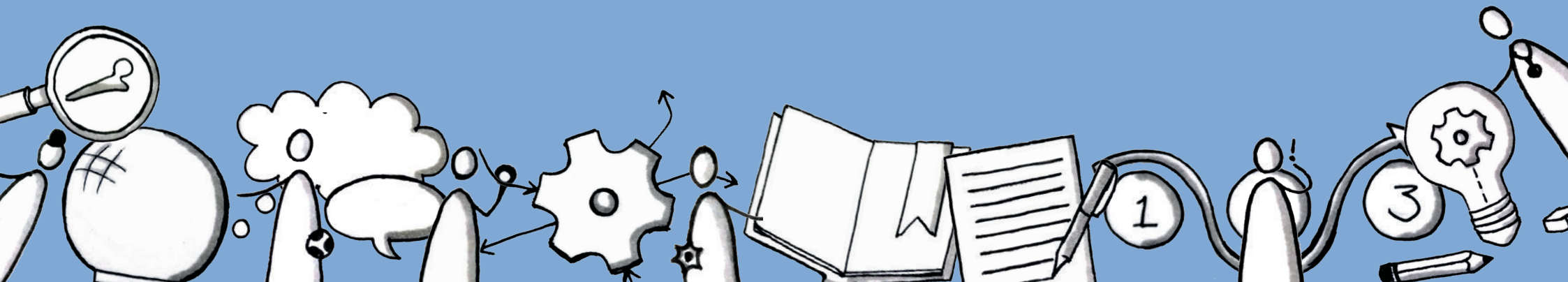
# SERVICE ROADMAPPING OF SMART CARE SOLUTIONS

## TOWARDS THE ORTHOPEDIC CARE JOURNEY OF THE FUTURE

MASTER THESIS - STRATEGIC PRODUCT DESIGN - TU DELFT
LOTTE BERNARDS

GRADUATION PERIOD:
SEPTEMBER 2019 - FEBRUARY 2020



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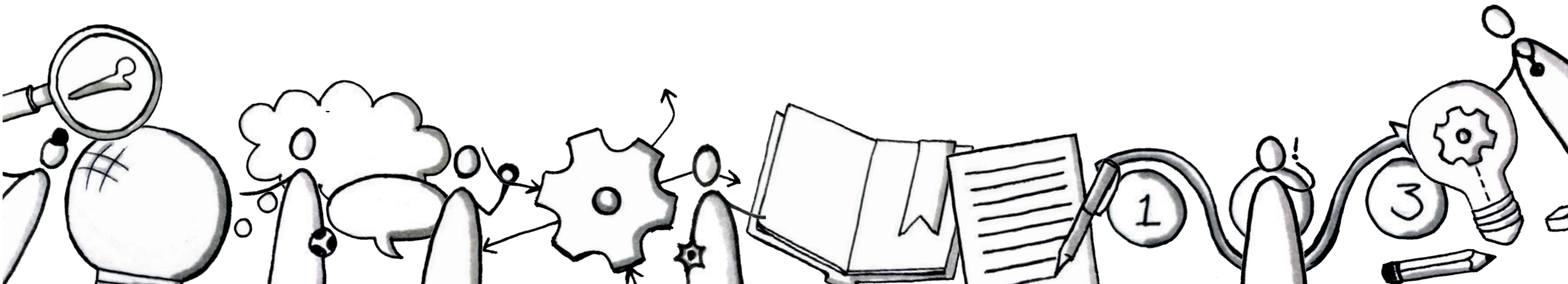


# PREFACE

In the first four years of my studies, the Master Graduation Project seemed like the impossible mountain to climb. It sounded so advanced, and so far away, that it was hard for me to create an image on the topic. But gradually, the idea of one big final individual project started growing on me. And now, here I am; writing my thank you word for my Master Thesis.
In the end I can say that setting up the project was the biggest hassle. During the project itself, I surprised myself many times in terms of skill and handling certain matters. The biggest enemy in this project was actually myself, knowing when my work is good enough instead of pushing myself relentlessly. Luckily these are one of the most important things I've learned during my years of studying Industrial Design. How I work best, what I like, and when to stop.

Concerning things I like, I think this graduation project turned out to be even better fitting for me than I initially thought. I like to deep dive into a topic, and come up with interesting findings based on analysis. Not just analyzing numbers, but people, trends and ideas. And finally, visualise these findings my own way. This project allowed me to do all these things. Although it was stressful sometimes, I enjoyed it as well.

In the realization of this project, there are some people I would like to thank. First of all my supervisors, Lianne and Armagan, for all their time, effort and knowledge to continuously improve my project in all kinds of ways. I really appreciated our meetings were we could share both a laugh and constructive feedback.

Second of all I would like to thank all the people I interviewed for this project. The OA patients for their time, openness and hospitality to meet them in their own homes. I would like my great-aunt Tony in particular here, for setting up contacts with so many different OA patients (too many to fit in this project!). And secondly, the health professionals, for providing time and knowledge in their incredibly busy schedules. I would like to thank Matthijs Netten in particular here, for setting up contact with most of them.

Thirdly, I would like to thank my family, and especially my parents, for always thinking along with me when I was feeling stuck, for a listening ear for all the insights I found, or providing knowledge on specific topics. I think my brothers had no idea what I was doing exactly, but thank you for bringing me food when I forgot to eat :)

Fourth, I would like to thank my friends, both from inside and outside my studies, for letting me strut my project stuff to you and for your valuable support.

And last but not least my boyfriend Patrick, who 'suffered' the most from my endless stories about every phase of my project. As an Industrial Design couple graduating in the same period, it wasn't always easy and we had to fight the urge to constantly compare each other's projects. Luckily our projects lied very far apart in terms of topic, and you were always there for me no matter what (too many different things to fit in a thank you word I'm afraid).

Now it is time for a next step. I am not exactly sure where it will take me yet, but I know I am excited to test my Strategic Design skills in the professional world.

# REPORT SUMMARY

The implementation of digital innovations is becoming vital in the provision of healthcare. Only this way, issues concerning employee decline and increased demand for care can be tackled. Furthermore, it is seen as the key towards Person Centered Care, a concept where patients and health professionals act as partners. Many digital multi user innovations have already been developed to a conceptual level. However, the cohesion between these concepts and their future potential is yet under researched.
This projects aims to investigate both, with a new service model and service roadmap as a result. A service roadmap can be seen as a future timeline for the service model and its supporting elements. The project tried to answer the following research question: 'How can service roadmapping enable an integrated service delivery using digital healthcare innovations?'
Orthopedic care was used as a case study for this research, based on 41 concept demonstrators aimed at improving the orthopedic care journey.

To answer the research question, a concept demonstrator analysis was performed, focusing on function, user and technology (Figure 1). This analysis showed that most concept demonstrators contained a service model focusing on achieving patient self-management, by obtaining insight, in the form of an app-wearable combination. The user analysis showed that the patient, General Practitioner, Orthopedic surgeon and the Physiotherapist should be the multi user group. And finally, the technology analysis showed a need for technological enhancements in the concept demonstrator setup.

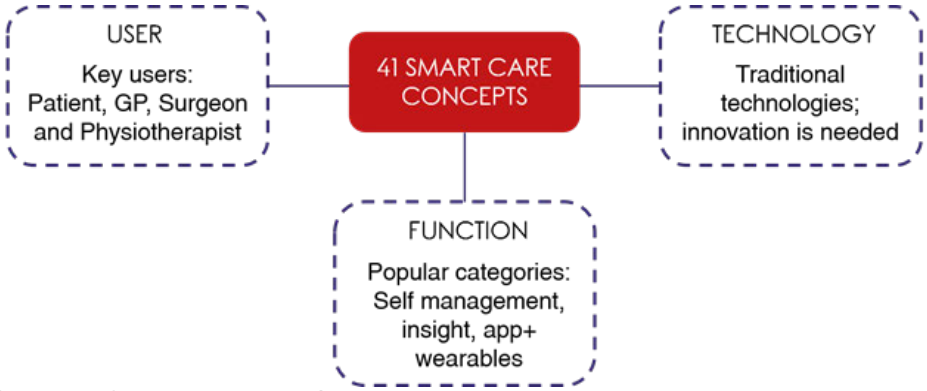



*Figure 1: Concept research*

Next to the concept research, research on the Orthopedic care context was performed, with special interest in treating hip Osteoarthritis. The

research was focused on stakeholder explorations; both desk research and performing interviews in the field. Next to that, a trend research in both the socio-cultural and technological area was performed (Figure 2). This research highlighted the need for a shared learning aspect; both for the service users and the service itself. Furthermore, a need for enhanced personalisation, information and communication was found, with the preservation of the 'human' aspect.

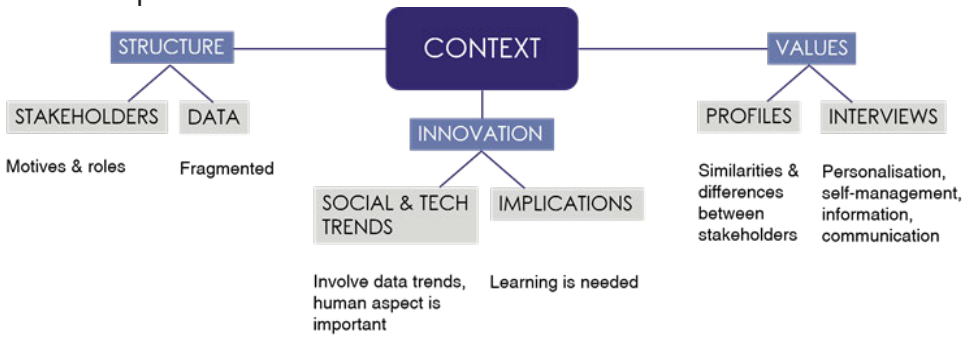



*Figure 2: Context research*

Based on this research as a whole, three visions were created, next to a selection of 13 concept features from the concept demonstrators. These form the basis of the service model. It consists of an patient app, on body wearable and a plugin for health professionals, making it a multi user service (Figure 3). The service model will focus on providing information and feedback to all users in a personalised manner, about the patient status within the Osteoarthritis treatment. Furthermore, it allows for digital communication to occur. Future adjustments are primarily focused on improving the back end of the service, by adopting shared learning with help of Artificial Intelligence. This allows for minimal adjustments in workflow, but great improvements in learning activities. Ultimately, patient and health professional become partners in the Osteoarthritis treatment. In this way, Person Centered Care is achieved.

To summarize both the drivers for innovation, the service model setup and the back-end enablers in the context of time, a service roadmap was developed. Both a strategic one to act as a summary and an in depth tactical version were created (Figure 4). These roadmaps can be used by the Smart Care Lab of the TU Delft to start further dialogue with stakeholders in orthopedic care, as well as a starting point for new projects focusing on user interactions of the service model, algorithms development and an implementation plan.

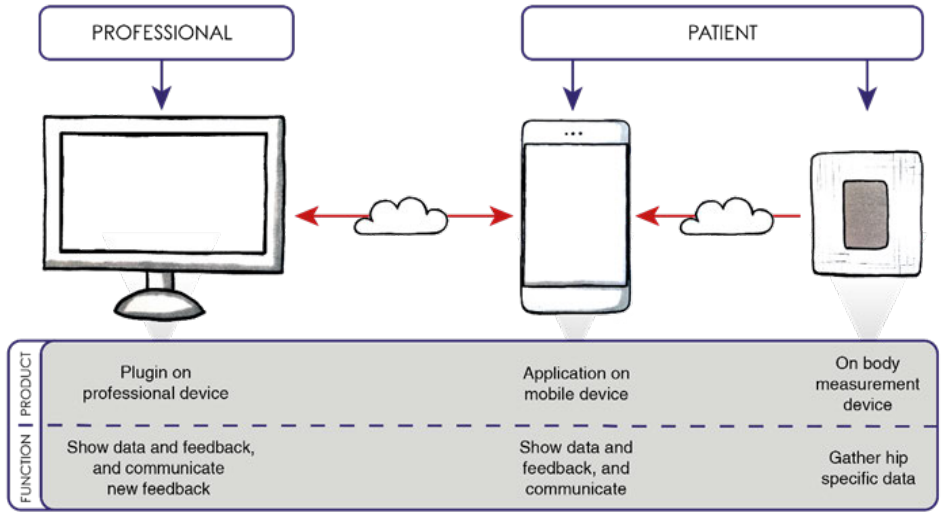



*Figure 3: Service setup*

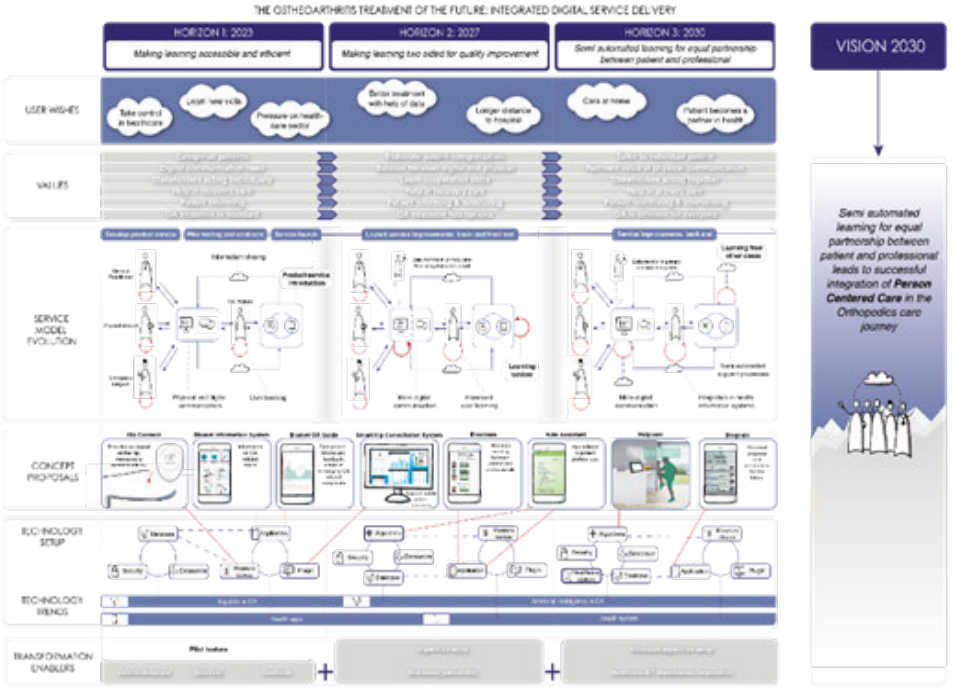
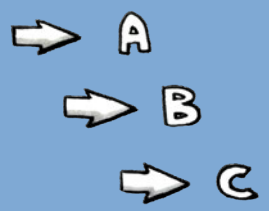



