance (Tanriverdi, 2005).

So, exploitation of existing IT in executing patient knowledge processes and the capability to deploy new and innovative IT for this purpose will possibly have an impact on the performance of those processes. This in turn will possibly have an impact on the organizations ability to satisfy the needs and expectations of the customer, or the patient agility.

In the context of healthcare and hospitals patient agility is defined as the degree to which the department is able to sense and respond quickly to patient-based opportunities for innovation and competitive action (Bradley, Pratt, Thrasher, Byrd, & Thomas, 2012; Jayachandran et al., 2004; Roberts & Grover, 2012a).

Finally, the strength of the above-mentioned relations may be affected by the environment, specifically the complexity of the processes. Complexity refers to the non-routineness, difficulty, uncertainty, and interdependence within a process (Karimi, Somers, & Bhattacherjee, 2007). Research by Setia et al. suggest a moderating effect of process complexity on the relation between information quality and customer response capability (Setia, Venkatesh, Joglekar, & University of

Arkansas, 2013). However, while it seems logical to assume a relationship between business processes, or even patient knowledge processes, and information quality, such a relationship is not well documented in literature and remains a topic for further research.

1.3. Problem statement

Although literature suggests there is a relation between IT ambidexterity and patient agility the mediating role of patient knowledge processes in this relation is not well documented. Furthermore, process complexity may have a moderating impact on the relation between patient knowledge processes and patient agility but there is insufficient literature available to determine the strength of the moderating effect. Therefor the problem statement presented here is:

There is insufficient insight in the role of patient knowledge processes in the relation between IT ambidexterity and a hospitals' patient agility, and it is unclear how this relation is affected by the level of process complexity.

1.4. Research objective and questions

The aim of this research is to see what relation exists between IT ambidexterity and a hospitals' patient agility, specifically through mediation of patient knowledge processes. Additionally, the role of process complexity as moderator in the relation between IT ambidexterity and patient agility is examined.

This results in the main research question of this paper:

Can a balanced approach to exploration and exploitation of IT resources leverage a hospitals' patient knowledge processes and consequently increase a hospitals' patience agility and is this leverage stronger for hospitals with higher process complexity?

The answer to this question will be comprised by answering the following research questions:

- What is the relation between IT ambidexterity and patient knowledge processes in hospitals?
- What is the relation between a hospitals' patient knowledge processes and its patient agility?
- How is the relation between IT ambidexterity and patient agility moderated by a hospitals' process complexity?

1.5. Motivation/relevance

This research will provide more insight in the enabling effect that IT ambidexterity has on patient knowledge processes and consequently how this enabling translates to agility in terms of being able to sense and respond to changing patient needs. This is useful because it could help increase the efficiency of hospitals in becoming more agile by paying due attention to their patient knowledge processes.

Furthermore, it will provide insight into the effect of process complexity on this relation. This could further leverage the attention on IT ambidexterity and patient knowledge processes for hospitals with complex knowledge processes.

Finally, this research contributes to the extant literature on the specific role that process complexity plays as a moderator in the relation between the exploration and exploitation of IT and the patient agility. A role that is not well researched at this moment. Also, it contributes to the existing but scarce literature on the mediating role of knowledge processes when it comes to leveraging IT ambidexterity to influence patient agility.

1.6. Main lines of approach

In the remaining part of this thesis the theoretical frameworks of the resource-based view, dynamic capabilities, IT ambidexterity, patient knowledge processes, patient agility and process complexity are described as well as the formulated hypotheses resulting in a conceptual model.

After establishing the theoretical frameworks in chapter two the methodology of this research is described in chapter three. This part consists of a description of the conceptual design and the main approach to the research, an explanation of the technical design including the measurement model and data gathering process. This part also describes the approach to data analysis and a reflection on reliability and validity of the research.

Chapter four includes the validation of both the measurement and structural model based on the collected data together with an interpretation of those results with regards to the formulated hypotheses. The concluding chapter five ends this thesis with a discussion of the results, an answer to the main research question, an overview of the limitations and recommendations for both practice and further research.

2. Theoretical framework

2.1. Research approach

This research focuses on the relationship between IT ambidexterity and patient agility, the mediating role of patient knowledge processes and the moderating effect of process complexity. Patient agility is regarded as a dynamic capability comprising an organizations' sense and response capabilities. The consideration of processes as enabler of agility is in line with the RBV of organizations. The information provided in this theoretical framework aims to provide insight based on extant literature on these topics, particularly with regards to their inter-dependencies. This information will be analysed and synthesised to lead to a conceptual research model extending the existing literature in line with Webster & Watson (2002).

To find relevant literature several queries have been done using the Open University (OU) digital library and Google Scholar. The queries that were executed centered around the keywords: dynamic capabilities, IT flexibility, (healthcare OR hospital), IT ambidexterity, (knowledge processes OR knowledge management), agility, process complexity, patient response capability. For the OU library the additional filter "peer-reviewed" was used in all cases. A complete overview of the exact queries used for both Google Scholar as the OU digital libray can be found in Appendix 1.

2.2. Implementation

The combined queries together resulted in almost 7000 results, including duplicate results so further filtering was necessary. For query 1 and 3 all results were considered. For query 2 only the first 100 results (sorted on relevance) in OU digital library were considered, but all of the results from Google Scholar. For query 4 only the first 100 results (sorted on relevance) in Google Scholar were considered, but all of the results from OU digital library. The choice for considering 100 results was somewhat arbitrary, and could have been extended if needed, but it was a balanced approach between retrieving sufficient relevant information and being able to process the information within the time limitations.

Based on the titles a selection was made to read the abstract. When the abstract provided sufficient indication that the research paper provided insight into either providing context for the topics of interest, defining any of the topics of interest or hypothized about relations between two or more of the topics of interest the research paper was saved for future reference.

In case the abstract provided insufficent insight into the relevance of the paper the introduction and conclusions were read as well. In some cases the snowballing technique was used to research fundaments or conceptual descriptions of the topics of interest. Finally 31 articles were used for reference in the theoretical framework. A complete overview of which article resulted from which search strategy can be found in Appendix 2.

2.3. Results and conclusions

2.3.1. Resource Based View, Dynamic Capabilities and Agility

The Resource Based View (RBV) is a theoretical framework that deals with how competitive advantage in organizations is achieved (Eisenhardt & Martin, 2000; Wade & Hulland, 2004). It is a view of organizations as a collection of resources. Van de Wetering (2018) argues that deployment and usage of IT, where IT is regarded a capability, is a resource for hospitals. Earlier systematic literature on business capabilities confirms this reasoning by positioning IT Capabilities as *'the ability to effectively combine and apply IT resources, including IT infrastructure and human IT skills, to organizational processes (p. 5.)'* (Offerman, Stettina, & Plaat, 2017).

The dynamic capabilities' view (DVC) is an extension of the RBV where the emphasis is on those capabilities or resources that can be used to achieve new forms of competitive advantage (Teece, Pisano, & Shuen, 1997). It adds to the RBV the capacity to renew competences to adapt to a changing environment in a timely matter and it emphasizes the role of strategic management herein. Other scholars define dynamic capabilities as processes specifically aimed at dealing with market change (Eisenhardt & Martin, 2000).

In dynamic environments the term agility is widely used to describe the ability of organization to react to the rapid changes in those environments (Roberts & Grover, 2012b). Consisting of sensing and responding capabilities, agility can be considered an important dynamic capability (Roberts & Grover, 2012a). This view is consistent with that of scholars who consider dynamic capabilities to consist of transactional and transformational level capabilities, where the transactional level capabilities are linked to the sensing capabilities and transformational level capabilities are linked to the responding capabilities (Singh et al., 2011). The ability to sense and respond to changing patient needs is of particular interest to hospitals, that operate in a continuously changing environment (Haux, 2010)

This research builds on those views and regards the DCV as a lens through which the researched organizations are looked at and sees the IT capabilities or IT enabled capabilities that are considered in this research as dynamic capabilities enabling agility in those organizations.

2.3.2. IT Ambidexterity and Patient Knowledge Processes

Ambidexterity can be found in different levels of an organizations. Heckmann et al. (2016) describe organizational ambidexterity as the combination of short term efficiency through exploitation of existing resources and long term flexibility by exploring new ones. They consequently translate this to business processes, as a combination of process efficiency and flexibility, and to IT capabilities where they distinguish explorative and exploitative IT capabilities. IT ambidexterity has been found to positively impact firm performance (Ferraris et al., 2018; Heckmann et al., 2016; Revilla, Prieto, & Rodriguez-Prado, 2007).

Although the impact of IT ambidexterity on firm performance has been researched, this impact has been confirmed using mediated models (Lee et al., 2015; Vrontis, Thrassou, Santoro, & Papa, 2017) but Vrontis et al. (2017) found no significant direct impact of organizational ambidexterity on performance. The study by Lee et al. (2015) showed that the effect of IT ambidexterity on firm performance was mediated by operational ambidexterity. Little research exists on the effect of IT ambidexterity on performance of organizations in the healthcare domain but IT in healthcare has been shown to have a positive impact on both quality and efficiency of healthcare (Agarwal et al., 2010).

To research a possible direct effect of IT ambidexterity on patient agility the first hypothesis in this thesis is:

H1*: IT ambidexterity has a positive impact on patient agility.*

Exploitation of IT resources has been linked to the standardization of business processes while exploration of IT resources has been linked to the adaption of business processes due to changing demands (Heckmann & Maedche, 2018). And, though both standardization and adaptability seem to require some trade-off between exploration and exploiting of IT resources, the impact of IT-ambidexterity on business process performance seems significant.

In supporting knowledge processes IT plays both a convergent role, by enhancing analysis and discourse and supporting virtual networks for knowledge sharing, and a divergent role, by enabling access to and retrieval of online, indexed and mapped information (Revilla et al., 2007). This requires an ambidextrous management stance towards IT, exploring for example new technologies for networking, sharing and online accessibility and exploiting existing IT with regards to ensuring efficient access and retrieval of patient information.

Rovers et al. (2012b) argue that IT capabilities are a crucial antecedent to the sensing capabilities of an organization through the enabling of knowledge management. In light of the importance of patient-centric knowledge in hospitals (Wu et al., 2012) the second hypothesis in this thesis is:

H2*: IT ambidexterity has a positive impact on patient knowledge processes.*

2.3.3. Patient Knowledge Processes and Patient Agility

Hospitals serve various patient-needs, ranging from providing information on health-related topics or administrative procedures to providing treatment for health-related problems. Therefore the ability or competence with which a hospital is able to serve those needs can be defined as a hospital's patient response capability (Bradley et al., 2012; Jayachandran et al., 2004). In a slightly broader view it can be argued that the ability to sense the needs, and opportunities to address those needs complements or precedes this response capability (Roberts & Grover, 2012a). together sensing and responding to changes and opportunities can be viewed as patient agility.

Among the factors that influence this agility are information flow, information quality and integration of IT infrastructure (Bradley et al., 2012). Research by Wu et al. indicates that knowledge assets and capabilities are the basic elements for realized financial and patient care performance (Wu et al., 2012).

Jayachandran et al. define customer response capability as the competence of an organization in serving customer needs through effective and quick actions (Jayachandran et al., 2004). According to those scholars the customer knowledge process will improve a firm's ability to identify customer needs. Recent research by Cegarra-Navarro et al. has shown that knowledge processes have a positive influence on organization agility (Cegarra-Navarro, Soto-Acosta, & Wensley, 2016). They use "knowledge processes" to refer to processes involving the application of knowledge. Knowledge is even labeled a '*key dimension when discussing agility*' by Oak (2013). In this research agility is regarded as the ability to manage and apply knowledge effectively in the context of performing in a continuous changing environment (Oak, 2013).

Though differences in terminology exist scholars seem to agree on the fact that the capability to sense and respond to changing customer need is positively influenced by the ability of an organization to make use of customer related information. Having business processes in place that deal with the application of this information contributes to the organization's agility. From this and as a logical extension of the first two hypotheses follows the third hypothesis in this thesis:

***H3**. Patient knowledge processes mediate the positive relationship between IT ambidexterity and patient agility.*

2.3.4. Process complexity

IT enabled business processes consists of activities that transform input, for example incoming information, to output, also often in the form of information with a specific goal (Jayachandran et al., 2004; Trkman, 2010). Complexity of those activities in terms of nonroutineness, difficulty, uncertainty and interdependence is an important aspect of business processes (Karimi et al., 2007).

