MASTER'S THESIS

Rapid implementation of eHealth due to COVID-19

a retrospective implementation study

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Abstract

Background

The COVID-19 pandemic was the reason for unexpected changes in legislation and regulations, which meant that a large part of usual care could not be provided physically. There was great interest in eHealth to keep offering daily care as much as possible. Several eHealth innovations were implemented in a short time in ZGT. By analysing this process of implementation retrospectively, insights can be gained on innovating with eHealth during a pandemic, and recommendations can be done to implement future technological innovations faster and more effectively.

Method

Based on a mixed-method study, two narratives were formed on two different technological innovations. This was done on three levels: the innovation determinants, the innovation process and the innovation strategy. The primary data consists of 20 semi-structured interviews with stakeholders together with the analysis of various secondary data. Using the *NASSS framework*, factors have been uncovered across the following domains: (1) condition, (2) technology, (3) value proposition, (4) adopters, (5) organisation, (6) wider context and (7) embedding and adaptation over time.

Results

The qualitative data show that hindering and facilitating factors influence the degree of use across all domains. The usage of both innovations have declined with the change in the value proposition after the lockdown ended. The domains of the technology, value proposition and adopters have shown to have had a negative influence on uptake and use. Due to rapid development and implementation, the value proposition is unclear, the technology is underdeveloped, and the user experiences are not optimal. Furthermore, the components of the strategies have been identified and found to be insufficiently attuned to complexities found. The implementation process was reconstructed by combining the insights gained from the semi-structured interviews with the secondary, quantitative data on the actual end-use.

Conclusion

It was found that the current degree of implementation is minimal for both eHealth innovations. Various factors that are likely to have had their influence on these implementation processes have been identified. Various complexities have complicated the fast and effective implementation of eHealth-supported care. In ZGT, adopters' widely supported sense of urgency due to COVID-19 has ensured that eHealth could be introduced more quickly. Innovators have been forced to become acquainted with the value that eHealth can bring to healthcare. However, under the influence of urgency, the value proposition is very uncertain. It is therefore unlikely that the accelerated introduction contributed to the continued use of these eHealth innovations. Complexities that are persistent and affect new implementation processes have been identified, and recommendations are made to develop a sustainable strategy for the further development of fast and effective eHealth-supported care in ZGT.

Preface

Before you lies the thesis ‘Rapid eHealth-supported innovation due to COVID-19: an implementation study’. I carried out the research at Hospital Group Twente (ZGT). This thesis was written as part of my graduation from the master's degree in Health Sciences at the University of Twente and commissioned by the Science Office of ZGT from February 2021 to July 2021.

A so-called science voucher was awarded for the internal research proposal, which allowed the start of the study “Success factors for rapid and effective implementation of eHealth during the COVID-19 pandemic: lessons for the future”. Nick Kramer, MSc., researcher at ZGT, has taken on this assignment. In that way, I was involved in part of that assignment via the University of Twente.

Before starting the master Health Sciences at the University of Twente, I earned a bachelor's degree in Nursing at Windesheim University of Applied Sciences. While I was finishing my bachelor, I was already busy taking the step to a master's degree because I realised early that my interest lies in promoting health at the macro-level instead of the micro-level. I also wanted to delve deeper into health care in a general sense, instead of just the nursing specialism (for example, nursing sciences).

The target group of this thesis are people working in the healthcare sector who are involved in technological innovations in one way or another. Initially, this thesis will be used to inform on a scientific research report and also to develop policy advice for ZGT. I will also contribute to this.

First of all, I would like to thank Nick Kramer for the guidance he has provided me with in writing this comprehensive research report. He has always been open to providing (and receiving) feedback, did not shy away from substantive discussions (and was only too happy to fuel them, too) and has also been my social support in the challenging and lonely COVID-19 time this thesis was written. This thesis was written almost entirely from home, supported by telephone contact and video calling.

Furthermore, I would like to thank dr. Pieter-Jan Klok, assistant professor to the department of Public Administration of the University of Twente, and prof. dr. Sabine Siesling, full professor to the department of Faculty of Behavioural, Management and Social Sciences of the University of Twente, for their constructive feedback and thinking along, which laid the foundation for the master's thesis as it is now before you.

Finally, I would like to thank my partner Dennis in particular. His wisdom, motivating words, unconditional support and feedback helped me to complete this thesis.

I wish you pleasant reading.

Bart Oosterink

Deventer, August 18, 2021

Contents

Abbreviation list

Term	Explanation
COVID-19	Coronavirus Disease 2019
DOI	Diffusion of innovation
DTC	Diagnose Treatment Combination
ER	Emergency Room
GP	General Practitioner
HiX	Healthcare Information eXchange: electronic patient file within ZGT
MIDI	Measurement Instrument Determinants of Innovations (Fleuren et al., 2014)
NASSS	Non-adoption, Abandonment, Scale-up, Spread and Sustainability (Greenhalgh et al., 2017)
WHO	World Health Organisation
WGBO	Wet op de Geneeskundige Behandelingsovereenkomst; Medical Treatment Act
ZGT	Ziekenhuisgroep Twente

1. Background

1.1 The pandemic and its consequences in healthcare

Since the February 27, 2020, the novel coronavirus SARS-CoV-2 has been roaming the entirety of the Netherlands. Drastic changes in legislation and regulations have been made and were expected to aid in the non-transmission of the virus, including a nationwide lockdown limiting travel moments and interpersonal contact to a bare minimum. These drastic changes to legislation have had severe consequences on public healthcare in the Netherlands. Dinmohamed et al. (2020) recently commented on this, describing that many hospital based-resources are being allocated to the care of patients diagnosed with COVID-19. This changed allocation of resources led to reduced access to usual health care for the overall public, causing postponed or delayed care in hospitals for acute, non-COVID-19 care. A decline in referrals was observed from both GPs and preventive national screening programs (Dinmohamed et al., 2020; Filipe et al., 2020). For patients, barriers might have been experienced in consulting their general practitioner - resulting in postponed care. These barriers may include the assumption of less capacity for non-COVID-19-related healthcare or hesitation to visit the general practitioner or a hospital in fear of getting infected with COVID-19 (Dinmohamed et al., 2020). The pandemic meant that priorities in healthcare had to be set differently and that daily care had to be organised differently.

The drastic changes to regulation and the fear of getting infected increased the need for alternative ways to deliver the usual health care, such as providing health care remotely through digital solutions to aid in diagnostics, treatment, and follow-up. The added value of eHealth has already been proven. Neubeck et al. (2020) argued the added value of remote healthcare, or eHealth, in a quarantine situation, as a means to mitigate the effects of quarantine and adverse impact on mental and physical well-being. The implementation of eHealth does, however, not often go hassle-free, which is striking. Health care innovations have been known to take a long time to disseminate into the daily care within an organisation, or among organisations, due to an implementation process being very complex (Berwick, 2003). Diffusion of innovations may sometimes even take over fourteen years to diffuse well (Dearing & Cox, 2018).

eHealth is considered a general term for different related concepts, such as telehealth, telemedicine, mHealth and telematics (Otto et al., 2018). eHealth can take different roles in care; this study focuses on eHealth that aid in diagnostics, treatment and follow-up. The definition of eHealth, as referred to in this paper, is the developed definition of Van Lettow et al. (2019) (Nictiz), who have recently described eHealth as: “eHealth is the innovation of both digital information and communication to support and/or improve health and healthcare”. Nictiz is the Dutch national independent knowledge organisation committed to digital information exchange in healthcare, of which its activities are financed by the Ministry of Health, Welfare and Sport.

We are currently witnessing a phenomenon whereby the outbreak of COVID-19 is hastening managers, ICT staff, clinicians and patients to overcome barriers for implementation of eHealth overnight. It is not yet known what this entails for the implementation of innovations. Therefore, it is crucial to study the facilitating and impeding factors of the implementations as they have taken place during the COVID-19 pandemic to enable faster and more effective implementation of eHealth in the future. This study focuses on implementation processes in the two locations of Ziekenhuisgroep Twente (ZGT). In their multi-year vision, mission and policy statement, ZGT describes value-based care as their central vision wherein technological innovation is one of the four building blocks (ZGT, n.d.). ZGT would like to learn from past implementation efforts to enable more effective implementation of future innovations.

1.2 *ZGT Traumachirurgie-app* and *FysioThuis*

In ZGT, several eHealth innovations were introduced during the pandemic to aid in or temporarily even replace usual healthcare. That is including two eHealth apps for physiotherapeutic rehabilitation at home, both of which are central to this thesis. These are *ZGT Traumachirurgie-app* and *FysioThuis*. In both cases, it is either unclear how the innovations have been received. It is now interesting to investigate which factors have influenced the implementation process and what can be learned from such a particular time.

The *ZGT Traumachirurgie-app* is a mobile phone innovation developed by the traumatology department in close collaboration with an innovation department and an external developer. It allows the patient to look up relevant leaflets and physiotherapeutic exercises accompanied by tutorial videos and background information. It was intended to support patients with fractures in the large joints in their physiotherapeutic care during the lockdown after visiting the emergency room. The reason was that primary care physiotherapists had to temporarily close their doors due to temporary changes in regulation due to the COVID-19 pandemic. The innovation was introduced in March 2020. At the time of the lockdown, it served as a temporary replacement for therapy. However, the value proposition has changed – the innovation currently serves as a replacement for the leaflets usually handed out at the emergency room. This means that the innovation is no longer an entire replacement of care but rather an addition to usual care. The *ZGT Traumachirurgie-app* is a rushed version of the *#ENKEL-app* that had been in development for several years, originally exclusively built for patients with ankle fractures. The *ZGT Traumachirurgie-app* has therefore replaced the *#ENKEL-app* and was quickly extended to serve a broader patient population.

FysioThuis is a web-based innovation taken into use by the physiotherapy department of ZGT. It was developed by an external developer for the physiotherapeutic rehabilitation of patients discharged after hospitalisation for COVID-19. It was introduced in April 2020. The patients recovering from COVID-19 are a rapidly growing patient population, which put the available staffing of healthcare professionals under pressure. *FysioThuis* features a personalised environment for every patient, in which the physiotherapist can prescribe exercises based on the personal rehabilitation process. This innovation was also built on the *Telerevalidatie* framework. The *Smartup Innovation* department of ZGT recently initiated an exploration process to see whether the innovation could be used in other patient categories. The main difference with the former innovation is that *FysioThuis* requires interaction between healthcare professionals and patients. The development of *FysioThuis* was rushed due to the necessity and high pressure. A similar, stagnated project was abandoned to free up resources for its development.

1.3 Research aim and research questions

This study was performed to analyse the implementation process of two eHealth interventions in a general hospital and gain insight into what we can learn from implementing technological supported healthcare innovations in times of a pandemic in ZGT. The results are expected to aid future eHealth implementations for this organisation by ex-post indicating complexities in the implementation process. Uncovering this information is likely to aid in further implementation (Haider & Kreps, 2004). Based on this analysis, recommendations are made on how the insights could aid in future eHealth implementation efforts. These insights will eventually inform on a policy advisory report that will be developed later.

The main research question is as follows:

What insights on healthcare innovation can we derive from eHealth-supported change in health care delivery at ZGT during the COVID-19 pandemic, and what recommendations can be made to develop a sustainable strategy for the (further) development of fast and effective eHealth-supported care?

To answer this question, the following sub-questions are formulated:

1. What facilitating and impeding factors at the level of the eHealth innovations, users, organisation and socio-political context can be identified that have played a role in the implementation of eHealth during the COVID-19 pandemic?
2. What strategy was used in the implementation of eHealth in ZGT during the COVID-19 pandemic?
3. To what extent were the eHealth innovations implemented into the daily care of ZGT during the COVID-19 pandemic?

In the next chapter, the theoretical framework behind the study its approach is explained. In chapter 3, the methodological approach is described. In chapter 4, the results are shown. In chapter 5, the results are discussed, and in chapter 6, a conclusion is drawn. Chapter 7 shows the bibliography, followed by various appendices.

2. Theoretical framework

In this chapter, definitions and theoretical concepts that form the rationale of the approach to this study are elaborated on and discussed. It is discussed what an implementation process implies and what the components of one are. At the end of the chapter, a summary is given about which concepts are used in this study.

2.1 Implementation

The literature on implementation strategies has been characterised as a 'Tower of Babel' due to a high variation in terminology and description of concepts, making identification and usage difficult for researchers (Powell et al., 2012; Grol & Wensing, 2017-b, p. 9). In the implementation of innovations, as Goossens et al. (2011) described, it is important to implement improvements step by step in a planned and systematic manner to achieve optimal implementation of quality improvement. In this study, we use the definition of Zorg Onderzoek Nederland (ZON) as they described implementation in 1997 as: "*a process-based and systematic introduction of renewal and/or improvements (of proven value) with the aim that these are given a structural place in (professional) practise, in the functioning of the organisation(s) or in the structure of healthcare*" (Grol & Wensing, 2017-b, p. 9-10). There are various underlying assumptions to this definition. Firstly, it is assumed that process-based and planned implementation is inherent to innovation. Herein lies the suggestion that innovation needs a strategy, anticipating various determinants, to accomplish change. Secondly, it concerns innovations or improvements that are considered newer, better than or different from the golden standard. Thirdly, innovation gains a structural place in professional practice and fourthly, innovations can occur at different levels within an organisation or a specific context. Therefore, 'implementation' is much more than just putting an innovation to use.

Innovations are a complex phenomenon since many factors appear to play a role in the implementation process of innovation. How an innovator deals with those factors most definitely defines the success or failure of an innovation. For example, in a qualitative study, Van der Cingel et al. (2021) have shown that nurses are not primarily inclined to suggest eHealth interventions to clients due to complexity in implementation, and there is no room for experimenting in day-to-day care. Nurses fear eHealth hinders patient-centred care, even though eHealth interventions might aid patient empowerment and personal contact between patients and practitioners. Van der Cingel et al. (2021) state that nurses' beliefs are very determinant in implementing innovations. This is merely an example - in reality, the success or failure of the innovation process is dependent on many factors, which potentially differ for each context.

2.2 Approaches to implementation

Divergent approaches to the implementation of healthcare innovations exist, wherein roughly two contrasting approaches can be distinguished: the *rational approach* and the *participation approach* (Grol & Wensing, 2017-b, p. 10).

The *rational approach* is characterised by a top-down approach and is mainly driven by the available supply of technology. There is a clear starting point for implementation, and an external party usually controls it. The implementation process is relatively linear, and there is often a positive attitude towards innovation. A critical note to this approach is that it does not consider that there may be a diversity of needs in adopters. Therefore the innovation may not fit every other department within the same hospital, for example.

The *participation approach*, however, does take this into account. It is characterised by a bottom-up approach and is mainly driven by demand or need for technology, often controlled by professional practice. The starting point for implementation is often unclear and can be described as an incremental approach. The attitude towards innovation is often neutral due to the need for innovating lying in technological needs, instead of innovating just 'to be innovative'. A critical note to this approach is that an optimal (evidence-based) method is not always introduced because macro processes or structural factors that influence the implementation are not considered. Therefore there is a probability that

suboptimal or inferior technology is introduced. Grol & Wensing (2017-b) summarised both approaches, which can be found in Table 1.

Table 1

Summary of the Rational Versus the Participation Approach to Innovation (Grol & Wensing, 2017-b, p. 11)

Rational approach	**Participation approach**
Controlled by external party	Controlled by professional practice
Implementation is linear	Implementation is incremental
Clear starting point for implementation	Unclear starting point for implementation
Driven by a supply of technology	Driven by technological needs
Often positive attitude towards innovation	Neutral attitude towards innovation
No attention to diversity of needs in practice	No attention to the influence of macro processes, chance of implementation of suboptimal technologies

2.2.1 *NASSS framework*

Nowadays, both approaches are incorporated into frameworks intended to conduct implementation studies to prepare or evaluate an implementation effort. The only current framework that has combined both the strong and weak points of the rational approach and the participation approach is the *NASSS framework* (Greenhalgh et al., 2017). The main focus of the *NASSS framework* is the study of healthcare technology implementation. It does this by addressing challenges to implementations at micro-level (individual users of the technology), meso-level (organisational processes and systems) and macro-level (policy, legislation and wider context) in the scale-up, spread and sustainability of technology-supported change efforts in health and social care.

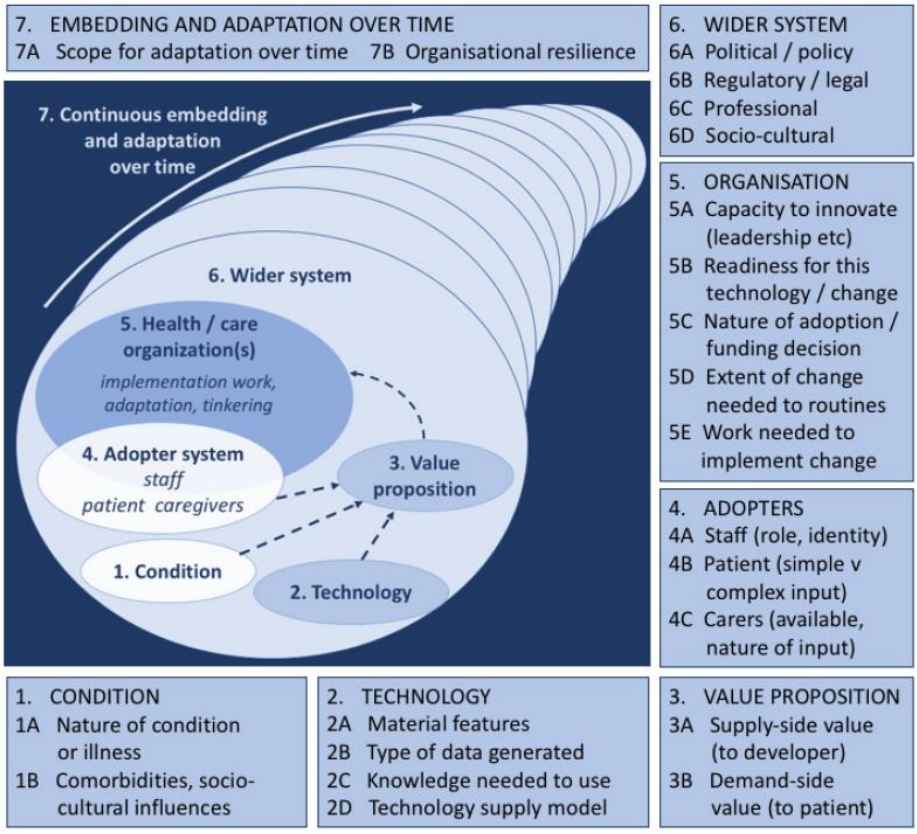
Greenhalgh et al. (2017) propose the exploration of seven broad domains in which complexity may lie. Its flexible approach characterises the framework – it is merely an indication of relevant themes. Identifying the complexities and interdependencies in and among the different domains within an innovation context can aid in overcoming those barriers for (better) embedding and adaptation over time (Greenhalgh et al., 2019). These seven domains are (1) condition, (2) technology, (3) value proposition, (4) adopters, (5) healthcare organisation, (6) wider system and (7) embedding and adaption over time (Figure 1). These seven domains may be classified as complex when dynamic, unpredictable or not easily disaggregated into constituent components. When domains are found to hold complexity, the chances of the implementation effort succeeding are limited, and effort should be made to reduce complexity as much as possible.

In the domain of the condition, the target group of the technology and relevant disease-related factors that could have influenced the degree of implementation are examined. Complexity within this domain may occur when the condition is unstable or poorly described or understood. The technology domain looks at the technology itself and its characteristics to determine to what extent these could have influenced the degree of implementation. Complexity may occur in the knowledge needed to use the technology, properties of the material, or the technology's functionality. Concerning the domain of the value proposition, the expected and real added value at the micro, meso and macro-level are considered to what extent these could have influenced the degree of implementation. Complexity may occur if there are difficulties in formulating a plausible business case, patients may not want or need the technology if it is (possibly) unsafe or unaffordable. In the fourth domain, (intended) adopters, the characteristics of this group could have influenced the degree of implementation. Complexity may occur in the knowledge or skills the user needs to use the technology or when roles and practices assumed by the technology

threaten deeply held values or norms. Other reasons for complexity in the domain of the adopters may be that the technology shows to be a threat to people's jobs, exceed their scope of practice or when a network of lay carers is assumed for patients to be supported in using the technology. The organisation domain looks at which organisation-related factors could have influenced the degree of implementation. Complexity may occur in the general capacity of the organisation to innovate, how easy the funding is or the organisations' readiness for a particular technology. The wider system domain examines which developments in the wider system could have influenced the degree of implementation. Complexity may occur in negative perceptions of the technology or barriers policymakers may come across. The last domain is embedding and adaptation over time. This domain examines to what extent expectations about the adaption over time could influence the implementation. Complexity may occur in the technology's lack of potential to adapt to changing contexts.