*Figure 4: Service roadmap*

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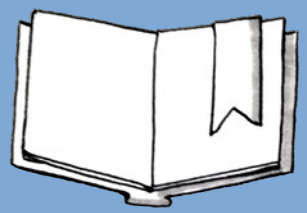
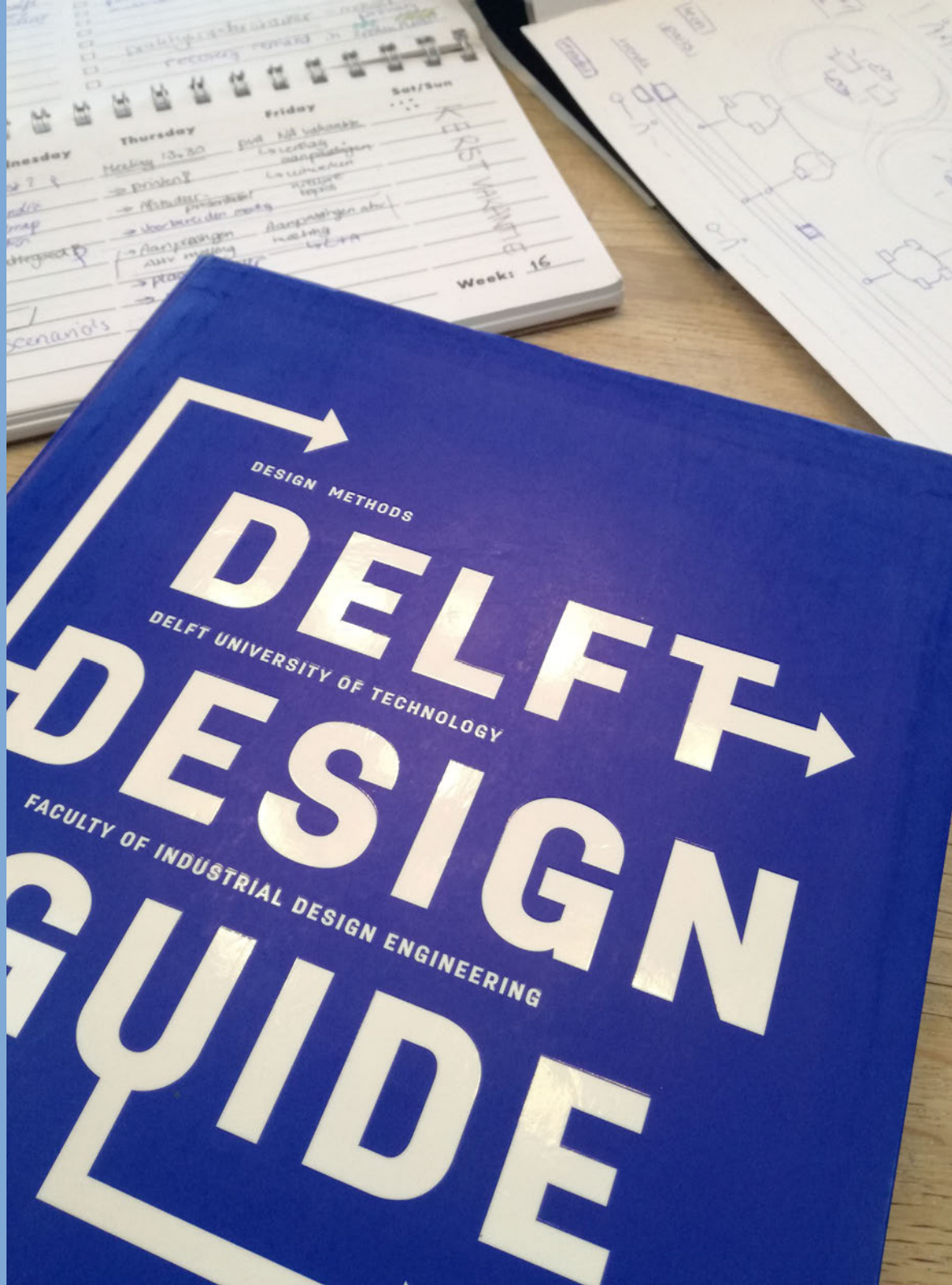
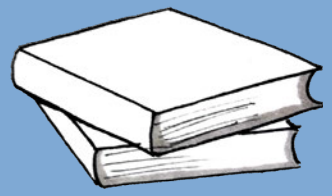


# BIBLIOGRAPHY



| | |
|---|---|
| AI | Artificial Intelligence |
| ACD | Advanced Concept Design; a master course within the master programmeIntegrated product design at the TU Delft |
| FIS | Fysiotherapeut Informatie Systeem (Physiotherapist Information system) |
| GP | General Practitioner |
| HIS | Huisarts Informatie Systeem (GP information system) |
| LOS | Length of stay; in the hospital after surgery |
| OA | Osteoarthristis |
| PCC | Person Centered Care; an equal partnership between patient and professional in the treatment process |
| RRP | Rapid Recovery Program; shorter stay at the hospital after hip surgery |
| THA | Total Hip Anthroplasty; a person receiving a hip prosthesis with help of surgery |
| ZIS | Ziekenhuis Informatie Systeem (Hospital information system) |



# INTRODUCTION: A LITERATURE REVIEW

This chapter gives an overview of all the relevant literature found within the context of this project.

## Challenges in the healthcare sector

The current Dutch healthcare industry can best be described as a dynamic sector. Although it is conservative in nature, societal developments are forcing to critically evaluate and innovate healthcare practices in all its facets (Wortell, 2018).

The Dutch population is in a process of ageing. The baby boom generation is in a state of retirement. According to CBS (2017), the number of 70+ aged people is increasing with 34% towards 2,75 million people in 2025. This has two effects on the healthcare sector. On one hand, it increases the demand for care. And on the other hand, it decreases the amount of healthcare professionals (van Meeuwen et al., 2015). This results in a skew distribution between care supply and demand, and an increase in health costs. While a shortage in healthcare professionals can technically be solved, this turned out to be difficult because of the unfavorable reputation of the sector and a small amount of new personnel as a result (Wortell, 2018).
Next, the relationship between patient and health professional is changing. The patient used to see the healthcare professional as an authority. However, the rise of the Internet caused the patient to develop a more critical attitude towards professional expertise and look for information themselves. (van Geerse et al., 2019). This attitude is also encouraged by the government. The developments in knowledge acquirement makes that healthcare professionals should focus on new or different user values than merely disease information (Thakur, Hsu & Fontenot, 2012, Wu et al, 2011).

The industry developments result in the challenge to increase efficiency in healthcare, to remain quality of care with a smaller amount of resources. Another challenge is to redefine the value of the health care professional for the patient, where the patient itself is more involved in self-management.

## Person Centered Care

As an answer to these challenges, the phenomenon ‘Person Centered Care’ (PCC) has taken a flight in popularity (Ekman et al., 2011). Also known as ‘Patient Centered Care’, PCC means that health professionals actively involve the patient in the care and decision making process. (Wildevuur & Simonse, 2015) First elements aligning with PCC already date back to the 1960’s, but its’ current form developed from the early 2000’s until today (The

Health Foundation, 2016). Adopting a PCC approach in practice is associated with an improved health status and satistaction of the patient and an increased efficiency of care (Ekman et al, 2012). Ekman et al. (2011) has established 3 routines that characterize the PCC practice.

**1.** Starting a narrative with the patient, to unveil patient preferences, beliefs and values.
**2.** Shared decision making; create a partnership between patient and professional, and evaluate all treatment options at the moment of diagnosis.
**3**. Documenting patient preferences, beliefs and values; make the sharing of information transparent.

While these three routines provide an image of what PCC is about, the question still remains how PCC is actually implemented in practice. Since this working approach strongly deviates from the traditional care approach with the healthcare professional as an authority symbol, the innovation approach also needs to be different.

## Towards PCC; the innovation practice

So what is healthcare innovation then? Within this project, the definition from Thakur, Hsu & Fontenot (2012) is used to describe the term 'healthcare innovation': 'Those changes that help healthcare practitioners focus on the patient by helping healthcare professionals work smarter, faster, better and more cost effectively.' These changes apply to both administrative and organisational changes, but also to contact with the patient. This definition shows that healthcare innovation is about moving towards a PCC approach.

The innovation practice in the healthcare sector is unique compared to other fields, due to the interplay between a strongly regulated nature established by the government on one hand, and a large influence from technological developments on the other. Herzlinger has illustrated this further by establishing 6 forces that drive or hinder innovation in healthcare in 2006, which is still concerned relevant today (Moreira, Gherman & Sousa (2017);
**-Players;** stakeholders in the healthcare system have a significant influence on which innovations are adopted and which aren't. Innovation can be seen as a threat to the current business model.
**-Funding;** funding for new products or services with a patient focus can be difficult because few health care investors possess expertise in this area.
**-Policy;** the challenge to innovate within complex hospital hierarchy and regulations such as the privacy norms
**-Technology;** Technology for healthcare is often advanced in development, but the challenge is to relate it back towards real life integration.
**-Customers;** Patients' attitudes require innovations regarding self-management, but not every innovation in this area will be accepted.
**-Accountability;** who is responsible for the performance within the adoption of a new product or service.

These 6 factors interact with each other, and only when all 6 factors show positive outcomes, an innovation is likely to succeed in practice. This makes innovation in healthcare a complex activity. Thakur (2012) and Gemert-Pijnen et al. (2011) therefore plead for a continuous dialogue between both healthcare managers, healthcare practitioners and other relevant stakeholders.

## Design methods for digital innovation

The research of Herzlinger and Thakur, Hsu & Fontenot showed the nature of the innovation practice in healthcare, but the question remains how innovation activities are performed, and in what direction?

Currently, a lot of innovation practices take place in the field of digitalization. This is because studies on innovation have indicated that success and survival of the health care industry depend on the effectiveness and efficiency of ICT use or implementation (Wildevuur & Simonse, 2015). In the search for digital innovation, an incorporation of the PCC approach becomes vital. These goals drive healthcare institutions towards the development of new service designs and product service systems (Chamberlain & Craig, 2017). However, as Simonse Albayrak & Starre (2019) already indicated, this activity is complex: it requires bridging of technology, business and people aspects, and a different management approach than the current work practice within healthcare. This is where designers come into play. Designers are skilled to deal with complex, multi facet problems and can come up with innovative ideas. To do this, they make use of design methods. Next to 'traditional' methods, these existing methods are also being specified for use in a healthcare context.

A first example is the care pathway. This method can be seen as a derivative of an actor network. A care pathway is defined by Vanhaecht, de Witte & Sermeus (2007) as 'a complex intervention for the mutual decision making and organisation of care processes for a well-defied group of patients during a well-defied period'. Complementary to the care pathway is the care pathway model, which Is a visualised version of the care pathway. Care pathways and care pathway models are used to give insight into care procedures, make care processes manageable and show possible improvements in care processes (Oosterholt et al., 2017)
Examples of care pathway use are the cases of Oosterholt et al. (2017), Geerse et al., (2019) and Verhees, van Kuijk & Simonse (2017), where both the current and new care process were mapped in a care pathway model, to show how service innovation can improve the management of THA surgery, blood pressure monitoring and primary care.

Next method is the patient journey, which derived from the customer journey (Simonse, Albayrak & Starre, 2019). A patient journey is defined by them as a 'comprehensible representation of a health service and its procedures, including relationships and feelings from a patient perspective'. The method is used to centralize the patient within the treatment process, and highlight pain points concerning experience. This tool can serve as a basis for improvements in care processes.
An example of patient journey use is the case of Simonse Albayrak & Starre (2019), studying the VCE procedure from a patient perspective, and highlighting key activities in the patient journey process.

## The value of service roadmapping

Overall, research has indicated that the care pathway and patient journey are excellent methods for developing a clear vision of the current practice for efficient management, reveal important issues and show possible improvements for service offerings working towards implementation of PCC. However, the methods pay little attention to a long term future strategy in service innovation. This topic is also barely discussed in literature.

Therefore, this project tries to fill this gap in literature, by advocating the use of a service roadmap for digital innovation in healthcare. To clarify this method, definitions are in order. In this project, a roadmap is defined as a 'visual portray of design innovation elements; user values, new products or services, and technologies, plotted on a timeline, towards a future vision'. (Simonse, Hultink & Buijs, 2014). Consequently, a service roadmap is a roadmap where value propositions are centralized, and its evolution over time is presented. It will show how services can improve the care experience for all stakeholders involved.