Process complexity has been the topic of research in relation to information quality, where information quality is defined as quality dimensions, such as completeness, accuracy, format and currency, of the output of knowledge processes (Setia et al., 2013). Research across many branches of a bank shows a positive relation between information quality and customer service capabilities and a positive moderating effect of process complexity (Setia et al., 2013).

Further research has confirmed that environmental complexity acts as a positive moderator in the relationship between IT capabilities and firm agility (Chen et al., 2014). While environmental complexity doesn't equal process complexity, Chen et al. argue that: '*having superior IT capability can help firms to cope better with the complexity induced by the processes and to coordinate such complex operations more effectively'* (p. 332). In other words, when faced with complexity having solid business processes and underlying IT capabilities is more important than in the absence of complexity.

In line with the scarce literature that has been found on the possible moderating effect of process complexity the fourth hypothesis is:

H4*: The relation between patient knowledge processes and patient agility is stronger in an environment with more complex processes.*

2.3.5. Conceptual model

The four hypotheses formulated in the theoretical framework are represented in the conceptual model in Figure 1. As can be seen there is both a direct hypothesized relation (H1) between IT ambidexterity as a mediated relation (H2 -> H3).

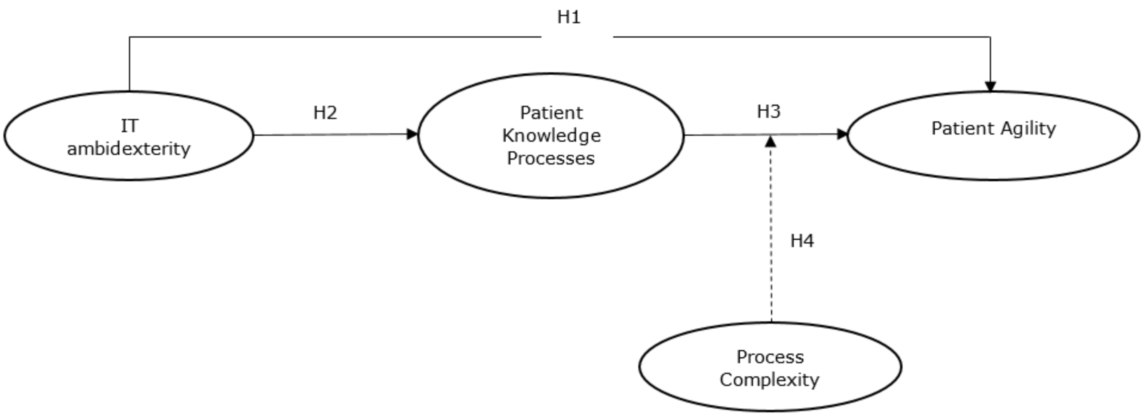

Figure 1, conceptual model

2.4. Objective of the follow-up research

The objective of the follow-up research is to gather relevant data to test the formulated hypotheses. By testing the hypotheses, the relation between the constructs can be quantified and tested for significance and thus provide the following information:

- the relation between IT ambidexterity and patient agility;
- the relation between IT ambidexterity and patient knowledge processes
- the relation between patient knowledge processes and patient agility
- the influence of process complexity on the relation between patient knowledge processes and patient agility.

This information combined provides an answer to the main research question:

Can a balanced approach to exploration and exploitation of IT resources leverage a hospitals' patient knowledge processes and consequently increase a hospitals' patience agility and is this leverage stronger for hospitals with higher process complexity?

3. Methodology

3.1. Conceptual design: select the research method(s)

As is common with deductive research (Saunders, Lewis, & Thornhill, 2016) the aim of this research is to test the theoretical propositions that are presented in paragraph 2.3. A representation of the four hypotheses can be found in Figure 1, conceptual model.

The constructs in the conceptual model do not reflect direct observable facts so to test the relationship between the constructs underlying variables need to be measured. By measuring those underlying variables or indicators the construct can be measured as well. A quantitative research approach is most suitable for this (Hair Jr, Hult, Ringle, & Sarstedt, 2016). Qualitive research focuses on understanding the meaning of the constructs (Saunders et al., 2016) but this thesis draws upon already established definitions of the constructs and is mainly focused on testing the strength of the relations.

Because this type of research depends on statistical correlation between indicators and construct it is necessary to have an adequate set of equidistance measurements (Hair Jr et al., 2016). For this purpose, using a survey to collect data is the preferred method in this research.

3.2. Technical design: elaboration of the method

3.2.1. Measurement model

The variables in the conceptual method do not represent observable phenomena but rather latent variables or constructs (Hair Jr et al., 2016). To determine the relation between the constructs testing needs to be done through measuring indicators that are either reflective where the construct causes the measurement of the indicator variables or formative where the causal indicators form the construct by means of linear combinations (Hair Jr et al., 2016).

The constructs and indicators used for this thesis are based on existing empirical validated research and only slightly modified to apply to the research context, hospitals. An overview of the constructs, their source and indicators can be found in Table 1.

ITA is operationalized using the item-level interaction terms of the reflective constructs IST and ISR (Lee et al., 2015). PA consists of two dimensions represented by the reflective constructs PSC and PRC (Roberts & Grover, 2012a).

Table 1: constructs and indicators

Construct	*Source*	*Indicator*	*Description*
IT Ambidexterity (ITA)	(Lee et al., 2015)		Second order construct formed by IS Exploitation and IS Exploration
IS Exploitation (IST) - reflective		ita_1	Reuse existing IT components, such as hardware and network resources
		ita_2	Reuse existing IT applications and services
		ita_3	Reuse existing IT skills
IS Exploration (ISR) - reflective		ita_4	Acquire new IT resources (e.g., new generation of IT architecture, potential IT applications, critical IT skills)
		ita_5	Experiment with new IT resources
		ita_6	Experiment with new IT management practices
Patient knowledge processes (PKP) - reflective	(Jayachandran et al., 2004)	pkp_1	We regularly meet patients to learn about their current and potential needs for new health services
		pkp_2	Our knowledge of patients' needs is thorough
		pkp_3	We systematically process and analyze patient data and information
		pkp_4	We regularly study our patient's needs for new health service development
		pkp_5	We have interdepartmental meetings regularly to discuss patient's needs
		pkp_6	Our department spend time discussing patient's future needs with other (clinical) departments
Patient agility (PA)	(Roberts & Grover, 2012a)		Second order construct formed by Patient sensing capability and Patient responding capability
Patient sensing capability (PSC) - reflective		pa_1	We continuously try to discover additional needs of our patients of which they are unaware.
		pa_2	We extrapolate key trends to gain insight into what patients in a current market will need in the future.
		pa_3	We continuously try to anticipate our patients' needs even before they are aware of them.
		pa_4	We attempt to develop new ways of looking at patients and their needs
		pa_5	We sense our patient's needs even before they are aware of them.
Patient responding capability (PRC) - reflective		pa_6	We respond rapidly if something important happens with regard to our patients.
		pa_7	We quickly implement our planned activities with regard to patients
		pa_8	We quickly react to fundamental changes with regard to our patients
		pa_9	When we identify a new patient need, we are quick to respond to it.
		pa_10	We are fast to respond to changes in our patient's health service needs
Process complexity (PC) - reflective	(Karimi et al., 2007; Setia et al., 2013)	pc_1	The healthcare delivery processes often cut across multiple functional areas
		pc_2	We frequently deal with ad hoc, non-routine healthcare delivery processes
		pc_3	We generally have a high degree of uncertainty in our healthcare delivery processes
		pc_4	A majority of our healthcare delivery processes are quite complex

3.2.2. Data Gathering

To gather data on each of the indicators a survey is used that can be found in Appendix 3. The target audience for the survey consists of all departments of hospitals in the Netherlands that have patient contact. General information that is collected for each department includes:

- Number of doctors (fte);
- Total size (fte);
- Type of hospital;
- Type of department;

- Age of department;
- Working experience respondent;
- Annual patient contacts;
- Care type provided (insured/uninsured);
- Role of the respondent.

The survey is conducted using LimeSurvey and a 7-point Likert scale is used for scoring. Targeted respondents are selected by searching the social network LinkedIn[1] for people working at Dutch hospitals on a department with patient contact, preferably in a position that likely has knowledge of both patient related processes and IT support of those processes. Potential respondents are then sent a connection invitation with a brief note explaining the nature of the connection request.

Upon accepting the request an e-mail is sent containing additional information as well as a link to the survey. Follow up messages are sent approximately one week after the last message has been sent.

3.3. Data analysis

Since the conceptual model researched in this thesis consists both of an inner structure, the formulated hypotheses, and outer measurements, the indicators reflecting the constructs, Partial Least Squares - Structural Equation Modeling (PLS-SEM) is used for data analysis (Hair Jr et al., 2016). The advantage of using SEM is that it can test the measurements of latent variables and the relationships between those latent variables (Hair Jr, Sarstedt, Hopkins, & G. Kuppelwieser, 2014). There are several reasons why PLS-SEM is more suitable for this thesis then another SEM variant, namely covariance-based SEM (CB-SEM), that are relevant for this thesis. Research shows that PLS-SEM is particularly useful, compared to CB-SEM, in case of a relative small sample size and non-normal data (Ringle, C. M., Sarstedt, & Straub, 2012). The used dataset in this research is relatively small and most indicators do not have a normal distribution based on the skewness and kurtosis of indicator data. Also PLS-SEM is more applicable to research that is more explorative by nature (Hair Jr et al., 2016) which is the case in this thesis. The software SmartPLS version 3 is used to perform the analysis using the PLS-SEM method (Ringle, C. M., Wende, & Becker, 2015).

To evaluate the outer model the reliability and validity of the first order construct measures are determined. For IST, ISR, PKP, PC, PRC and PSC, all reflective constructs, composite reliability are used to evaluate the construct measures' internal consistency reliability (Hair Jr et al., 2014). Next the validity is examined by evaluating the construct's convergent validity and discriminant validity. Support is provided for convergent validity when each item has outer loadings above 0.70 and when each construct's average variance extracted (AVE) is 0.50 or higher (Hair Jr et al., 2014). Discriminant validity is examined by looking at cross-loadings, Fornell-Larcker and heterotrait-monotrait ratio.

Finally to evaluate the inner model the paths that represent the hypotheses are tested using the coefficient of determination R^2 values (Ringle, C. M. et al., 2012). Stone-Geisser's Q^2 value is examined to predict out-of-sample predictive power of the model for the reflective constructs as well as the size and significance of the path coefficients (Hair Jr et al., 2016).

[1] https://www.linkedin.com

3.4. Reflection w.r.t. validity, reliability and ethical aspects

The quality of this research can be judge for a great deal by its validity and reliability (Saunders et al., 2016). Reliability refers to the extent that the results are consistent upon replication of the research. Validity indicates the appropriateness of the measures, do the measurements measure what they are intended to do, see Figure 2. If you aim for bullseye reliability means you consistently hit the same spot as can be seen in the left and middle example. Validity means you hit the bullseye. Evidently the goal is to hit the bullseye consistently (left example).

Measurement validity is addressed as described in 3.3. Furthermore, several actions are taken to minimize the threats to reliability. Saunders et al. (2016) identify four threats to reliability that are addressed in this research. The responses are confidential and the results are published with aggregated data to help prevent participant bias. Results are not related to individual respondents and any personal information that is collected is not retained longer than necessary for the purpose of this research to comply with all relevant regulations concerning privacy (Uitvoeringswet algemene verordening gegevensbescherming. 2018).

Researcher error is prevented as much as possible by describing the used methods and data, peer-reviewing and only using methods that have been validated in extant literature. Using a survey with validated items and Likert-scale for response helps preventing researcher bias.

Figure 2, reliability and validity (source: https://www.unthsc.edu/center-for-innovative-learning/assessment-reliability-and-validity/, accessed on 12-4-2018)

4. Results

This section describes the result of analyzing the research model with PLS-SEM. The PLS-Algorithm was executed with a maximum of 300 iterations and a stop criterion of 10^{-7}. The algorithm always converged within the maximum number of iterations. Where applicable, bootstrapping was executed with 1000 samples, a significance level of 5% and a two-tailed test type.

About 2000 potential respondents were invited to participate through a LinkedIn invitation request. Roughly 30% accepted the invitation and of this last group just over 15% completed the survey. A very small percentage (< 5%) was contacted through other channels (phone or direct e-mail). Response rate in this group was similar.