Figure 1

The NASSS framework (Greenhalgh et al., 2017)



Greenhalgh et al. (2017) argue that the possible success of an implementation is determined by a dynamic interaction between individual factors rather than simply adding up all the individual factors themselves. So, there is a cohesion between complexity in and among the seven domains and the likelihood that an innovation is successfully adopted, scaled up, spread and sustained. This means that implementation should be regarded as holistic, thus seeing all factors as a whole since they are inextricably connected. The *NASSS framework* is therefore not intended to be used in a formulaic way. The *NASSS framework* also assumes that it is not interesting to see *whether* an innovation works, but rather *why* innovation does or does not work.

2.2.2 Retrospective theorisation using the NASSS framework

The framework was initially developed to inform on the preparation of an implementation effort rather than a retrospective analysis. However, Abimbola et al. (2019) have studied an ex-post or retrospective theorisation of technology-supported change in healthcare. A thematic analysis of previous publications on a particular innovation was undertaken to explain varied and partial uptake of an eHealth innovation

retrospectively. It was demonstrated how the *NASSS framework* can be used to construct a rich ex-post narrative of a technology-supported change effort to identify various complexities that, at the one hand, can explain interacting influences that can help explain its success, failure or unexpected events, and at the other hand, lay out factors that need to be managed to make a change effort more likely to succeed (Abimbola et al., 2019). The limitations of using the *NASSS framework* for ex-post analysis are not different to undertaking any other retrospective research. To aid researchers and innovators in using the *NASSS framework*, the authors also have developed an adjacent-to-valid instrument, the NASSS-CAT, as a practical tool to understand, guide, monitor and research technology projects in health care (Greenhalgh et al., 2020). The NASSS-CAT was used to inform on the development of semi-structured interviews for this thesis and structure this study's results-section.

2.2.3 Conclusion

In conclusion, the strength of the *NASSS framework* lies in that it fills the knowledge gap in retrospectively addressing non-adoption and abandonment of technological innovations, and identifying the challenges associated with scaling up innovation, spreading innovation to new settings, and maintaining the change through adaptation to the specific context (Greenhalgh et al., 2017). The *NASSS framework* is a helpful fitting framework for the retrospective theorisation of technological innovations that it owes to its abstract approach. Therefore, the *NASSS framework* seems suitable for this study and is used to answer sub-question one.

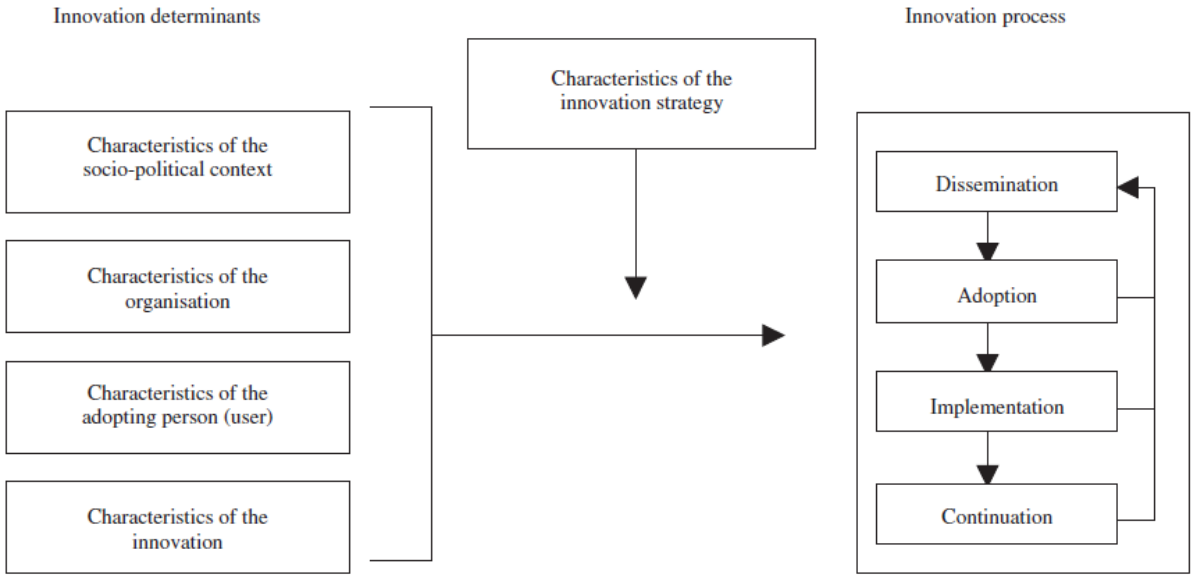
2.3 The components of an implementation process

Although helpful in identifying promoting and hindering factors in innovation determinants, the *NASSS framework* does not sufficiently consider the moderating effect of the innovation strategy on the relationship between the determinants/domains and the overall innovation process. This is why this paragraph discusses a framework that can be seen as a blueprint for an overall implementation process.

In addition to the *NASSS framework*, Fleuren et al. (2004) acknowledge the influence of the innovation strategy on the relationship between the determinants and the overall innovation process. Fleuren et al. (2004) have developed a clear schematic representation of the entire implementation process (Figure 2). Fleuren et al. (2002) and Fleuren et al. (2004) have also researched innovation determinants and divided all of what they found into four groups or determinants: characteristics of the socio-political context (e.g. legislation), characteristics of the organisation (e.g. staff turnover and financial resources), characteristics of the adopting person (user) (e.g. knowledge and self-efficacy) and characteristics of the innovation (e.g. complexity and clear procedures). Ten years later, Fleuren et al. (2014) published the *Measurement Instrument Determinants of Innovations* (MIDI), identifying 29 potentially relevant factors for innovations to aid researchers in their implementation studies. However, the MIDI framework by Fleuren et al. (2014) is not intended for use in more technology-based innovation implementations. Above all, the framework has not been used for the retrospective theorisation of an implementation effort before. Therefore, it is enriching to combine the determinants of the *NASSS framework* with the theory that proves the influence of the innovation strategy on the relation between the determinants and the process. Paragraph 2.5.1 discusses the innovation strategy part and paragraph 2.5.2 discusses (the stages of) the innovation process.

Figure 2

Framework Representing the Implementation Process (Fleuren et al., 2004)



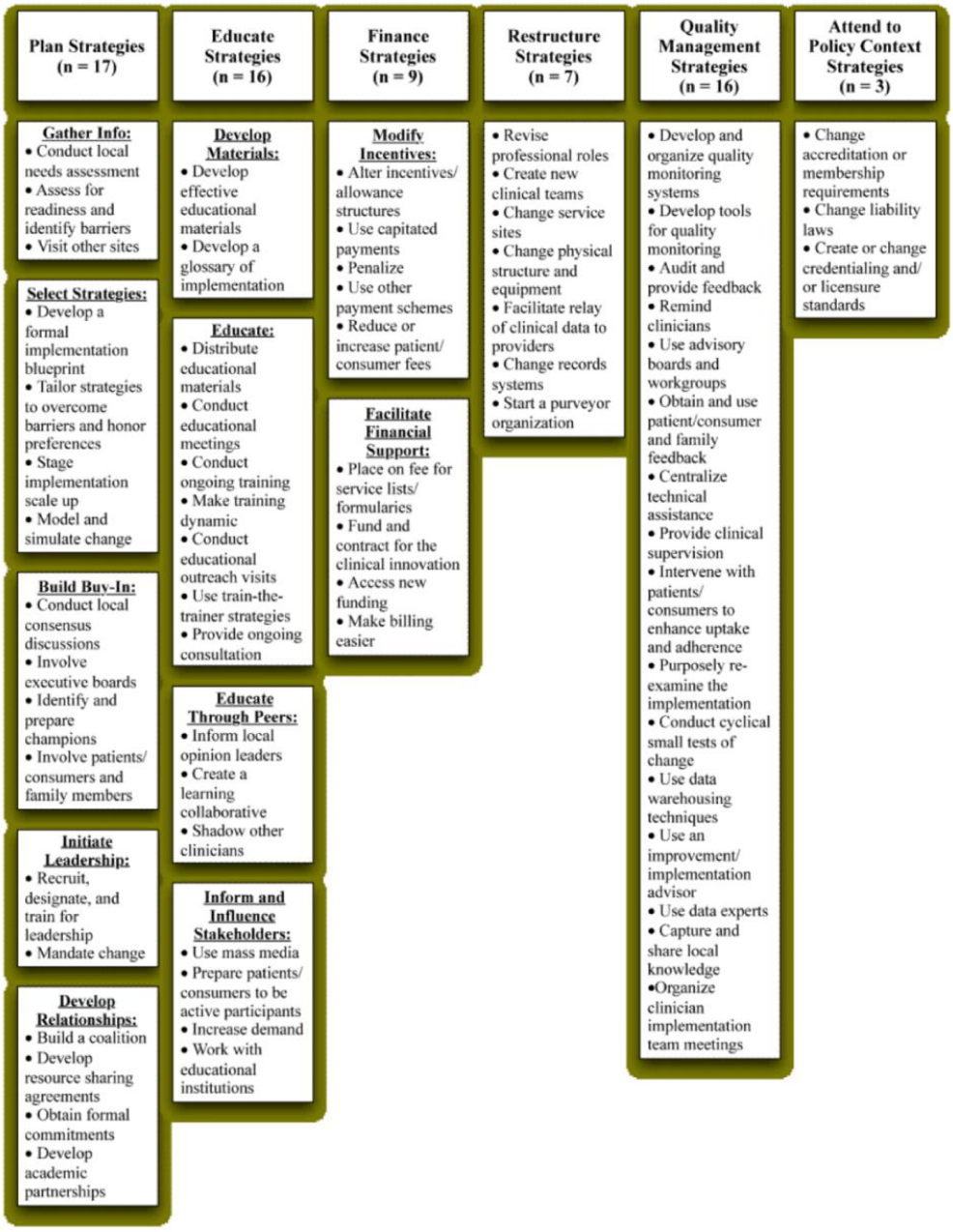
2.3.1 Innovation strategy

To answer sub-question two, the innovation strategy needs to be examined. The crucial role of an innovation strategy has been thoroughly argued in literature and influences the relationship between innovation determinants and innovation process (Fleuren et al., 2004; Goossens et al., 2011; Proctor et al., 2013; Grol & Wensing, 2017-a). Innovation strategies for use in public health have been under study since the early 2000s and are now recognised as necessary for realising the possible benefits of evidence-based care (Proctor et al., 2013). They influence the relation between the innovation's determinants and the overall innovation process (Fleuren et al., 2004). Innovation strategies can be single component strategies, often referred to as innovation interventions, as well as multifaceted and consisting of multiple interventions, often referred to as implementation programs (Powell et al., 2012; Proctor et al., 2013). In this study, both are referred to as innovation strategies - a single component innovation strategy might sometimes be enough to count as a strategy.

Regarding the aforementioned Babylonian 'confusion of tongues', Proctor et al. (2012) made a brave effort to resolve this and presented a consolidated compilation of innovation strategies based on a thorough literature review. Sixty-eight innovation strategies and definitions are grouped in six subjects: planning, educating, financing, restructuring, managing quality and attending to policy context. This summary will be used to retrospectively identify individual components of the innovation strategy (Figure 3).

Figure 3

Domains of Innovation Strategies (Proctor et al., 2012)



Additionally, Proctor et al. (2013) describe challenges in specifying and reporting innovation strategies and made recommendations to improve that. They propose guidance to measuring innovation strategies in three consecutive steps: naming, defining, and operationalising them in terms of seven dimensions: the actor, the action, action targets, temporality, dose, implementation outcomes and theoretical justification. These dimensions are operationalised in Table 2. A combination of the paper by Proctor et al. (2012) and Proctor et al. (2013) can help us in our attempt to conduct a retrospective analysis of an implementation attempt, and specifically in naming, defining and specifying the innovation strategy used in universal terms. These prerequisites can inform on in building a data collection instrument to retrospectively identify different components of the innovation strategy. This interview instrument can be found in Appendix A.

Table 2

Prerequisites to Measuring Innovation Strategies (Proctor et al., 2013)

Prerequisites	Requirements
1) Name it	Name the strategy, preferably using language that is consistent with existing literature
2) Define it	Define the innovation strategy and any discrete components operationally
3) Specify it	It is split up into a) actors, b) action, c) action target, d) temporality, e) dose, f) implementation outcome affected, and g) justification.
a) The actor	Identify who enacts the strategy.
b) The action	Use active verb statements to specify the specific actions, steps, or processes that need to be enacted.
c) Action target	Specify targets according to conceptual models of implementation. Identify the unit of analysis for measuring implementation outcomes.
d) Temporality	Specify when the strategy is used.
e) Dose	Specify the dosage of the innovation strategy.
f) Implementation outcome affected	Identify and measure the implementation outcome(s) likely to be affected by each strategy.
g) Justification	Provide empirical, theoretical, or pragmatic justification for the choice of the innovation strategies.

Apart from merely defining the innovation strategy, there is no way to determine the *fit*. A measurement instrument does not exist. In other words: measuring whether a strategy is the right one, given the determinants, is not possible. If a strategy can hardly be described, then the assumption is made that the strategy does not fit.

2.3.2 Innovation process

To answer sub-question three, the innovation process and stage of implementation need to be examined. Fleuren et al. (2004) developed a framework representing the main phases in innovation processes based on several theories. The dissemination phase describes the spread of an innovation. In the adoption phase, individual users familiarise themselves with the innovation and decide about their intention to innovate. In the implementation phase, the innovation is put into daily professional practice. In the continuation phase, the innovation has found its permanent place in daily practice. These phases can be seen as points at which the desired change may or may not occur. Combining the existing determinants with the chosen innovation strategy affects whether the transition is successful or not.

2.4 Summary

In summary, the *NASSS framework* by Greenhalgh et al. (2017) was used to retrospectively and systematically assess the innovation determinants of two eHealth innovations implemented in ZGT during the COVID-19 pandemic. Due to various reasons, this framework was combined with the theory of Fleuren et al. (2004), who describe the influence of an innovation strategy on the relationship between determinants and the process. The overview given by Proctor et al. (2012) on different innovation strategies was used to study and describe the innovation strategy components retrospectively. The theory on recommendations for reporting innovation strategies by Proctor et al. (2013) informed a data collection method to measure the strategies used. Then, based on the quantitative data combined with the qualitative data that informs on the innovation strategy, it was suggested which phase of the implementation process the innovations were in at the time of the assessment. Even then, it was not expected to be entirely possible to make a valid assumption on to what extent the innovations have become part of the daily routine of the healthcare professional.

3. Method

This chapter discusses the methodology behind the reconstruction of the implementation process of *ZGT Traumachirurgie-app* and *FysioThuis*. This was done by identifying the innovation determinants, the innovation strategy and the innovation process. The methodology behind the reconstruction of the implementation processes of the individual innovations does not differ in essence. However, the amount of data varies per innovation. First, the methodology behind the reconstruction of the determinants, the implementation strategy and the implementation process of both innovations are discussed. Then, the methodology is discussed in light of the differences between the innovations. In paragraph 3.5, all secondary data are discussed. Paragraph 3.6 elaborates on reliability, paragraph 3.7 on validity and paragraph 3.8 on ethical considerations within this study. Appendix J and Appendix K show a summary table summarising all available data and its use for the analysis.

3.1 Study type

This mixed-method study was conducted to retrospectively analyse the implementation process of two eHealth innovations adopted in ZGT. The research is of qualitative and quantitative nature. The analysis was done using both a primary and a secondary dataset. The study was targeted to gain an in-depth understanding of the specific context within which these eHealth innovations have been taken into use, and to identify the promoting and hindering innovation determinants, to reconstruct the innovation strategy and make an overall conclusion on where the innovation is, according to the stages of the innovation process.

3.2 Sub-question 1 – the innovation determinants

3.2.1 Primary data collection and analysis

Due to the explorative nature of this study, there was a need for a narrative on each of the implementation processes of the eHealth innovations under study. This was also what the authors of the *NASSS framework* intend it to be used for: not to study *whether* an innovation works, but rather *why* it does or does not work. For this, a qualitative study is needed. The primary data used in answering this sub-question consists of 20 ex-post semi-structured interviews with all stakeholders involved (see Table 3). Originally, 22 interviews were planned however two stakeholders dropped out due to time constraints. Stakeholders included organisational stakeholders and healthcare professionals and were to be approached based on their roles within the organisational hierarchy of ZGT and their involvement in the implementation process. Patients were not included in the primary data collection because this was not considered to be of added value to the analysis of these two specific innovations. Patient experiences were included in secondary data analysis, however.

The determinants of the *NASSS framework* were individually measured to identify complexity in and amongst domains. All stakeholders identified were interviewed on specific innovation determinants. For each stakeholder, it was decided on what determinant(s) they were expected to be able to inform on (see Appendix J). The interview schedule for identifying and exploring the innovation determinants can be found in Appendix B. The interview schedule was made in collaboration with and verified by a researcher from ZGT.

Table 3

Summary of Primary Data Collection

eHealth innovation	Invited stakeholders	Dropped out	No. of interviews
ZGT Traumachirurgie-app	11	1	10
FysioThuis	11	1	10

Large amounts of data were collected by conducting semi-structured interviews. The process of data analysis of the interviews conducted concerned a deductive analysis based on the method of Van der Donk & Van Lanen (2019). Deductive coding was used in line with the theoretical framework to organise the results. The determinants of the *NASSS framework* were analysed individually through a narrative to identify complexity in and across domains. For the questions related to the determinants of the *NASSS framework*, the answers were coded according to the subject, followed by the determinant for which it is relevant. The coding was done using ATLAS.ti 9.

3.2.2 Secondary data collection and analysis

The secondary data used to answer sub-question one were secondary datasets consisting of patient questionnaire data on both innovations. These were used to additionally inform on the domains of technology, value proposition and intended adopters. See paragraphs 3.5.1 and 3.5.4.

The qualitative data on *FysioThuis* did not sufficiently inform on relevant disease-related factors. Therefore, a quantitative data analysis was performed on the hospital patient dataset on *FysioThuis*. After all, several disease-related factors remained underexposed in the qualitative research. It was expected that secondary, quantitative, hospital patient data supports identifying disease-related factors that play a role in advising or continuing to use the innovation. Only for the analysis on *FysioThuis* descriptive statistics were used to inform on the domain of the condition. This was done using data-analysis methods logistic regression analysis and correlation analysis to identify factors that may or may not be significant in predicting actual usage. See paragraph 3.5.5 for information on the dataset. The secondary data were analysed using Rstudio 1.3.1073.

A summary of all available data to answer sub-question one can be found in Table 4.

Table 4

Summary of Available Data on the Innovation Determinants

eHealth innovation	Primary data	Secondary data
ZGT Traumachirurgie-app	Semi-structured interviews with ten stakeholders	Patient questionnaire data
FysioThuis	Semi-structured interviews with ten stakeholders	Patient questionnaire data, hospital patient data

3.3 Sub-question 2 – the innovation strategy

3.3.1 Primary data collection and analysis

With the ex-post semi-structured interviews, together with four additional ex-post semi-structured interviews with stakeholders expected to inform on the innovation strategy, the innovation strategy was reconstructed (see Table 5). The recommendations done by Proctor et al. (2013) guided the individual

identification of all prerequisites of the innovation strategy. These were used to measure the characteristics of the innovation strategy to analyse its effect on the implementation process. The interview schedule for exploring the innovation strategy, informed by Proctor et al. (2013), can be found in Appendix A. The interview schedule was also made in collaboration with and verified by a researcher from ZGT.

3.3.2 Secondary data collection and analysis

Secondary data, consisting of a project strategy document for *FysioThuis*, were used to further inform on the narrative of the innovation strategy used with that innovation, and to what extent it deviated from the original plans. Similar data that can inform on the analysis of *ZGT Traumachirurgie-app* does not exist. Aspects of the innovation strategy used were coded in the document according to the prerequisites as proposed by Proctor et al. (2013). With the help of this coding frame, it was expected to be easier to represent the narrative in the results and do justice to the analysis within the structured analysis framework.

A summary of all available data to answer sub-question two can be found in Table 5.

Table 5

Summary of Available Data on the Innovation Strategy

eHealth innovation	Primary data	Secondary data
ZGT Traumachirurgie-app	Semi-structured interviews with four organisational stakeholders	-
FysioThuis	Semi-structured interviews with four organisational stakeholders	Project strategy document

3.4 Sub-question 3 – the innovation process

3.4.1 Primary data collection and analysis

The implementation process was reconstructed by questioning intended users about the extent to which they use the applications. The insights from the semi-structured interviews were also used to reconstruct to what extent the innovation is part of the work process of the intended users. This question can instead be considered an interim conclusion based on the insights gathered when examining the data on sub-questions one and two in combination with an analysis of secondary data.

3.4.2 Secondary data collection and analysis

The implementation process was reconstructed by combining the insights gained from the semi-structured interviews with the secondary data in the form of quantitative data on the actual end-use. The datasets of ZGT consisting of patient data regarding potential users of the innovations were requested from the business intelligence department of ZGT (see paragraphs 3.5.2 and 3.5.5). Datasets of *Telerevalidatie* consisting of user statistics regarding the actual users of both innovations were requested from the innovation manager (see paragraphs 3.5.3 and 3.5.6). For *ZGT Traumachirurgie-app*, the end usage is expressed in the *number of times the application has been downloaded*, the *number of times users have opened the application*, and the *number of times exercises/information have been consulted*. These data were then compared to the number of potential users: the number of patients with a traumatic bone fracture in (a) large joint(s) who visited the emergency room of ZGT from March 2020 to March 2021. For *FysioThuis*, the end use is expressed in *the number of patients who have been recommended to use FysioThuis* and the *number of patients who have used FysioThuis*. These data were then compared

to the number of potential users: the number of patients admitted to ZGT with COVID-19 from March 2020 to March 2021.