A few articles mention the use roadmapping in healthcare (Geum et al., 2011, Tierny, Hermina & Walsh, 2013, Shakshuki & Reid, 2015). However, most of these articles use a different definition of a roadmap then the one formulated by Simonse, Hultink & Buijs; they are poorly visualized, are not working towards a future vision, and mostly pay attention to technology development. Geum et al. (2011) does mention a connection with products and services and formulates six types of integrated roadmaps based on internal relations between product, service and technology. Nevertheless, attention to user values remains limited. Thierny, Hermina & Walsh do integrate landscape drivers in their roadmap, but they have no clear connection to either the time aspect, the users, or products and services in the roadmap.
Next to the use of roadmaps, a few articles have mentioned the development of an implementation model for a healthcare context (Kilbourne et al., 2007), for example the REP framework. This model provides a useful step by step process and guidelines, but the service itself and stakeholder roles are missing in the process visualtisation.

## Research question

To conclude, this project will try to answer the following research question:

***How can service roadmapping enable an integrated service delivery using digital healthcare innovations?***

Meaning project will investigate the unexplored area of service roadmapping in healthcare. The service roadmap will show both connections between products, services, technology and stakeholders, but also serve as a communicative tool showing implementation activities step by step towards the future, where the service offering is continuously evolving.

## Notes on the roadmapping method

The book 'Design Roadmapping' (Simonse, 2017 pp. 16-19) explains the execution of a roadmapping project in detail, and is used as a basis for the workflow setup of this project. It proposes three stages in performing a roadmapping project; value mapping, idea mapping and pathway mapping. (Figure 1). In this project, the same topics as this roadmapping process will come across, but in a different setup. The chapter 'Research & Design Approach' will discuss the project approach in depth.

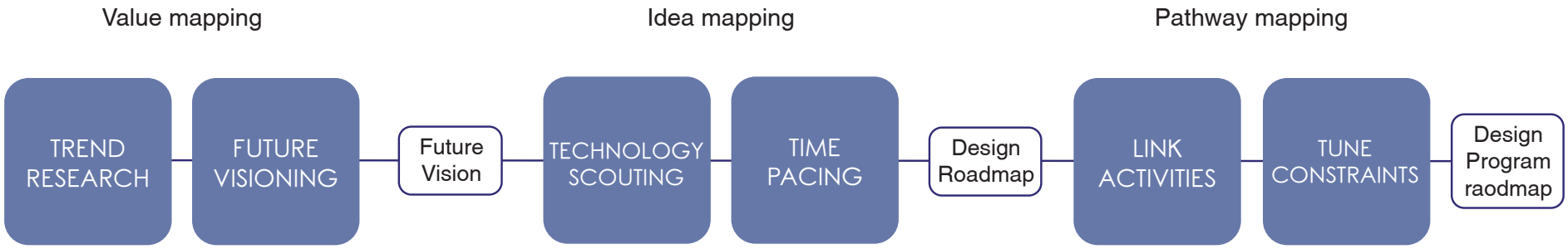
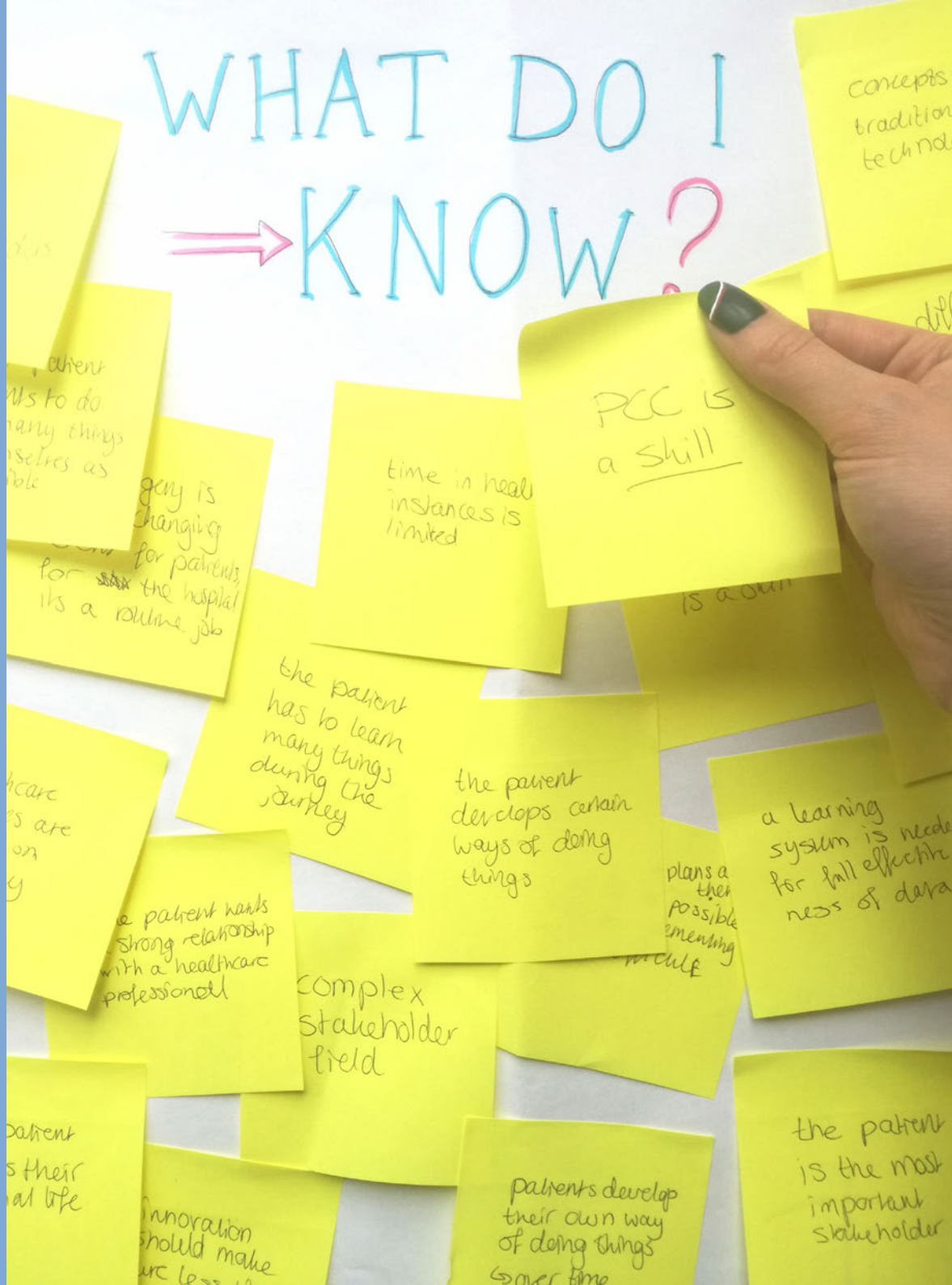



*Figure 5: The roadmapping process. Adopted from Simonse, (2017).*

# ASSIGNMENT

This chapter builds upon the conclusions of the literature review, and explains the problem definition and assignment of this project.



The contents of this chapter derived from the project brief; a document initiating the execution of this project. The original project brief is attached at the end of this report

## Problem definition

This project will zoom in on existing concept proposals within the topic of smart care in orthopedic care. Over the past 7 years, numerous of these projects have been carried out during the Master course Advanced Concept Design at the TU Delft as part of the HiPP project. Basic categorization mapping showed that more and more of the resulting concept proposals consist of smart care solutions with multiple users, containing sensors, data and internet technology. However, the concepts are generated separately from each other which make them fragmented on a system level. There has not been looked at the common ground between the concepts in terms of service delivery. Investigating the cohesion between the concept proposals could significantly raise their potential to innovate the patient journey in orthopedic care.

The formulation of a service roadmap for the Smart Care Lab can help communicate the cohesion between concepts and their innovation potential to eventually achieve an *integrated* service delivery. Within this project, 'integrated' means service embedding in multiple stages of the care journey, allowing for engagement of all relevant stakeholders. Service roadmapping is yet uninvestigated in the field of healthcare, but it has proven to be the perfect tool to show product-service innovation concepts in the context of time, and the connections between these concepts.

This project will investigate how service roadmapping can enable an integrated service delivery with multi user smart care solutions in orthopedic care. Reports from the Advanced Concept Design (ACD) course will be used as input in this research. The concept proposals formulated in these reports function as **concept demonstrators**. This formulation implies the concepts are used as examples within the bigger picture of performing a service roadmapping project. The final service roadmap can be used by the Smart Care Lab to show clear innovation potential to stakeholders, and the roadmap development process can also be repeated in other implementation contexts.

## Assignment

The final deliverable of this project is a service roadmap for the Smart Care Lab, for the upcoming 10 years. This means the service roadmap shows the sequence and timing of implementation for a selection of concept demonstrators about smart care in orthopedic care. Next to this, it shows the relations beween concept demonstrators and their supporting factors. For example external trends, or required technologies.
A patient journey created for total hip replacement surgery patients by A. Albayrak will serve as the target context for the roadmap. This target context is also used by the master students developing the ACD reports.

To come up with a selection of concept demonstrators, qualitative research is performed, into the current organization, innovation activities and values in the orthopedic care sector. This implied both desk research and field research.This research phase allowed to validate which concept demonstrators have high implementation potential, and develop a service model as a basis for the roadmap. In this project, a concept demonstrator with a high potential means it has strategic fit with the future goals of the important stakeholders, fits with a Person Centered Care approach, a link with innovation developments in the healthcare field, and is easy to combine with other concept demonstrators; allowing to add to each other's' strengths and build up on each other in time, continuously improving the patient journey in the future.


# RESEARCH & DESIGN APPROACH

This chapter builds upon the suggested method of this project; service roadmapping. It explains how a research & design approach will be executed in order to generate a service roadmap. Furthermore, this approach is compared to the roadmapping approach by Simonse (2017).

## Adapting the roadmapping approach

In the 'Literature Review' chapter, the Roadmapping process by Simonse (2017) was discussed and shown in Figure 5. In theory, it would be possible to follow this process as prescribed. However, some requirements within this project limit the use of the Roadmapping process as is. Therefore, a new setup was created based on the requirements of this project.

A project related to digital innovation implies an early investigation of technology. Therefore, the technology scouting step has to happen before a future vision is formulated. In this way, it plays a more prominent role in the future vision, matching the goal of this project.
Furthermore, the use of existing concept proposals requires a different roadmapping approach. Currently, there is no specific indication for an investigation of existing service offerings in the roadmapping process. Only the technology scouting step could loosely be associated with a concept analysis, but it does not suffice as a full analysis. Therefore, the concept analysis step should be added.
Consequently, a service model step should be added to the process as well. The service model serves as the result of the concept analysis; combining the most promising ones into a new offering.
To keep the project approach consice next to all the new additions, it was chosen to combine the 'time pacing', 'link activities' and 'tune constraints step into one step; service roadmap development.

Figure 6 shows how the alternations to the traditional roadmapping process lead to the research & design approach used in this project.

## Project approach

This project is executed by following two cycles; a research and a design cycle. Both cycles consist of two big topics to investigate.

The research cycle is executed first. The cycle consists of an elaborate exploration on the context of interest and the concept proposals. The context analysis focused on context setup, trends and values, with special interest in orthopedic care. This investigation is done with both information obtained in the ACD reports, but also by speaking to relevant stakeholders. At the same time, a concept analysis is performed, to work

towards a concept selection. The analysis of context and concepts is a back and forth process. Halfway through the project, the research phase is finalised by formulating future visions and formulating a concept selection. With these findings, a conceptual product service system is set up, with a accompanying service model to show the bigger contextual picture in orthopedic care. Finally, the service model and all the relevant research findings are summarized into a strategic and tactical service roadmap.