Data gathering in the initial phase has targeted not only people working on departments with patient care processes but also people working in health-related IT functions both inside and outside hospitals with the objective to reach our targeted response group through their network. Also, in the initial phase more people were contacted through direct e-mail messages and phone calls while after the initial phase people were almost exclusively contacted through LinkedIn based on their function.

The final sample of 95 responses is small but meets the often cited 10 times rule (Thompson, Barclay, & Higgins, 1995) and more important is sufficient to detect a minimum R^2 of 0.25 with a significant level of 5% given the maximum number of independent variables (Cohen, 1992; Hair Jr et al., 2016).

To evaluate any statistical differences between the response of the early group compared to the later group a multi-group analysis between the first 20 and last 20 respondents has been done. It shows no significant differences in path coefficients but is does show a significant difference in the value of R^2 for PKP. Since the path coefficients do no differ significantly and the sample size of the subgroup is too small to reliably detect R^2 values under 0.25 (Cohen, 1992) and the R^2 value for the first group of respondents is 0.135 this statistical difference is accepted.

4.1. Measurement model

The evaluation of the reflective measurement model is based on the internal consistency reliability, convergent validity and discriminant validity of the reflective first order constructs IST, ISR, PKP, PC, PSC and PRC. Internal consistency involves correlating the scores on different items of the same construct, measuring the consistency of the answers given. This contributes to the reliability of the research (Saunders et al., 2016).

To ensure that different items of a construct correlate, and in fact measure the same latent variable, convergent validity is used (Hair Jr et al., 2016; Saunders et al., 2016). Discriminant validity is indicative for the extent to which different constructs do not in fact measure the same phenomena, ensuring the uniqueness of a construct (Hair Jr et al., 2016). Both convergent and discriminant validity contribute to the validity of the research.

4.1.1. Internal consistency reliability

Traditionally internal consistency is measured using Cronbach's alpha (Hair Jr et al., 2016) although Hair Jr et al. point out that it may be a more conservative measure and it is technically more appropriate to use composite reliability. The latter one considers the different outer loadings of the indicator variables, whereas Cronbach's alpha assumes equal outer loadings.

Table 2: Construct Reliability and Validity

	Cronbach's Alpha	*Composite Reliability*	*AVE*
ISR	0.860	0.915	0.781
IST	0.937	0.959	0.888
PC	0.810	0.872	0.632
PKP	0.875	0.905	0.616
PRC	0.939	0.953	0.804
PSC	0.901	0.927	0.719

As can be seen in Table 2 both Cronbach's Alpha as Composite Reliability values are well above the threshold of 0.70 indicating sufficient internal consistency reliability (Nunnally, 1994). Since Composite Reliability tends to overestimate the internal consistency reliability it can be seen as the upper bound of it, where Cronbach's Alpha can be regarded the lower bound (Hair Jr et al., 2016). According to Hair et al. (2016) values for both Cronbach's alpha and composite reliability above 0.90 but definitely above 0.95 are not desirable. The constructs IST and PRC both have a composite reliability just above 0.95. This may be caused by semantic redundancy in the survey. Since this survey is based on constructs and items that have been validated in earlier literature (Jayachandran et al., 2004; Karimi et al., 2007; Lee et al., 2015; Roberts & Grover, 2012a) and researchers are advised to minimize rather than to prevent the use of redundant indicators (Hair Jr et al., 2016) the constructs are not changed.

4.1.2. Convergent validity

Since the different indicators connected to a reflective construct are said to be alternative approaches to measure that construct those indicators should share a high proportion of their variance. The extent to which they do can be measured by the outer loadings of the indicators and the average variance extracted (AVE).

Table 3: Outer Loadings

	ISR	*IST*	*PC*	*PKP*	*PRC*	*PSC*
ita_1		0.927				
ita_2		0.953				
ita_3		0.947				
ita_4	0.853					
ita_5	0.908					
ita_6	0.890					
pa_1						0.881
pa_10					0.934	
pa_2						0.778
pa_3						0.897
pa_4						0.803
pa_5						0.874
pa_6					0.872	
pa_7					0.839	
pa_8					0.919	
pa_9					0.916	
pc_1			0.752			
pc_2			0.827			
pc_3			**0.702**			
pc_4			0.886			
pkp_1				0.709		
pkp_2				0.787		
pkp_3				0.727		
pkp_4				0.803		
pkp_5				0.845		
pkp_6				0.827		

As can be seen in Table 3 there is one indicator below the 0.708 threshold (Hair Jr et al., 2016): pc_3. PC is a first order construct reflectively measured with four indicators. Given this number of indicators it may be beneficial to remove the indicator with the lowest outer loading, pc_3 and re-evaluate the model. However the outer loading is above 0.40 and composite reliability of PC is well above the threshold so the indicator should be retained (Hair Jr et al., 2016). Retention of the indicator is further justified by the average variance extracted (AVE) value for PC which is above the 0.50 threshold (Fornell & Larcker, 1981). See Table 2 for the AVE values of all first order constructs.

4.1.3. Discriminant validity

To establish that a construct is really different from other constructs cross-loadings can be used to measure discriminant validity (Farrell, 2010). Each indicator should have more correlation with its own construct than with any of the other constructs. Table 4 shows all relevant cross-loadings, indicating sufficient discriminant validity by this standard.

Table 4: Cross Loadings

	ISR	*IST*	*PC*	*PKP*	*PRC*	*PSC*
ita_1	0.520	**0.927**	0.141	0.467	0.287	0.410
ita_2	0.492	**0.953**	0.212	0.394	0.317	0.300
ita_3	0.451	**0.947**	0.276	0.453	0.408	0.399
ita_4	**0.853**	0.535	0.158	0.450	0.380	0.443
ita_5	**0.908**	0.430	0.254	0.421	0.297	0.473
ita_6	**0.890**	0.402	0.229	0.430	0.230	0.455
pa_1	0.496	0.405	0.254	0.670	0.488	**0.881**
pa_10	0.309	0.282	0.336	0.334	**0.934**	0.477
pa_2	0.553	0.514	0.165	0.591	0.390	**0.778**
pa_3	0.393	0.310	0.243	0.620	0.560	**0.897**
pa_4	0.444	0.203	0.233	0.573	0.402	**0.803**
pa_5	0.325	0.242	0.186	0.576	0.448	**0.874**
pa_6	0.218	0.280	0.315	0.501	**0.872**	0.522
pa_7	0.370	0.357	0.217	0.386	**0.839**	0.541
pa_8	0.342	0.378	0.370	0.374	**0.919**	0.464
pa_9	0.306	0.306	0.351	0.278	**0.916**	0.433
pc_1	0.191	0.279	**0.752**	0.284	0.287	0.245
pc_2	0.186	0.002	**0.827**	0.129	0.292	0.193
pc_3	0.108	0.208	**0.702**	0.027	0.170	0.058
pc_4	0.240	0.227	**0.886**	0.251	0.327	0.243
pkp_1	0.296	0.321	0.158	**0.709**	0.218	0.409
pkp_2	0.372	0.345	0.292	**0.787**	0.377	0.599
pkp_3	0.301	0.431	0.157	**0.727**	0.355	0.557
pkp_4	0.443	0.343	0.178	**0.803**	0.175	0.488
pkp_5	0.411	0.403	0.084	**0.845**	0.331	0.600
pkp_6	0.470	0.341	0.247	**0.827**	0.451	0.657

A second approach to determine discriminant validity is the Fornell-Larcker Criterion analysis which is based on the logic that a construct shares more of its variance with its associated indicators than with other constructs. Table 5 shows that each reflective construct has a higher square root of the

AVE than its correlation with other reflective constructs. This is another indication of discriminant validity.

Table 5: Fornell-Larcker Criterion

	ISR	*IST*	*PC*	*PKP*	*PRC*	*PSC*
ISR	**0.884**					
IST	0.518	**0.942**				
PC	0.241	0.222	**0.795**			
PKP	0.491	0.465	0.239	**0.785**		
PRC	0.345	0.357	0.354	0.419	**0.897**	
PSC	0.517	0.392	0.256	0.715	0.544	**0.848**

However, while both examining cross-loadings and the Fornell-Larcker criterion are indications of discriminant validity, neither of those measures is able to reliable detect issues concerning discriminant validity (Henseler, Ringle, & Sarstedt, 2015). Therefor a third method was applied, namely assessing the heterotrait-monotrait ratio (HTMT) of the correlations. And while a solid threshold for this method cannot be given, Henseler et al. (2015) propose a HTMT value below 0.90 as an indication of sufficient discriminant validity. Table 6 shows that all constructs are validated using this method.

Table 6 : Heterotrait-Monotrait Ratio (HTMT)

	ISR	*IST*	*PC*	*PKP*	*PRC*	*PSC*
ISR						
IST	0.574					
PC	0.273	0.272				
PKP	0.561	0.513	0.279			
PRC	0.381	0.382	0.386	0.447		
PSC	0.593	0.431	0.275	0.793	0.587	

4.2. Structural model

To test the hypotheses the structural model was analyzed using the PLS Algorithm. Additionally a non-parametric group analysis was performed (Henseler, Ringle, & Sinkovics, 2009).

4.2.1. Second order constructs

There are two second order constructs in the structural model; PA and ITA (see Figure 3). The construct PA is a second order reflective-formative construct (Hair Jr et al., 2016) consisting of two reflective first order constructs (PRC and PSC) that formatively define the second order construct. When such a construct is used as an endogenous variable all the variance will be explained by the lower order reflective constructs that make up the higher-order formative construct making it impossible to assess the path coefficients and significance for its exogenous variables. To solve this issue a repeated indicator/two-stage approach was taken (Henseler & Chin, 2010). The construct was validated using bootstrapping to perform a factor analysis for the construct.

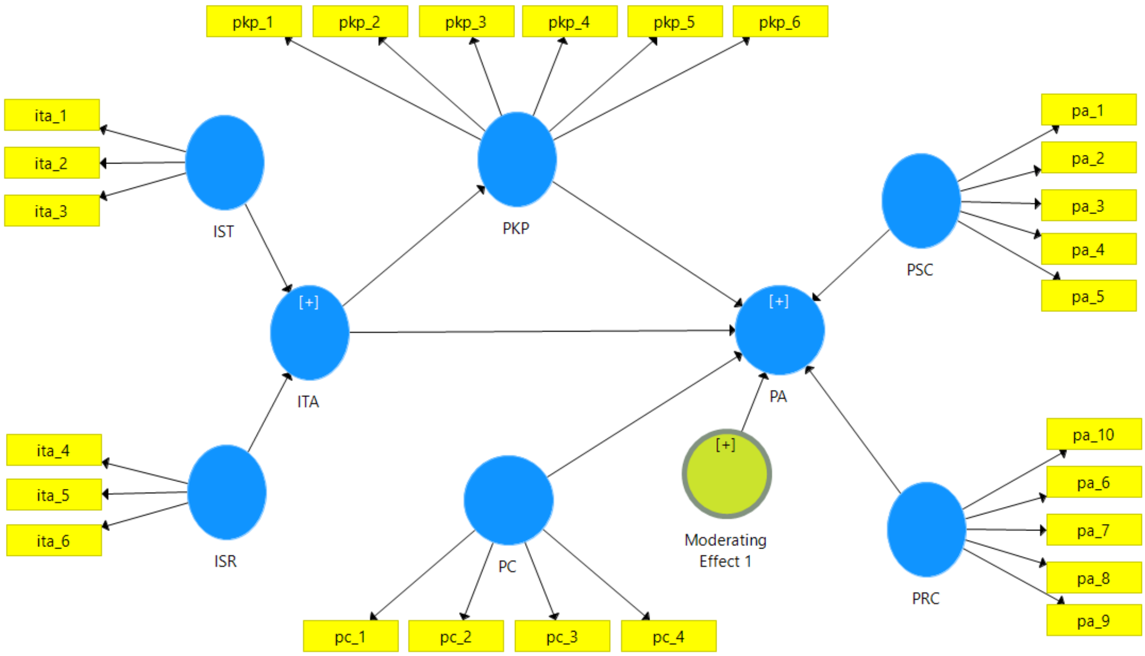

Figure 3, measurement and structural model

As can be seen in Table 7 the results indicate good formative factors with T values far above the 1.96 threshold (Hair Jr et al., 2016). Also, the inner VIF values show no indication of collinearity of PSC and PRC with a value of 1.421. The two-stage approach was used to replace the second order construct PA with a first order construct having one manifest indicator which value is based on the latent variable scores.