A summary of all available data to answer sub-question one can be found in Table 6.

Table 6

Summary of Available Data on the Innovation Determinants

eHealth innovation	Primary data	Secondary data
ZGT Traumachirurgie-app	-	Number of innovation downloads and (type of) use, number of potential users over time, number of actual users over time
FysioThuis	-	Number of patients recommended, number of potential users over time, number of actual users over time

3.5 Secondary quantitative data analysis

This paragraph describes the available secondary data in more detail. A summary of all available secondary data, and what it was used for, can be found in Appendix K.

3.5.1 *ZGT Traumachirurgie-app* patient questionnaire data

An online survey was conducted earlier among the *ZGT Traumachirurgie-app* users who have visited the emergency room between March 1, 2021, and April 1, 2021. The results were used to further inform the domains of the *NASSS framework*. The data consists of 9 rows of valid data, which was quantitatively analysed. The data consist of three patients with an elbow fracture, three patients with a shoulder fracture, two patients with an ankle fracture, and one with a knee fracture. This satisfaction survey is therefore by no means representative. The variables of the dataset are shown in Appendix C.

3.5.2 *ZGT Traumachirurgie-app* hospital patient data

The dataset consisted of 2,195 consultations that took place at the emergency room of ZGT in the period from March 2020 to March 2021. The variables of the dataset are shown in Appendix D. In total, 2,195 rows hold valid data. Consultations for which no DTC has been recorded are not included in the analysis. In some cases, a patient has made multiple visits to the emergency room. These cases were marked as duplicates, and only the most recent registration was kept in the dataset. After applying inclusion criteria, 1,876 cases remained. The inclusion criteria are the following:

- the consultation was completed, and
- the consultation took place at the emergency room of ZGT, and
- the consultation was not cancelled, and
- the appointment must contain an appointment code and patient number, and
- inclusion starts on March 1, 2020, and
- patients have visited the emergency room to treat the wrist, knee, hip, arm or ankle.

The description of the DTC is expressed in six values (ankle = 0, knee = 1, elbow = 2, wrist = 3, shoulder = 4). Regression analysis was not performed since it was not expected to be of added value. It was only informative to look at the potential number of users and compare that to the actual number of users of the innovation to inform on the implementation process.

3.5.3 *ZGT Traumachirurgie-app* application data

The quantitative data on actual innovation usage was requested from the developer, *Telerevalidatie*. The data consist of 1,150 rows of valid data. The data show the type of fracture the innovation was used for, the number and specification of leaflets consulted by patients, the number and specification of instructional videos consulted by patients, and the date of every action done in the innovation. The variables of the dataset are shown in Appendix E.

The following inclusion criteria were applied to the data to make a reliable estimate of the number of actual users of the innovation.

- A user can select only one condition; users who have selected multiple conditions, only the most recently selected condition is included, and
- user statistics related to consulting information are only counted when the number of times a user has consulted information spreads over more than one day. Only then it is assumed that the innovation has really been used, and
- user statistics related to consulting exercise videos are all included; however, if there are multiple inputs (e.g. a user watching more than one video), only the oldest seen video is included to not unnecessarily exclude patients, since … (see next point)
- the inclusion dates are March 1, 2020, to March 1, 2021.

When the above inclusion criteria are applied, there are 208 valid cases of application users who have consulted information and there are 187 valid cases of application users who have consulted exercise videos. Those numbers do not match, so this means that not all users have both consulted information and consulted exercise videos.

3.5.4 *FysioThuis* patient questionnaire data

An online survey had already been conducted earlier amongst users of *FysioThuis* that had used the innovation between March 1, 2021, and July 3, 2021. The results were used to further inform on the domains of the *NASSS framework*. The data consists of 12 rows of valid survey data. There are many missing inputs since respondents have not provided answers to all questions. Due to the qualitative basis of the survey, the answers were qualitatively coded according to the adopter's domain of the *NASSS framework* and relevant factors. The variables of the dataset are shown in Appendix F.

3.5.5 *FysioThuis* hospital patient data

A dataset was acquired consisting of 1,134 patients admitted to the hospital due to COVID-19, with 1,134 valid data rows. The data were not filtered to specific dates due to patients being admitted for multiple reasons, resulting in technical problems when exporting the data. The dataset variables are shown and explained in Appendix G. The variables *recommended, use, date_diff, date_diff_centered, age_centered* and *interactieterm_age_en_date_diff* were added to create a richer analysis and were derived from existing data. The variables *recommended* and *use* were coded according to what was interpreted from the open text field *open_field_FysioThuis*, which showed a healthcare professional's report. This was necessary because the original dataset did not contain a specific variable that could inform on the use of the innovation. The variable *interactieterm_age_en_date_diff* was created by multiplying the centered values of *age* and *date_diff*.

To complete the dataset, the following assumptions were made:

- If the patient file report does not contain any information on *FysioThuis*, then *recommended* and *use* are coded FALSE, and
- if the patient file report explicitly stated that a patient was eligible for the use of *FysioThuis* or was recommended to do so, then *recommended* is coded TRUE, and

- if the patient file report explicitly stated that a patient was included in the programme or an evaluation on use was done or planned, then *use* was coded TRUE, and
- if the patient file does not have a discharge date recorded, the number of days in the hospital equals 0.

3.5.6 *FysioThuis* application data

The quantitative data on innovation usage was requested from the developer, *Telerevalidatie*. This data frame shows the unique account identification numbers with their creation date, unsubscribe date and the date of last use. The data consists of 89 rows. The variables of the dataset are shown in Appendix H.

The following inclusion criteria have been applied to the data to make a reliable estimate of the number of actual users of the innovation.

- Each row must be a unique user, and
- the date of creation is not equal to or greater than March 1, 2021.

When the above inclusion criteria are applied, there are 82 valid cases of innovation users.

3.6 Reliability

To increase the reliability of the interviews, all interviews were recorded. A researcher from ZGT has been able to listen to the recordings of the interviews afterwards. This made it possible to check the correctness of the transcripts, discuss the interpretation, thereby adding to the quality of the interviews and thus the reliability of the measuring instrument.

Inter-rater reliability is accounted for by combining purposive sampling (Palinkas et al., 2013) of the stakeholders in combination with a stakeholder analysis in consultation with two researchers and one expert of ZGT. Transcribing was always intended to be done as soon as the interview was conducted to evaluate and reflect on the interview before the next interview. In this way, meaningful themes could also be recognised and discussed with a researcher from ZGT, and be accounted for in subsequent interviews if something showed to be an important aspect. Inter-rater reliability finds its place in the analysis by discussing the coding of unclear parts of the interview transcriptions. The coding of the secondary data was done individually by two researchers, and differences in codes were discussed until consensus was reached.

Due to the semi-structured interview questions being summarised in an interview manual in the appendices, the repeatability of the study is positively influenced. This increases the reliability of the measuring instrument.

3.7 Validity

Proctor et al. (2010) propose qualitative or semi-structured interviews as a measurement tool for implementation studies. Using semi-structured interviews, there is an opportunity for further questions, explanation of the questions and the observation of the non-verbal attitude of the interviewee so that the empirical situation can be clarified. Semi-structured interviews also have an added value since a literature review on the factors influencing successful implementation has already preceded. It has already become clear which themes are important and should be further explored. Due to the regulative measures to aid in the non-transmission of the new coronavirus, all data collection was done via online video-conferencing software if possible and ‘in person’ only if necessary.

Due to the lack of validated measurement instruments, semi-structured interviews have been developed for this study and conducted with stakeholders. The structure of the frameworks proposed by Greenhalgh et al. (2017), Greenhalgh et al. (2020) (NASSS-CAT) and Fleuren et al. (2014) (MIDI) are merely considered a guideline in the development of the interview schedules as used in this study, not as measurement instruments themselves.

Because the semi-structured interviews are focused on two specific cases of innovations, a trade-off took place between external and internal validity (Rol, 2017). The research aims to inform on an organisation-related issue, hence the importance of an internal valid instrument. This was at the expense of the external validity of the measuring instrument. Also, due to the specific context of ZGT, the results are not intended to be generalizable to a broader population (Rol, 2017).

The *NASSS framework* has not been formally validated for the Dutch context to date. In 2020, the University of Twente started developing the *NASSS framework* for the Dutch context. However - given the abstraction of the framework - validation for a particular context is not expected to be of added value, therefore substantiating why the *NASSS framework* is expected to be helpful in this study.

3.8 Ethical considerations

All methods discussed above have been approved by the ethics committee of BMS (department of the University of Twente) under request number 210665.

All participants of the semi-structured interviews were invited to participate by ZGT intern emailing and were handed over written information on what was expected. A copy of the invitational email to the respondents that created the *informed consent* can be found in Appendix I. The main subjects that respondents were interviewed on were shared with them in advance. All transcriptions of interviews were anonymised, respondent names were replaced by respondent numbers and put in a different order from which they were taken. The recordings were disposed of after transcription. The transcripts of the interviews will be kept within ZGT for five years. The use of citations in the paper cannot be traced back to a specific individual. Informal or unofficial responses were omitted from the transcriptions. All respondents had the opportunity to check the transcription for factual inaccuracies. If the respondent agreed or did not object by letter, the transcription was considered definitive and was used for data analysis. All of these measures were shared with the respondent before the interview. At the end of the interview, each respondent was asked permission for the researcher to contact them if any further questions would arise at a later stage. In total, three respondents requested minor adjustments to the interview transcripts, which did not influence the transcript's content.

4. Results

In this chapter, the results are discussed for each innovation.

4.1 *ZGT Traumachirurgie-app*

4.1.1 Innovation determinants

To answer the first sub-question, the determinants of the *NASSS framework* were analysed individually through a narrative to identify complexity in and between domains. The insights below are summarised in Table 16 (page 52) for easy comparison with the *FysioThuis* analysis.

Condition

Nature of the condition

A facilitating factor in this domain is that the nature of the condition is clearly defined and that the condition has a predictable treatment trajectory. The *ZGT Traumachirurgie-app* has been developed for patients with an elbow, ankle, knee, wrist or shoulder fracture. The target group cannot be specified to a specific age group ("This mainly concerns adult patients, from 18 to 70/80 years. The 80-year-old with osteoporosis naturally breaks something faster and may fall more often, but the younger ones practise more dangerous sports" – interview 08). The target group is "ambulatory patients" (interview 03) after being discharged from the emergency room. There is, however, a slight difficulty in the treatment of the disease: respondents indicate that not all bone fractures in the same joint are comparable ("You now measure all ankle fractures by the same yardstick, although there is still much difference" – interview 08). Each type of fracture may require a unique treatment. This factor could negatively affect the uptake of the innovation.

Co-existing illnesses or impairments

The second facilitating factor in this domain is that, in general, there is no co-morbidity related to the condition that could influence the ability to make use of the innovation.

Social or cultural factors

A third hindering factor in this domain is a social-cultural factor related to the specific patient group for which this technology was developed: age. This could have influenced the uptake of the innovation. The hip fracture, for example, seem to be much more prevalent in elderly people and therefore treatments targeting hip fractures were not included in the application. Respondents share concerns on the digital skills of elderly people and, therefore, the usefulness of the innovation ("elderly people, this group has the most doubts whether they will use the app" – interview 10). As a result, a conscious choice seems to have been made to limit the innovation to several conditions that do not necessarily have a higher prevalence among the elderly ("we do not yet have the hip in it, but when I see which group is suitable for this, I wonder if that will work" – interview 09). However, not everyone agrees that age determines the extent to which a patient is digitally proficient ("it just depends on how one stands in digital life" – interview 09).

Verdict: the condition does have slight complexity, which is likely to have negatively affected the project's success.

Technology

Material properties

The first facilitating factor in this domain is that there is little uncertainty about what the technology entails. The respondents describe the innovation as an innovation for the smartphone, consisting of leaflets with information and videos about physiotherapeutic exercises. The *ZGT Traumachirurgie-app* is an innovation that does not depend on anything else to work correctly. The use of the innovation does not require interaction between healthcare professionals and patients. The innovation is only used by patients. Respondents characterize the innovation as a simple technology ("If you look at the Trauma

App, you are dealing with something that you can easily deploy from that Trauma department. You do not need anyone else for that, from a care perspective" (…) "no primary care, a physiotherapist or other DTCs, nobody is bothered by that" – interview 01; "It is a basic app that fulfils a few things so that people can practice some themselves while they cannot go to a physiotherapist" – interview 07).

Supply model

Another promoting factor is no uncertainty in the supply chain due to how the innovation works. The innovation is developed by *Telerevalidatie* and built on their platform, but it is offered on a virtual innovation store from which the patient can download the innovation freely. Therefore the innovation is available anytime, anywhere. *Telerevalidatie* manages the innovation, and so adding and modifying the content has to be done by the developer ("if you need to change things in the structure, [*Telerevalidatie*] should do that" – interview 03).

Technology's performance and dependability

The innovation is, however, not part of ZGT's current digital infrastructure. There has been little to no contact between Telerehabilitation and the ICT department of ZGT. Healthcare providers and project staff have indicated that they see this as an obstacle to continued use because the link with their electronic patient record called *HiX* is missing. Therefore, the use of the innovation is seen as inefficient ("I believe that at some point you have to develop an app that is in line with HiX and that you should be able to send a leaflet or information to the patient from HiX, or an assignment, or a request for information and that you should eventually receive that back in HiX." – interview 08). By not offering a link to the electronic patient record, the innovation is not personalised ("not personalised at all, no chat function, no specific person-oriented functions of this kind" – written supplement to interview 07). As a result, the patient cannot be provided with relevant information at a particular stage of treatment. This could likely have negatively influenced the level of use.

Usability and acceptability

Another impeding factor is the uncertainty about the innovation's usability, which is related to the fact that the innovation is not personalised. Project staff and the developer have attempted to overcome the problem that each patient needs a different treatment by processing various information in the innovation. The problem now is that patients see all the available information, including the information not relevant to them. Use is thus made more difficult because patients are overloaded with information, which could have negatively influenced the level of use. In total, five of the nine patients surveyed started using the app. Of the latter group, two patients judged that they could find the correct information about their treatments. Of the five interviewed patients who started using the innovation, only one considered that the innovation was not easy to use.

Concerning usability, the opinions of the respondents are divided. Using the innovation is easy, as there is no need to log in. The app is "clear and not difficult to get into" (interview 07). However, the uptake could have been negatively influenced because the innovation is not yet fully developed. This is described as an impeding factor. A respondent says that the "structure of the exercises still needs improvement" (interview 03). This would be related to the technology used ("that is also the shortcoming of *Telerevalidatie*. You have to clearly state what you want and when you want what. But that is how it is built" – interview 09). There is no introduction process or built-in 'onboarding' (an onboarding is a part of an innovation that takes users by the hand when they first use the innovation and introduces it step by step). The fact that this is not available in the current innovation could hinder the uptake of the innovation ("it is not in there right now" – interview 05). The innovation developer indicates that no onboarding has been built in because, in the first instance, the assignment from ZGT was that the patient should be satisfied with a leaflet provided. However, this has never been tested or discussed with patients. One respondent indicated that this is necessary ("If we had to recreate the app again now, then you would have to do something like this onboarding. This is also because in the course of the all kinds of functions have been added over time" – interview 05). Therefore, it is evident that the innovation is not yet fully developed, which is likely to have hindered the implementation.

Patients with a weaker social network cannot fall back on technical support. This quote shows implied support of informal caregivers to patients who are less digitally skilled: “that app can also be read or supported by someone else” (…) “informal caregivers could also provide support” (interview 08). Healthcare professionals do not seem to ask the patient about this when offering the innovation.

Other barriers for the intended users could be low literacy or inability to read the Dutch language. The innovation does not seem to be prepared for that (“Of course you have people who are illiterate and cannot read the leaflet, or people of foreign origin who only speak Arabic, whom you could quickly throw a translation over with an app, for example. ” – interview 08). For people who can read, the language seems to be too complex (“Much too complicated. Not accessible” – interview 03; “There are still quite a few medical terms used in the innovation” (…) “the app is now also not screened for people who are low literate” – interview 05). The innovation has also been “not tested for colour blindness” (interview 05).

Technical interdependencies

Owning a smartphone and being able to use it are preconditions for using the innovation. It is unlikely that this precondition for use will have had a significant adverse effect on the implementation process (“if you can work with a smartphone, you should be able to use the app” – interview 05).

Requirement of organisational tasks and routines

A final promoting factor is that no significant organisational tasks and routines were required to use the innovation. The innovation is offered to the patient by the healthcare professional at the Emergency room through a leaflet. This leaflet with information on the innovation replaces the usual treatment brochures that were always given before. A slight adjustment in the work processes is implied, but it is not likely that this will affect the level of use of the innovation.

Verdict: the technology has significant complexity, which is likely to have negatively affected the project’s success.

Value proposition

Change of the value proposition

The value proposition of the *ZGT Traumachirurgie-app* has radically changed, prompted by the reopening of the physiotherapists in June 2020. At the time of the lockdown, which started in March 2020, the innovation served as a temporary total replacement of usual care because patients were “sub-optimally guided” (interview 07) due to the temporary closure of physiotherapists. Nowadays, the value proposition has changed, and the innovation now serves purely as a replacement for the leaflets that are usually given from the emergency room to the same patient group as additional information ("that is why I think you should see it as a kind of reference work, and together in combination with the physio who really sees the patients and treats them further” – interview 09). This means that the innovation is no longer a replacement for part of the care process but rather an addition. Thus, a limiting factor in this domain is that the demand-side value proposition is uncertain.

Value to the intended users

First, the value proposition to the intended users is somewhat uncertain. Concerning patients, respondents indicate that the value proposition mainly lies in its use as a reference work, providing supportive videos and providing patients with the correct information at the right time. However, it is debatable whether the latter goal is achieved because the innovation is not personalised. The innovation provides one possible filter: patients can enter the date of surgery, based on which the information offered in the innovation is filtered somewhat. Respondents indicate that the innovation is offered too general and is not patient-oriented. As a result, the innovation does not necessarily appear to be of added value in the treatment process, as a result of which it has been received differently by care providers. Healthcare professionals indicate that patients in principle receive the same care, regardless of whether they use the innovation or not (“If someone does not want to use the app and wants to go home, without already starting therapy, the patient is told what he or she can or cannot do.” – interview 09). However,

it was “never really studied” (interview 09) whether this supposed added value for the patient is correct. The experiences of the patients and effects on the treatments have never been measured (“this is an innovation that you offer your patients, and it yet has to prove its success” – interview 03; “you have to investigate that … is it also used?” – interview 07; "I do not know" - interview 09; "maybe people were more aware of the paper brochures instead of this app. I do not know, but I do not expect that." - interview 10). Healthcare professionals who offer the innovation to patients “do not hear experiences back because people do not come back to the emergency room” (interview 08).

For the healthcare professionals, the expected added value is the contribution to “sensible care” (interview 09) and working with “well-informed patients” (interview 03). Because they are now better informed, patients are enabled to make better choices for themselves in their treatment process ("Actually, if the patient reads that, he could choose either an operation or a plaster treatment. I feel that you can implement things like this very quickly, and it could be very supportive to the care process” – interview 08). In addition, by using the innovation, patients are enabled to “practice more independently” (interview 09). Healthcare professionals indicate that the innovation is also not considered more than a reference work (“Look, I was a bit afraid that they were going to replace physiotherapy. That is not possible” – interview 09). However, the added value of the innovation for the healthcare professional is experienced differently by every other respondent. Offering the innovation in the emergency room provides convenience for the healthcare professional (“Writing out exercises and handing them in takes time, of course. You have that less now” – interview 09; “In that I no longer have to carry so many different leaflets with me. The best thing I like is that I offer an app in which all information is offered, and that makes it much easier for me” – interview 10). A remark multiple respondents discuss is that the innovation is not complete in its information provision. As a result, leaflets are still given (“We also give leaflets, and we still combine it a bit” – interview 08; “People who are older than 50 are given a DEXA-scan to measure bone density and to see if there is osteoporosis. If so, it can be treated, but I do not know if that is also in the app. I do not think so. I am now handing out a separate leaflet" - interview 10) while "in principle, there are no leaflets more are given” (interview 09). However, healthcare professionals also indicate that the innovation has no added value for them because it is not suitable for them to support the treatment process (“you sometimes have outcome measures from patients: when were you able to walk when were you able to move fully with your ankle when was the pain under control, that would be nice things to add but that would also imply many privacy issues” – interview 08).

Value to the healthcare system

Secondly, the value to the healthcare system is uncertain. There is no clear business case, the innovation has not been studied for cost-effectiveness, and no market research has taken place. The health benefits of the innovation have not been investigated. This could have negatively influenced the implementation and could harm further implementation if not examined.