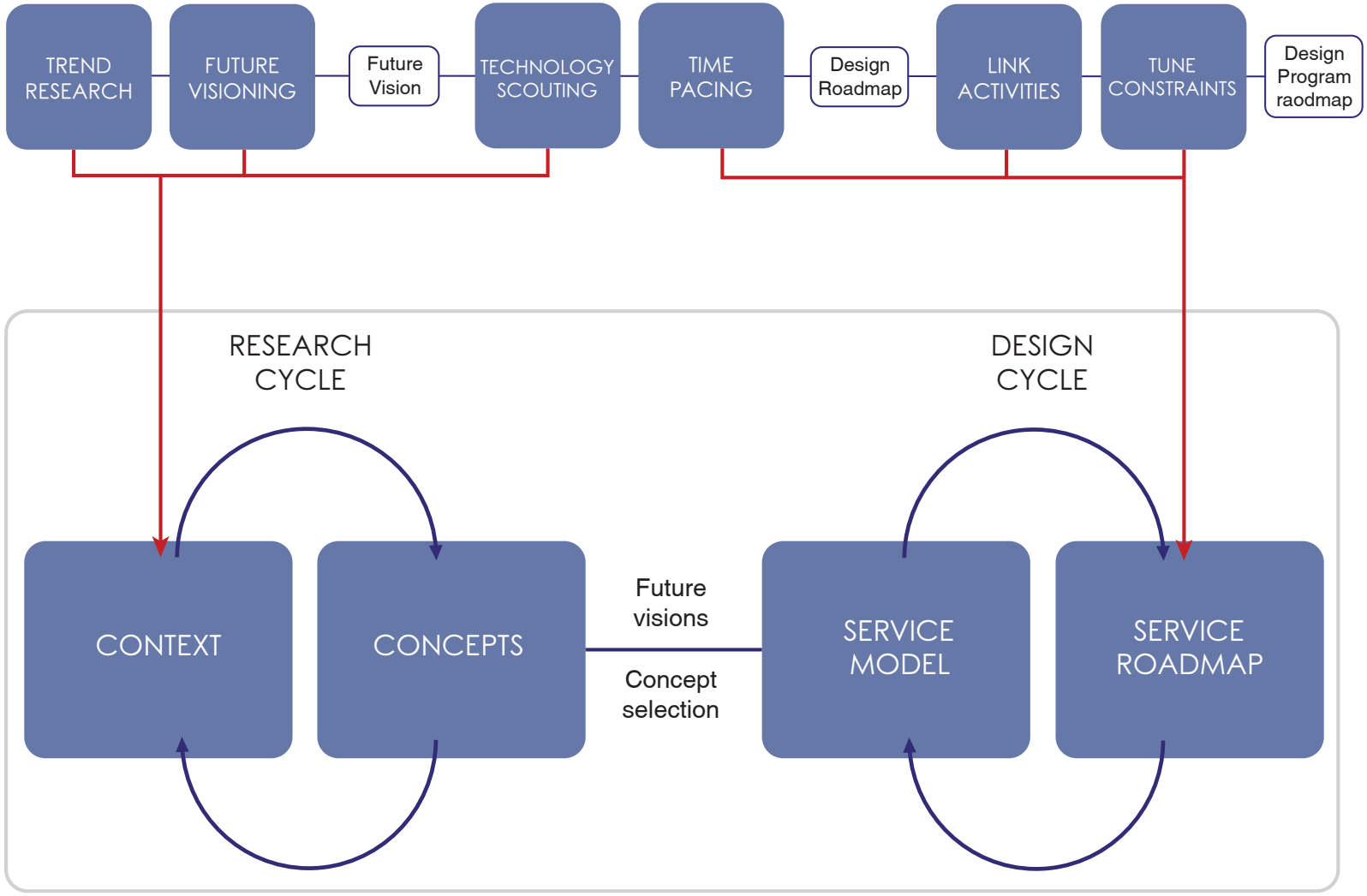
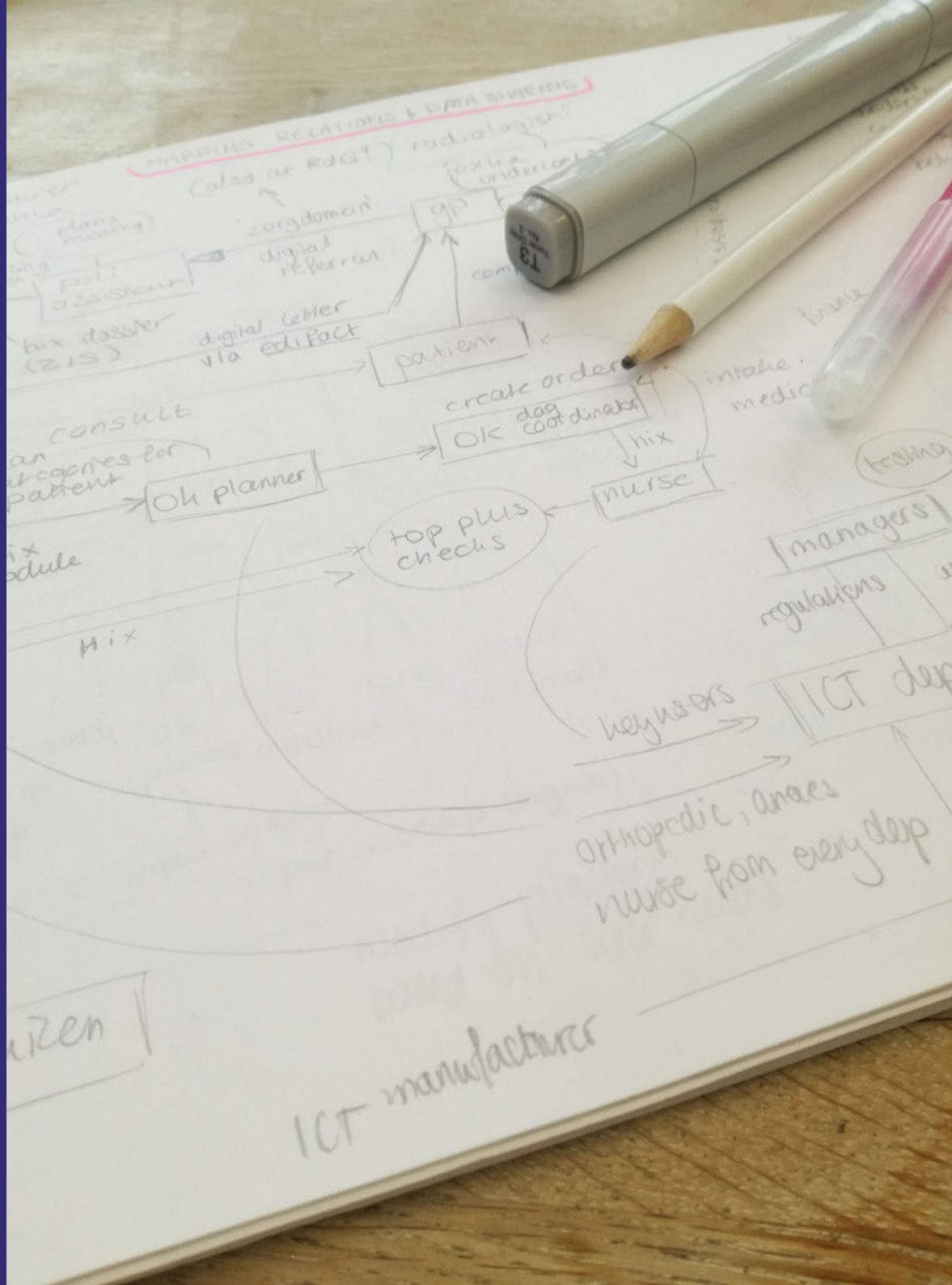



*Figure 6: Scematic overview of project approach*

# INTRODUCING THE ORTHOPEDIC CARE CONTEXT

As a start of the research phase, it is of great importance to investigate the context of interest. In case of this project, this context is orthopedic care. The research works from a general setup of the healthcare system to the setup of the orthopedic care procedure. Finally, a bridge between the context and concept analysis is build.



# QUALITATIVE RESEARCH METHOD

In this research project, 68 reports created by Master students during the course Advanced Concept Design (ACD) at the TU Delft will be used as an input basis for qualitative research. The ACD reports were generated within the HiPP project. The HiPP project is a research consortium between the TU Delft, Reinier de Graaf Hospital and Zimmer Biomet. The goal of this collaboration is to improve the patient journey during a Total Hip Arthroplasty (THA). Therefore, all the ACD reports generated also address the topic of orthopedic care, and more specifically the hip Osteoarthritis treatment.

This research project follows the focus of the ACD reports, and uses orthopedic care and hip Osteoarthritis as the context of interest. Information from the ACD reports is used in several ways within this project. It is used to both explore the orthopedic care context, and the concept proposals.

This chapter will perform a first exploration on the orthopedic care context, based on research performed on the ACD reports. Basic understanding of orthopedic care and hip Ostoarthritis is necessary to understand the setup of the concept demonstrators, investigated in the next chapter.

# CONTEXT LAYERS

As explained in the previous section, this research has an interest in orthopedic care and hip Osteoarthritis. However, this context operates in a bigger picture. To illustrate the landscape in which the context of interest is set, Figure 7 was created. On top is the Dutch healthcare system, the backbone of care. From there, contexts become more specified. This goes from levels of care (primary and secondary), to provision of care (GP, physiotherapist, hospital), towards orthopedic care and hip Ostoarthritis. The blue blocks indicate the topics that are most important to discuss in this chapter, since they provide the necessary understanding for the concept demonstrators.

Research on the other context layers can be found in “Appendix A: OA Context”.

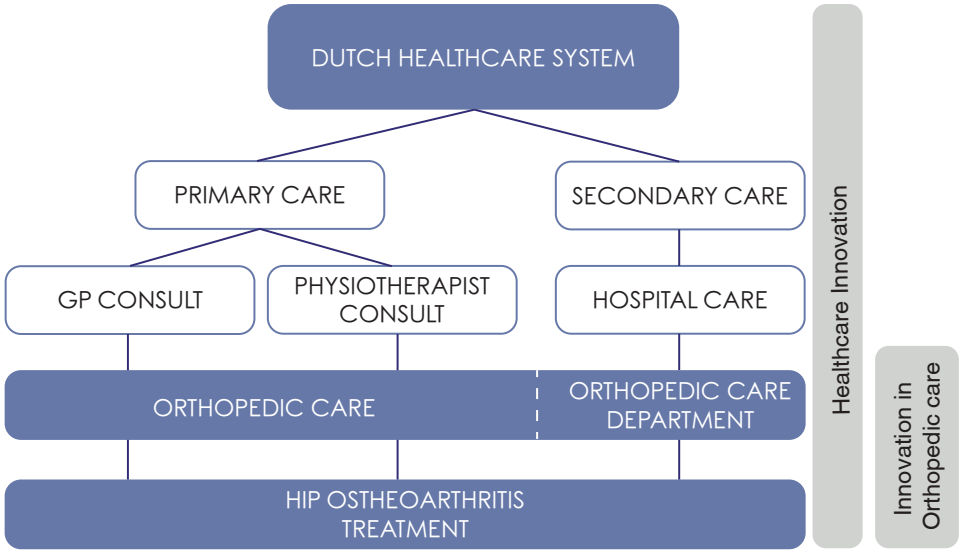



*Figure 7: Context layers*

# THE DUTCH HEALTHCARE SYSTEM

As Figure 7 indicated, the main context of this project is the Dutch healthcare system. By knowing the basic functionalities of this system and who belongs where, a fitting service model can be developed. Figure 8 shows the basic setup of the the Dutch healthcare system. In the Netherlands, we have five laws that stand as the basis of the healthcare system. In line with these laws, several layers of care are distinguished. The most important ones are primary care and secondary care. Stakeholders in primary care are the first points of contact for a patient with a certain complaint, the GP for example. Stakeholders in the second-line care are only visited after a referral, the orthopedic surgeon for example.

Furthermore, it is good to know that there are three types of roles to distinguish in the healthcare system: healthcare provider, healthcare recipient and healthcare purchaser. This means that there is a third party taking care of the financial side of health, in contact with both the healthcare providers and recipients. These are the health insurers, strongly regulated by the government. This setup is unique compared to the healthcare systems of other countries.

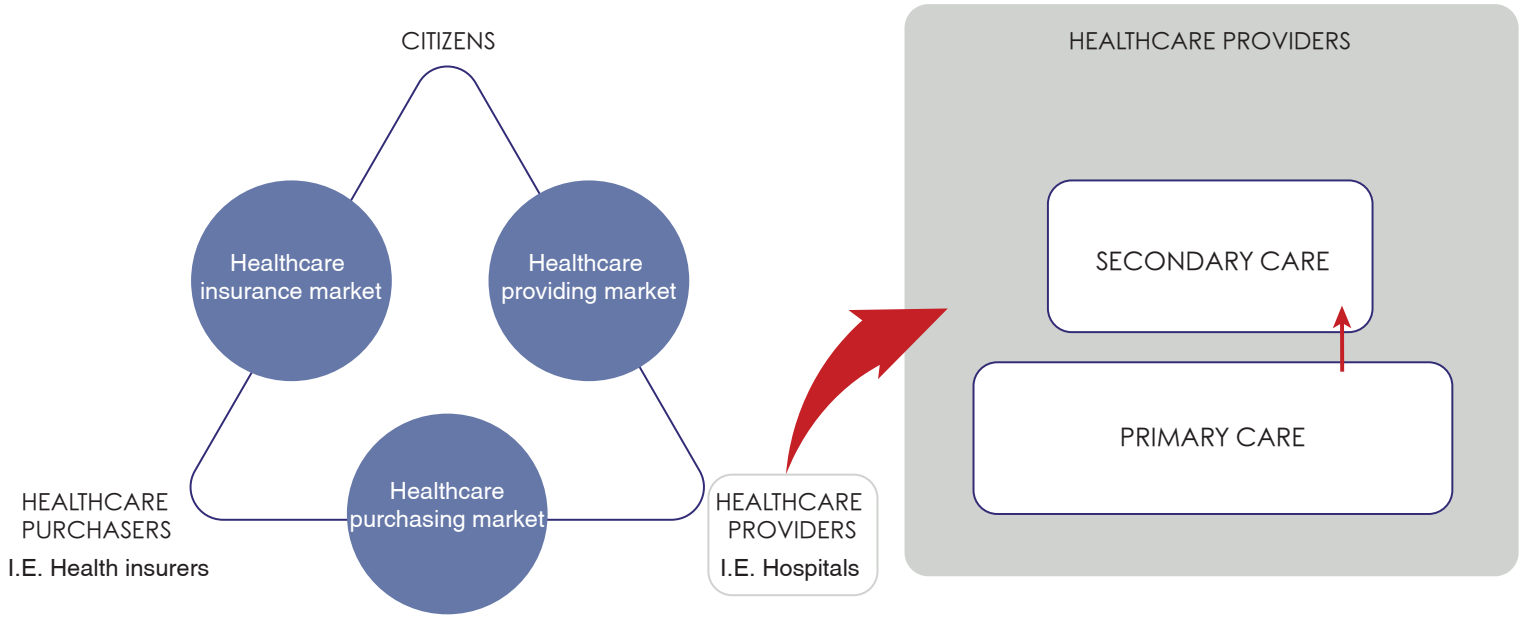



*Figure 8: The health market with different levels of care*

# (HIP) OSTEOARTHRITIS

Within the Dutch healthcare system, orthopedic care is a specialised sector which, amongst other activities, deals with Osteoarthritis patients. Osteoarthritis, also known as OA, is the most common chronic joint condition. (Healthline, 2018). In 2018, 1,5 million people in the Netherlands were diagnosed with this disorder (Volksgezondheid en Zorg, 2018). OA mostly affects elderly people and more women than men, but it can happen to any adult.