Table 7: Mean, STDEV, T-Values, P-Values

	Original Sample (O)	*Sample Mean (M)*	*Standard Deviation (STDEV)*	*T Statistics (|O/STDEV|)*	*P Values*
PRC -> PA	0.603	0.605	0.025	23.865	0.000
PSC -> PA	0.534	0.534	0.023	22.934	0.000

The second order construct ITA can also be classified as a reflective-formative construct but given the nature of the relation between IT ambidexterity and its dimensions IT exploitation and IT exploration a different approach needs to be taken. In previous research IT ambidexterity has been operationalized using item-level interaction of the subdimensions (Lee et al., 2015) but there exist some discussion on the nature of this interaction. Gibson and Birkinshaw (2004) applied multiplication of IT exploitation and IT exploration on item level amplifying high scores on both subdimensions. Other scholars have applied subtraction instead of multiplication to emphasize an unbalance between exploration and exploitation (He & Wong, 2004). This research adapts a third approach consisting of adding ISR and IST on item level because this approach supports the interpretation of IT ambidexterity as simultaneous explorative and exploitative capabilities, and it minimizes the information loss that is inevitable when combining two constructs in a single index (Jansen, Tempelaar, Van den Bosch, Frans AJ, & Volberda, 2009; Lubatkin, Simsek, Ling, & Veiga, 2006).

Further analysis was done using this new model (see Figure 4).

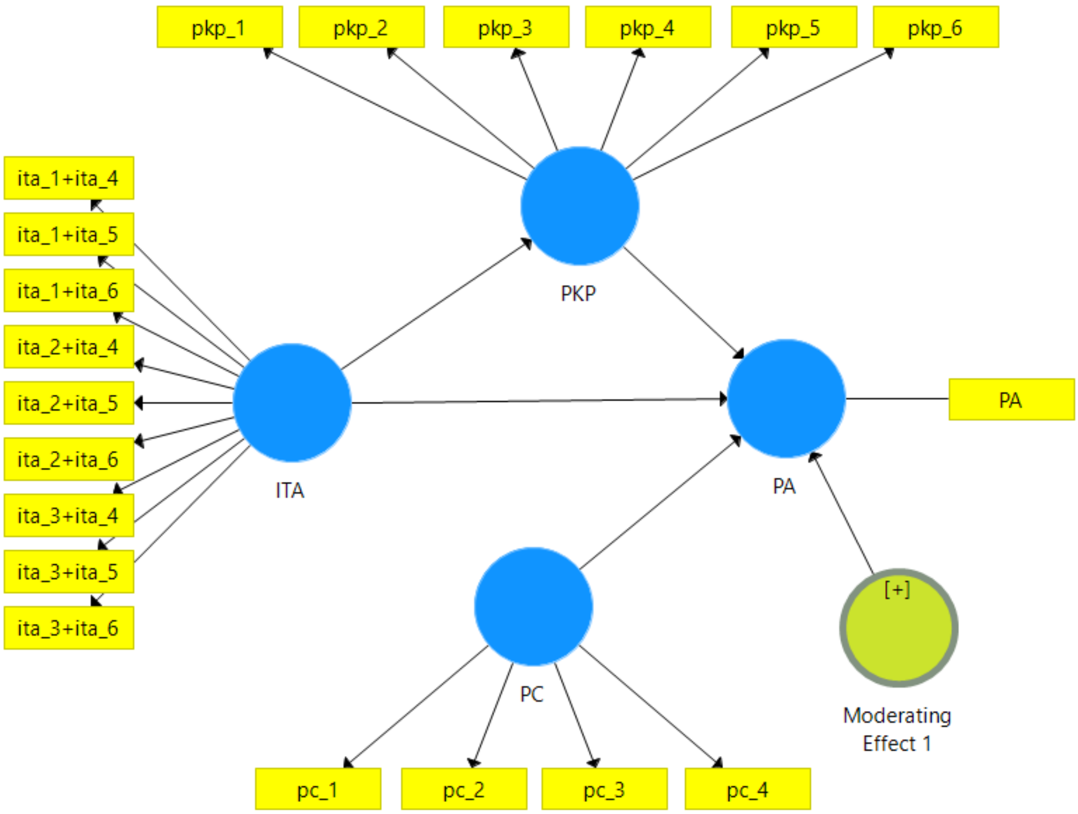

Figure 4, Measurement model second stage

4.2.2. Assessing the structural model

To further assess the structural model the explained variance (R^2), the effect size (f^2), the predictive relevance (Q^2) and the size and significance of the path coefficients of the model were evaluated (Hair Jr et al., 2016). However, to be able to test the third hypothesis and to distinguish between the direct effect in an unmoderated model and simple effect in a moderated model all steps described up to 4.2.4 were carried out without the construct PC and its moderating role in the model (Henseler & Fassott, 2010).

First the collinearity was checked by looking at the VIF values of the inner model. With a maximum of 1.431 all VIF values remain well below the threshold of 5.

Then bootstrapping was executed to determine the significance of the path coefficients. The paths ITA -> PKP, PKP -> PA and ITA -> PA are significant (significance level = 5%) according to their T values and P values (see Table 8).

Table 8: Path Coefficients

	Path Coefficients	*T Statistics (|O/STDEV|)*	*P Values*
IT ambidexterity -> Patient agility	0.312	3.056	0.002
IT ambidexterity -> Patient knowledge processes	0.549	6.734	0.000
Patient knowledge processes -> Patient agility	0.372	4.080	0.000

To determine the ability to predict the variance in the dependent variables (PKP and PA) the coefficients of determination (R^2) and the size and significance of the path coefficients (f^2 and Q^2) were evaluated. R^2 values for PKP and PA are 0.301 and 0.363 respectively. Those values can be described as weak to moderate. However, f^2 values indicate medium to large effects of ITA and PKP on their respective endogenous constructs PKP and PA (see Table 9).

Table 9: f Square

	F Square
IT ambidexterity -> Patient agility	0.107
IT ambidexterity -> Patient knowledge processes	0.431
Patient knowledge processes -> Patient agility	0.152

PKP and PA have Q^2 values 0.166 and 0.316 respectively. The Q^2 value is an indication for the out-of-sample prediction power of the model and values above zero are an indication that the model can predict the endogenous variables for data not included in the data sample (Hair Jr et al., 2016). Both values are above zero indicating that the model indeed has predictive power for PKP and PA.

Based on these findings the first and second hypothesis were confirmed.

4.2.3. Mediating role of Patient Knowledge Processes

Given the relatively small sample size and the non-normal distribution of the data bootstrapping was used to determine the nature of the mediating effect of PKP (Hair Jr et al., 2016). The results show a significant indirect effect for the indirect relation ITA -> PKP -> PA (t = 3.168) and a significant total effect for ITA -> PA (t = 6.196) since none of the confidence intervals include 0 and T values are above 1.96. These results are indicative for partial mediation where PA is both influenced by ITA directly and through mediation of PKP.

The assessment results of the structural model show a significant path coefficient for the direct relation between ITA and PA (t = 3.056). Therefor the third hypothesis was confirmed by showing a partial mediating effect of PKP on the relation between ITA and PA.

4.2.4. Moderating role of Process Complexity

The purpose of this research with regards to the fourth hypothesis, given the scares literature on the subject, is testing for a significant effect of the moderator rather than maximizing the prediction of it. Therefor in line with extant literature a two-stage approach has been taken to test the moderating effect of PC (Hair Jr et al., 2016; Henseler & Chin, 2010).

The results of the bootstrapping procedure show that the moderating effect is not significant (t = 1.154). Therefor the fourth hypothesis was not confirmed.

4.2.5. Multi-Group Analysis

The results reported in paragraph 4.2 have been obtained under the implicit assumption that the group of respondents form a homogeneous group but in reality respondents come from different backgrounds. Although this has no consequences for the results in general, PLS-SEM is not depending on the assumption of either a homogeneous or heterogeneous population from which the sample is collected, it could have implications in applying the results in real life.

To gain additional insight in the results multi-group analysis was performed for groups based on the control variables hospital type, department age, function and number of patients. Distribution of the values for the other control variables does not support a meaningful multi-group analysis because it is not possible to create meaningful subgroup-pairs of significant size each (N > 10). See Appendix 4 for an overview of all control variable distributions.

Table 10: Parametric Test Path coefficients academic - top clinical (*N* = 68) vs other (*N* = 27)

	Path Coefficients-diff (| academic_top_clinical - type_other |)	*t-Value(academic_top_clinical vs type_other)*	*p-Value(academic_top_clinical vs type_other)*
ITA -> PA	0.654	2.835	**0.006**
ITA -> PKP	0.237	1.371	0.174
Moderating Effect 1 -> PA	0.123	0.589	0.558
PC -> PA	0.154	0.747	0.457
PKP -> PA	0.698	3.516	**0.001**

The multi-group analysis was performed using the non-parametric PLS-MGA method that uses bootstrapping for 2 different groups and compares the bootstrap estimates (Henseler et al., 2009). Since the main purpose of the multi-group analysis is to determine the difference in validity of the hypotheses for different subgroups only the significance of the difference in path coefficients and R^2 were evaluated.

A significant difference was found between subgroups based on hospital type (see Table 10). Surprisingly the relation between ITA and PA seems almost completely mediated by PKP for non-academic, non-top-clinical hospitals, N = 27 (β = 0.963 for PKP -> PA), showing even a significant negative path coefficient (β = -0.291) for ITA -> PA. (see Table 11)

Table 11: Path Coefficients academic - top clinical (*N* = 68) vs other (*N* = 27)

	Path Coefficients Original (academic_top_clinical)	*Path Coefficients Original (type_other)*
ITA -> PA	**0.362**	**-0.291**
ITA -> PKP	0.493	0.730
Moderating Effect 1 -> PA	-0.083	0.040
PC -> PA	0.173	0.019
PKP -> PA	**0.265**	**0.963**

A multi-group analysis on department age, 0-10 years (N = 43) and > 20 years (N = 32) does not show any significant path coefficient differences, however the difference in explained variance for patient agility is significant (t = 2.223), showing a higher value for R^2 for younger departments (age 10 years or younger) compare to older department (age 20 years or older).

Since the moderating relationship of PC is not significant in this research an additional multi-group analysis was performed based on latent variable score of PC (mean = 0.281). This analysis also did not find any significant differences between the group low_pc (latent variable score < 0.281), N = 35, and high_pc (latent variable score > 0.281), N = 60.

The multi-group analysis on function, consisting of a subgroup containing managing or coordinating functions (head of department, medical manager, chef de Clinique, N = 55) and a subgroup containing other functions (N = 40) does not show any significant differences. Neither does the multi-group analysis on department size, consisting of subgroups with less than 6.500 patients annually (N = 39) and more than 10.000 patients annually (N = 35).

5. Discussion, conclusions and recommendations

5.1. Discussion and conclusion

The aim of the research was to answer the central question of this thesis: Can a balanced approach to exploration and exploitation of IT resources leverage a hospitals' patient knowledge processes and consequently increase a hospitals' patience agility and is this leverage stronger for hospitals with higher process complexity? Answering this question contributes to existing literature with regards to the role of dynamic capabilities in organization performance based on the DCV by possibly confirming the hypothesis that IT ambidexterity, as a lower order capability, enables patient agility, a higher order dynamic capability.

The overall results show a positive relation between IT ambidexterity and patient agility, thereby contributing to earlier research on the relation between IT ambidexterity and firm performance (Ferraris et al., 2018; Heckmann et al., 2016; Revilla et al., 2007). This relation was found to be mediated by process knowledge processes for all investigated hospitals but specifically for non-academic, non-top-clinical. For this last group this mediating effect seems to be full rather than partial, meaning IT ambidexterity will only result in patient agility when applied to enable patient knowledge processes.

These findings extent existing literature on the role of IT ambidexterity as an enabler of process knowledge processes (Revilla et al., 2007; Roberts & Grover, 2012b) and knowledge processes as an enabler of agility (Cegarra-Navarro et al., 2016; Jayachandran et al., 2004; Tanriverdi, 2005), thus emphasizing the role of patient knowledge processes as mediator. They also seem to be confirming very recent research that shows that innovation ambidexterity positively impacts firm performance both directly and through mediation of absorptive capacities (Božič & Dimovski, 2019).