Value to the particular healthcare organisation

Thirdly, the value to the particular healthcare organisation, given the current situation, is uncertain. The added value for the organisation is mainly presented as “goodwill, PR, patient satisfaction” (interview 07), but the respondents always stated that this “has not been investigated” (interview 03). The innovation is described as a form of service. When asked whether and why it would be attractive for ZGT to continue investing in the innovation, the respondent’s answers are often that the innovation contributes to the innovative image of ZGT (“the use of these types of innovations contributes to our innovative image” – interview 03; "And as a hospital, you also want to innovate and you want to provide your patients well ... you cannot always express that in money, but you do want to have a certain appearance" – interview 07; “People also want to have their information digitally, so I think so” – interview 10). This means that innovation seems to have taken place without a clear business case being present (“I wonder whether it is of any value to the organisation really, apart from better advertising and properly publishing information that benefits the patient. It will yield nothing financially, yes maybe that the information is not printed anymore, but that does not outweigh the costs of the app” – interview 09). A healthcare professional indicates that the expectation was not that the innovation would yield

anything (“the manager said: you put so much time into it, is there something in return? And we get nothing from such an app in return apart from knowing that our name is mentioned” – interview 09).

Verdict: the value proposition has significant complexity, which is likely to have negatively affected the project’s success. Under the influence of the sense of urgency and the hastened implementation, a thorough investigation of the value proposition was skipped. Failure to properly investigate the value proposition, combined with not testing the innovation with the intended adopters, may have resulted in sub-optimal technology being implemented.

Adopters

Two groups of target users can be identified with this innovation that influences the degree of implementation: the healthcare professionals and the patients. In this section, healthcare professionals mean physician assistants, nurse specialists and physician assistants on the emergency room.

Patients

An impeding factor in this domain is uncertainty about whether patients will take over the innovation. It has been noticed that the care professionals of the emergency room do not seem to be well aware of the innovation's content. Because they are not kept informed by the project team, they are forced to view the innovation themselves (“I last did that half a year ago” (…) “I do provide it, but it is not the case that I look at what to do with it, I am not quite sure whether it is complete or not.” – interview 10). In addition, healthcare professionals also lack “knowledge” (interview 08) when deciding whether the innovation is suitable for a particular patient with a particular disease. One respondent indicated that the emergency room nurses are not (well) aware of the existence and content of the *ZGT Traumachirurgie-app*, which may have hindered its use (“Nurses are still very unfamiliar with it, I notice). They do not know it; they have not downloaded it, they do not know what it contains, there is still a lot to gain there” – interview 10). As a result, nurses do not discuss the innovation with a patient earlier in the care process: the patient is now informed of the innovation moments before discharge. The respondent indicates that it is due to “how that was implemented here” (interview 10). By not properly educating the patient, the degree of use may have been negatively influenced.

Another impeding factor is that the experiences and opinions of patients have not been taken into account in the development of the innovation (“We have the illusion that it is simple enough for the patient to deal with, but we have never checked that with the patient ” – interview 05). The *ZGT Traumachirurgie-app* is offered to patients at the emergency room, but the patient does not return to that department. This makes it difficult to see the results of usage of the innovation (“I have not evaluated anything with patients and do not see patients back at the outpatient clinic. I only hand it out, but I have no idea what the patient has done with it” – interview 08; “we do not always ask whether people are planning on using the app” – interview 09). The following contact between the healthcare professional and the patient occurs at the outpatient clinic, but there is only an informal question about experiences with the innovation. That is why it might be interesting to look at the results of the survey. Of the surveyed patients, two patients have not downloaded the innovation, although the healthcare provider has recommended them to do so. Of the five patients who used the innovation, three patients judged that the innovation has contributed to the recovery. The patients in question judge that “the app is not user-friendly and is very unclear and not usefully designed” (written interview patient 1) and that “[I] would certainly not recommend the app to others” (written interview patient 2). A patient also indicates that he has only used an instructional video once. One week after the visit to the emergency room, the patient deleted the innovation from their smartphone (written interview patient 1). Another patient stated that “the app is even more cluttered than ordinary leaflets” (written interview patient 2).

Front-line staff

A contributing factor is that there is little uncertainty about whether healthcare professionals will adopt the innovation. The subjective norm that seems to apply among healthcare professionals is that the app is “a nice addition to the trauma” (interview 08). It is noted that healthcare professionals working in the emergency room are “satisfied” (interview 09) and “enthusiastic” (010) about the innovation. There does not seem to be a descriptive standard for the use of the innovation by management, but it is unlikely that

this could have harmed the degree of use ("They [department management] do think it is important that we apply innovations and that is important, they think it is a nice development" – interview 09).

Verdict: there is significant complexity relating to intended adopters, which is likely to have negatively affected the project's success.

Organisation

Organisation's capacity to take on technological innovation

An impeding factor in this domain is the capacity and ability of the organisation to take on technological innovations. This is due to uncertainty in the effectiveness of collaboration within and between innovation departments. A strategy to innovate with eHealth is currently still under development. There are currently few resources to innovate due to another large and long-term project. All three arguments are discussed below.

Innovations can enter the organisation in two ways. On the one hand, innovations can be "scanned in the market by healthcare professionals and that person then says: I want that too" (interview 01); on the other hand, there may be a problem that someone would like a solution to. With both options, the process starts with the *Smartup Innovation* department created by ZGT to "push and support" innovations (interview 03). The primary task of this department is to coordinate "pilots and quick scans" (interview 01) and try out technological innovations on a small scale. Referring to *Smartup Innovation*, a manager indicates that ZGT can innovate because "several people are continuously working on innovation and also have a certain amount of money with which we can also temporarily acquire several innovations" (interview 01). Moreover, it is a department that does not have to carry the burden of day-to-day care, unlike a regular care department. A manager indicates that innovations consist of different phases, in which different departments play a role ("a kind of gradual scale from proof of concept, to pilot, to project, to implementation, to going live" – interview 02). In addition to *Smartup Innovation*, two other primary departments within ZGT are involved in technological innovations. Secondly, there is the Innovation and Organisation (I&O) department, which is held responsible for "security, privacy, policy matters, project/portfolio management" (interview 06). I&O is concerned with the actual "implementation" (interview 01) and is concerned with compatibility with laws & regulations. The privacy & security officer is part of this department, and this department checks innovations against legislation and regulations but is described several times as "a particularly delaying factor in this organisation" (interview 03). Innovations are transferred to this department when they are scaled up, when links need to be created with the electronic patient record or when privacy issues play a role. This department often has a testing role. Thirdly, the ICT (Information and Communication Technology) department is responsible for technology and technology management. The relationship between I&O and ICT departments can be explained as that I&O looks at which innovations best match organisational goals and that ICT is concerned with the technological part of innovation.

Concerning the agreements made between the above departments, in ZGT's eHealth strategy, "this could also be formulated a bit sharper" (interview 02). The interviews conducted with managers show that there is a kind of confusion of tongues between departments. This creates uncertainty about what belongs to which department and when ("there is much discussion about the question: when is something a pilot and what is a quick scan? Then it turns out that you speak other languages." – interview 01; "When is something a proof of concept, when is something a pilot?" (…) "You notice that we as ZGT still have to work on that as a methodology" – interview 02; "Developing the same language in it, where are we talking actually about? That is something to look for." – interview 04). According to a manager, the result of unclear agreements is that it can harm innovation projects because unnecessary risks are run. When asked whether it is straightforward for each department what the responsibilities of those departments are, it is stated that the roles of the departments are not clear to each other, as it turns out that sometimes misunderstandings arise in the collaboration ("what do people at Smartup know about technology?" - interview 04; "then you also get situations in which people say: who are you telling me to manage that innovation? Then you have a third form. With innovation, you sometimes also have situations that you are sitting in a chair that someone else thinks should be sitting there. That sometimes happens at I&O […] I call it border battles to make it clear for you, where we still think: is this I&O or

Smartup?" – interview 01; "I just suspect that *Smartup Innovation* does not fully realize that this is done by ICT, for example, it just works, right? Just about that." – interview 06). The difficult cooperation between departments is experienced as hindering by project assistants and care professionals, which means that the leaflets that are part of the ZGT Trauma Surgery app cannot be quickly changed ("in the hospital, it is then that those leaflets ... that is less or more centrally invested and from there decentralised again. And then you have to go through another committee. I know a lot. Everyone has to give their opinion about that. That drives you crazy" – interview 03).

The collaboration between the departments involved in innovation is characterised as "starting" (interview 02) and "growing" (interview 04). There is a lack of "early coordination with the parties involved" (interview 06). A manager indicated that too much work is still being done individually and that the departments are not challenging each other to work on innovations proactively. A manager indicates that the interests differ between the departments. For example, a department like *Smartup Innovation* wants to tackle quick small projects, and the ICT department often has significant long-term projects. A manager indicates that the ICT department is often involved in an innovation process at a late stage, which unnecessarily slows down an innovation process. This arises because, on the one hand, ICT has not yet been able to start developing technical preconditions and, on the other hand, has not been able to contribute to the development of an innovation.

ZGT has worked hard in recent times to develop this capacity further to innovate. In March 2021, ZGT was admitted to the Association of Collaborative Top Clinical Training Hospitals (STZ), in which innovation is one of the core competencies. In ZGT's vision on healthcare, "eHealth innovations" (interview 01) are seen as supporting the realisation of that vision. An organisational stakeholder indicated that the vision on care and the strategy concerning eHealth "can be even better" (interview 01): "We have now worked out who does what innovating in that strategy document, but how do you involve the patient and the professionals? You can explore this on all kinds of layers" (interview 01). The eHealth strategy is not being developed further because the usual sufficient resources are no longer sufficient due to a large project currently being worked on. ZGT has devoted most of its resources to the 'HiX standard content' project of the new electronic patient record in ZGT called HiX. A manager indicates that the current agreement concerning innovation projects is: "HiX, and nothing else" (interview 06). Managers indicate that they currently have few resources available ("This year we are in an exceptional situation in which we have the full focus on the implementation of the electronic patient record. In that area there is very little possible from my department" – interview 02 "The only thing is that if I now look at the team and the work pressure that prevails there, we are really at a loss." – interview 06), but also indicate that this is not necessarily due to the HiX project ("Apart from HiX, if it is not HiX, it is something else." – interview 06).

Work needed to routinise the innovation

Another hindering factor in the organisational context is that the work needed to introduce and routinise the innovation has been inadequately resourced. During the development of the predecessor of the *ZGT Traumachirurgie-app*, the *#ENKEL-app*, management has changed a lot between students. This has caused much delay in developing the innovation ("I think it could have been better for the *#ENKEL* part in terms of speed. That took a long time, I thought. And you also noticed I found that increasingly annoying over time. At some point, you almost miss the momentum to make a difference" – interview 03).

In times of COVID-19, the project management was done by a small ZGT project team so that the innovation was quickly developed in a short amount of time, under the influence of the sense of urgency. That has supported the success of the innovation in the time of need due to COVID-19. Now, a year later, the *ZGT Traumachirurgie-app* has been taken under management by a student for the coming year, in the absence of a structural solution ("Now there is an intern who sets up here for a year as an innovation manager, but that has to be arranged structurally. That has to be invested somewhere, and that is still not happening" – interview 03; "now placed with someone from *Smartup Innovation* combined with an intern. Who can do that well in terms of content? Only that intern will, of course, leave at some point too." – interview 07). Management by students is characterised as delaying ("by wanting to maintain that ownership must lie in the line and that the line should facilitate. Yes, then you

end up with students, but that slows down enormously because those people have all their work" – interview 03; "Interns, by definition, they come and go. The going is a bit of a problem in this case. So when a new one comes and he looks at it, and he has a new idea. That would mean that the whole app must be overhauled, regardless of whether it is a better idea" – interview 05; "I think there was little continuity at first" – interview 09).

Commissioning/purchasing of the innovation

There is insufficient insight into whether ZGT intends to include the innovation in its standard offer of care. It is still too early in the implementation process for that. The innovation is currently being funded for a second term by the *Smartup Innovation* department.

Verdict: there is significant complexity relating to the organisation, which is likely to have negatively affected the project's success.

Wider system

Regulatory context

An impeding factor in this domain is the regulatory context. According to a manager, the delaying effect of the privacy/security officer, which was discussed earlier, stems from the many laws and regulations that must be complied with by the hospital ("you have medical device regulations, you have all kinds of new legislation, such as AVG, you have an additional provision for personal processing in healthcare" […] "From a broader view, we are creating our own culture of fear, to put caution first and to handle data and personal data very carefully. When you hear that fines of four and a half tons are very normal in a hospital; for an innovation that costs twenty or thirty thousand euros, it is not worth it to pay a fine that big." – interview 02; "There are quite a lot of rules and guidelines that you should comply with, I think that innovation does not exactly help. These rules sometimes stand in the way of the smooth completion of a project or change. Sometimes it is much manoeuvring." – interview 06). A manager indicated that due to the high pressure, legislation and regulations might have been less strictly complied with ("I think that COVID has accelerated several things, but mainly because we were less keen on laws and regulations […] or about the question: can this be linked, is this something we need in the long term? That external pressure has accelerated the process because you are less precise about the long term effects. You are more willing to take risks" – interview 02).

The departments involved in innovation processes also set priorities differently, making more money and resources available ("the sense of urgency was extremely high, I could just make time for this" – interview 03). With the need for implementation in mind, there was uncertainty built-in on long-term implementation since certain aspects were not included in the development process ("After that phase of urgency and implementation you enter a phase where you have to perpetuate it." and sustainability and that is a lot more difficult in my opinion" – interview 07; "under the pressure of the situation, we have to arrange something quickly. I think you are more inclined to emphasize the positive sides and less risk discover" – interview 02). This concerns the fact that an innovation does not work as intended, that specific laws and regulations have been encountered or that there are unacceptable risks involved with the innovation ("it could just be that several eHealth apps that we are currently rolling out that at some point we have to say: we have to stop, or you run into certain laws and regulations, or risks you do not want to run" – interview 02). Choosing not to personalise the innovation seems to have been a pragmatic choice in the rush of development. The responsible project team opted for this because they "did not want to involve the security officer" (interview 05).

External changes

A facilitating factor in this domain is the external changes that have (had) an impact on the organisation, in this case, the COVID-19 pandemic, which has created a shared sense of urgency. The influence of this seems to have been positive, and it is unlikely that this will threaten the further introduction of the innovation. Respondents indicate that the COVID-19 pandemic has worked as a catalyst in the innovation process. A project employee indicates that COVID-19 has been the "flywheel" (interview 07) to accelerate the development of the *ZGT Traumachirurgie-app* ("I enjoyed making progress very

quickly in COVID and yes, I would always want it to go this way." – interview 03; "The role of COVID has been to determine the urgency" – interview 07). The urgency arose because the primary care physiotherapists temporarily had to close their doors. As a result, the target group of the innovation has expanded considerably in a short time because the choice was made to serve as many patients as possible. According to a healthcare professional, the need for this innovation stems from the professional obligation to inform and support a patient as best as possible. This has been recorded in "the WGBO" (interview 08) ("COVID still evokes the urge in the care provider to be able to help people as best as possible and to provide as well as possible and I want to do everything for that" – interview 01). A healthcare professional and a head of a department indicated that factors that previously had an obstructive effect no longer played a significant role in the innovation process due to the high urgency ("perhaps because you can better indicate or indicate the urgency, this is now necessary because of this problem, people cannot go to the physiotherapist, that the problem became a bit clearer so that the barriers fell away a bit." - interview 07; "I think that a lot of superficial reasons can now be brushed off the table and a few real reasons are left" – interview 01). A healthcare professional doubts whether the innovation would have been developed so quickly without the impact of the COVID-19 pandemic ("We already had something. Corona gave a kind of extra urgency that made us scale up more quickly" - interview 07; "it was a kind of reference work in terms of practice, but it was perhaps also a replacement at the time of the therapy because there was nothing. Nothing was allowed. Now that that urgent problem is no more, you could wonder whether this innovation was indeed very urgent" – interview 09).

According to this project assistant, the mandatory working from home has made it more difficult "to keep and get the employees involved" (interview 03). All consultations have been digital, but that does not seem to have harmed the development ("I do not think the corona has harmed the development. The only thing you can say about that is that everything is done via digital meeting, so sitting together with your team to brainstorm online is a bit of a letdown" – interview 07).

Verdict: there is significant complexity relating to the external context, which is likely to have negatively affected the project's success.

Embedding and adaptation over time

Expected stability

Facilitating factors in this domain include the following: firstly, it is not likely that there will be significant changes to individual users' perceptions of the technology. Secondly, the organisation involved is not likely to have significant restructurings or changes in leadership, mission or strategy over the next 3-5 years. Thirdly, this innovation's policy, regulatory and economic context is not likely to be turbulent over the next 3-5 years. The regulatory context seems more stable compared to the start of the pandemic.

Expected changes

Impeding factors in this domain include the following: firstly, the population with the condition is likely to change significantly over the next 3-5 years due to the innovation's target group being expanded. A project employee and a healthcare professional denounce that the innovation is not being used more widely ("It would be nice if, for example, we could have the physiotherapists join in. Now it is a kind of hospital thing" – interview 07; "I think it could be interesting but that you have to broaden it" – interview 08; "I hope that we will expand it with some other conditions and a little more specified." – interview 10). Secondly, the technology is likely to change significantly within the next 3-5 years due to not being fully developed yet. Several respondents confirm this ("We are really at an early stage and the app is not fully developed yet" – interview 07; "I think it still needs further development" – interview 08; "I hope that we are going to expand it" – interview 10). Thirdly, the value proposition will likely change significantly over the next 3-5 years due to the value proposition hopefully being better explored. This can lead to better implementation but may also lead to the abandonment of the innovation.

Verdict: there is significant complexity relating to the embedding and adaption over time which is likely to negatively affect the project's success in the future.

4.1.2 Innovation strategy

To answer the second sub-question, the insights provided by Proctor et al. (2013) and Proctor, Powell and McMillen (2012) were used to arrive at a detailed description of the implementation strategy.

Under the influence of the sense of urgency due to COVID-19, it was decided to accelerate the development and implementation of an innovation to the care process. In terms of the *NASSS framework*, two groups of target users can be identified, each influencing the degree of implementation: first, the patients eligible to use the innovation, and second, the physician assistants, nurse practitioners and physician assistants in the emergency room. The responsible project team, consisting of four members, ensured the awareness of the innovation by putting up posters, printing information leaflets and informing the care professionals in the emergency room. These information leaflets are given to the patient by the physician assistants, nurse specialists and physician assistants in the emergency room. All actions took place at the time of the innovation's introduction. No distinction can be made in dose because the innovation is only used in one department. The results of the implementation strategy can be measured by looking at the number of times a patient is recommended to use the innovation. This method has been purely a pragmatic consideration to offer this innovation to the patient as soon as possible. A summary of the innovation strategy's actions can be found in Table 7. A conclusion is drawn in paragraph 4.3.

Table 7

Measuring the Innovation Strategy on ZGT Traumachirurgie-app (Proctor et al., 2013)

Prerequisites	Requirements
The actor(s)	Trauma surgeon, physiotherapist, developer and *Smartup Innovation*
The action	Hanging information posters, printing advertising brochures, informing the healthcare professionals on the emergency room who will be handing out the leaflets to the patient.
Action target	Physicians, nurse specialists and physician assistants of the emergency room
Temporality	During the introduction of the innovation
Dose	No difference in dose
Implementation outcome affected	The number of times a patient is recommended to use the innovation
Justification	Pragmatic justification given the necessity due to the COVID-19 pandemic and small scope: namely one department

If the components of the implementation strategy are named using unambiguous terms such as Proctor, Powell and McMillen (2012) propose, then this concerns 'conduct local needs assessment' due to the shared sense of urgency, 'change physical structure and equipment' due to the removal of current disease information leaflets and to 'inform and influence stakeholders' by informing intended users through paper and verbal communication. Of the nine patients who participated in the satisfaction survey, seven patients indicated that they were recommended to download the innovation by the care provider of the emergency room. Of those seven patients, five patients received a short explanation about the innovation from the healthcare provider.

4.1.3 Innovation process

To answer the third sub-question, insight was provided into the degree of implementation by combining the insights from the first and second sub-questions, and patient data and application data were used to support this. An overview of the available data can be found in Table 8.