With OA, the cartilage of a joint in the human body breaks down; it thins and becomes rougher (Figure 9). This causes the bones of the joint to rub against each other, making movements with the joints less smooth and painful (Thuisarts, 2018). OA can happen in any joint, but it occurs most often in the neck, lower back, hands, feet, knees and hips. The knee and hip Osteoarthritis is the most common form in the Netherlands, with 47,700 and 31,100 diagnosis in 2018 alone (Volksgezondheid en Zorg, 2018).

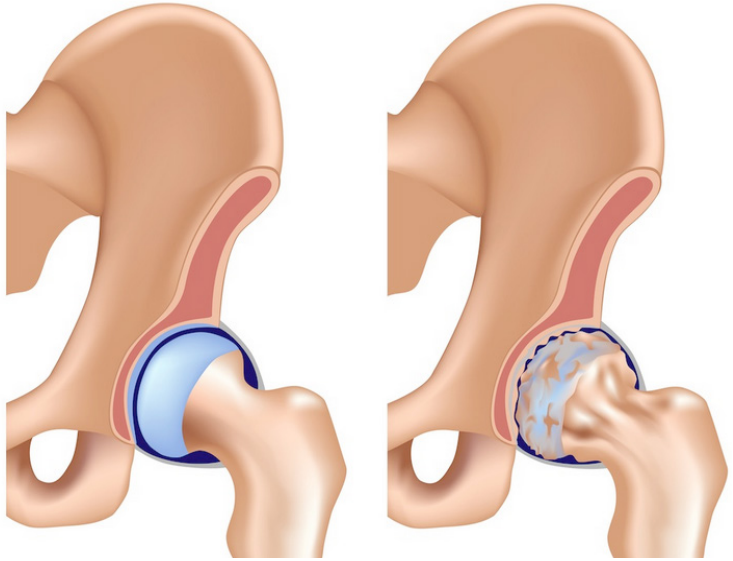


*Figure 9: Scematic overview of OA in the hip left healthy, right OA. (Image source: Setyo, 2015)*

## Management of the disorder

The most common actions that are taken after the diagnosis of OA is **exercising**. It is important that the joint is moved regularly, but overcharging has to be avoided. Research has shown that exercising can significantly improve physical health of OA patients, and thus a limitation in complaints (Devos-Comby, Cronan, and Scott Roetsch, 2006).
When the OA related pain complaints get worse, it might be decided to perform Total Hip Anthroplasty (THA surgery). In the case of the hip, the affected joint will be replaced with a prosthesis. Recovery after THA surgery is speed up in recent years thanks to the development of the Rapid Recovery Program (RRP) and Fast Track surgery. (Oosterholt et al, 2017, Kehlet & Thienpont, 2013). More information on this these innovations can be found in “Appendix A: OA Context”

# OA TREATMENT PROCEDURE; PATIENT JOURNEY

Figure 10 on the next page shows how the current OA treatment process is set up in the case of a THA procedure; the patient journey. There are 8 phases to distinguish, where the patient is always centralized, and its relation to the other stakeholders is presented. This patient journey is based on the research of Dr. Ir. A. Albayrak and was given as one of the starting points for further research, next to the ACD reports.

The total duration of the Patient Journey can be a maximum of 8 years. The longest phase is the ‘General Practitioner consult’ phase. A patient can spend up to 7 years in primary care before going to a specialist for surgery. Waiting for the surgery itself can also take up half a year. And after that, the recovery phase takes up several months. The patient journey presented in Figure 10 will be the application context for the final service roadmap.

| | PREVENTION | FIRST COMPLAINTS<br>Years to months before surgery | GENERAL PRACTIONER CONSULT<br>Years to months before surgery | DIAGNOSIS (IN THE HOSPITAL)<br>Months to weeks before surgery |
|---|---|---|---|---|
| PATIENT | The patient gets aware of the first signs and starts doing exercises. | The patient experiences the first complaints, usually in the groin. | Patients put effort into dealing with their complaints by physical exercise, seeking out information and sharing with others. | The patient gets diagnosed by the orthopedic surgeon. |
| INFORMAL CAREGIVERS | | | | An informal caregiver often joins the patient to the orthopedic surgeon. |
| GP | At the GP practice, information leaflets about hip complaints are provided to everyone visiting the clinic. | | The patient sees the GP (several times). He advises alternative solutions like physical therapy. After unsuccesful attempts to treat the pain, the patient is forwarded to the Orthopedic surgeon. | |
| PHYSIO-THERAPIST | | | The physiotherapist can help patients relieve some of the pain, in hope of complete recovery. | |
| ORTHOPEDIC SURGEON | | | | The orthopedic surgeon sees the patient for the first time and examines him. He will diagnose the patient and explains the necessary procedures including hip replacement surgery. |
| RADIOLOGIST | | | | The radiologist takes x-rays of the hips. The radiologist evaluates these and gives his diagnosis for the patient to the orthopedic surgeon. If necessary, the radiologist examines the patient further (e.g. MRI, injections, etc.) |
| ANAESTHESIST | | | | |
| NURSE | | | | |
| GOVERNMENT & INSURANCE | The government and insurance companies benefit from good prevention to the patient. | | | |

PREVENTION | PAIN RELEIVING BEHAVIOR | CONSULTING THE GP: GATEKEEPER | DIAGNOSIS

*Figure 10: The patient journey for OA treatment with THA procedure*




| PRE-OPERATION, AT HOME<br>Months to weeks before surgery | HOSPITALISATION; PREPARATION, SURGERY, AFTERCARE | | 6-8 WEEKS RECOVERY AT HOME | AFTERMATH<br>Months to years after surgery |
|---|---|---|---|---|
| The patient lives towards the surgery and prepares himself physically and mentally for the procedure. | At the day of the surgery, the patient arrives at the hospital. | The patient leaves the hospital. | The patient rehabilitates by doing physical exercises given by the physiotherapist. | The patient has reached the optimal physical recovery from the surgery. |
| | The patient is often accompanied by an informal caregiver to the hospital | The informal caregives usually accompanies the patient when leaving the hospital | | |
| | | The physiotherapist quickly starts treating the patient, on the day of the surgery. | The physiotherapist decides when the patient patient is ready to be released from the hospital and he regularly helps the patient to physically recover. | |
| | The O.R. team performs the surgery. | | | The orthopedic surgeon reflects on the surgery with the surgery with the patent, looking at the recent x-rays of he replaced hip. |
| | During the surgery, the radiologist provides the orthopedic surgeon with x-rays. | | | The radiology staff takes the new x-rays of the hip. |
| | The anaesthesist provides the patient with an epidural and sedation. | | | |
| | The nurse informs the patient about the procedure, helps with preparation and guides the patient to O.R. | After the patient is escorted back to the recovery room, the nurse regularly checks on the patient. | | |

PRE-OP: MENTAL AND PHYSICAL PREPARATION

HOSPITALISED

RAPID RECOVERY PROGRAM

REHABILITATION

LOOKING BACK AND FORWARD

# STAKEHOLDER OVERVIEW

## STAKEHOLDER MAP

Based on the information from the ACD reports and the patient journey, a stakeholder map could be formulated for the OA treatment process. Figure 11 shows the stakeholder map. Lines indicate contact between one stakeholder and another. In the case of a stakeholder with many employees, such as the hospital, only basic connections are specified. First and foremost, this stakeholder map aims to illustrate the amount of different people a patient comes across in the OA treatment process. Some are direct and well known, such as the GP. And some are indirect, such as ICT software manufacturer or a prosthesis manufacturer. But they can still have a large impact on the treatment experience.There are also two stakeholders indicated with a red line, these stakeholders can be in contact with the patient but are not obligatory in the care process. The following section will briefly describe the current roles of the stakeholders without a red line.

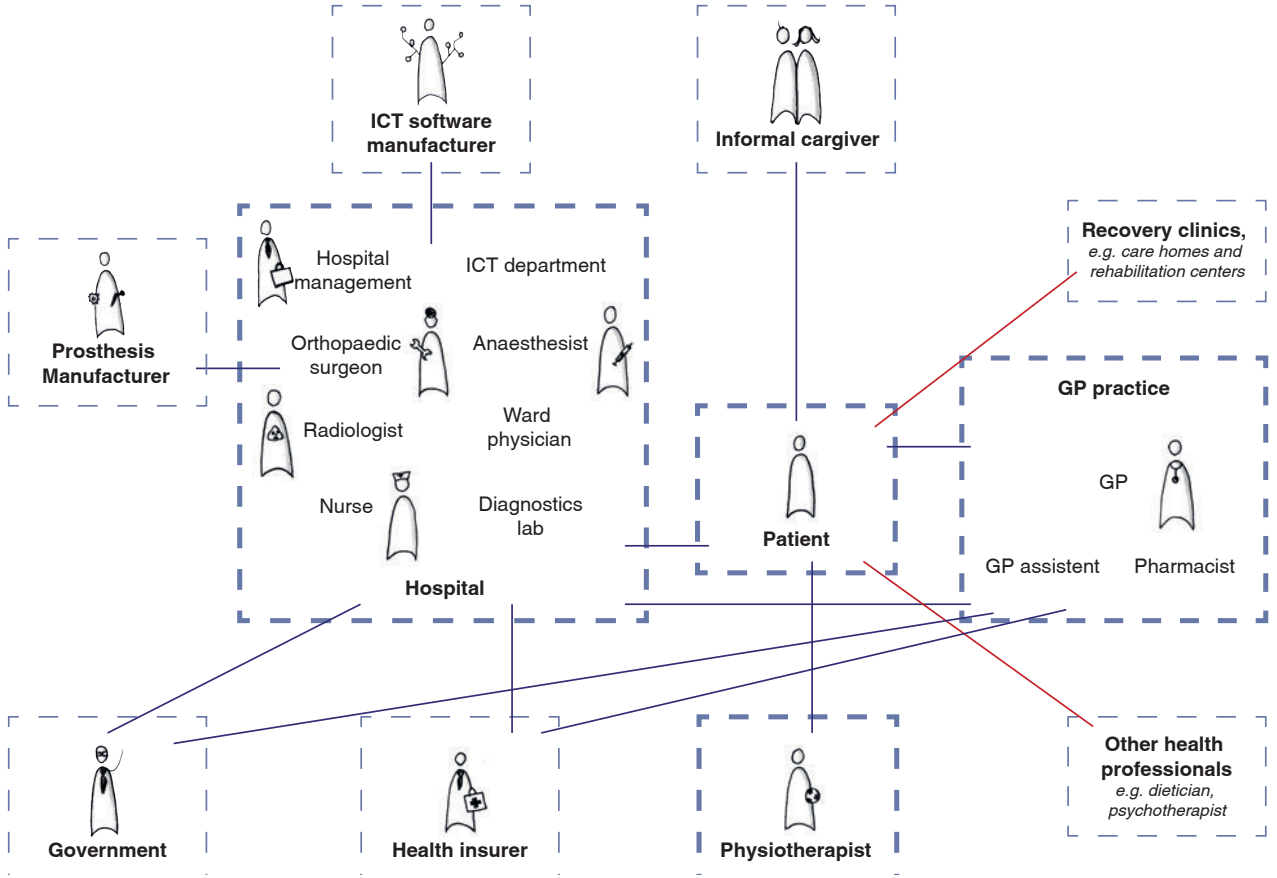



*Figure 11: Stakeholder map for the OA treatment*

# STAKEHOLDER ROLES

Now that it is clear which stakeholders play a part in the treatment process of OA, it is time to evaluate each stakeholder. The following section gives a short description on the roles of each stakeholder. “Appendix A: OA Context” shows an in depth discription of the stakeholders with a direct link to the patient.

## Patient

Without patients, there would be no healthcare system at all. Therefore the patient is the most important stakeholder. The patient receives care from all the healthcare providers necessary, as mentioned in the patient journey (Figure 10). They can receive suggestions or referrals to visit other healthcare providers, but ultimately they make their own decisions. Next to this, they are expected to take some responsibilities themselves in the care process; by preparing consults for example. In the end, all efforts are directed towards improving the patient’s life.

## General Practicioner (GP)

Where the GP used to be perceived as a health god and a life saver, this role is now moderated to a health advisor. Nevertheless, the GP is most often the first point of contact with a health professional in the patient journey, after the OA related complaints have started to occur. This also implies that the GP has general knowledge on many different health related topics.

## The orthopedic surgeon

Since the orthopedic surgeon plays a role in both consulting and diagnosing the patient, but also during the surgery and aftercare. Therefore he is chosen to represent the hospital as a whole. Unlike the GP or physiotherapist, the orthopedic surgeon has very specific knowledge on one of the body joints; symptoms, treatment options, different prosthesis options, etc. He shares this knowledge during the consults with a patient, but also in performing the THA surgery.

## Physiotherapist

Next to the GP, the physiotherapist is often visited by the patient in an early stage of the OA treatment. In the primary care phase, the role of the physiotherapist is to provide the patient with a treatment program limiting a patient’s complaints; ultimately to delay the moment of surgery. The physiotherapist can play an important role in recovery care. Directly after the surgery, a physiotherapist from within the hospital assists in the first movement exercises, to gain trust in using the prosthesis.

## Prosthesis manufacturer

The prosthesis manufacturer is a supporting party who is in direct contact with the hospitals. They deliver the most appropriate prosthesis for a patient to the hospital in consult with the orthopedic surgeon. This is also in line with regulations set by the health insurers and the government.

## Informal caregiver

The informal caregiver can be friends, family or volunteer cargivers of the patient. They can support the patient both mentally and physically throughout the entire treatment process. For example motivate them in exercising, or perform housekeeping activities. They often accompany the patient to consults as well.

## Health insurer

The health insurer is a supporting party who is in direct contact with all professional health instances, such as GP’s hospitals, physiotherapists etc. They determine which treatment options are offered with reimbursement. In their treatment offerings, they like to focus on prevention, because this can ultimately limit treatment costs.