The negative path coefficient in the direct relation between IT ambidexterity and patient agility resulting from the multi-group analysis for the subgroup non-academic and non-top-clinical hospitals even suggest that IT ambidexterity may have a negative impact on patient agility unless these capabilities are used to enable patient knowledge processes (for this particular subgroup).

Despite some indications found in previous literature (Chen et al., 2014; Setia et al., 2013) that process complexity could moderate the relation between process knowledge processes and patient agility, such an effect has not been found. A multi-group analysis based on a group with below average process complexity and a group with above average process complexity showed no significant difference in the model's path coefficients or R^2 values, further confirming no significant role for process complexity in the relation between patient knowledge processes and patient agility. A factor that may be of influence is that hospitals possibly have above average process complexity, compared with most other organizations, which possibly makes it more difficult to detect a moderating effect of this variable. However, this observation is based only on the relatively high average score on process complexity and it should be further investigated to reach a conclusion.

The answer to the main question in this thesis thus is: IT ambidexterity has a positive influence on patient agility and this influence is mediated by a hospital department's patient knowledge processes. This mediating effect is stronger for non-academic, non-top-clinical hospitals. Process complexity does not significantly influence the relation between patient knowledge processes and patient agility.

5.2. Limitations

It must be noted that the results in this thesis are based on a relatively small sample size (N = 95) and some feedback was received during data gathering from targeted respondents that they either had insufficient insight in IT processes or patient related processes. This may have led to a form of nonresponse bias where targeted people with relatively high IT capabilities are more likely to respond. The targeted audience consisted mainly of people working on a hospital department with patient care. There were no responses included of people working on non-medical departments (IT, Finance, etc.).

This research has been restricted to Dutch hospitals only, so the results are not generalizable to hospitals outside the Netherlands. However, the research model is based on existing literature and the used constructs and indicators have been validated by scholars in various international settings (Jayachandran et al., 2004; Karimi et al., 2007; Lee et al., 2015; Roberts & Grover, 2012a). So, the results may be of interest to researchers outside the Netherlands as well.

The hospitals that have been included in this research differ in size, type, age, number of departments, etc. and though some multi-group analysis have been done the results of those were mostly discussed in general terms due to time limitations and sample size.

Even though this research suggests that the improvement of patient knowledge processes leads to improved patient agility, it does not consider the practical restrictions that hospitals may encounter in doing so. Registering, processing and disclosing patient related information may be sensitive to legislation such as the recently implemented General Data Protection Regulation (GDPR) (Uitvoeringswet algemene verordening gegevensbescherming. 2018)

5.3. Recommendations for practice

Given the increasingly important role of IT in hospitals (Haux, 2010) and its potential to enable patient agility (Heckmann & Maedche, 2018) this research provides some justification to an increased attention for patient knowledge processes, given their mediating role in the relation between IT ambidexterity and patient agility. Specifically, for non-academic, non-top-clinical hospitals, collecting, processing and disclosing patient related knowledge could contribute to their agility towards changing patient needs. These patient knowledge processes should be executed regularly, thoroughly and systematically, and crossing functional departments. As noted previously this research has not taken into account the consequences of more restrictive regulation on privacy (Uitvoeringswet algemene verordening gegevensbescherming. 2018) that could complicate the implementation of effective patient knowledge processes.

In general, the application of existing IT to support new patient related processes and the implementation of new IT for existing patient related processes also supports a departments agility. However, this seems to be less actionable for departments with patient care since decisions on IT investments are more likely taken on organization level. It does however emphasize the need for collaboration between those responsible for IT investments and those responsible for patient care specifically because it seems plausible that IT capabilities need to be enabling patient care specific processes to be able to have an impact on agility.

5.4. Recommendations for further research

Due to the nature of the goal of this research, writing a master thesis in a limited amount of time, this research has some clear limitation. The sample size (*N* = 95) is relatively small so a larger scale replication of this research seems relevant to confirm the findings. To be able to collect relevant information about both IT related processes and patient related processes a matched pair analysis might be recommendable (Saunders et al., 2016). Such research model would allow pairing an IT-knowledgeable respondent with a respondent with a background in patient care. However, this might be harder to implement on department level if IT related functions are organized differently than patient care related functions. In that case extra effort should be taken to relate IT oriented results with the patient care related results.

While both a direct relation between IT ambidexterity and patient agility, and a mediated relation via patient knowledge processes has been found the strength of the mediating effect differs significantly between different types of hospitals. This research does not have the intention to offer insight in why this may be the case and further research in this area may be beneficial, specifically to be able to formulate operationable advice for those hospitals that could benefit most.

Although some multi-group analyses have been done, the results should be interpreted with caution because of the statistical limitations when analyzing small sample sizes (Cohen, 1992). An extension of this research collecting more data might provide additional insight in the consequences of the heterogeneity of the response group.

Although some scholars have researched the role of process complexity in relation to organization agility, this research has not been able to detect such an influence. Further research could investigate the moderating effect of process complexity on the non-mediated relation between IT ambidexterity and patient agility.

5.5. Reflection

This research has been accomplished using a structured, academic method that consists of literature review, research design, research execution and analyzing of the results leading to a conclusion and an answer to the main research question. This method has provided both structure and challenges. Structure was derived from the clear deliverables like for example the theoretical framework and methodology. By following the available guidelines in producing these deliverables not only the quality of the thesis was increased but also critical thinking and accurate and thorough argumentation were stimulated.

There were some challenges, however. Creating a sound theoretical framework involves a good insight in existing literature on the relevant topics. Since this has to be accomplished in the early phases of the process and since the domain, healthcare, was new for me, over enthusiastically collecting papers to use for reference resulted in a less than optimal traceability of how I collected these papers.

Due to the nature of the qualitative research a survey was chosen as method of data collection. Even though there is no doubt this is the preferred method for data collection for this research, execution of it has been cumbersome. The initial approach, to contact suppliers of Healthcare-IT solutions, and people working in IT functions in hospitals with the goal to reach the target audience through these contacts, did not deliver significant results. Direct calling of people working on hospital department involved in patient care processes proved to be a very time consuming and inefficient approach. Using the social network LinkedIn proved to be a better method. Nevertheless, the goal to reach 100 respondents was not reached. The final number was acceptable but the effort and time it took to get there have been the hardest part of the research for me. Being dependent on your fellow researchers and target respondents was difficult for me since I prefer to work in isolation. It is useful, however, to realize that as a researcher maybe a lot of work is solitary, but your environment is a crucial contributor to succeeding.

Once the results of the survey were available, the analyzing part was a relief. The use of the SmartPLS software (Ringle, Christian M., Wende, & Becker, 2015) makes it easy to quickly achieve results but I found that a correct understanding and interpretation of this results does require some additional effort. On one hand the book on SEM-PLS (Hair Jr et al., 2016) serves as a ‘recipe’ to analyze the model. But on the other hand, limiting yourself to the steps and instructions in the book will not provide you with enough knowledge on how to interpret the results in the specific context of your own research. For this more literature review proved to be necessary.

The kind of research presented in this thesis starts with a real-life question for which a conceptual model is constructed. The research question then becomes more abstract. This abstract question is answered (hopefully) but the added value of this answer depends on the ability of the researcher to relate the abstract answer back again to the real-world question. It wasn’t until that final stage that I fully appreciated the domain of this theses, healthcare and IT. To me that was a very valuable realization.

It is safe to say that I immensely enjoyed the whole process. I feel I’ve learned some very valuable things along the way and for that I’m thankful.

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Appendix 1 – Literature sources

Table 12: Theoretical framework - sources

	Source	*Google Scholar*	*Open University Digital Library*
Query 1	Query	"IT ambidexterity" agility	(Abstract:(IT ambidexterity)) AND (Abstract:(agility OR performance))
	Additional criteria	none	Peer-reviewed Add results from other sources
	Results	169	372
Query 2	Query	"customer knowledge process" (agility OR performance)	(Abstract:("knowledge process" OR "knowledge management"))) AND (Abstract:(agility OR performance))
	Additional criteria	none	Peer-reviewed
	Results	374	1701
Query 3	Query	"IT capabilities" AND (hospital OR healthcare OR "health care") AND "dynamic capabilities"	("IT capabilities") AND (Abstract:("dynamic capabilities")) AND (hospital OR healthcare OR "health care")
	Additional criteria	none	Peer-reviewed Add results from other sources
	Results	781	415
Query 4	Query	"information quality" ("healthcare" OR "health care" OR "hospital") (performance OR agile) "information technology" "business process"	(Abstract:("information quality")) AND (Abstract:("healthcare" OR "health care" OR "hospital")) AND (performance OR agile)
	Additional criteria	none	Peer-reviewed Add results from other sources
	Results	3010	133

Appendix 2 – Reference-query matrix

Table 13: reference-query matrix

Reference	Q1	Q2	Q3	Q4	B.L.[2]	Snowballed from
(Agarwal et al., 2010)				X	X	
(Bradley et al., 2012)					X	
(Cegarra-Navarro et al., 2016)		X				
(Chen et al., 2014)						(Heckmann et al., 2016)
(Eisenhardt & Martin, 2000)			X			
(Ferraris et al., 2018)	X					
(Gastaldi et al., 2018)					X	
(Haux, 2010)					X	
(Heckmann et al., 2016)	X					
(Heckmann & Maedche, 2018)	X					
(Jayachandran et al., 2004)		X			X	
(Karimi et al., 2007)						(Ferraris et al., 2018)
(Lee et al., 2015)	X				X	
(Oak, 2013)	X					
(Offerman et al., 2017)	X					
(Preuss, 2003)				X		
(Raschke, 2010)						(Chen et al., 2014)
(Revilla et al., 2007)	X					
(Roberts & Grover, 2012a)		X				
(Roberts & Grover, 2012b)		X				
(Sambamurthy et al., 2003)						(Lee et al., 2015)
(Setia et al., 2013)		X				
(Tallon et al., 2018)	X					
(Tanriverdi, 2005)						(Wu et al., 2012)
(Teece et al., 1997)						(Roberts & Grover, 2012a)
(Trkman, 2010)						(Ferraris et al., 2018)
(van de Wetering, 2018)			X			
(Vrontis et al., 2017)						(Ferraris et al., 2018)
(Wade & Hulland, 2004)					X	
(van de Wetering et al., 2018)			X		X	
(Wu et al., 2012)					X	

[2] Base Literature (B.L.)

Appendix 3 – Survey

Survey constructen en items: IT proficiency capability and patient agility dr. Rogier van de Wetering (2019)	
Constructen	*Bronnen*
1. Geef aan hoeveel artsen (fte) werkzaam zijn binnen uw afdeling (met arts wordt bedoeld medewerker met minimaal kwalificatie basisarts)	Open vraag
2. Geef aan hoeveel medewerkers (fte) in totaal werkzaam zijn binnen uw afdeling (inclusief ondersteunend en administratief)	Open vraag
3. Geef het type ziekenhuis aan waar u werkzaam bent:	Universitair Medisch Centrum (UMC) Samenwerkend Topklinisch opleidingsZiekenhuis (STZ) Samenwerkend Algemeen Ziekenhuis (SAZ) Overig Algemeen Ziekenhuis (OAZ) Anders, namelijk:
4. Geef uw afdeling aan	Algemene Inwendige Geneeskunde Anesthesiologie Apotheek Cardiologie Cardiothoracale Chirurgie Chirurgie Dermatologie Endocrinologie Geriatrie Infectieziekten Intensive Care Volwassenen Keel-, neus- en oorziekten Kindergeneeskunde Neonatologie Kl. Immunologie & Reumatologie Klinische Hematologie Klinische Oncologie Longziekten Maag-, darm en leverziekten Mondziekten-kaakchirurgie/Ziekenhuistandheelkunde Neurochirurgie Neurologie Nierziekten Oogheelkunde Orthopedie Plastische en Reconstructieve chirurgie Psychiatrie Revalidatie Spoedeisende hulp Urologie Vasculaire geneeskunde Verloskunde/Gynaecologie Anders, namelijk:
5. Geef aan hoelang uw afdeling al bestaat in haar huidige vorm.	0–5 jaar 6–10 jaar 11–20 jaar 20–25 jaar 25+ jaar
6. Geef aan hoeveel jaar u op uw huidige afdeling werkt.	0–5 jaar 6–10 jaar

	11–20 jaar 20–25 jaar 25+ jaar
7. Hoeveel jaar werkervaring heeft u na het afronden van uw opleiding als basisarts?	0–5 jaar 6–10 jaar 11–20 jaar 20–25 jaar 25+ jaar Geen arts
8. Geef het aantal patiënten aan dat uw afdeling jaarlijks bezoekt.	< 4000 4000 – 6500 6500 – 9000 9000 – 11500 11500 – 14000 > 14000
9. Onze afdeling richt zich <u>primair</u> op:	Verzekerbare zorg Niet-verzekerbare zorg Allebei (ongeveer evenveel)
10. Geef uw huidige functie binnen de organisatie aan:	Afdelingshoofd Chef de Clinique Arts (Specialist) AIOS ANIOS Manager bedrijfsvoering Anders, namelijk:

IT capability

De aanwezigheid van IT vaardigheden en kennis kan zich uiten in de manier waarop IT middelen worden gebruikt en/of de mate waarin men begrijpt hoe IT middelen gebruikt kunnen worden binnen de organisatie/afdeling.