Table 8

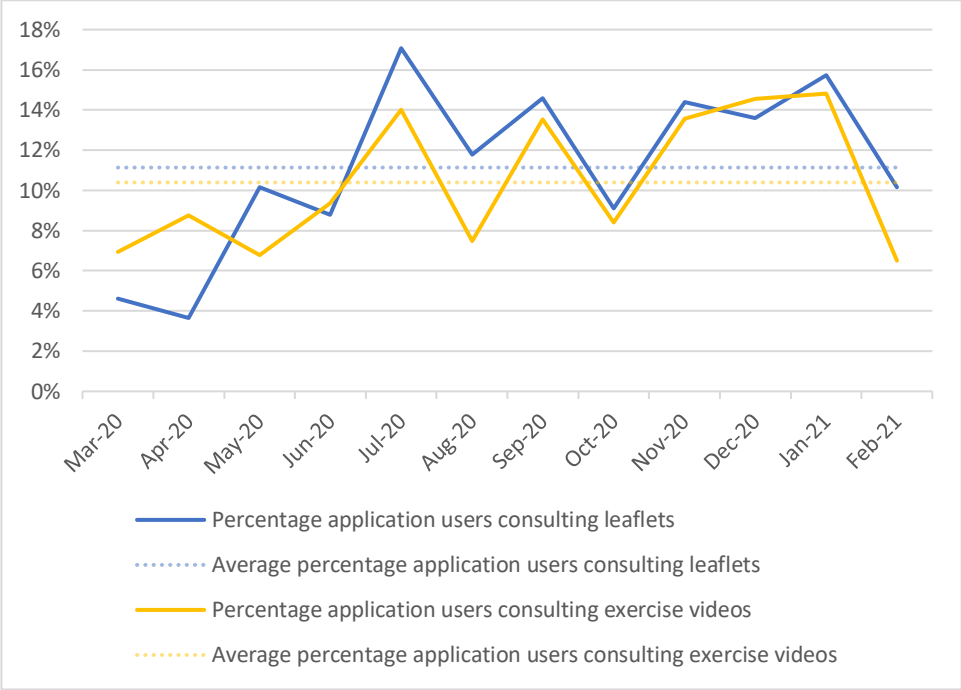
Number of Potential Users in Target Group Versus the Number of Actual Users from March 1, 2020, to March 1, 2021

		Number of patients in the target group	Number of innovation users consulting leaflets	Number of innovation users consulting exercise videos
Month	March 2020	130	6	9
	April 2020	137	5	12
	May 2020	177	18	12
	June 2020	171	15	16
	July 2020	164	28	23
	August 2020	187	22	14
	September 2020	192	28	26
	October 2020	143	13	12
	November 2020	118	17	16
	December 2020	103	14	15
	January 2021	108	17	16
	February 2021	246	25	16
Total		1876	208	187

It can be deduced from the table that no more than 11% of the total group of patients that was eligible for use from March 2020 to March 2021 have used the innovation. The percentage of actual users seems to follow the trend of the total supply of patients. A graph was generated to show the percentage of innovation users consulting leaflets and exercise videos set off to the number of potential users in the same month: see Figure 4. This figure shows that there is a slight increase per month between March 2020 and January 2021. Therefore, the *ZGT Traumachirurgie-app* seems to be used more and more. In February 2021, usage declines even though the number of potential users more than doubles. It is not known what has caused this effect.

Figure 4

Percentage of Actual Users Set Off to Potential Users of ZGT Traumachirurgie-app from March 1, 2020, to March 1, 2021



It was previously discussed that it is hardly possible to estimate the implementation process of the *ZGT Traumachirurgie-app*. The user statistics and insights gained from the semi-structured interviews suggest that the implementation process is in the implementation phase, i.e. before the continuation phase. The healthcare professionals seem to advise patients persistently to use the innovation. However, actual usage lacks. Full implementation and continued use have not yet been achieved. This is because the qualitative data suggest barriers to the continued use of this innovation concerning all domains, which is likely to have resulted in the relatively low actual use.

4.2 *FysioThuis*

4.2.1 Innovation determinants

The insights below are summarised in Table 16 (page 52) for easy comparison with the *ZGT Traumachirurgie-app* analysis.

Condition

Uncertainties about the condition

The complexity of the condition is a limiting factor in explaining the degree of implementation. The *FysioThuis* program was initially aimed at a new group of patients within physiotherapy: the COVID-19 patient ("Almost no knowledge is available about the disease" – interview 03). It is a new disease of which the course is still uncertain. The course varies significantly from patient to patient ("we increasingly see that a large part of it comes from the disease very badly." – interview 03). This has grown the need to provide patients with personalised care; to tailor care to the individual patient. The program is offered to patients who have been discharged after hospitalisation with COVID-19 and who have an indication for physiotherapy but who want to perform physiotherapy independently without needing intensive physiotherapeutic guidance.

The first innovation of *FysioThuis* was complex because there were not enough patients anymore ("we had great difficulty getting those ten patients as well" – interview 03). A project employee indicates that the focus of the innovation may have been too narrow to deploy the innovation on a large scale ("the reason it was not used so much was that the app was mainly used for the treatment of corona patients and those were not there anymore" – interview 05). In addition to COVID-19 patients, the innovation is currently being used more widely in general outpatient physiotherapy within ZGT ("this concerns, for example, post-covid patients, also without hospitalisation, hand patients, oncology patients, et cetera" - interview 14).

Co-existing illnesses or impairments

A facilitating factor in this domain is that there is no co-morbidity related to the condition that could influence the ability to use the innovation. The condition of patients must be good enough to practice independently, and the exercises must be safe to perform. The duration of treatment with *FysioThuis* is six weeks at most.

Verdict: the condition does have significant complexity, which is likely to have positively affected the project's success.

Social or cultural factors

To gain more insight into disease-related factors that influence the degree of use, quantitative data analysis was performed. A summary of the descriptive statistics of the data is shown in Table 9.

Table 9

Descriptive Statistics in FysioThuis Data

Total	N	Mean	SE	Min	Max
FysioThuis recommended (TRUE)	1134	.056	.229	0	1
FysioThuis used (TRUE)	1134	.037	.0189	0	1
Age	1134	67.47	15.241	22	97
Gender (men)	1134	.41	.04	0	1
Days of hospitalisation	1109	6.35	8101	0	58

Two logistic regression analyses are performed in this study. In these two analyses, the variables *FysioThuis recommended,* and *FysioThuis used* to act as dependent variables. The variables *age* and *days of hospitalisation* are presented as independent variables. In addition, the variable *age*days of hospitalisation* is added as an interaction term. The variable *gender* is provided as a control variable. The following logistic regression analyses are performed:

$$p_{recommended} = \frac{e^{\beta_1 age + \beta_2 daysofhospitalisation + \beta_3 A*D + \beta_4 gender}}{e^{\beta_1 age + \beta_2 daysofhospitalisation + \beta_3 A*D + \beta_4 gender} + 1}$$

$$p_{used} = \frac{e^{\beta_1 age + \beta_2 daysofhospitalisation + \beta_3 A*D + \beta_4 gender}}{e^{\beta_1 age + \beta_2 daysofhospitalisation + \beta_3 A*D + \beta_4 gender} + 1}$$

Before performing the logistic regression analysis, please refer to Table 10, which shows correlations between the mentioned variables.

Table 10

Correlations FysioThuis Recommended, FysioThuis Used, Age, Days of Hospitalisation and Gender

	1	2	3	4	5
1. *FysioThuis* recommended	-	.809*	-.158*	.086*	.015
2. *FysioThuis* used	-	-	-.139*	.063*	.025
3. Age	-	-	-	.122*	.026
4. Days of hospitalisation	-	-	-	-	.049
5. Gender	-	-	-	-	-
Mean	.056	.037	67.47	6.35	.41
SE	.189	.189	15.24	8.1	.04

*Two-sided significance level p <0.01

Logistic regression analysis on FysioThuis recommended

Table 11 shows the regression analysis results in which *FysioThuis recommended* is predicted using *age* and *days of hospitalisation* and controlled for *gender*. Finally, the interaction term *A*D* is added.

Table 11

Parameter Estimation for a Regression Model on the Dichotomous Variable FysioThuis Recommended

	Model 1a		Model 1b	
	b (SE)	*p*	*b (SE)*	*p*
Intercept	-3.06 (.191)	<.001	-3.04 (.191)	<.001
Age	-.040 (.007)	<.001	-.043 (.008)	<.001
Days of hospitalisation	.040 (011)	<.001	0.16 (0.17)	.326
Gender	.097 (.270)	.719	.113 (.273)	.679
A*D	-	-	-.004 (.001)	.004

The regression coefficient of *age* in model 1a shows that patients with a higher age generally have a lower score on *FysioThuis recommended* (b = -.040). The independent variable *age* is significant when controlling for *age*, *days of hospitalisation*, *gender* and the interaction between *age* and *days of hospitalisation* in the interaction term *A*D* (b = -.043; p < .001). More concretely, this means that the older the patient is, the smaller the chance this patient has been recommended to use *FysioThuis*. The regression coefficient of *days of hospitalisation* in model 1a shows that patients with a longer length of stay have a higher score on *FysioThuis recommended* (b = .0.40). The independent variable *days of hospitalisation* is significant, except when controlling for *age*, *gender* and *A*D* (b = .016; p < .326). The interaction term represents a significant correlation. This means that there is a meaningful interaction between the *age* of a patient and the *days of hospitalisation* in predicting whether a patient is recommended to use *FysioThuis*. For the controlling variable *gender*, no significant association is identified with *FysioThuis recommended*, when controlling for *age*, *days of hospitalisation*, *gender* and *A*D* (b = .113; p = .679). There is a significant interaction between *age* and the *days of hospitalisation*, which is shown by the significant interaction term A*D. This means that the magnitude of the effect of age is dependent on the duration of hospitalisation. The interaction term is significant in model 1b when controlling for age, days of hospitalisation and gender (b = -.004; p = .004).

Logistic regression analysis on FysioThuis used

Table 12 shows the regression analysis results in which *FysioThuis used* is predicted from *age* and *days of hospitalisation* and controlled for *gender*. Finally, the interaction term A*D is added.

Table 12

Parameter Estimation for a Regression Model on the Dichotomous Variable FysioThuis Used

	Model 2a		Model 2b	
	b (SE)	*p*	*b (SE)*	*p*
Intercept	-3.56 (.238)	.028	-3.55 (.239)	.029
Age	-.031 (.009)	<.001	-.043 (.009)	<.001
Days of hospitalisation	.038 (.014)	.004	.013 (.021)	.533
Gender	.221 (.324)	.495	.242 (.327)	.459
A*D	-	-	-.003 (.001)	.026

The regression coefficient of *age* in model 1a shows that patients with a higher age generally have a lower score on *FysioThuis used* (b = -.031). The independent variable *age* is significant when controlling for *days of hospitalisation*, *gender* and the interaction between *age* and *days of hospitalisation* in the interaction term *A*D* (b = -.043; p < .001). More concretely, this means that the older the patient is, the smaller the patient will use *FysioThuis*. The regression coefficient of *days of hospitalisation* in model 1a shows that patients with a longer length of stay have a higher score on *FysioThuis used* (b = .0.38). The independent variable *days of hospitalisation* is significant, unless *A*D* is controlled for *age* and *gender* (b = .013; p = .533). The interaction term is significant (b = 0.122, p = <.001). This means that patients with a longer hospital stay generally also have a higher age and vice versa. Therefore, only age can be included as a significant predictor in predicting whether *FysioThuis* is used. For the control variable *gender*, there is no significant association with *FysioThuis* usage when controlling for *age*, *days of hospitalisation*, *gender* and *A*D* (b = .242; p = .459). There is a significant interaction between *age* and the *days of hospitalisation*, which is shown by the significant interaction term A*D. This means that the magnitude of the effect of age is dependent on the duration of hospitalisation. The interaction term is not significant in model 2b when controlling for age, days of hospitalisation and gender (b = -.003; p < .026).

All in all, it is shown that the disease-related factor *age* is a significant factor that defines whether a patient is recommended to use *FysioThuis*, and whether this is followed by actual use or not.

Technology

Supply model

The innovation, like the *ZGT Traumachirurgie-app*, is built on the platform of *Telerevalidatie*. With this, the app is built and managed by *Telerevalidatie*. The program can be tailored to the individual patient by the physiotherapist in the hospital. The healthcare professional prepares an exercise program for the patient, which they can view with their account. Therefore, the innovation is not part of ZGT's existing digital infrastructure, and there has been limited collaboration with ZGT's ICT department. A project employee indicates: “it took half an hour of work for someone from the IT department” and “what they had to do was very basic” (interview 05). The innovation is offered online, so there has been no uncertainty in the supply chain, which is a contributing factor.

Usability and acceptability

However, an impeding factor in this domain is that the technology is not yet fully developed, which means uncertainty about what the technology will entail. A care provider indicated that the platform of *Telerevalidatie*, which *FysioThuis* was built on, offers many possibilities but is not yet “completely

ready for use" (interview 13). Respondents discuss two impeding factors: on the one hand, the program has not yet been fully developed; on the other hand, the user-friendliness for the healthcare professional leaves something to be desired. Both points are related to the observation that *FysioThuis* is a very adaptable platform and does not offer standard programs ("The biggest disadvantage is that it is not ready-made" – interview 13). Due to the way the innovation is structured, the healthcare professional needs much time to prepare exercises for the patient because the healthcare professional is presented with 1500 exercises to choose from ("how do I find the exercise I want in that huge container of exercises? That is not easy" – interview 05; "I notice that the physios now find that it takes them much time. More time than they want." – interview 03) and there is no unambiguous language for the name of exercises ("You have to know which exercises are included and what they are called. Because even there, people sometimes differ in opinion about what a certain exercise should be called" – interview 05). In addition, the innovation is also not complete yet ("At the moment there are still some exercises missing" – interview 14), and there is no message function in the innovation that allows easy contact between patient and practitioner. Physiotherapists indicate that, for themselves, many technology-related barriers influence the degree of use. The developer indicates that this aspect harms the persistence with which new caregivers use the innovation. In addition, a healthcare professional noted that the fact that the innovation does not link to the existing electronic patient record hinders the efficiency of use. Some of the physiotherapists prefer a different technology because it offers standard treatments. These standard treatments are missing in current technology ("Within the world of physiotherapy, you have *FysiTrack*, that is just IT! But then, we could not use that in ZGT in the end, so we ended up with *FysioThuis*. Colleagues were a bit more sceptical about that." – interview 14).

The physiotherapy department in ZGT has been running a project to explore home exercise programs, but this project stalled when the program had to be approved by the I&O department. As a result, the choice fell on an existing technology, *FysioThuis*, which could be applied quickly when the need was greatest ("In principle, we just applied it because there was a need." – interview 12).

An introduction process in the program supports the procedural clarity of the innovation. E-learning has been built in for the healthcare professional that explains which function can be found in the program. There is "a sort of a help function" for patients (interview 05). A conscious choice has been made for a simplistic view of the program for patients, in which patients only see the prepared exercises and some associated information with the exercises.

What seems to be a facilitating factor to the degree of use are the reminders that patients receive on their email the morning of the day that exercises have to be done ("And they also get an email every day, don't they? Exercises are set ready for you, so they will also be kept on track" – interview 03). In addition, the innovation is safe to use because users receive an additional access code by email or SMS after logging in. The portal can only be used after entering this access code.

Technical interdependencies

The only precondition for using the program is the possession of and being able to use a computer, smartphone or tablet. The physiotherapists also use this as a rigid inclusion criterion to allow patients to start using *FysioThuis*. It is unlikely that this will significantly affect the degree of use ("What you should be able to do is: remember your password and know your email address" – interview 05). Technical support for healthcare professionals has been set up at *Telerevalidatie*. A central e-mail box and a telephone exchange have been set up for patients to support their use.

Changes to organisational tasks and routines

The technology has not required changes to work routines in ZGT.

Verdict: the technology has significant complexity, which is likely to have negatively affected the project's success.

Value proposition

Value to intended users

A first promoting factor in this domain is that the current value proposition to the intended users is relatively certain. However, physiotherapists and project staff indicate that the value proposition is mainly on the side of the patients and that the value proposition for healthcare professionals is limited ("the practitioner has to do more for it and does not always see added value in this, because more administrative tasks are necessary. This is mainly because the benefit is mainly on the side of the patients and not so much on the side of the practitioners" – interview 05). Compared to the first use, the value proposition in the treatment process has changed over time. Initially, the purpose of the innovation was: "To be able to support the patient as early as possible in his recovery process with appropriate exercises and thereby rebuild his condition" (interview 03). The innovation was temporarily used as a complete replacement for physical physiotherapy ("In the beginning, it was not that difficult, because you have nothing else. Everything you can give to therapy that is necessary is included." – interview 12). Nowadays, physical physiotherapy is combined with digital support ("I now also sometimes use it to support my treatment here. Then I see someone here once a week and let someone practice with the exercises at home" – interview 13). The innovation is therefore used in addition to and as a partial replacement of the regular care of the physiotherapist ("because I think there is also the belief that exercises at home can be complementary to your regular treatment and that you can make it easier for people less burdensome" – interview 12). This is because physiotherapists indicate that they prefer high-frequent treatment over low-frequent treatment. Healthcare providers seem to unanimously agree that a digital platform will not replace their regular care ("an app can never fully replace a physiotherapy treatment" – interview 13). In some instances, a combination treatment is not desirable and exclusively physical therapy is chosen. A limiting factor to the degree of use is that the innovation is not suitable for all patients. The suitability of the innovation depends on the nature of the condition and the treatment required. If only one or a few exercises are prescribed, the healthcare professional prefers to give them homework without using a digital platform.

A second stimulating factor is the added value of the innovation compared to other options. According to healthcare professionals, the added value compared to the paper leaflets is the exercises combined with the videos, explanations and voice-overs. This enables the patient to better work on his recovery. Physiotherapists indicate that patients who cannot use the innovation receive the same care but that the treatment is less flexible to personal progress.

A third facilitating factor in this domain is the perception of future value for healthcare professionals. Physiotherapists and project staff indicate that with the help of *FysioThuis*, "more patients" (interview 12) can be treated, there are "less waiting times" (interview 12), and there is a "faster recovery" (interview 03). This is because patients can work more responsibly with their exercises, which means that fewer consultations from a physiotherapist are required ("If you let a patient do the same exercise at home, it saves much more time. Then it is easy to do. That is much better because that is hard to do here. I think that is another advantage." – interview 12; "I also have a patient I see once a week here and who practices the rest of the week with *FysioThuis*, if he did not, I would see him twice a week" – interview 13). The value proposition for healthcare professionals influenced the decision from which point *FysioThuis* enters the care process. Initially, the plan was to include patients starting from the intensive care unit, but this soon changed to apply when patients were discharged from the hospital. This has to do with the fact that healthcare providers do not see any added value in digitally guiding clinical patients, so they prefer to work with the regular paper leaflet. The added value is expressed in outpatients because then there is a need to individualize the treatment ("That is the advantage of *FysioThuis*: you can then make an individual program for the patients. So I think it is added value in outpatients have" – interview 14).

Value to the healthcare system

A hindering factor in implementation is that the value to the healthcare system is uncertain. There is no clear business case, the innovation has not been studied for cost-effectiveness, and no market research has taken place. The health benefits of the innovation have not been investigated. This could have

negatively influenced the implementation and could harm further implementation if not examined ("We have not done a proper study on people who did or did not have access and what the added value would be" – interview 11).

Value to the healthcare organisation

A second hindering factor is that the value to this particular healthcare organisation is uncertain. How the innovation entered the organisation may have hindered the level of use. The value proposition is uncertain. The developer has drawn up a standard program in national collaboration with healthcare professionals for the rehabilitation of COVID-19 patients and built in the Telerehabilitation platform. ("This was something that was lying there and that someone knew from the other project with the trauma" – interview 11). Healthcare professionals indicate that the reasoning was not based on the problem but based on a solution ("So I think that is a step that was skipped. This was there, and then we looked; now it is workable, and it is something. Does not go back to which providers or options there are, so in that sense that is a step that you skip in the initial phase." – interview 11). Project staff and healthcare professionals indicate that the value proposition for the organisation is that ZGT can support the patient in a more person-oriented way in his treatment. In addition, *FysioThuis* contributes to "the profiling of the hospital as an innovative hospital" (interview 03). Healthcare professionals give for this because there was no time to dwell on this under the influence of the wider context. This has likely harmed the degree of use.

Verdict: the value proposition has significant complexity, which is likely to have negatively affected the project's success.

Adopters

Two groups of target users can be identified with this innovation that influences the degree of implementation: the healthcare professionals and the patients. In this section, healthcare professionals mean physiotherapists of ZGT.

Patients

A promoting factor in this domain is no uncertainty about whether patients will adopt the technology. The experiences that healthcare professionals hear back from patients are positive ("in general, it was rated highly in the first evaluation. The patients who used it were happy with it" – interview 03). The only criticism that seems to have emerged is that logging in, again and again, is experienced as hindering. It is plausible that the positive experiences of patients have positively influenced the degree of use.

In addition to the above, the interim evaluation that was previously performed among patients was analysed. All 12 patients who submitted an evaluation form think of *FysioThuis* as an added value to their treatment process. Patients describe the added value as a "big stick" (evaluation form 6; evaluation form 7). Two patients indicated that the exercises of *FysioThuis* did not match their recovery. A patient expresses concern that the program and support are only offered digitally. Two patients indicate that they want to use the program in combination with physical physiotherapy. All 12 patients indicate that they have received sufficient instructions from their practitioners and believe that the practitioner has also been sufficiently involved in their treatment with the help of *FysioThuis*. All 12 patients would also like to use *FysioThuis* for other complaints that require physiotherapeutic exercises. Overall, the patient experiences seem to be good and a facilitating factor in the implementation process.