## Government

The government is the responsible party for the setup of the Dutch healthcare system. Within this system, they set regulations for all stakeholders present in the treatment process. For example the setting of the health insurance premiums. They also focus on measurements regarding prevention, since this will ultimately lower governmental expenses on treatments.

# STAKEHOLDER BACK END: DATA FLOWS

Since my project will focus on creating a service model with digital innovations, the use of data will be almost inevitable. Therefore, it is important that the current situation of data use is made explicit. Figure 12 shows an overview of all the data exchanges happening in the OA treatment process. This overview was created with help of a functional applications manager in a Dutch hospital.

## What does the overview show?

This overview shows that the data flows within the OA treatment are incredibly complex. Every stakeholder uses their own information system; the hospital uses a ZIS system (HIX is a commonly used example), the GP uses a HIS system, and physiotherapists use a FIS system. These systems are not directly connected; there are intermediate systems that allow for communication. For example 'Zorgdomein', which allows the sending of referral letters from GPs to hospitals. However, this means that the information about a patient can differ in every information system, which can hinder the quality and efficiency of care.

Within the hospital, all health professionals can use the HIX system, and they all get to see a different summary of information that is important for them. This is determined by consults with the ICT department. However, within the hospital, different information systems are used for different specialisations. The radiologist, who can make x-rays for an OA patient, uses the PACS system for performing the x-ray analysis. A standard called HL7 is needed to connect this analysis data in the HIS system.

To get relevant data to the patient, several healthcare instances have introduced a patient portal. However, these patient portals display different information since they are corrected to either a ZIS, HIS or FIS system. A patient has the possibility to combine all this information in a PGO (persoonlijke gezondheidsomgeving), but this requires great personal effort and is therefore not actively used yet.

# CONCLUSION & IMPLICATIONS

## The OA treatment

The patient journey showed that the treatment process can be significant in length, where the patient is often dependent on itself for a sufficient treatment in their own environment. This treatment takes on the form of exercising, to limit complaints. There is room for support on this topic, especially with the rise of the Rapid Recovery Program and Fast Track surgery.

## The stakeholder overview

The section above indicates that the stakeholder field in the OA treatment process is a complex interplay between stakeholders in direct contact with patients, supporting parties such as the prosthesis manufacturer, and regulating parties such as the government. The difference in roles indicate they all benefit from improvement of the OA treatment in their own way. This means they also have different motives in the improvement of the OA treatment. For regulating parties it is mostly money related, whereas the supporting parties have process quality motives and the patient is concerned with quality of life.

## The data flow analysis

Completely redesigning the current data system will be too complex to achieve within this project, and is therefore out of scope. However, in designing a service model it is good to know that the current data flow system is complex and fragmented, and obtaining data requires significant effort for the patient. The current data flow can be used to indicate where the service model can contribute towards the simplification of data flows.

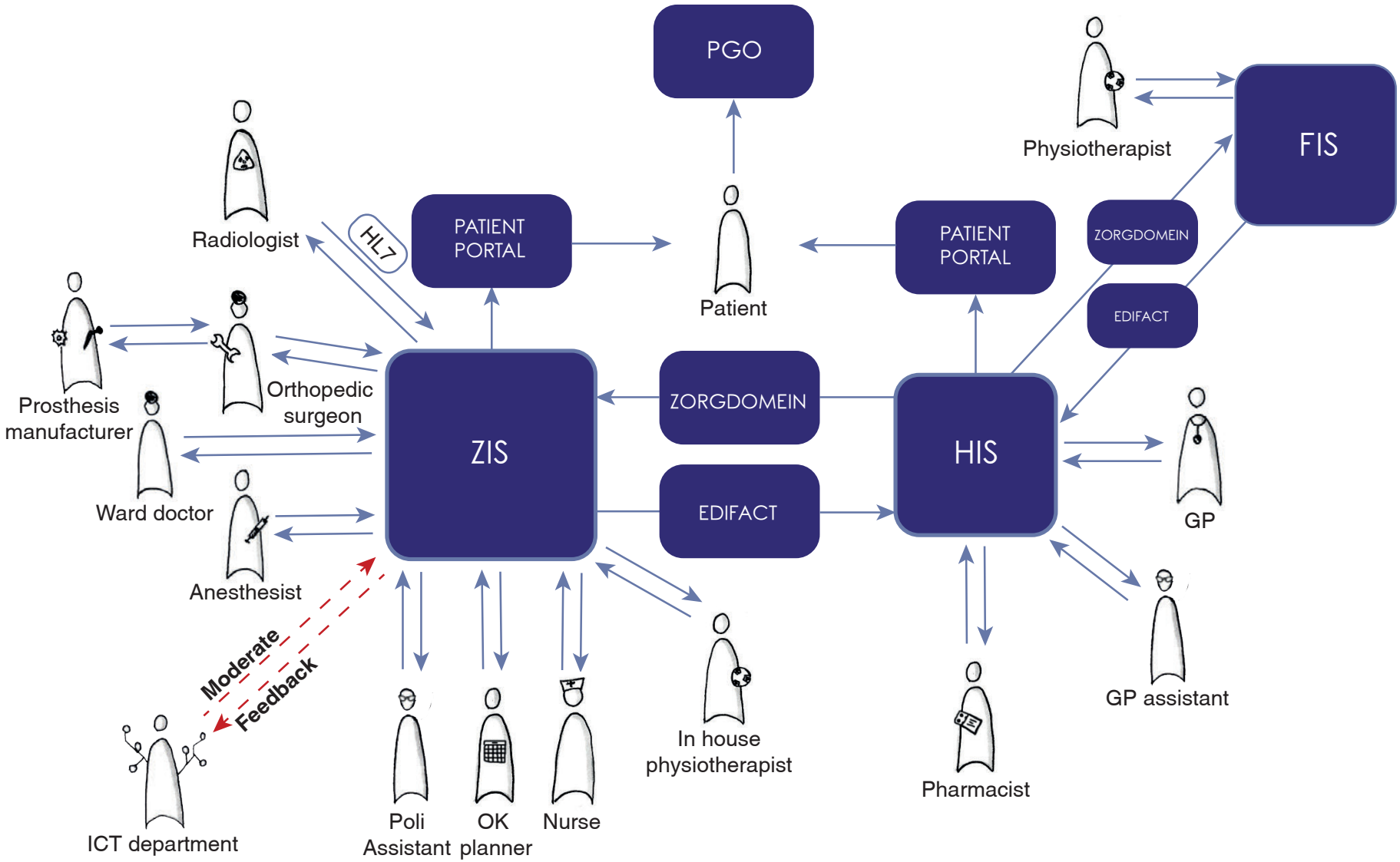



*Figure 12: Data flows in orthopedic care*

## Implications on characteristics and selection criteria

Ultimately, the service model will be able to tackle the complexites mentioned in the previous sections, by supporting the right stakeholder relations, accomodating to different stakeholder motives and enease to the current data flow setup.

Some selection criteria for concept selection can be identified based on the research findings in this chapter;
-The patient effort to make the concept function is limited; user friendliness is prioritised
- The patient should be supported in their OA treatment by the concept
- The concept should contribute to a simplifiation of data flows
- The concept should improve quality of life for the patient
- The concept should improve process quality for health professionals

# TOWARDS THE CONCEPT ANALYSIS

The introduction of this chapter already stated that this research project makes use of ACD reports created within the HiPP project as a basis for qualitative research; concerning the orthopedic care context and concept demonstrators. This chapter made a start with this qualitative research by exploring the setup of the orthopedic care context. Based on this understanding, the concept demonstrators can be explored.

## Concept reports

The concept demonstrators are illustrated by 41 design concept reports. This is the result of 3 runs of the HiPP assignment during the past 7 years. The project assignment was always the same: **'Improve the patient experience journey of hip or knee osteoarthritis patients'.** But each time, a different focus point was chosen.

In the first run, there was a focus on improving the **recovery care** experience. This is the phase after the patient gets a prosthesis, and learns how to live with it. Next, there was a focus on **primary care**, which is the phase before someone gets a hip prosthesis, and involves visiting the GP with first OA related complaints. And finally, students worked on developing a complementary service to '**the smart hip**'; a non-existent product concept where the hip prosthesis itself collects data inside the body.

All the assignments led to design concepts related to service delivery in the hip ostheoarthritis treatment. The demonstrators often involve multiple users; both patients and professionals. This shows a link with PCC.

## Group reports

Next to the concepts demonstrators, the Master students also had to generate research reports in groups regarding contextual factors, trends and user analysis. Many interviews and experiments were conducted to generate these group reports. There are 27 group reports, setting the total to 68 reports. These reports were used for stakeholder information in this chapter, and will be used as input on the value analysis as well. Also see Table 1 for a distribution overview.

The next chapter will explain the analysis performed on the individual concept reports.

*Table 1: Distribution of concept demonstrator reports*

| | Primary care | Recovery care | Smart Hip |
|---|---|---|---|
| **Individual concept reports** | 15 reports | 14 reports | 12 reports |
| **Group research reports** | 9 reports | 9 reports | 9 reports |

# TAKE AWAYS ON ORTHOPEDIC CARE

OA treatment can take up a significant amount of time, up to 8 years

There are many stakeholders, both active helpers, supportive roles and regulating roles

The data flow setup is fragmented

Different roles in the proces result in different stake-holder motives for participating in a service model;

Patients often depend on them-selves for sufficient treatment of OA related complaints

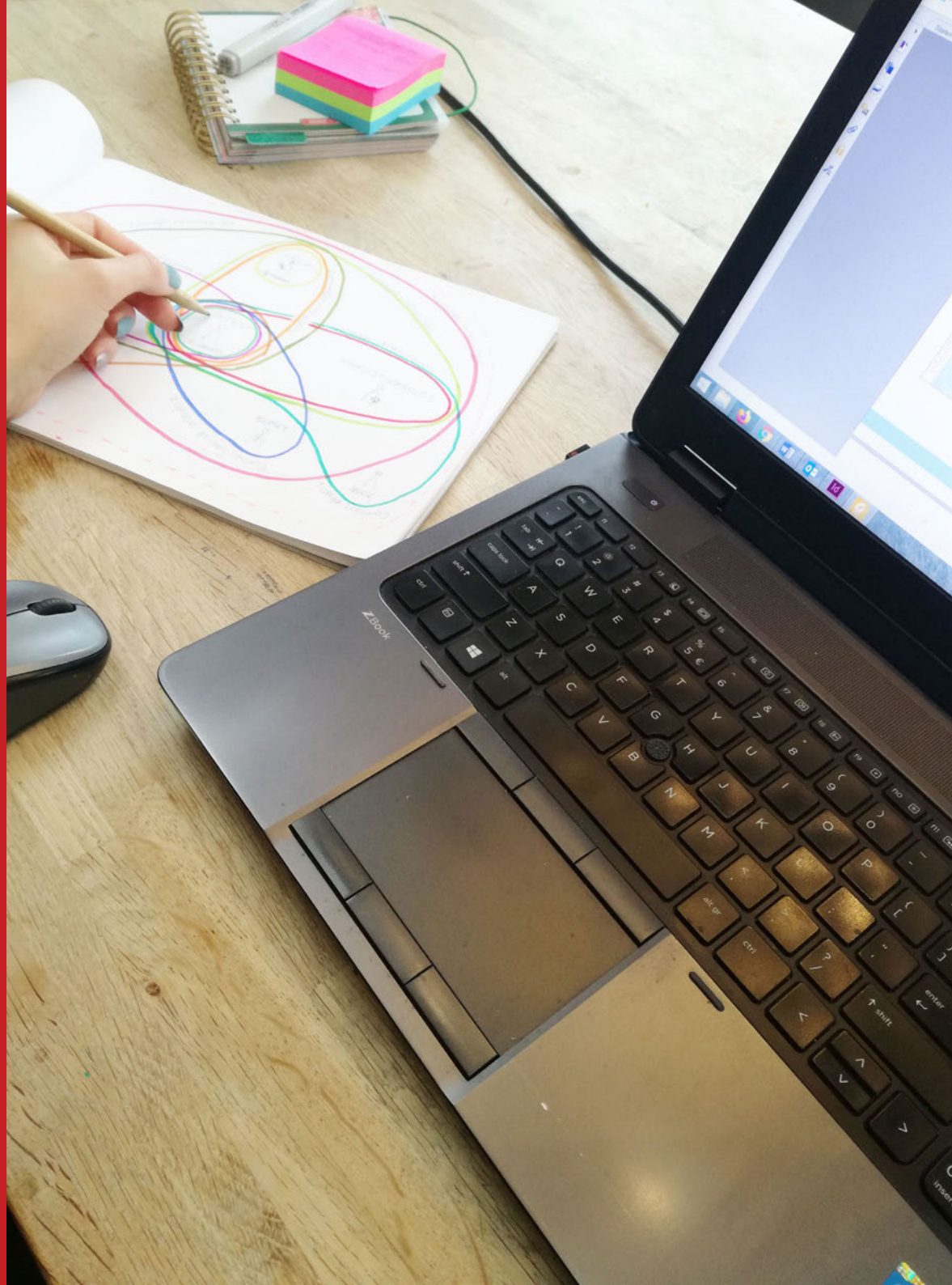
Large varieties in stakeholder relations and roles make the stakeholder field complex

Ideally, services contribute to a simplification of data flows, with low patient effort

Motives:
Money
Process quality
Efficiency
Quality of life

# INTRODUCING THE CONCEPT DEMONSTRATORS

This chapter analyses the concept demonstrators used within this research project. This is done from three angles: function, user and technology. The outcomes of this analysis are used to specifiy my area of interest within the concept landscape; which concepts are interesting to use in the service model and roadmap?