Geef aan in welke mate u het eens bent met de onderstaande stellingen omtrent de vaardigheden van de afdeling (1 – sterk mee oneens 7 – sterk mee eens)

1. Wij gebruiken IT systemen op adequate wijze
2. Wij zijn op de hoogte van relevante IT ontwikkelingen
3. Ons gebruik van IT is vergelijkbaar met de beste organisaties /afdelingen in de sector
4. Wij investeren veel in de ontwikkeling onze medewerkers op het gebied van IT-gebruik
5. Wij kennen de voordelen van het gebruik van IT systemen

IT Ambidexterity

IT exploitatie heeft betrekking op het toepassen van reeds aanwezige IT middelen binnen nieuwe zorgprocessen. IT exploratie heeft betrekking op het zoeken naar en toepassen van nieuwe IT middelen binnen de bestaande en nieuwe zorgprocessen.

Geef aan in welke mate u het eens bent met de onderstaande stellingen omtrent de vaardigheden van de afdeling (1 – sterk mee oneens 7 – sterk mee eens)

1. Wij gebruiken bestaande IT infrastructuur (computers, netwerkonderdelen, etc.) voor nieuwe zorgprocessen of behandelmethodes
2. Wij gebruiken bestaande IT applicaties voor nieuwe zorgprocessen of behandelmethodes
3. Wij gebruiken onze reeds aanwezige IT vaardigheden voor nieuwe zorgprocessen of behandelmethodes
4. Wij krijgen regelmatig nieuwe IT middelen (computers, applicaties, training) om toe te passen binnen bestaande of nieuwe zorgprocessen of behandelmethodes
5. Wij experimenteren regelmatig met nieuwe IT middelen (computers, applicaties, training) om toe te passen binnen bestaande of nieuwe zorgprocessen of behandelmethodes

6. Wij experimenteren regelmatig met nieuwe manieren om onze IT middelen te beheren

Patient knowledge processes

Patient knowledge processes zijn processen die gericht zijn op het begrijpen van de behoeftes van de patiënten ten behoeve van de zorgverlening.

Geef aan in welke mate u het eens bent met de onderstaande stellingen omtrent de vaardigheden van de afdeling (1 – sterk mee oneens 7 – sterk mee eens)

1. We overleggen regelmatig met onze patiënten om huidige en toekomstige behoeften voor nieuwe zorgdiensten te bespreken
2. De kennis over de patiënt zijn/haar behoeften is grondig
3. We verwerken en analyseren patiëntdata en -informatie op systematische wijze
4. We bestuderen de vraag naar de ontwikkeling van nieuwe zorgdiensten vanuit patiënten regelmatig
5. We hebben regelmatig overleg met andere afdelingen om de patiëntbehoeften te bespreken
6. Onze afdeling besteedt tijd aan het bespreken van de toekomstige behoeften vanuit de patiënt met andere (klinische) afdelingen

Patient agility

Patient agility is de mate waarin een afdeling in staat is veranderingen in de behoefte van patiënten te signaleren en de snelheid waarmee hier op gereageerd kan worden.

Geef aan in welke mate u het eens bent met de onderstaande stellingen omtrent de vaardigheden van de afdeling (1 – sterk mee oneens 7 – sterk mee eens)

1. We proberen continu aanvullende, onbewuste behoeften van onze patiënten te ontdekken
2. We gebruiken historische gegevens om vooruit te kijken en toekomstige behoeften van patiënten in te schatten.
3. We proberen continu de behoeften vanuit patiënten te anticiperen zelfs voordat zij zich bewust zijn van deze behoeften.
4. We proberen nieuwe manieren te ontwikkelen om te kijken naar de patiënten en hun behoeften.
5. We signaleren behoeften van patiënten voordat zij zich bewust zijn van deze behoeften.
6. We reageren snel op het moment dat er iets belangrijks gebeurt omtrent onze patiënten.
7. We implementeren nieuwe en geplande geplande zorgactiviteiten omtrent onze patiënten snel
8. We reageren snel op fundamentele veranderingen omtrent onze patiënten
9. Als een nieuwe zorgbehoefte van een patiënt wordt gesignaleerd dan reageren wij daar snel op.
10. Wij reageren snel op veranderingen in de zorgbehoeften van onze patiënt

Digital Capabilities

Digitale competentie is de mate waarin een afdeling in staat is om in te spelen op nieuwe digitale innovaties.

Geef aan in welke mate u het eens bent met de onderstaande stellingen omtrent de vaardigheden van de afdeling (1 – sterk mee oneens 7 – sterk mee eens)

1. We zijn in staat om belangrijke digitale technologieën (b.v., social, mobile, big data analytics, Internet of Things, Artificial intelligence, Cloud) te verkrijgen
2. We identificeren nieuwe digitale mogelijkheden voor onze zorgverlening
3. We verbeteren processen op onze afdeling met behulp van digitale innovaties
4. We beheersen nieuwe digitale technologieën op adequate wijze
5. We ontwikkelen innovatieve zorgdienstverlening gebruikmakend van digitale technologieën

Process sophistication

Process sophistication is de complexheid en informatiedichtheid van een proces. Een proces is meer complex wanneer activiteiten niet-routinematig, moeilijk of onzeker zijn. De informatiedichtheid is hoog wanneer er veel informatie verwerkt moet worden om het proces effectief te kunnen doorlopen.

Geef aan in welke mate u het eens bent met de onderstaande stellingen omtrent de vaardigheden van de afdeling (1 – sterk mee oneens 7 – sterk mee eens)

1. Onze zorgverleningsprocessen zijn informatie-intensief
2. Onze zorgverleningsprocessen omvatten vele stappen die frequent het gebruik van informatie nodig hebben
3. Informatie gebruikt in onze zorgverleningsprocessen moet vaak aangepast worden
4. Informatie is een wezenlijk onderdeel van onze zorgdienstverlening aan onze patiënten
5. Het zorgverleningsproces loopt vaak over meerdere functionele gebieden en afdelingen
6. We hebben vaak te maken met ad-hoc, niet routinematige zorgverleningsprocessen
7. We hebben over het algemeen te maken met een hoge mate van onzekerheid in onze processen omtrent zorgverlening
8. Het merendeel van onze processen omtrent zorgverlening zijn uiterst complex

Environmental turbulence

Omgevingsturbulentie is de onzekerheid of de onvoorspelbaarheid veroorzaakt door veranderingen in de wensen en behoeften van patiënten en veranderingen door technologische ontwikkelingen. Deze kunnen van invloed zijn op de patiënt-processen.

Geef aan in welke mate u het eens bent met de onderstaande stellingen omtrent de vaardigheden van de afdeling (1 – sterk mee oneens 7 – sterk mee eens)

1. Voorkeuren van patiënten veranderen zeer snel in ons marktsegment
2. Er is een hoge mate van concurrentie voor marktaandeel in onze industrie
3. Voorspellen van de behoeften van patiënten in ons marktsegment is zeer moeilijk.
4. Technologische innovaties hebben in recente jaren geleid tot vele nieuwe ideeën binnen de zorgverlening.

Relative patient service performance

In plaats van volledig te focussen op het meten van productiviteit, richten wij ons expliciet op de kwaliteit van de output van ‘patient response’ processen omdat de kwaliteit van de zorgverlening het perspectief van de klant meeweegt.

Geef aan in welke mate u het eens bent met de onderstaande stellingen omtrent de vaardigheden van de afdeling (1 – sterk mee oneens 7 – sterk mee eens)

Over de afgelopen 2 of 3 jaar, hebben we het veel beter gedaan dan vergelijkbare afdelingen binnen andere ziekenhuizen in:

1. Behalen van patiënttevredenheid
2. Verlagen van de operationele kosten
3. Service leveren van hoge kwaliteit
4. Behouden van bestaande patiënten
5. Aantrekken van nieuwe patiënten
6. Opbouwen van een positief imago
7. Behalen van gewenste marktaandeel
8. Behalen van gewenste groei
9. Verbeteren van de toegankelijkheid van dienstverlening