Front-line staff

However, a hindering factor is uncertainty about whether and how front-line staff will adopt the technology. This is characterised by the integration of the innovation into the work of healthcare professionals. Because the deployment of *FysioThuis* takes much time, the physiotherapists have too little time for this in their daily work ("due to the many COVID patients and the often moderate physiotherapeutic occupation due to the absence of colleagues" (…) "It currently just costs us too much time" – written supplement to interview 14). In addition, the experiences of healthcare professionals are also an impeding factor for the degree of implementation. The healthcare professionals have varying experiences with *FysioThuis* ("There are healthcare professionals, they do not like it three times." –

interview 03). A project employee indicated that he did not have a good view of the barriers to use that healthcare professionals experience. The limited use of *FysioThuis* is partly determined by the distribution of the number of accounts among the care providers. Because the innovation is still in a pilot phase, not all physiotherapists in the COVID department have had an account, which means that "the work cannot be divided" (interview 14).

Partly because of the above, the subjective norm that prevails in the department cannot be regarded as a promoting factor. The interviewed care professionals indicate that it is not yet easy for all care professionals ("I have colleagues who are very actively involved with it, even more than I am. However, some colleagues have less feeling for it" – interview 13 "There was a colleague who was also in our working group, and he immediately said: this is not half of it, this is nothing at all" – interview 14). A healthcare professional indicates that within the Physiotherapist department, there is a broadly supported preference for using another program, but that *FysioThuis* was a second choice ("I think that if *FysiTrack* had been approved by the privacy officer, then there was a greater chance that we use that wax within the paramedics, because that program is almost ready-made" (…) "If I were to ask all colleagues here, I think three quarters would like *FysiTrack*." – interview 14). It is plausible that dissatisfaction with the innovation among healthcare providers may harm the extent to which *FysioThuis* is used in the future.

Verdict: there is significant complexity relating to intended adopters, which is likely to have negatively affected the project's success.

Organisation

The findings described in the *ZGT Traumachirurgie-app* also apply to *FysioThuis* because it concerns the same organisation. In addition to the earlier analysis, it is the case for *FysioThuis* that the Physiotherapy department had a "tight clinical staffing" in the past year (interview 14), leaving few resources to innovate. Likely, this has negatively influenced the degree of use. This supports the argument that the work needed to introduce and routinise *FysioThuis* has been inadequately resourced.

The delaying effect of the privacy and security officer also influenced the degree of use during the development of *FysioThuis*. The healthcare professionals and project staff describe that by the time they could start using the innovation, most patients had already left the hospital ("when we finally got around to applying, all those patients were almost gone. Yes, I found that very unfortunate" – interview 03). This supports the argument that the organisation's capacity to take on technological innovations is limited.

Verdict: there is significant complexity relating to the organisation, which is likely to have negatively affected the project's success.

Wider context

The findings described in the *ZGT Traumachirurgie-app* also apply to *FysioThuis* because it concerns the same context. In addition to the earlier analysis, the following can be mentioned explicitly for *FysioThuis*.

A facilitating factor that likely has also determined a large part of the degree of use of *FysioThuis* is the widely supported feeling of need that arose for an alternative to care during the COVID-19 pandemic ("a huge sense of urgency and everyone was prepared. .." - interview 03; "Positive influence with that there was a bit more momentum behind it, yes. So that everyone was very enthusiastic and involved, moreover, that there was good speed in developing this" - interview 11). This sense of necessity was caused by changing laws and regulations: on the one hand, because primary care physiotherapists had to close their doors and COVID-19 patients needed physiotherapy, on the other hand, because physical support after hospitalisation was not desirable due to the risk of contamination for healthcare professionals ("We could not see people physically." – interview 13). Physiotherapists from ZGT, therefore, provided the care. "More is now known about how long people remain contagious" (interview 14), which means that the use of *FysioThuis* has decreased compared to the start of the pandemic because the first-line physiotherapist takes over care again earlier.

Verdict: there is significant complexity relating to the external context, which is likely to have negatively affected the project's success.

Embedding and adaption over time

Expected stability

Facilitating factors in this domain are the following: the organisation involved is not likely to have significant restructurings or changes in leadership, mission or strategy over the next 3-5 years and the policy, regulatory and economic context for this innovation is not likely to be turbulent over the next 3-5 years.

Expected changes

Firstly, due to the newness of the condition and the lack of scientific literature and good standards of care, the population with the condition, or how the condition is treated, is likely to change significantly over the next 3-5 years. Secondly, the technology is likely to change significantly within the next 3-5 years due to the extension of the target group and the technology not being fully developed at the time of this study. Thirdly, the value proposition is likely to change significantly over the next 3-5 years. There has not been a sufficient focus on the value proposition until now, mainly due to the sense of urgency. Now that the COVID-19 pandemic has come to an end, the value proposition has changed, and there is essentially a new product that is being explored and applied to multiple patient groups. Therefore, there are technology-related factors and contextual factors that adapt themselves over time. Lastly, there will likely be significant changes to individual users', or rather the staff's, perceptions of the technology in the next 3-5 years due to the current value proposition being very uncertain for hospital staff.

Verdict: there is significant complexity relating to the embedding and adaption over time which is likely to negatively affect the project's success in the future.

4.2.2 Innovation strategy

Under the influence of the common sense of urgency due to the COVID-19 pandemic, it has been decided to implement an existing program in ZGT's healthcare offer. A project team has been set up for this, consisting of two doctors, two physiotherapists, the developer and the *Smartup Innovation* department. The project team was aware of the risks associated with accelerated implementation because an extensive risk assessment was carried out. In addition, there was close contact with the I&O department to assess the legal framework for adoption.

Smartup Innovation collaborated with *Telerevalidatie* in setting up an information meeting for professionals. The decision was made first to include ten patients and evaluate these experiences before further scaling up the innovation. The first funding was provided by the *Smartup Innovation* department, which has funds available for piloting innovations. Two physiotherapists who were also involved in the project group were the drivers of innovation within their department. They informed their patients, made use of the innovation and made colleagues aware of the existence of the innovation. During the treatment, the physical therapist evaluates the innovation and progress of the rehabilitation with the patient weekly, whereby there is a constant consideration whether or not to continue using *FysioThuis*. Technical assistance is centralised and easily accessible to patients. For a summary of the activities of the innovation strategy in broad terms, see Table 13.

Table 13

Measuring the Innovation Strategy on FysioThuis (Proctor et al., 2013)

Prerequisites	Requirements
The actor(s)	Physiotherapist
The action	I. Informing the patient and asking for permission
	II. Send leaflet and login instructions to the patient and verify access
	III. Portal becomes part of the treatment
	IV. Monitor patient recovery progress
Action target	Patient
Temporality	Maximum 6 weeks
Dose	Depending on the request for help
Implementation outcome affected	The number of times a patient is recommended to use the innovation
Justification	Pragmatic justification given necessity by COVID-19

If the components of the implementation strategy are named using unambiguous terms as proposed by Proctor, Powell and McMillen (2012), this concerns the following components (see Table 14). A conclusion is drawn in paragraph 4.3.

Table 14

Innovation Strategy Actions on ZGT Traumachirurgie-app

Category	Strategy	Practical innovation
Plan strategies	Conduct local needs assessment	Common sense of urgency
Plan strategies	Assess for readiness and identify barriers	Risk inventory by the project team
Plan strategies	Develop a formal implementation blueprint	Development project initiation document by the project team
Plan strategies	Stage implementation scale-up	Planned scaling, first ten patients for initial deployment, then scaling up to 50 patients
Plan strategies	Identify and prepare champions	Two physiotherapists were appointed as key users
Educate strategies	Conduct educational meetings	Organisation training for professionals
Educate strategies	Provide ongoing consultation	Two key users are available for this
Educate strategies	Prepare patients to be active participants	Information to patients
Finance strategies	Fund and contact for the clinical innovation	Money made available from *Smartup Innovation* for pilot
Quality management strategies	Use advisory boards and workgroups	Collaboration with advisory bodies, here I&O department
Quality management strategies	Obtain and use patient feedback	Interim evaluation with patients via survey
Quality management strategies	Centralize technical assistance	Central mailbox/telephone system for questions from patients about *FysioThuis*
Quality management strategies	Intervene with patients to enhance uptake and adherence	The physiotherapist evaluates use with the patient during treatment

4.2.3 Innovation process

To answer the third sub-question, insight was provided into the degree of implementation using the insights gathered from the qualitative analysis. Patient and application-specific data were used to support this. The dataset is set out in Table 15.

Table 15

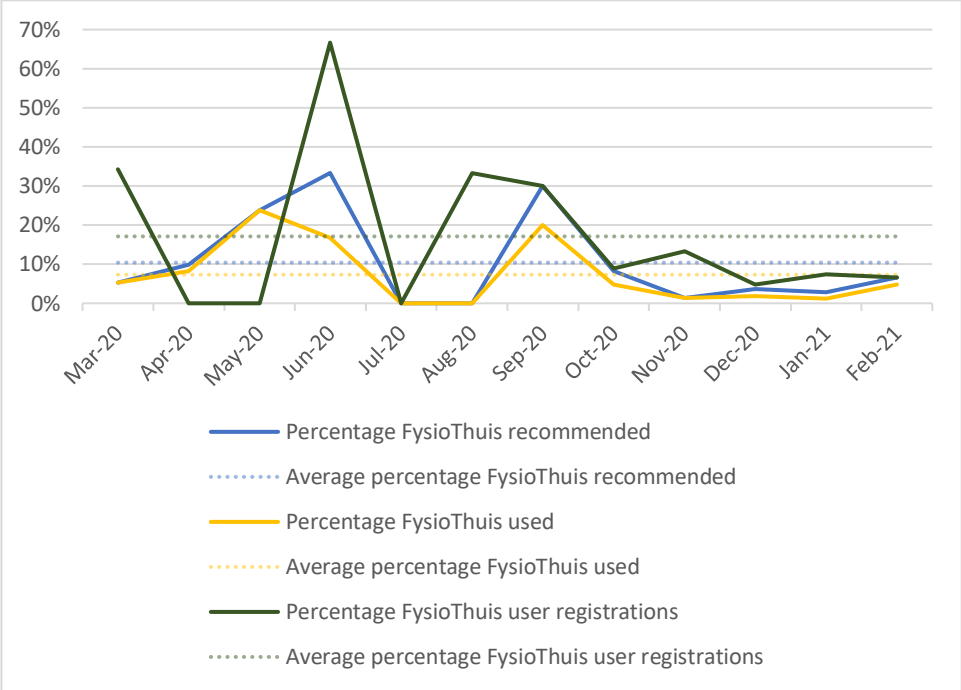
Number of Potential Users in Target Group Versus the Number of Actual Users from March 1, 2020, to March 1, 2021

		Number of patients diagnosed with COVID-19	*FysioThuis* recommended	*FysioThuis* used	*FysioThuis* user registrations
Month	March 2020	38	2	2	13
	April 2020	61	6	5	0
	May 2020	21	5	5	0
	June 2020	6	2	1	4
	July 2020	1	0	0	0
	August 2020	3	0	0	1
	September 2020	10	3	2	3
	October 2020	146	12	7	13
	November 2020	143	2	2	19
	December 2020	168	6	3	8
	January 2021	174	5	2	13
	February 2021	105	7	5	7
Total		876	50	34	81

From the hospital data, it can be deduced from the table that no more than 5,71% of the patients who are admitted to hospital with COVID-19 have reported in their patient file that *FysioThuis* was recommended and that 68% of those patients have reported in their patient file on actual use of *FysioThuis*. From the user registration dataset, it can be deduced that – assuming those are only patient registrations and not testers – *FysioThuis* has been used for more than one target group (e.g. not only COVID-19 patients). The percentage of actual users seems to follow the trend of the total supply of patients. To make the course clearer over time, graphs have been generated on the above data to show the percentage of actual users set off to the potential users of the innovation. See Figure 7.

Figure 7

Percentage of Actual Users Set Off to Potential Users of FysioThuis from March 1, 2020, to March 1, 2021



The insights gained from the semi-structured interviews and the patient and user statistics suggest that the implementation process is in the adoption phase. Because *FysioThuis* is still a pilot and falls under *Smartup Innovation*, the implementation phase has never been achieved. The innovation has not found a permanent place in the care process. It is not part of the daily actions of the care professionals of the physiotherapy department (“we are still in a scaling-up process” – interview 13). Healthcare professionals are not yet in agreement about the added value of using the platform for themselves. The platform has added value for the patient that healthcare professionals recognise. However, whether this platform is the right platform for the healthcare professional - opinions are still divided ("This portal is not yet one hundred per cent what we want it to be" - interview 14).

4.3 Provisional conclusion

ZGT Traumachirurgie-app

In summary, the analysis of the *ZGT Traumachirurgie-app* shows that complexity can be found in all domains of the *NASSS framework,* which is likely to have negatively affected the implementation process (and will, in the future). See Table 16 (page 52) for a comparative summary.

The nature of the condition is clear, and the treatment is predictable; however, there are a few significant uncertainties about the condition since not all fractures in the same joint can be treated in the same way. No co-existing illnesses or impairments could affect the patients' ability to benefit from this innovation. Still, when looking at social-cultural factors, it was found that a patient's age could do that. Due to ongoing developments, the population with the condition will likely change significantly over the next 3-5 years, which implies further uncertainty and complexity.

There are significant uncertainties in the technology since it has not been fully developed yet, and there are significant uncertainties about the technology's usability and acceptability. There are, however, no significant uncertainties in where the technology will come from or about the technology's performance and dependability. There are no significant technical interdependencies, and the technology does not require significant changes to organisational tasks and routines. Due to the technology not being fully developed yet, the technology is likely to change significantly within the next 3-5 years, which implies further uncertainty and complexity.

There is significant uncertainty in *value proposition*: there is uncertainty in the commercial value, the value to the intended users, the value to the healthcare system and the value to this particular healthcare organisation. The technology's costs, however, are not likely to outweigh benefits for stakeholders. Due to the value proposition being likely to be further explored, the value proposition is likely to change significantly over the next 3-5 years, which implies further uncertainty and complexity.

There is uncertainty about whether and how patients will adopt the technology, but there is little uncertainty about whether and how front-line staff will adopt the technology. The healthcare professionals at the emergency room have been very persistent in advising patients to use the technology. There will not likely be significant changes to individual users' perceptions of the technology over the next 3-5 years.

The innovation strategy for *ZGT Traumachirurgie-app* did not take these complexities into account. It seems to have had a more pragmatic justification than functionally contributing to the implementation process. All in all, it can be said that the implementation was not successful. The consequence for the eventual implementation is that the innovation stagnates in the implementation phase.

FysioThuis

The analysis of *FysioThuis* has also shown complexity within all domains of the *NASSS framework,* which is likely to have negatively affected the implementation process (and will, in the future).

There are no co-existing illnesses or impairments that could affect their ability to benefit from this solution. However, when looking at social-cultural factors, the patient's age was found to be a significant factor in predicting the actual use of the innovation. There are significant uncertainties about the condition due to the condition being very new, and there has not been much literature on the condition yet. Due to the much new literature expected soon on how the condition is treated is likely to change significantly over the next 3-5 years.

There are significant uncertainties in what the technology is since it has not been fully developed yet. Physiotherapists indicate that various technology-related barriers influence the degree of use. The usability is not optimal: the use of the innovation currently takes the healthcare provider too much time. Therefore, there are also significant uncertainties about the technology's usability and acceptability. Due to the expected further development, the technology is likely to change significantly within the next 3-5 years, which implies further uncertainty and complexity. Apart from that, there are no significant

uncertainties in where the technology will come from or about the technology's performance and dependability. *FysioThuis* does not have significant technical dependencies, and its use does not require significant changes to the organisational tasks and routines.

Concerning the value proposition: the technology's commercial value, the value to the healthcare system, and the value to this particular healthcare organisation are uncertain. Above all, the technology's costs are likely to outweigh benefits for the healthcare professionals. The value to the intended users is reasonably certain, but, all in all, the value proposition has significant complexity. Due to the value proposition being further explored soon, the value proposition is likely to change significantly over the next 3-5 years, which implies further uncertainty and complexity.

There is uncertainty about whether and how front-line staff will adopt the technology. Therefore, there will be significant changes to individual users' perceptions of the technology over the next 3-5 years due to further technology development, which implies further uncertainty, and therefore complexity. There is, however, no uncertainty about whether and how patients will adopt the technology.

The innovation strategy of *FysioThuis* seems to have only partially addressed the complexity that was identified, although mostly carrying a pragmatic justification due to the necessity. Even though *FysioThuis* is still considered a pilot, its implementation has had little success due to its complexity. It is necessary to consider the complexities and act on them. Only then it is likely that the innovation will continue to grow in its implementation.

Organisation and wider system

For both innovations, there is significant complexity in the overarching domains of the organisation and the wider system. This has implications for every other eHealth implementation effort and is not specific to one innovation. The organisation's capacity to take on technological innovations is limited due to a lacking strategy on eHealth and ineffective collaborations between departments concerned with innovation. Due to the strategy still being under development, the organisation involved is likely to have significant restructurings or changes in leadership, mission or strategy over the next 3-5 years, which implies further uncertainty, and therefore complexity. Also, the regulatory context is adverse due to changing regulations and a maze of legislation concerning technology-supported healthcare. Both innovations are, however, not threatened by external changes that impact the organisation. This innovation's policy, regulatory and economic context is not likely to be turbulent over the next 3-5 years.

Table 16

Results on Domains NASSS framework Summarised per Innovation

		ZGT Traumachirurgie-app		*FysioThuis*
Condition	+/-	The nature of the condition is clear, and the treatment is predictable; however, few significant uncertainties about the condition	-	There are significant uncertainties about the condition
	+	No co-existing illnesses or impairments could affect their ability to benefit from this solution	+	No co-existing illnesses or impairments that could affect their ability to benefit from this solution
	-	Age could affect the patients' ability to benefit from the technology or service	-	Age could affect the patients' ability to benefit from the technology or service
Technology	-	There are significant uncertainties in what the technology is since it has not been fully developed yet	-	There are significant uncertainties in what the technology is since it has not been fully developed yet
	+	There are no significant uncertainties in where the technology will come from	+	There are no significant uncertainties in where the technology will come from
	+	There are no significant uncertainties about the technology's performance and dependability	+	There are no significant uncertainties about the technology's performance and dependability
	-	There are significant uncertainties about the technology's usability and acceptability	-	There are significant uncertainties about the technology's usability and acceptability
	+	There are no significant technical interdependencies	+	There are no significant technical interdependencies
	+	The technology does not require significant changes to organisational tasks and routines	+	The technology does not require significant changes to organisational tasks and routines
Value proposition	-	The commercial value of the technology is uncertain	-	The commercial value of the technology is uncertain
	-	The value to the intended users is uncertain	+	The value to the intended users is reasonably certain
	-	The value to the healthcare system is uncertain	-	The value to the healthcare system is uncertain

	-	The value to this particular healthcare organisation, given the current situation locally, is uncertain	-	The value to this particular healthcare organisation, given the current situation locally, is uncertain
	+	The technology's costs are not likely to outweigh benefits for stakeholders	-	The technology's costs are likely to outweigh benefits for healthcare professionals
Adopters	-	There is uncertainty about whether and how patients will adopt the technology	+	There is no uncertainty about whether and how patients will adopt the technology
	+	There is limited uncertainty about whether and how front-line staff will adopt the technology	-	There is uncertainty about whether and how front-line staff will adopt the technology
Organisation(s)	-	The organisation's capacity to take on technological innovations is limited	-	The organisation's capacity to take on technological innovations is limited
	-	The work needed to introduce and routinise the innovation has been inadequately resourced	-	The work needed to introduce and routinise the innovation has been inadequately resourced
Wider system	-	The regulatory context is adverse	-	The regulatory context is adverse
	+	The introduction of the innovation is not threatened by external changes that impact the organisation	+	The introduction of the innovation is not threatened by external changes that impact the organisation
Embedding and adaptation over time	-	The population with the condition is likely to change significantly over the next 3-5 years	-	How the condition is treated, is likely to change significantly over the next 3-5 years
	-	The technology is likely to change significantly within the next 3-5 years	-	The technology is likely to change significantly within the next 3-5 years
	-	The value proposition is likely to change significantly over the next 3-5 years	-	The value proposition is likely to change significantly over the next 3-5 years
	+	It is not likely that there will be significant changes to individual users' perceptions of the technology over the next 3-5 years	-	There will be significant changes to individual users' perceptions of the technology over the next 3-5 years
	-	The organisation involved is likely to have significant restructurings or changes in	-	The organisation involved is likely to have significant restructurings or changes in

	leadership, mission or strategy over the next 3-5 years		leadership, mission or strategy over the next 3-5 years
+	The policy, regulatory and economic context for this innovation is not likely to be turbulent over the next 3-5 years	+	The policy, regulatory and economic context for this innovation is not likely to be turbulent over the next 3-5 years

5. Discussion

What explains the implementation and use of ZGT Traumachirurgie-app?