As mentioned in the previous chapter, a combined total of 68 ACD reports was used as a basis for this research project, which defined 41 different concept demonstrators for improving the patient journey during a THA procedure. Eventually a selection should be made within these concepts, to form the basis of the service model and service roadmap.

While it is essential to perform additional research on the orthopedic care context before the final decision can be made, some analysis on the concepts themselves needs to be performed first. What do the concepts do? Who are proposed as active users of the concept? What technical characteristics are used? Answering these questions will specify my areas of interest for the next analysis phase.

# ANALYSING FUNCTION

## PRODUCT TYPE OVERVIEW

To start off the concept demonstrator research, all reports were scanned to get a basic idea of the concept setup. Figure 13 shows all the names of the different concept demonstrators, and describes them in one sentence. The background colour indicates which focus the concept demonstrator has; yellow means primary care, blue means recovery care and red means smart hip. A full overview file on all the main characteristics of each concept can be found in “Appendix B: Concept categorisation”.

With this information processed, product type overviews could be made. Since the concepts were already categorized in primary care, recovery care and smart hip concepts, the overviews are also made for each phase. Product type categories with many concepts in it are divided into different focus points of the concepts. Furthermore, the concepts are placed relatively to their focus on either the product or the service. The setup of the product type overviews was based on the characteristics of a stakeholder landscape (van Boeijen et al., 2014, p 85). The next pages show the overviews for primary care, recovery care and the smart hip.

| | |
|---|---|
| **Biomet OA Guide:** app + wearable activity & lifestyle tracker | **Biomet Information Platform:** website with verified OA information |
| **Integrating Exercises:** app + sticker set to trigger exercising at home | **Solemate:** insole + app measuring posture and activity |
| **Verification center:** website to check OA information on validity | **Activities:** activity planner for OA patients and their family and friends |
| **Hobby Game:** game to find new hobbies for OA patients | **Biomet You:** app + wearable setting an exercising schedule matching the user |
| **Tap:** modular device to track pain and activity | **Wolk:** shoes measuring activity |
| **Biotracker/Support:** app + wearable to track daily activity | **Biocomm:** communication platform between OA patients and professionals |
| **BCAPP:** app to support with OA related exercising | **Transformo:** crutch measuring posture and give feedback |
| **Activisor:** app to help find activities doable with OA related complaints | **MIO:** app for in-hospital use, supporting the OA patient and professional |
| **OA Sense:** device that measures cartilage sounds to diagnose OA | **Helpcare:** app + wearable measuring exercising performance |
| **Biomet Exercise Coach:** bowl + wearable to stimulate exercising habit | **Smarthipp:** infection detector inside the hip prosthesis |
| **Aple Assistant:** app to track emotional of the OA patient | **Ace That:** training tool for OA surgeons to improve accuracy |
| **The Bridge:** business model for the OA treatment, uniting stakeholders | **Patient Persona Program:** program tailoring the THA surgery to the patient |
| **Futuro Motus:** app + wearable estimating moment of THA surgery | **Smart Hip Consultation System:** data dashboard for the smart hip |
| **Biomet Smart Assis:** device for the GP to structurize the GP consult | **Key Control:** keychain collecting data from the smart hip |
| **Health Coach:** app connecting to self chosen wearable, measuring activity | **Orient:** training and supporting tool for the OA surgeon |
| **SmartPatch:** digital baind aid, measuring activity after surgery | **CPRI:** device relieving the patient from OA related pain |
| **Biomet Link:** app + wearable to measure activity and give reminders | **Walkaway:** wearable providing real time feedback on posture |
| **Get Well Kit:** information folder to guide patient through recovery phase | **HipConnect:** on body wearable collecting data from the smart hip |
| **Biogoals:** app + wearable that help in setting and achieving recovery goals | **Smart Hipp Application:** app showing data from the smart hip |
| **DanceCure:** Kinect game for OA exercises | **Tilty:** tool for OA surgeon, helps with removal of bone |
| **Biowalk:** insole measuring activity of the OA patient | |

*Figure 13: Concept names and descriptions*

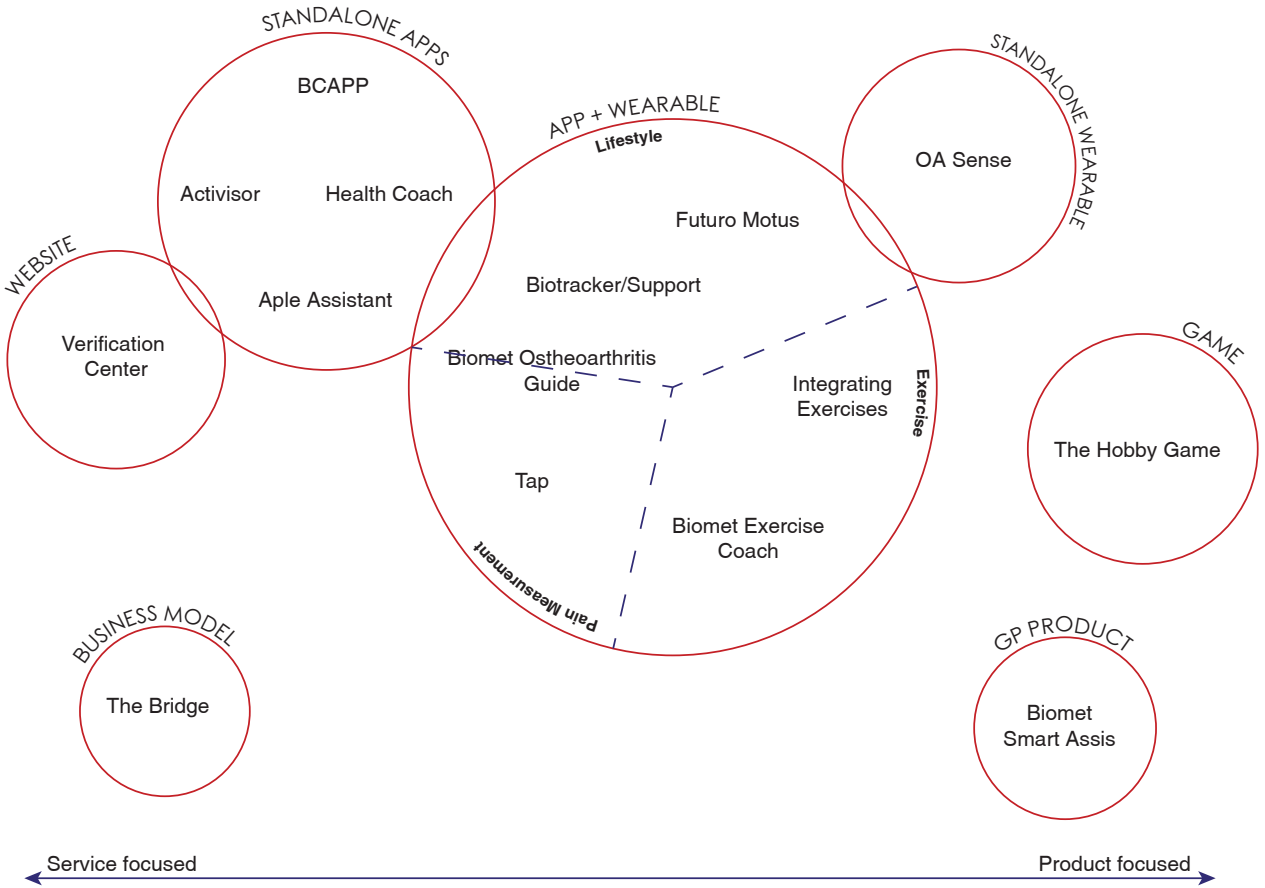



*Figure 14: The primary care concept landscape*

## Primary care

Figure 14 shows the landscape of primary care products. Most concepts are app+wearable combinations. These can be considered product service systems and therefore stand in the middle. App+wearable combinations were created with three different main goals in mind; pain measurement, exercising and lifestyle support. Concepts in the product corner are standalone wearables, a game and a GP tablet. This is the least represented area. Concepts in the service corner are standalone apps, a website and a business model. Especially standalone apps are popular in this area.

Since the aim of this project is to create a *service* roadmap with digital innovations, it is most likely that the **concept demonstrators in the 'product' corner are less favourable**; OA sense, the Hobby game and Biomet Smart Assis.

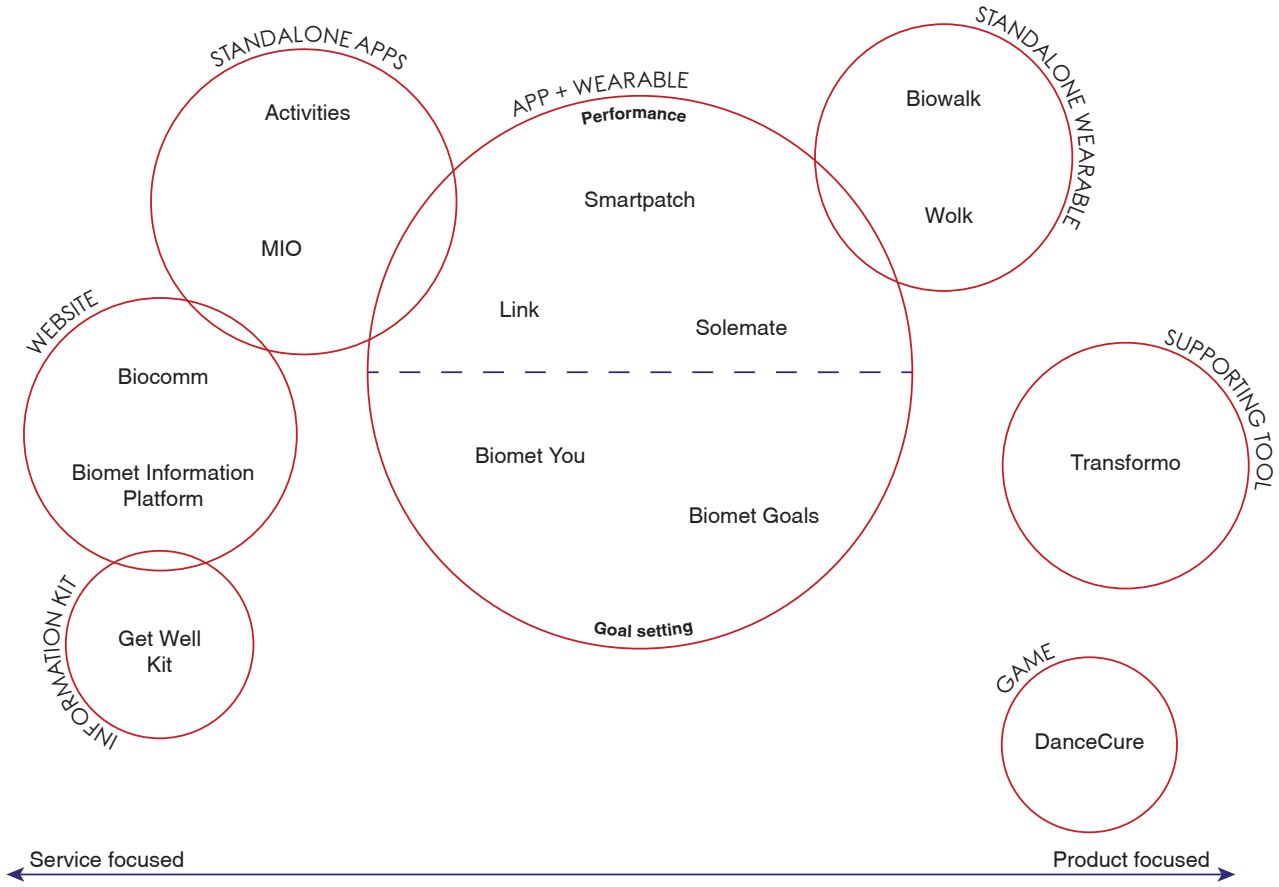



*Figure 15: The recovery care concept landscape*

## Recovery care

Just like the primary care landscape, most recovery care concepts are app+wearable combinations (Figure 15). The app+wearables concepts were created with two main goals in mind; feedback and goal setting. These differentiate from the goals in primary care.

Concepts in the product corner were standalone wearables, supporting tools and a game: Biowalk, Wolk, Transformo and DanceCure respectively. Just like with primary care, these concepts are likely to be less favourable.

Concepts in the service corner were standalone apps, a website and an information kit.

## Smart hip

The smart hip landscape covers different concept types compared to primary and recovery care. This is because of the framing of the initial assignment; students were also allowed to look at the technical improvements of the THA surgery itself, which fully focuses on the orthopedic surgeon. As a result, the functions of the concepts lie further apart (Figure 16). This topic is further discussed in the section 'User Overview'. Nevertheless, the most popular category was 'prosthesis performance', a category which also involved the patient. Concepts in the less favourable product corner are the surgeon concepts Orient, Ace That, Tilty and CPRI.

# GOAL-VALUE MAPS

If we dive a layer deeper into the concepts, one can take a look at its main goals and user values. To do this, a goal-value map was created. The target setup of this figure was based on the perceptual map (van Boeijen et al., 2014, p 87) However, instead of using scales, categories were used to show the different goals and values found. In this way, the map can give an indication on both the choice of goals and values, but also the spread of them. The next pages show goal-value maps for primary care, recovery care and the smart hip.