Appendix 4 – Control variable distributions

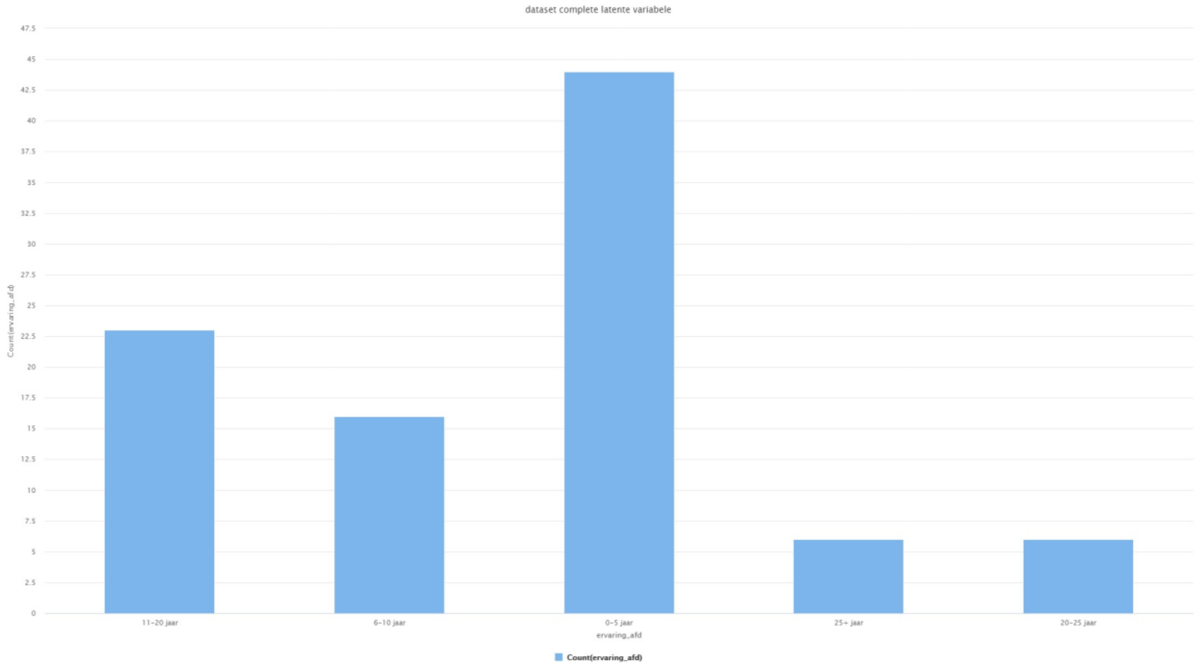

Figure 5: years experience on department

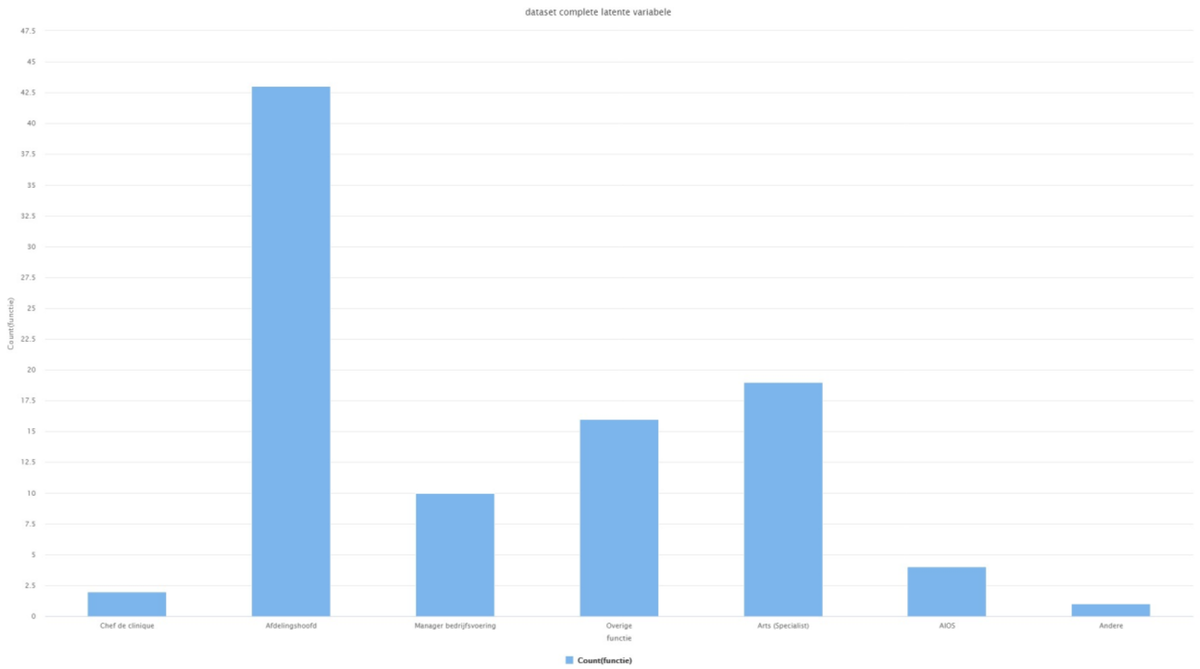

Figure 6: function

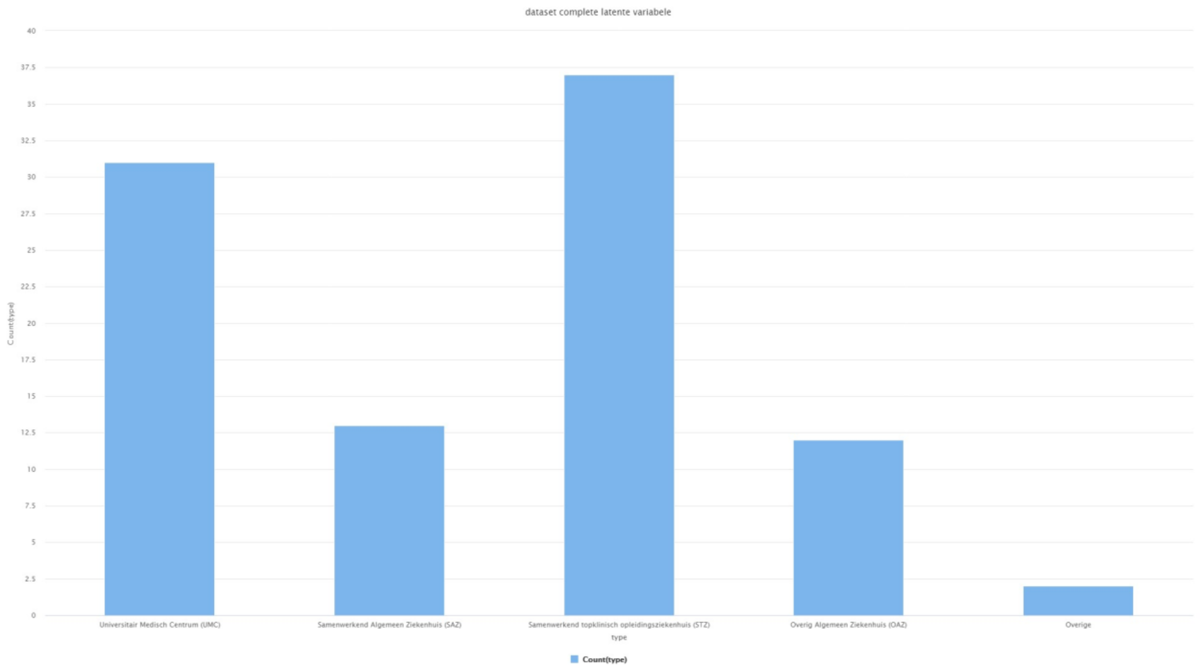

Figure 7: hospital type

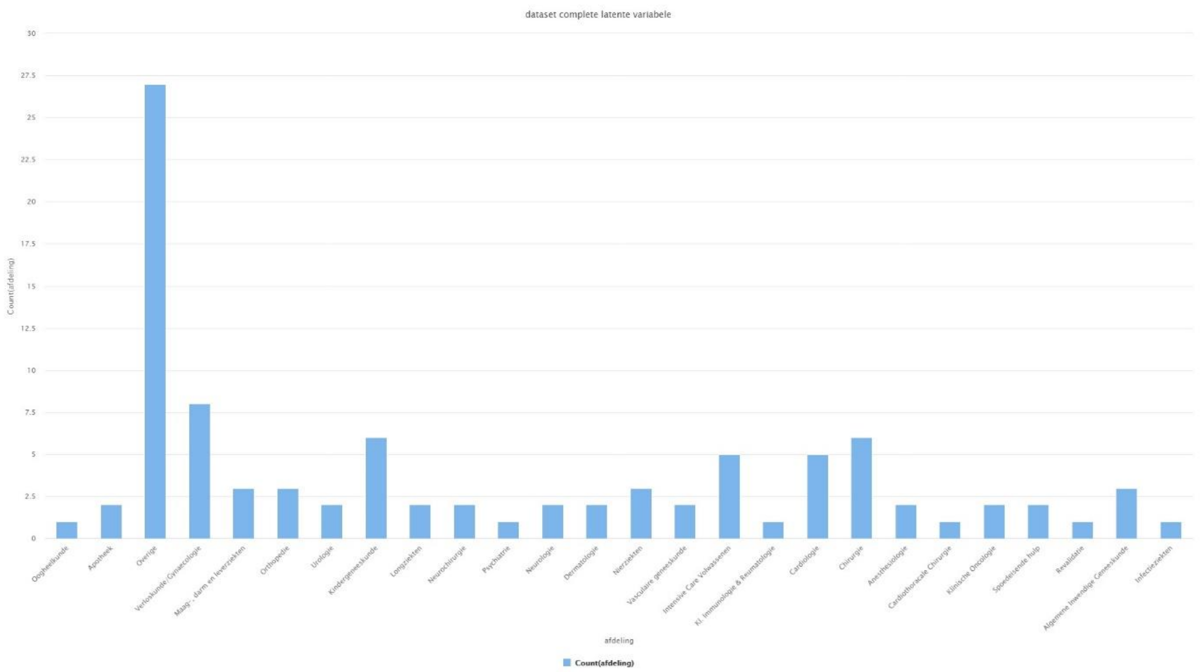

Figure 8: department

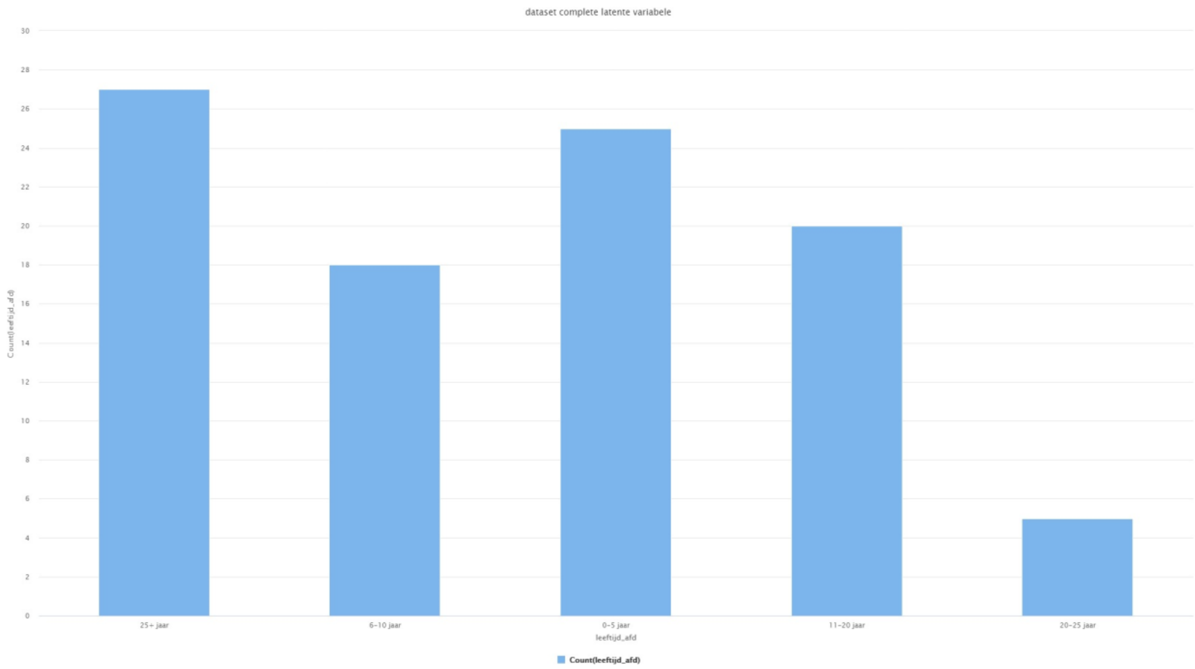

Figure 9: department age

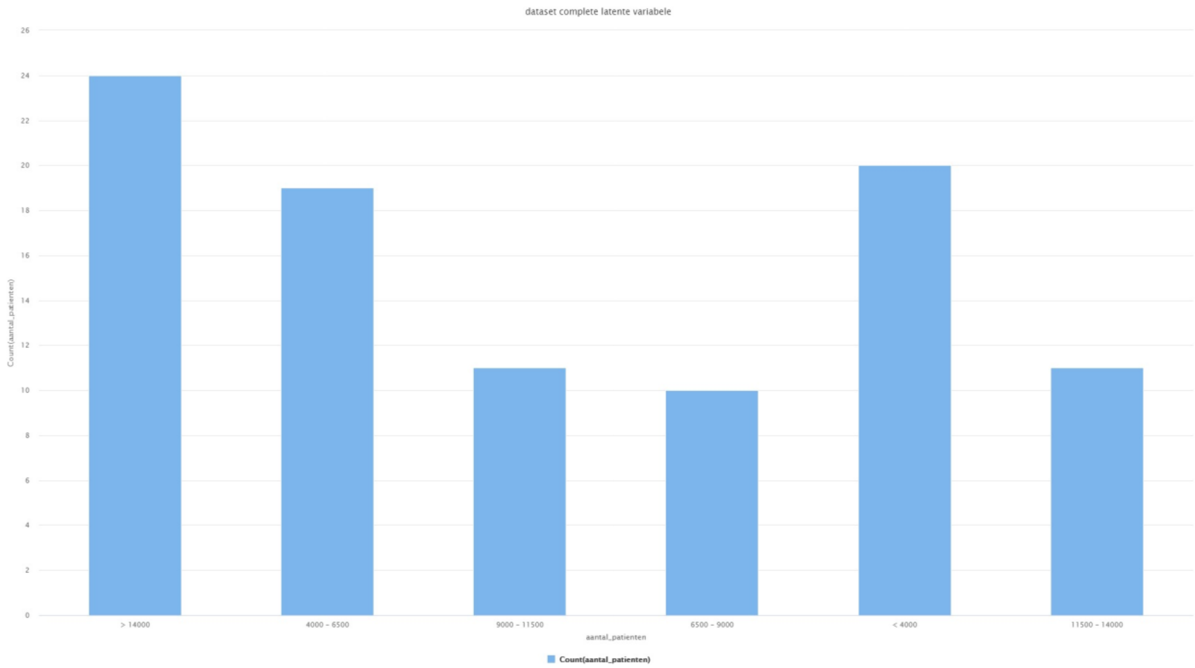