This retrospective evaluation has identified several interacting explanations for the partial uptake of *ZGT Traumachirurgie-app*. Before that is elaborated on, it would fit to first discuss the promoting factors that have made the innovation what it is today. These factors mainly concentrate on the domains of technology, intended users and the wider system. The main argument here is that COVID-19 has forcingly introduced healthcare providers to eHealth. In other words: there is a chance that healthcare providers and innovators will have seen the value of eHealth innovations. As a result, an innovation process that had been going on for multiple years had been accelerated. Furthermore, it was noticed that a strong value proposition positively influences the degree of implementation. After all, at the time of COVID-19, it was impossible to ignore the added value of eHealth. COVID-19 has further created a shared sense of urgency. As a result, the teams have become smaller to be more decisive. This shows that smaller teams work more efficiently. Despite these strengths, *ZGT Traumachirurgie-app* has only had a limited impact on patient outcomes. Below, the findings on that are discussed.

Two types of impediments were found: those that can be taken away with a 'simple' intervention (e.g. becoming part of existing infrastructure, limited resources due to HiX implementation) and those that are more persistent and affect new implementation processes (growing collaboration between departments, flawed thinking about the value proposition). There is some complexity in the disease and the treatment to follow: not all fractures in the same joint are equal. Due to technology-related factors such as the innovation not being personalised, the project team has tried to overcome this problem by processing much information in the innovation. Not personalising the innovation made it possible to start using it faster because no privacy issues could arise: consulting the privacy & security officer, which is experienced as a delaying factor, was avoided. This means that patients see all the available information, including information that is not relevant to them. As a result, patients are overloaded with information, which makes the innovation not sufficiently user-friendly. This prevents its ultimate use.

Today, the innovation replaces the regular leaflets, which means that the value proposition has changed compared to the value proposition during the first lockdown. The added value has also never been investigated, and there is insufficient insight into patient experiences up until today. The fact that implementation is out of necessity, coordinated by professional practice, and no attention was paid to the influence of macro processes on innovation, testifies to applying a *participatory approach*. This makes it plausible that inferior technology has been implemented (Grol & Wensing, 2017-b). Due to a changing context, to achieve lasting use, it will be necessary to reconsider how an implementation can be approached that does justice to the complexities in and between domains being interpreted. Moreover, one should be aware that a differently formulated value proposition can also lead to changes in other domains: adopters being more willing to adopt an innovation or a descriptive standard from within the organisation to make use of an innovation.

What explains the implementation and use of FysioThuis?

This retrospective evaluation has identified several interacting explanations for *FysioThuis*' partial uptake. Before that is elaborated on, promoting factors on the innovation process which made the innovation what it is today are discussed. These factors are mainly concentrated in the domains of technology, intended users and the wider system. It has been seen that COVID-19 has forced healthcare providers to look at alternatives of care and thus acted as the flywheel for the accelerated implementation. COVID-19 has created a shared sense of urgency. There was already a long process for implementing such a program, but that project was abandoned when it turned out that *FysioThuis* could be implemented faster. The added value of the innovation is shown because patients have had good experiences with the platform so far and are happy to continue using it. This means that much attention was paid to the value proposition among the users during the implementation. Despite these strengths, *FysioThuis* has only had a limited impact on patient outcomes. Below, the findings on that are discussed.

Due to the applicable legislation and regulations, combined with the resulting delaying effect of the privacy & security officer, which is further explained in the chapter about the *ZGT Traumachirurgie-app*, the *FysioThuis* innovation was limited in its development due to the high urgency. Furthermore, the impeding factors that play are related to characteristics of the disease, technology, value proposition, intended users, organisation, wider context and embedding and adaptation over time. Earlier, a paradox was pointed out with the analysis of the quantitative data. The data analysis was based on two expectations. On the one hand, the older the patient is, the less digitally skilled and therefore the less likely they will use *FysioThuis*.

On the other hand, the longer the patient's hospital stay, the greater the need for physiotherapy. The secondary data has shown that the patient's length of stay is likely to increase with age. This then suggests that the patients who need the most physiotherapy, and thus for whom the innovation would be most valuable, are less likely to use the innovation. In scientific literature, it has also been shown that elderly people have a less positive attitude towards eHealth (Nymberg et al., 2019), even though this is the patient group that could benefit from eHealth the most. Fristedt et al. (2021) argue that individual attitudes that shape the use of technology may prevail regardless of age. Therefore, this is one factor to investigate in future eHealth implementations.

During the first lockdown, the value proposition has changed. The implementation of *FysioThuis* was not primarily based on a problem but based on the availability of technology. This, in combination with a linear implementation process, suggests a *rational approach* to implementation. This means that little or no attention has been paid to the diversity of needs in practice (Grol & Wensing, 2017-b). This shows that the value proposition for physiotherapists is not or is hardly present. Its use takes them too much time, which creates uncertainty about the extent to which healthcare professionals will use the innovation. This observation weighs heavily because the actual implementation depends on the innovation by healthcare providers – after all if the innovation is not offered at all, it is of no use to the patients.

Added-value of the NASSS framework

Looking back at the process, the innovation of the *NASSS framework* has made it possible to systematically explore relevant domains and their factors, thereby identifying complexity within and between domains. The framework's open design offers much freedom to the researcher. Using the *NASSS framework* for a retrospective analysis of the implementation process has been successful. After all, the *NASSS framework* is not initially intended to retrospectively analyse implementation processes (Greenhalgh et al., 2017), thus the scientific relevance of this study. It was noticed that the *NASSS framework* has a rather negative perspective on analysing implementations. This is because the *NASSS framework* supports recognising complexity in domains instead of, for example, success factors. As a result, facilitating factors may be somewhat underexposed: a factor that is not impeding is not a facilitator by definition.

For a simple innovation such as the *ZGT Traumachirurgie-app*, the *NASSS framework* can be helpful to perform a thorough analysis of factors that play a role and with which the innovation could or could not have been successful. Before starting the analysis, it was complicated to use the *NASSS framework* for such an analysis, but the opposite was proven. During the study, it appeared that there is much intervariable dependence and that the domains cannot be entirely seen in isolation from each other. The seven domains of the *NASSS framework* are interdependent and interact in non-linear and unpredictable ways: this is also what Abimbola et al. (2019) had found. This made writing up the research sometimes very challenging, because causal relations needed to be thoroughly investigated to find how every other domain influences one another. For example, the causal relationship could be presented in pieces in the results chapter and then merged in the discussion. The consultation moments with a ZGT researcher were very supportive.

This also shows the scientific relevance of this study: the retrospective innovation of the *NASSS framework*, thereby contributing to the further development of this framework. Greenhalgh et al. (2017) have also previously called for this. Furthermore, the ultimate goal of improving the implementation of technological innovations is to improve patient care. A start has now been made on this, which means that the study is also relevant for society.

Strengths and limitations

Due to the choice for semi-structured interviews and their specification to the study context, the repeatability of the research is reduced. Therefore, a trade-off between internal validity and external validity has taken place. An attempt was made to correct this by giving the reader insight into the interview format, found in Appendix B. The *NASSS framework* (Greenhalgh et al., 2017), in combination with the NASSS-CAT (Greenhalgh et al., 2020) and the MIDI (Fleuren et al., 2014), formed the basis for developing the interview plans but also for coding the interview transcripts. There is a high probability of recall bias in the semi-structured interviews because it is a retrospective study of the situation of a year ago. As a result, not all factors may have been optimally exposed because details may have been misremembered, distorted or forgotten (Hassan, 2005), although an attempt has been made to maximize data saturation by including all key stakeholders based on purposive sampling. Patients were not included in the data collection because implementation is an internal process (i.e. becoming a part of daily work routines) and does not necessarily depend on patient actions. Moreover, sufficient information was already available about the use.

This study identifies complexity in and between the domains of the *NASSS framework*, describes the implementation strategy chosen and shows what has been the consequence for the final use. This study does not deal with how implementation should be approached. However, the conclusion does make recommendations for the organisation and further research.

It is beyond the scope of this study to investigate the fit of the innovation strategy or provide an all-encompassing answer to where an innovation currently finds itself in the implementation process. Currently, a testing framework is missing to make this more reliable. The *NASSS framework* was designed to indicate complexity prospectively. Therefore the share of the strategy on the complexity is not measurable. It was, however, possible to look at the relationship between identified problems and the strategy that was used. Therefore, a conclusion was drawn on the extent to which the strategy responds to the complexity found.

In the results, a suggestion is made on where in the implementation process the innovations find themselves. However, the measurement of the innovation process does not rely on rigid criteria, and it is not easy to measure which phase an implementation is in. Therefore, it seems hard to express the implementation process in terms of dissemination, adoption, implementation and continued use. De Veer et al. (2011) give two reasons for this. Firstly, they argue that the stage cannot reliably be measured in innovations that are less than three years old. Secondly, in daily practice, the stages of the innovation process overlap sometimes.

It should be noted that this study is partly based on secondary datasets requested from the developer and the hospital, without any pre-planned or systematic data collection, reflecting daily clinical practice. The available data is not sufficiently representative for the entire target group of both innovations because many assumptions had to be made when processing the data. It does, however, reflect daily practice. As a result, the secondary data can give a distorted picture of reality because it is likely that patient file registration on application usage was not performed systematically. However, an attempt was made to make the assumptions as truthfully as possible to extract the most valid results. There are many differences between the number of possible users and the number of actual users for both innovations. Either of three reasons may explain the differences in the datasets and the results: first, it might not have been registered when a patient was discharged from the hospital due to death or end-of-treatment. At

least, this was not part of the dataset. Secondly, it is possible that patient file registration has not been done adequately. Third, the current electronic patient file might not fit for easy data extraction, and to export a valid dataset, a more systematic approach is needed for data collection.

6. Conclusion

The conclusion answers the following central question: “What insights on healthcare innovation can we derive from eHealth-supported change in health care delivery at ZGT during the COVID-19 pandemic, and what recommendations can be made to develop a sustainable strategy for the (further) development of fast and effective eHealth-supported care?”.

It can be found that the current degree of implementation is very limited for both eHealth innovations, and various factors that are likely to have had their influence on these implementation processes have been identified. Informed by the *NASSS framework*, complexity was identified in the condition, the technology, the value proposition, the adopters, the organisation, the wider context and embedding and adaptation over time. These complexities have complicated the fast and effective implementation of eHealth-supported care. In ZGT, adopters' widely supported sense of urgency due to COVID-19 has ensured that eHealth could be introduced more quickly. The added value of the rapid implementation for future innovations is that innovators may recognize the value of eHealth now that they have been forced to become acquainted with its possibilities. However, under the influence of urgency, the value proposition is very uncertain. The value proposition has changed for both innovations and is therefore even more uncertain. It is therefore unlikely that the accelerated introduction contributed to the continued use of these eHealth innovations. Complexities that are persistent and affect new implementation processes have been identified. The following recommendations can be done to ZGT for developing a sustainable strategy for the (further) development of fast and effective eHealth-supported care.

Recommendations for ZGT

- Before *ZGT Traumachirurgie* and *FysioThuis* can grow in their implementation, the innovations should be taken back to the drawing board. Due to the accelerated implementation, steps in the implementation process have been skipped and it is likely that inferior technology was introduced.
- Because the value proposition has proven to be an essential factor for continued use, an essential lesson for the future is identifying the value proposition of an eHealth innovation for the patients, the front-line staff, the healthcare organisation and the overall healthcare system, exploring the value proposition thoroughly, prevents implementing inferior technology because a better-informed decision can be made on whether to adopt a technological innovation or not.
- To achieve more progress in a shorter time period, work with smaller project teams.
- Invest in a more efficient assessment of innovations so that momentum is not missed. Still, even more importantly, innovations are not unnecessarily torn down in functions, detracting from the value proposition.
- Continue to develop the eHealth strategy, thereby making collaboration in and between innovation departments more efficient and thereby support further development of fast and effective eHealth-supported care.
- In technology-supported innovations, ensure that pilots are adequately documented to measure adoption and assess facilitating and impeding factors prospectively.
- Project teams and innovators should use the *NASSS framework*, and more specifically the NASSS-CAT (Greenhalgh et al., 2020), to assess possible complexity that will inform on challenges ahead of an implementation effort.

Recommendations for follow-up research

- Further research should be carried out to establish retrospective theorisation using the *NASSS framework* of technology-supported change in healthcare.
- Future research is required to determine whether an innovation strategy fits the existing facilitating and impeding innovation determinants and its influence on the innovation process.

- Further work is also required to establish a tool that can aid innovators in choosing the right innovation strategy in the planning phase.

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Appendix A: Innovation Strategy Interview Schedule

Appendix A

Innovation Strategy Interview Schedule

To date, no testing or analysis framework has been validated for assessing the appropriateness of a particular implementation strategy for a particular innovation. Therefore, I reconstruct the implementation strategy using the steps of Proctor et al. (2013).

Step	Underlying question
1) Name it	Is het mogelijk om de gebruikte strategie te omschrijven en te definiëren met behulp van bestaande terminologie?
2) Define it	-> Zo ja, hoe?
3) Specify it	
a) Actors	Door wie is de strategie uitgevoerd?
b) Action	Welke acties zijn door de actoren uitgevoerd alvorens de innovatie geïntroduceerd werd? Zijn deze acties beïnvloed door de aanwezigheid van COVID-19 en zo ja, hoe?
c) Actiontarget	Wat was het beoogd doel van de acties?
d) Temporality	In welke tijdsspanne zijn deze acties uitgevoerd?
e) Dose	In welke mate of intensiteit is de strategie toegepast en verschilde de intensiteit van de acties per afdeling? Welke individuen hebben een naar verhouding hogere dosis ontvangen, en welke lager?
f) Implementation outcomes	Welke uitkomsten zijn door het toepassen van de strategie beïnvloed? Waaraan is te zien dat er een strategie is toegepast?
g) Justification	Waarom is de keuze voor strategie zoals die is?

Based on the above topics, an interview schedule has been developed that does justice to all parts of measuring an implementation strategy. The aim is to outline a narrative that is as complete as possible in which justice is done to the practical actions of the people who implemented the strategy.

Interview schedule strategy	
onderwerp	omschrijving
Introductie	Omschrijf het algehele onderzoek op beknopte wijze.
Omschrijving strategie (chronologisch)	Nodig de respondent uit om te vertellen over de toegepaste strategie *alvorens de applicatie* geïntroduceerd werd (e.g. hoe is de applicatie tot stand gekomen?) • Nodig de deelnemer uit om iets te vertellen over het begin van het project (e.g. welke rol had COVID-19 hierin?).

- Nodig de deelnemer uit om iets te vertellen over keuzes die *vóór* de introductie van de technologie zijn gemaakt (e.g. dan ligt de app er, en dan?).
- Verschilde de geplande acties per afdeling? Zo ja, in welk opzicht?
- Welke rol heeft de COVID-19 pandemie hierin gespeeld? Zijn de geplande acties door de aanwezigheid van COVID-19 beïnvloed? Wat was er waarschijnlijk gebeurd zonder COVID-19?
- Hoe zou u uw eigen rol in deze acties omschrijven?
- Wie waren betrokken bij de uitvoering van deze acties? Wie deed wat?
- [Mits referentie naar PID *FysioThuis*]: in hoeverre is er afgeweken van dit plan? Zo ja, waarom?

Nodig de respondent uit om te vertellen over de toegepaste strategie *nadat de applicatie* geïntroduceerd is.

- Is de geplande actie *nadat de applicatie* geïntroduceerd werd bijgesteld? Zo ja, op welke manier en waarom? Waren er redenen waarom het aangepast diende te worden? Zo nee, waarom niet?
- In welke tijdspanne zijn deze acties uitgevoerd?

Zodra blijkt dat de acties nog steeds uitgevoerd worden: waarom is het noodzakelijk dat de acties worden voortgezet?

Target group

Nodig de respondent uit om te vertellen over de *target group* van de implementatiestrategie.

- Op wie waren de eerdergenoemde acties gericht? Met welke personen (functie) is gesproken om de acties uit te voeren? Verschilde dit per afdeling? Zo ja, in welk opzicht?
- Is het zo dat er meer aandacht is uitgegaan naar bepaalde personen in het implementatieproces?
    - Mits personen onderscheiden worden: waarom was het noodzakelijk dat deze personen een hogere dosis ontvingen? Verschilde dit per afdeling?
    - Welke personen waren volgens u het meest ontvankelijk voor de door u geplande acties?

Werden personen uit uw *target group* geacht om acties ten behoeve van de introductie van de applicatie te ondernemen? Zo ja, welke acties?

Outcome

Nodig de respondent uit om te vertellen over de uitwerking van de strategie (e.g. aan welke uitkomsten van de interventie kunnen we zien dat er een implementatiestrategie is toegepast?).

- Wat werd er beoogd met de strategie? Is de implementatie in uw ogen gelukt? Zo ja, waarom wel? Zo nee, waarom niet?
- Wat ging tijdens het uitvoeren van de acties volgens plan? Welke zaken gingen niet volgens plan?
    - Nodig de respondent uit om enkele voorbeelden te geven.

- [Verwachting] In hoeverre wijkt het toegepaste actieplan af van een actieplan waarin geen rekening wordt met COVID-19? Welke zaken zijn volgens u anders verlopen dat ‘normaal’?

- Eerder hebben we het over de doelstellingen gehad van de door u uitgevoerde acties. Kunnen we op dit moment zien dat de door u uitgevoerde acties effect hebben?
    - Zo ja: waar kunnen we dit aan zien?

Afsluiting Sluit het interview op een gepaste wijze af. Bedankt de respondent voor het nemen van de tijd.

Appendix B: Innovation Determinants Interview Schedule

Appendix B

Innovation Determinants Interview Schedule

The interview schedule differs for each interviewee. That means: no explicit distinction has been made in this appendix.

Ziekte

- Doel van het (deel)interview is antwoord geven op de volgende vraag: In hoeverre zouden de ziekte en gerelateerde factoren de mate waarin de applicatie is geïmplementeerd kunnen hebben beïnvloed?

1. Ik zou u allereerst uit willen nodigen om iets te vertellen over de doelgroep van de applicatie. Voor wie en waarom is de app in het leven geroepen? Wat maakt dat de applicatie juist voor deze doelgroep zinvol is?
2. [Fysieke vaardigheden] In hoeverre kan de ziekte zelf invloed hebben op het gebruik van de applicatie?
3. [Cognitieve vaardigheden] Welke ziekte-gerelateerde factoren redenen zouden er verder kunnen zijn die het gebruik van de app bemoeilijken? Hoe wordt hier mee omgegaan? (eventueel aanvullen: vanuit sociaal-cultureel of co-morbiditeit zoals laaggeletterdheid, minder goed met technologie om kunnen gaan)

Technologie

- Doel van het (deel)interview is antwoord geven op de volgende vraag: In hoeverre zouden technologische specificaties de mate waarin de applicatie is geïmplementeerd kunnen hebben beïnvloed?

1. [Definitie] Hoe werkt de applicatie?
2. [Inbedding] Hoe is de technologie in gebruik te nemen ten overstaande van de huidige technologische voorzieningen bij ZGT?
    a. [Onderdeel van digitale infrastructuur ZGT] Maakt de applicatie onderdeel uit van de digitale infrastructuur van ZGT? Zo ja, in welk opzicht? Zo nee, waarom niet?
    b. [Onderdeel van digitale infrastructuur ZGT] Is het noodzakelijk (geweest) dat de digitale infrastructuur van ZGT ingrijpend gewijzigd moe(s)t worden, opdat de applicatie kan functioneren? Zo ja, in welk opzicht?
    c. [Onderdeel van digitale infrastructuur ZGT] Zijn er wijzigingen doorgevoerd in de organisatiestructuur, opdat de applicatie naar behoren kan functioneren? Zo ja, in welk opzicht?
    d. [Onderdeel van bestaande digitale infrastructuur] Is het noodzakelijk dat patiënten hun hardware/software wijzigen om de applicatie te kunnen gebruiken? Zo ja, in welk opzicht?
3. [Procedurele duidelijkheid] In welke mate is de applicatie in heldere stappen/procedures omschreven? Geeft de applicatie helder aan welke activiteiten in welke volgorde uitgevoerd moeten worden voor de zorgprofessional en de patiënt?
4. [Evidence-based technologie] In hoeverre is de technologie gebaseerd op feitelijke kennis over de toegevoegde waarde van de technologie?
5. [COVID-19] Welke rol heeft COVID-19 in de ontwikkeling van de technologie gespeeld? Welke keuzes zijn er gemaakt? (eventueel aanvullen: welk gevolg heeft het gevoel van noodzaak gehad? Zou het mogelijk geweest kunnen zijn dat er een onderontwikkelde

technologie in gebruik zou worden genomen? In hoeverre is dit van invloed geweest op de mate van implementatie?)

6. [Haalbaarheid] Wat wordt er van de patiënt (en/of directe verzorger) verwacht - en is dit haalbaar en acceptabel voor hen?
    a. [Randvoorwaarden] Welke kennis en/of ondersteuning wordt er van de patiënt (en/of directe verzorger) vereist om de technologie te gebruiken?
7. [Verwachting ontwikkelaar ten aanzien van benodigde ondersteuning] Is het volgens u aannemelijk geweest dat patiënten/medisch professionals de applicatie zouden gebruiken, zonder dat zij hierin ondersteund worden? Zo ja, waarom? Zo nee, waarom niet?
8. [Verwachting ontwikkelaar ten aanzien van benodigde ondersteuning] Is het voor zorgprofessionals noodzakelijk geweest dat zij hun werkzaamheden op een andere manier zouden invullen, zodat de applicatie naar behoren kan functioneren? Zo ja, in welk opzicht?
    a. [Ondersteuning patiënt] Is er zo nodig technologische ondersteuning voor patiënt en zorgprofessional geregeld? Zo ja, hoe?
9. [Vervangbaarheid] Wat is de toegevoegde waarde van de technologie voor mensen met de ziekte of aandoening? Welke andere mogelijkheden zouden er zijn, in plaats van de app?
10. [Barrières] Waar wordt tegenaan gelopen in het praktisch gebruik van de applicatie? Zou dit gevolgen kunnen hebben gehad voor de mate waarin de applicatie is gebruikt? (eventueel aanvullen: overzichtelijkheid applicatie, stappen in de applicatie niet duidelijk toegelicht)
11. [Gebruiksvriendelijkheid] Hoe gebruiksvriendelijk is de applicatie? In welke mate is de technologie makkelijk in gebruik, voor zowel zorgprofessionals als patiënten? Wat zijn verbeterpunten?

Waardepropositie

- Doel van het (deel)interview is antwoord geven op de volgende vraag: In hoeverre zou de waardepropositie de mate waarin de applicatie is geïmplementeerd kunnen hebben beïnvloed?

1. [Verwachting] Nodig de respondent uit om te vertellen over de reden voor het ontwikkelen van de applicatie. Wat was de verwachte meerwaarde van de innovatie?
    a. [Uitkomsten] In hoeverre zijn deze verwachtingen uitgekomen?
2. [Waarde vraagzijde] Hoe is de invloed van de applicatie op het behandelproces gemeten? Wat zijn de uitkomsten hiervan?
3. [Waarde patiënt] Wat is de toegevoegde waarde van de applicatie voor de patiënt? (e.g. behandeldoelen, gemak)
4. [Waarde zorgprofessional] Wat is de toegevoegde waarde van de applicatie voor de zorgprofessional?
5. [Waarde organisatie] Wat is de toegevoegde waarde van de applicatie voor de organisatie?
    a. [Commerciële waarde] In hoeverre is het voor ZGT aantrekkelijk om te investeren in de applicatie?
6. [Toegevoegde waarde] Nodig de respondent uit om na te gaan of de applicatie zinvol is, wat maakt dat dat wel of niet zo is en welke andere mogelijkheden er zijn. (e.g. is de app beter dan bijvoorbeeld leaflets meegeven?) Hoe wegen de nadelen op tegen de voordelen?
7. [Compleetheid] In welke mate is de technologie compleet in informatievoorziening?
8. [Wenselijkheid] Is de applicatie wenselijk geweest? In hoeverre zou dit de implementatie hebben kunnen beïnvloeden?
9. [Kosteneffectiviteit] Is de applicatie kosteneffectief voor de organisatie? Wegen de kosten op tegen de baten? Licht toe.
10. [Veiligheid] Hoe veilig is de applicatie in het gebruik? Licht toe.

11. [Ongelijkheid] In hoeverre kan de applicatie gebruikt worden door iedereen? Is de applicatie voor iedereen toegankelijk? In hoeverre krijgen alle patiënten dezelfde zorg?

Beoogde gebruikers

- Doel van het (deel)interview is antwoord geven op de volgende vraag: In hoeverre zou de kenmerken van de beoogde gebruikers de mate waarin de applicatie is geïmplementeerd kunnen hebben beïnvloed?

1. [Waardeperceptie gebruiker] Beoordeel de applicatie met een cijfer tussen de 0 en de 10 en beargumenteer. Waarom niet hoger? Waarom niet lager? Wat gaat er goed? Wat zijn verbeterpunten? Zou u een dergelijke applicatie zelf geïntroduceerd hebben? In hoeverre staat u achter de applicatie?
2. [Mate van betrokkenheid] Nodig de respondent uit om te vertellen hoe deze betrokken is geweest bij de ontwikkeling en gebruik van de app (e.g. gebruikt u de app, of wat heeft u daarin gemist?).
3. [Bewustwording van inhoud van innovatie] In hoeverre ben u geïnformeerd over de inhoud van de innovatie?
4. [Relevantie voor gebruiker] In welke mate is de technologie relevant voor jou(w patiënt)?
5. [Uitkomstverwachtingen] In hoeverre ondersteund deze applicatie bij het bereiken van behandeldoelen?
6. <u>voor professional:</u> [Patiënttevredenheid] In welke mate verwacht u dat de patiënt tevreden is met de innovatie?
7. [Samenwerking met patiënt] In welke mate verwacht u dat de patiënt meewerkt aan het gebruik van de innovatie?
8. [Waarneembaarheid] In hoeverre zijn de uitkomsten van gebruik van de applicatie zichtbaar voor u?
9. [Professionele verplichting] In welke mate past de innovatie bij de taken waarvoor u verantwoordelijk bent?
10. [Compatibiliteit] In welke mate is de inzet van deze technologie verenigbaar met uw werkwijze? In hoeverre hebt u uw werkwijze aan moeten passen? Hoe verhoudt de app zich tot uw beroepswaarden?
11. [Randvoorwaarden] In welke mate bezit u de kennis die nodig is om de innovatie te gebruiken?
12. [Randvoorwaarden] In welke mate ervaar of verwacht u steun van u omgeving voor het gebruik van de app, bijvoorbeeld vanuit collega's als vanuit het management?
13. [Barrières] Waar loopt u tegenaan in het gebruik van de applicatie?
    a. Heeft dit gevolgen gehad voor de mate waarin de applicatie is gebruikt?
14. [Beschrijvende norm] Welk deel van de collega's in uw organisatie voor wie de innovatie bedoeld is, maakt volgens u ook daadwerkelijk gebruik van de innovatie? Hoe valt dat te verklaren?
15. [Inpassing in werkzaamheden] Welke werkzaamheden van welke collega's worden door de inzet van de applicatie beïnvloed? En hoe?
16. [Subjectieve norm] In hoeverre verwachten collega's en management dat u de innovatie gebruikt? Als het gaat om werken met de innovatie, in hoeverre sluit u zich aan bij de mening van collega's en management?
17. [Eigen effectiviteit] In hoeverre denkt u dat u in staat bent om de applicatie te gebruiken?
18. [Kennis] Welke kennis is er nodig om de applicatie te gebruiken? Bezit u deze of heeft u daarin nog iets nodig?
19. [Sociale steun] In welke mate ervaar of verwacht u steun van u omgeving voor het gebruik van de app, bijvoorbeeld vanuit collega's als vanuit het management?

20. [Persoonlijke voordelen/nadelen] In hoeverre heeft het gebruik van de innovatie persoonlijke voor-/nadelen voor jou?

Organisatie

- Doel van het (deel)interview is antwoord geven op de volgende vraag: In hoeverre zou de kenmerken van de organisatie de mate waarin de applicatie is geïmplementeerd kunnen hebben beïnvloed?

1. [Context] Nodig de respondent uit om te vertellen over hoe de weg eruit ziet van integratie in het alledaags handelen van een innovatie tot het moment dat de beoogde gebruiker er baat bij heeft.
2. [Formele bekrachtiging door het management] Heeft het management in uw organisatie formele afspraken gemaakt met betrekking tot het implementeren/borgen van innovatie (in beleidsplannen, werkplannen enzovoort)? Zijn daar formele afspraken over?
3. [Rol] Wat is uw rol in dat proces?
4. [Context] Wat is de verantwoordelijkheid van *Smartup Innovation* en waar houdt deze op?
5. [Context] Wat is de verantwoordelijkheid van I&O en waar houdt deze op?
6. [Relaties] Zou u wat kunnen vertellen over de samenwerking tussen deze twee afdelingen? Hoe zou u deze typeren? Wanneer werken ze samen en hoe gaat dat?
7. [Coördinatie] In hoeverre is er sprake van aanwezigheid van een of meerdere personen die verantwoordelijk zijn voor het coördineren van implementaties van innovaties in de organisatie?
8. [Vermogen tot innoveren] Wat is het vermogen van de organisatie om te innoveren?
9. [Visie] Wat is de visie van ZGT op eHealth? Op basis waarvan is die visie tot stand gekomen?
10. [Context] Hoe ziet u de visie van ZGT op eHealth terugkomen in de praktijk?
11. [Visie] Is dat tot nu toe goed gedaan? Waarom wel, waarom niet?
12. [Visie] Nodig de respondent uit om de persoonlijke visie met betrekking tot eHealth uit te spreken. Wat zou de rol van eHealth in het zorgproces moeten zijn?
13. [Onrustige organisatie] Zijn er naast de implementatie van Trauma-app/*FysioThuis* nog andere veranderingen in de organisatie die de implementatie van de innovatie nu of in de voorzienbare toekomst beïnvloeden (reorganisatie, fusie, bezuinigingen, personeelswisseling, overige innovaties)?
14. [Visie] Wat zijn volgens u onmisbare ingrediënten in de implementatie van een eHealth toepassing?
15. [Middelen] In hoeverre biedt de organisatie voldoende tijd, geld en middelen voor innoveren?

Context

- In hoeverre zou de externe context de mate waarin de applicatie is geïmplementeerd kunnen hebben beïnvloed?

1. [COVID-19] Welke rol heeft COVID-19 waarschijnlijk in de implementatie gespeeld van Trauma-app/*FysioThuis* en wat is mogelijk het gevolg geweest voor de uiteindelijke implementatie?
2. [COVID-19] In hoeverre verwacht u dat COVID-19 blijvend gebruik van innovaties heeft beïnvloed?
3. [COVID-19] Wat was er waarschijnlijk gebeurd zonder COVID?

Adaptie over tijd

- In hoeverre zou de (mogelijkheid tot) adaptie over tijd de mate waarin de applicatie is geïmplementeerd kunnen hebben beïnvloed?

1. [Rol in zorgproces] Functioneert de applicatie nu zoals dat beoogd was? Nodig de respondent uit om dit toe te lichten.
2. [Rol in zorgproces] In hoeverre is de rol van de applicatie in het zorgproces veranderd over de tijd heen? Hoe komt dat?
3. [Toekomstperspectief (adoptie over tijd)] Is het waarschijnlijk dat de applicatie in een periode van drie tot vijf jaar ingrijpend zal wijzigen? Zo ja, waarom en in welk opzicht?[Perceptie toekomstige waarde] Wat verwacht u van de toekomst? Wat is er nodig om de applicatie beter te laten werken? Is er ruimte voor de applicatie in de toekomst?

Appendix C: Variables in the Patient Questionnaire Dataset on *ZGT Traumachirurgie-app*

Appendix C

Variables in the Patient Questionnaire Dataset on *ZGT Traumachirurgie-app*

Variable	Description	Coding
Condition	Why are you/were you being treated at ZGT?	Ankle = 0, knee = 1, elbow = 2, wrist = 3, shoulder = 4
Age	What is your age?	-
Download recommended	The healthcare provider recommended me to download the app	Strongly disagree = 0, disagree = 1, neutral = 3, agree = 4, strongly agree = 5, not applicable = 6
Explanation innovation	The healthcare provider has given me a short explanation about the innovation	Strongly disagree = 0, disagree = 1, neutral = 3, agree = 4, strongly agree = 5, not applicable = 6
Clarity brochure	The supplied information brochure about the innovation was clear	Strongly disagree = 0, disagree = 1, neutral = 3, agree = 4, strongly agree = 5, not applicable = 6
Download	I downloaded the innovation	No = 0, yes = 1
Ease of use	The innovation is easy to use	Strongly disagree = 0, disagree = 1, neutral = 3, agree = 4, strongly agree = 5, not applicable = 6
Usage support	I needed support using the innovation	Strongly disagree = 0, disagree = 1, neutral = 3, agree = 4, strongly agree = 5, not applicable = 6
Information provided	I found the right information about my treatment in the innovation	Strongly disagree = 0, disagree = 1, neutral = 3, agree = 4, strongly agree = 5, not applicable = 6
Instructional videos	I watched instructional videos	No = 0, yes = 1
Number of videos	How many instructional videos have you watched (approximately)?	Strongly disagree = 0, disagree = 1, neutral = 3, agree = 4, strongly agree = 5, not applicable = 6
First video	In what week after you visited the emergency room did you first consult an instructional video?	Strongly disagree = 0, disagree = 1, neutral = 3, agree = 4, strongly agree = 5, not applicable = 6

Value in recovery process	Using the innovation aided in my recovery	Strongly disagree = 0, disagree = 1, neutral = 3, agree = 4, strongly agree = 5, not applicable = 6
Recommendation	I recommend the innovation	Strongly disagree = 0, disagree = 1, neutral = 3, agree = 4, strongly agree = 5, not applicable = 6
Added value	I see the innovation as a valuable addition to the care provided by ZGT	Strongly disagree = 0, disagree = 1, neutral = 3, agree = 4, strongly agree = 5, not applicable = 6
Supplied demand of care	The information and instructional videos in the innovation are (or: closed) in line with my care question	Strongly disagree = 0, disagree = 1, neutral = 3, agree = 4, strongly agree = 5, not applicable = 6
Desirability	I find it more desirable to consult instruction leaflets (paper) instead of a digital app	Strongly disagree = 0, disagree = 1, neutral = 3, agree = 4, strongly agree = 5, not applicable = 6

Appendix D: Variables in the Hospital Dataset on *ZGT Traumachirurgie-app*

Appendix D

Variables in the Hospital Dataset on *ZGT Traumachirurgie-app*

Variable	Description	Coding
Description DTC	Open text field for the healthcare professional to describe the appointment	Ankle = 0, knee = 1, elbow = 2, wrist = 3, shoulder = 4
Appointment number	Appointment number as registered in the digital infrastructure of ZGT (HiX)	-

Appendix E: Variables in the Application Dataset on *ZGT Traumachirurgie-app*

Appendix E

Variables in the Application Dataset on *ZGT Traumachirurgie-app*

Variable	Description	Coding
Condition	The type of fracture for which a patient has consulted the innovation	Ankle = 0, knee = 1, elbow = 2, wrist = 3, shoulder = 4
Consulted information	The information that the patient consulted	-
Consulted instructional video	The instructional video that the patient consulted	-
Date	The date on which a user first registered in the innovation consulted information or consulted an instructional video	-

Appendix F: Variables in the Patient Questionnaire Dataset on *FysioThuis*

Appendix F

Variables in the Patient Questionnaire Dataset on *FysioThuis*

Variable	Description
Id	Unique survey respondent identification code
Date	Date of participating in the survey
Use	How have you worked with the innovation?
Daily	How long have you worked with the innovation on average?
Weekly	How often have you worked with the innovation on average?
Social support	Have you had help from third parties (e.g. partner/family) in using the innovation?
Social support explained	If so, what did you get help with?
Technical support	Have you contacted ZGT with questions/uncertainties about using the innovation or about the exercises?
Technical support explained	If so, how did you have contact with ZGT?
Hindering factors	Did you encounter any barriers to working with the innovation?
Hindering factors explained	If so, what barriers have you encountered?
Added value	Do you think that practising at home with *FysioThuis* has aided in your recovery after COVID-19?
Added value explained	Can you explain why *FysioThuis* did/did not have added value for you?
Adaption to care demand	Did the exercise program match the phase of your recovery?
Adaption to care demand explained	Which parts did/did not?
Pros	Can you name some of the benefits of using the innovation during your treatment?
Cons	Can you name some disadvantages of using the innovation during your treatment?
Healthcare professional involvement	How do you assess the involvement of your practitioner in the treatment supported by the innovation?
Instructions	Have you received sufficient instructions to be able to rehabilitate independently with the portal?
Safety	Were you able to perform the exercises independently and safely?

Safety explained	If limited, can you explain this?
Physical interaction	Did you miss the presence of a therapist when performing the exercises independently?
Physical interaction explained	If you missed the presence of the practitioner, can you explain this?
Mark	What grade do you give the treatment with *FysioThuis*?
Broader use	Would you also like to use *FysioThuis* for other conditions that require physiotherapy exercises?
Broader use explained	If so, what conditions do you have in mind?
Suggestions ease of use	Do you have any comments or suggestions for adjustments regarding the user-friendliness of the innovation?
Suggestions to content	Do you have any comments/suggestions for adjustments regarding the treatment contents?
Suggestions other	Do you have any other comments?

Appendix G: Variables in the Hospital Dataset on *FysioThuis*

Appendix G

Variables in the Hospital Dataset on *FysioThuis*

Variable	Description	Coding
pseudo_id	Unique patient identification string	-
gender	The patient's gender	-
age	The patient's age	-
age_centered	The patient's age centered around the mean of all patient ages	-
open_field_FysioThuis	Healthcare professional patient file report, which is an open text field	-
open_field_covid19	Reason for admission	-
specialisme	Department where the patient was admitted to	-
opnamedatum	Date of admission	-
ontslagdatum	Date of discharge	-
recommended	Shows a logical value whether the patient was recommended to use *FysioThuis*	TRUE/FALSE
use	Shows a logical value whether the patient had used *FysioThuis*	TRUE/FALSE
date_diff	The number of days between *opnamedatum* and *ontslagdatum*	-
Date_diff_centered	The number of days between *opnamedatum* and *ontslagdatum*, centered around the mean	-
interactieterm_age_en_date_diff	Interaction term, shows the value of multiplying *age_centered* and *date_diff_centered*	-

Appendix H: Variables in the Application Dataset on *FysioThuis*

Appendix H

Variables in the Application Dataset on *FysioThuis*

Variable	Description
Id	Unique patient identifier
Account creation date	The date on which the patient has made an account using the invitational link
Account unsubscribe date	The date on which the healthcare provider has turned the account to inactive status
Last login	The date on which the patient has last used the account

Appendix I: Invitational Email

Appendix I

Invitational Email

Geachte heer/mevrouw,

Als student-onderzoeker ben ik betrokken bij het onderzoek van Nick Kramer naar een procesevaluatie van de implementatie van *ZGT Traumachirurgie-app* en *FysioThuis* tijdens de COVID-19 pandemie. In het kader daarvan, zou ik u graag willen uitnodigen voor een interview. Doordat u betrokken bent geweest bij de ontwikkeling van *FysioThuis*/*ZGT Traumachirurgie-app*, zou ik u daar een aantal vragen over willen stellen. Het gaat dan met name over *onderwerpen*.

Het interview zal plaatsvinden via Starleaf. Ten behoeve van de data-analyse wordt het gesprek opgenomen, maar deze wordt alleen door mij en Nick Kramer teruggeluisterd en niet verspreid. De uiteindelijke bijdrage in het onderzoeksverslag wordt geanonimiseerd en is niet herleidbaar. Van het interview wordt een transcript geschreven en deze wordt achteraf met u gedeeld. Opzegging of afwijzing van deelname aan dit onderzoek kan op ieder moment zonder opgaaf van reden.

Indien u openstaat voor een interview en akkoord gaat met bovenstaande, zou u mij willen laten weten wanneer u *tijd* beschikbaar bent? Als het niet goed uitkomt binnen deze data, dan zouden we even verder moeten kijken in de agenda.

Ik hoor het graag.

Met vriendelijke groet,
Bart Oosterink
Student-onderzoeker

Appendix J: Summary of Primary Data Collection

Appendix J

Summary of Primary Data Collection

Trauma-app/*FysioThuis*	**Role**	**Respondent number**	**Relevant innovation determinant(s)**						**Relevant for innovation strategy**
			1	2	3	4	5	6	
TA/FT	Department head	1					✓	✓	
TA/FT	Department manager	2					✓		
TA/FT	Project assistant	3			✓			✓	✓
TA/FT	Department manager	4					✓		✓
TA/FT	Project assistant	5		✓					
TA/FT	Department manager	6					✓		
TA	Healthcare professional	7	✓		✓			✓	✓
TA	Healthcare professional	8			✓	✓		✓	
TA	Healthcare professional	9			✓	✓		✓	
TA	Healthcare professional	10			✓	✓		✓	
FT	Healthcare professional	11			✓			✓	
FT	Healthcare professional	12	✓		✓				
FT	Healthcare professional	13			✓	✓		✓	
FT	Healthcare professional	14			✓	✓		✓	
			2	1	9	5	4	9	3

Appendix K: Summary of Secondary Data Collection

Appendix K

Summary of Secondary Data Collection

Trauma-app/*FysioThuis*	**Sample**	**Retrieved from**	**Relevant innovation determinant(s)**							**Relevant for innovation strategy**	**Relevant for innovation process**
			1	2	3	4	5	6	7		
TA/FT	Patient questionnaire data	ZGT		✓	✓	✓					
TA/FT	Hospital patient data	ZGT	✓								✓
TA/FT	Innovation usage data	*Telerevalidatie*									✓
FT	Project strategy document	ZGT								✓	