Figure 10: number of patients

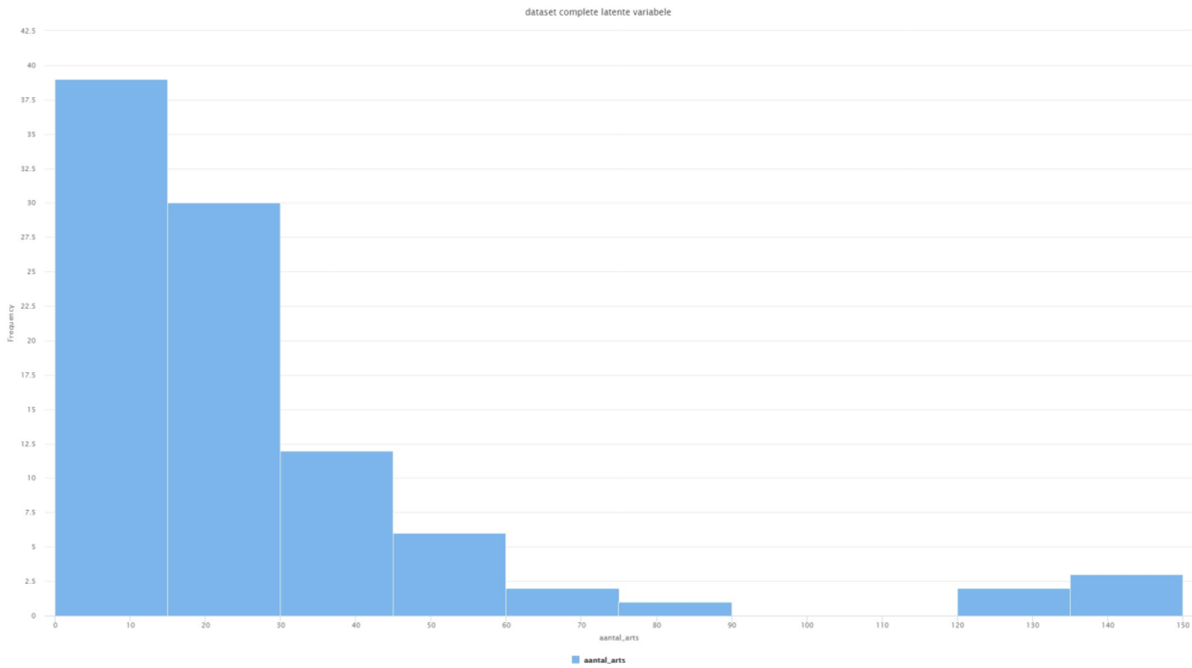

Figure 11: number of (medical) doctors

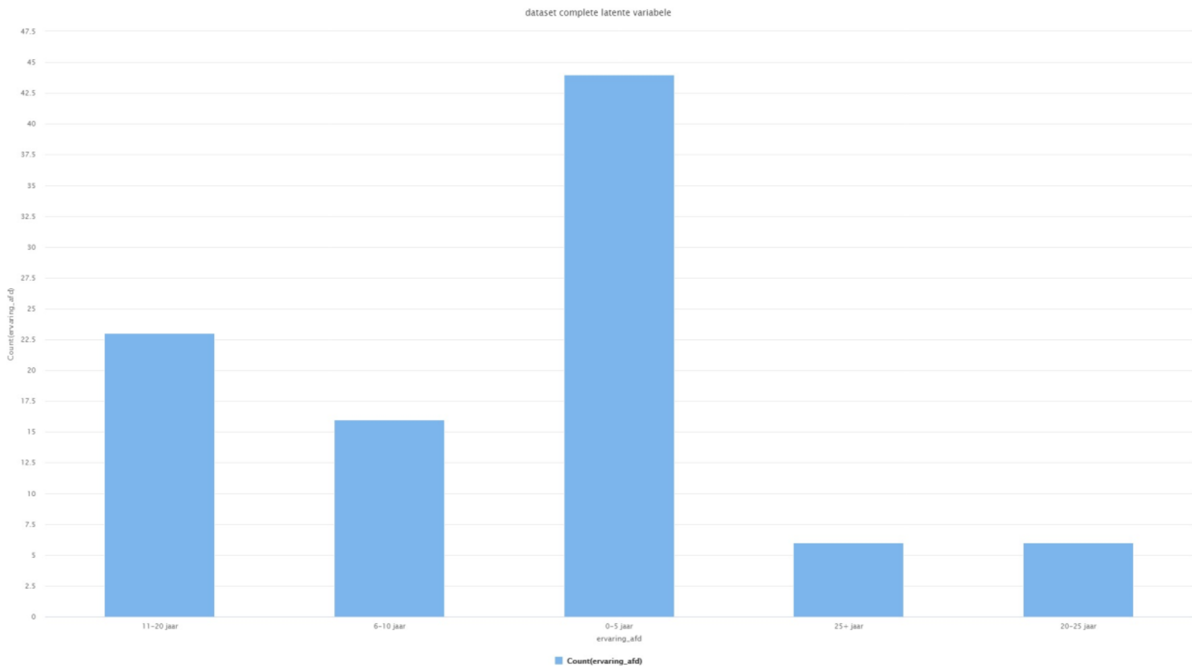

Figure 12: years experience on department

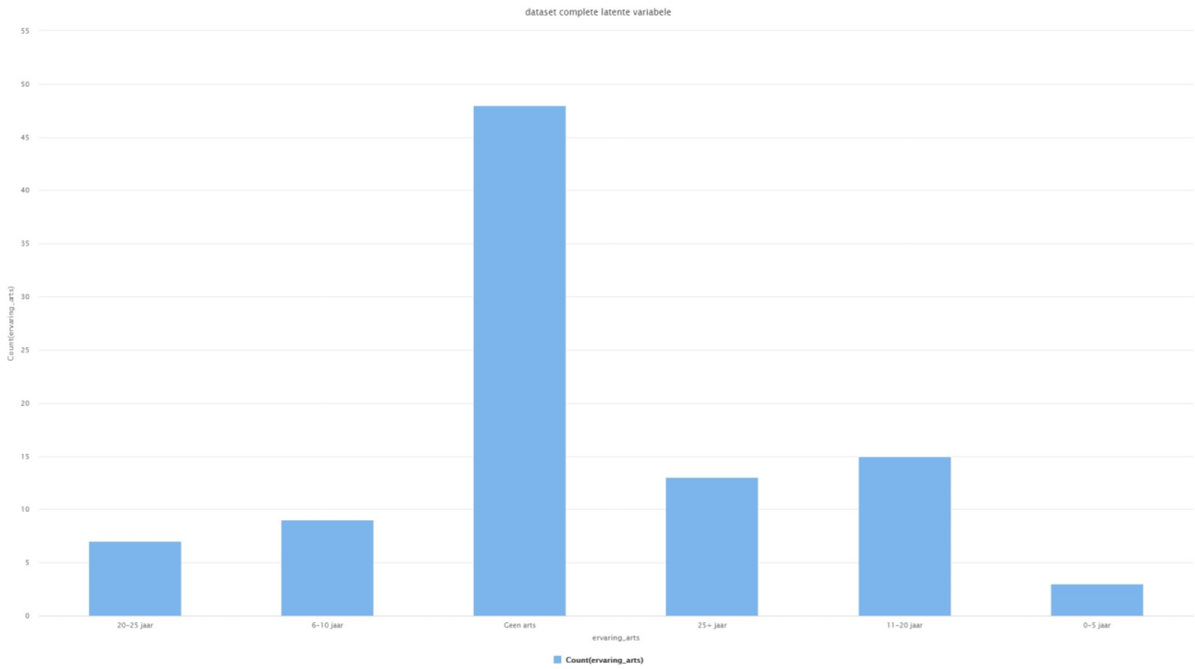

Figure 13: years experience as (medical) doctor

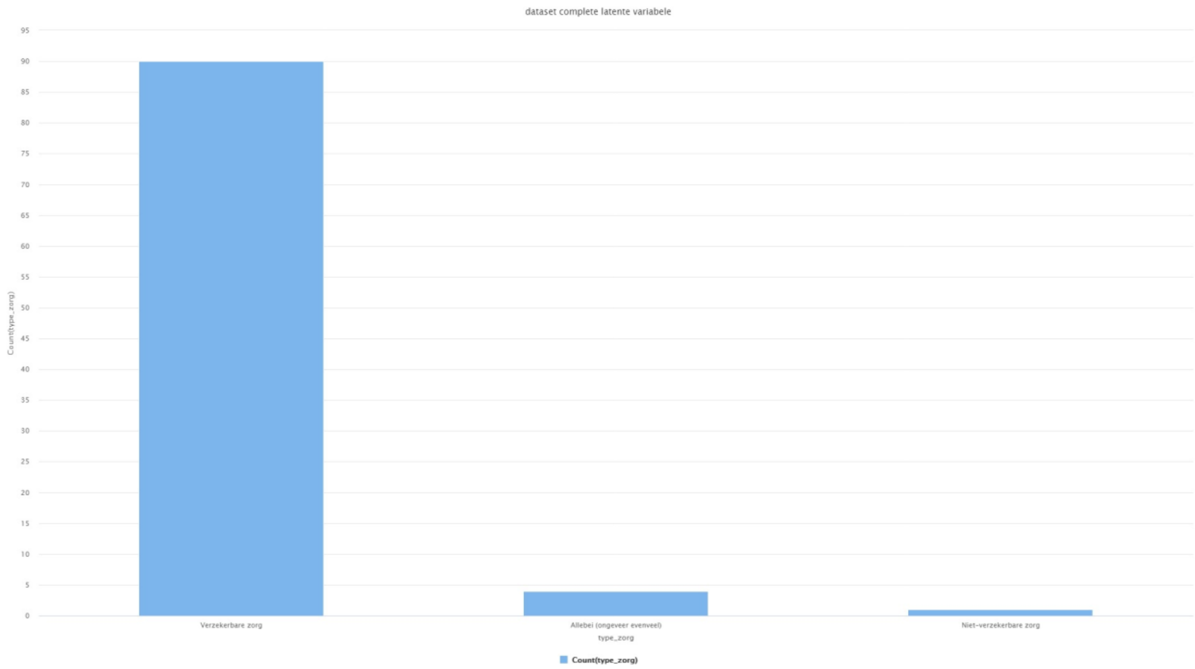

Figure 14: type of care

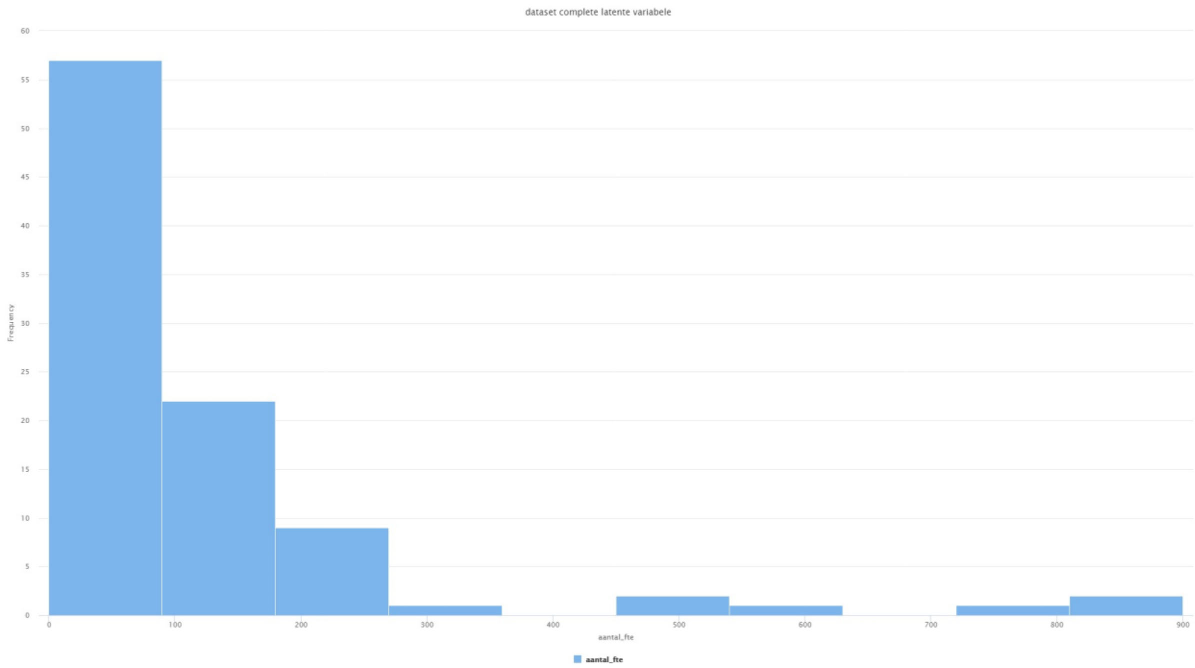

Figure 15: number of fte on department