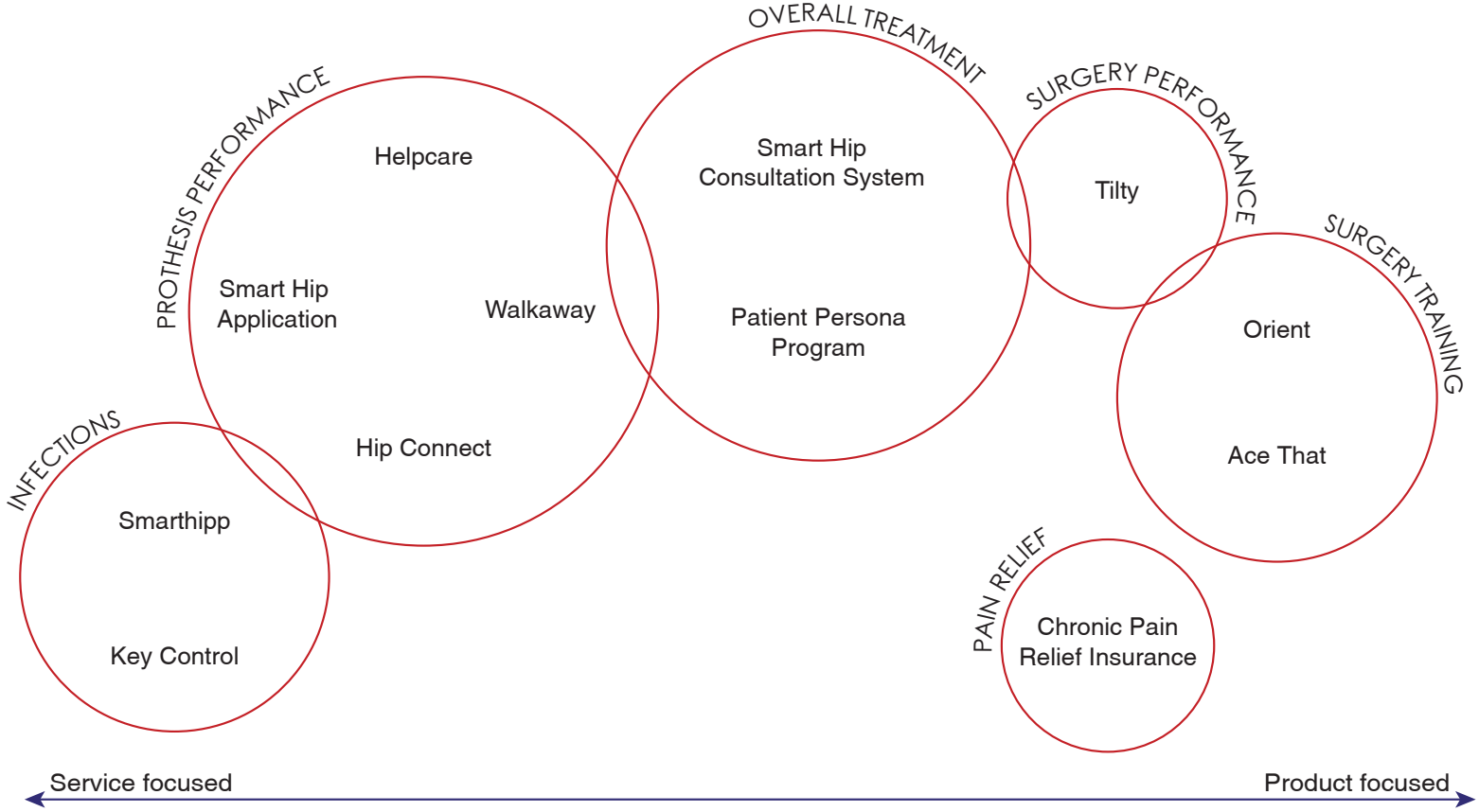



*Figure 16: The smart hip concept landscape*

## Primary care

Concepts for the primary care phase are made with **five different user values** in mind: *Insight, communication, personalization, support and awareness*. There are **three main goals** to distinguish which the concepts try to achieve: *self-management, GP-patient relation, diagnose*. See Figure 17.
If the user values and main goals are put into one diagram, this shows a peak of concepts in the 'insight' section. Next to this peak there is an equal spread over the other value categories.

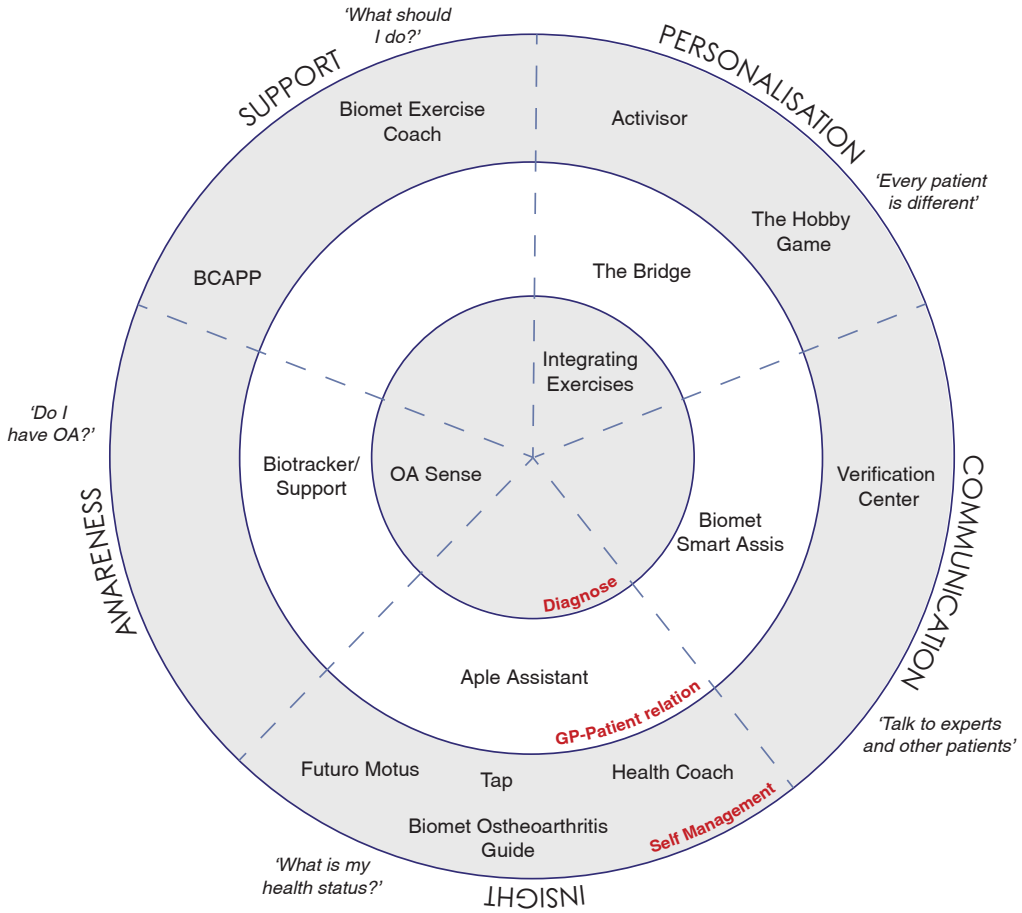



*Figure 17: The Goal-Value map for primary care concepts*

## Recovery care

Concepts for the recovery care phase are made with five different user values in mind. *Insight, structure, communication, support and personalization.* Awareness is not important anymore in this stage. The main goals are *self-management, consult quality* and *make it fun*. See Figure 18. This means that both in primary care and recovery care, self-management is considered important. When solutions are mapped in the diagram, most solutions end up in the insight/self-management corner.

## Smart hip

Concepts created around the smart hip are made with five different user values in mind; *Insight, quality, support, personalization and communication*. Again, only one value is new. The three main goals are *self-management, consult quality* and *better prosthesis*. See Figure 19. This means self-management is a goal in every stage. Because many concepts in this stage are focused on the orthopedic surgeon, many concepts end up in the quality corner. Nevertheless, the 'insight' corner is still popular as well.

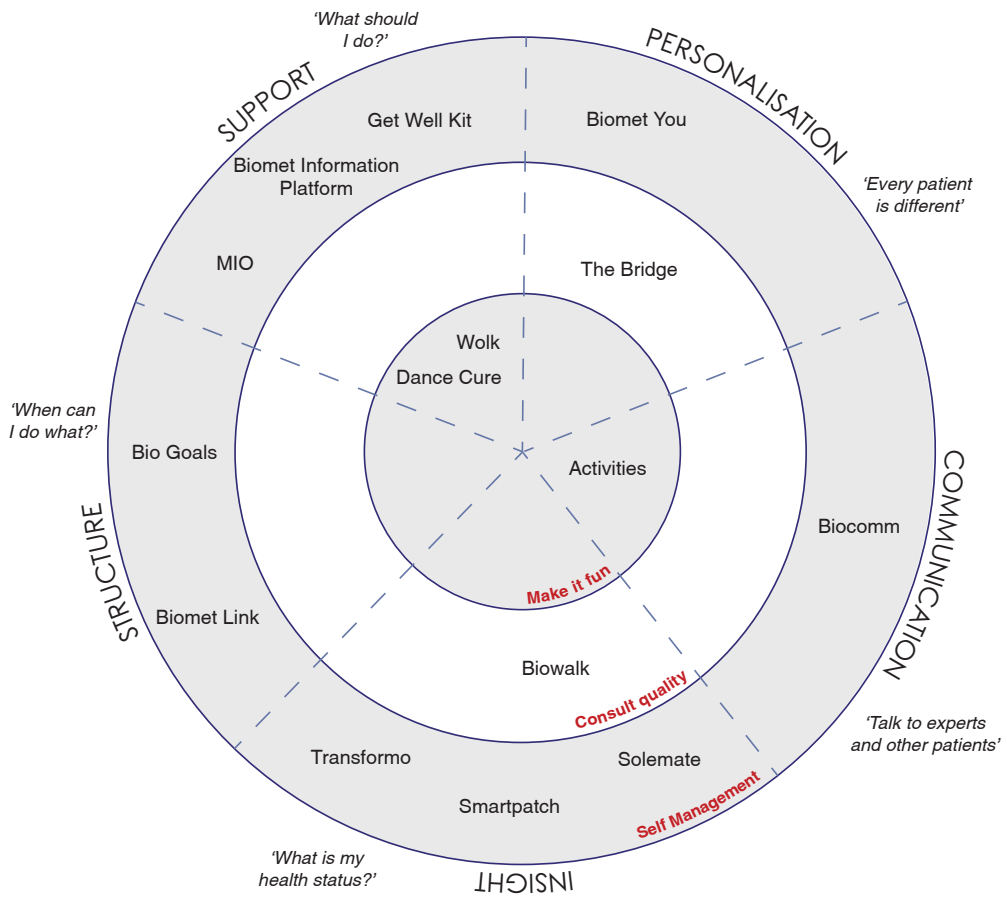



*Figure 18: The Goal-Value map for recovery care concepts*

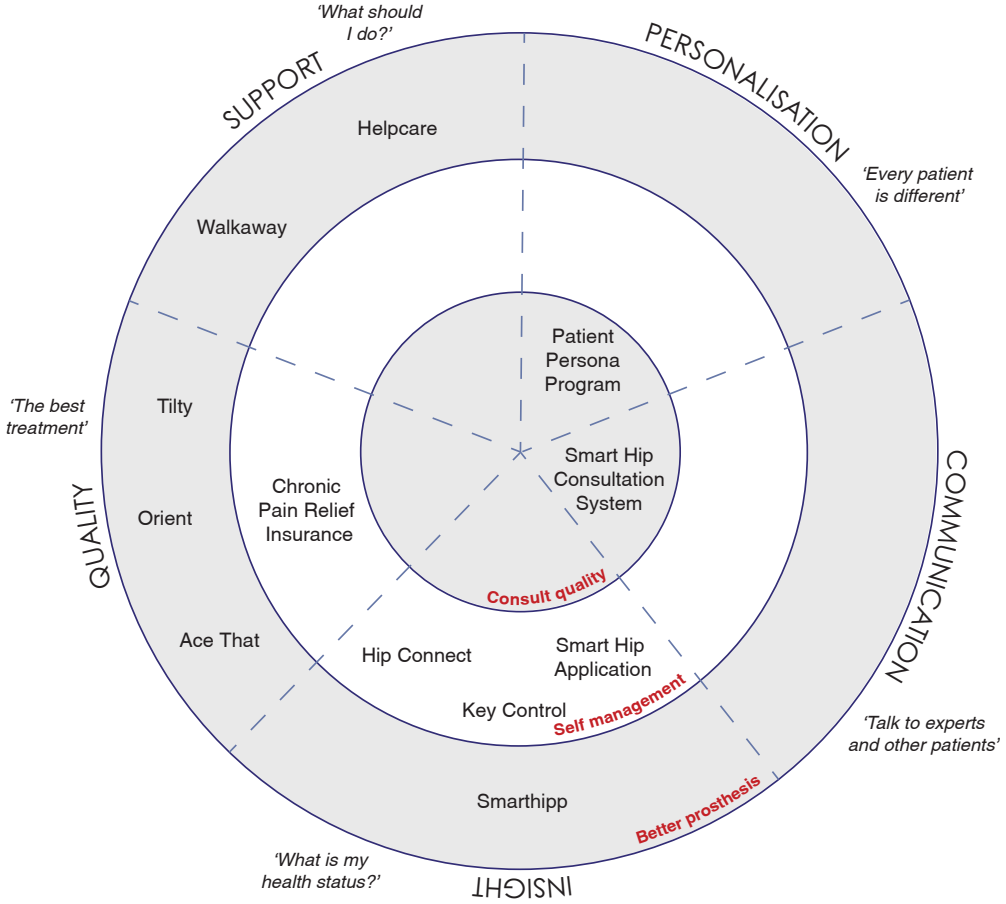



*Figure 19: The Goal-Value map for smart hip concepts*

# AREA OF INTEREST FOR FUNCTION ASPECTS

The function analysis of the smart care concepts thought us several things. First of all, it can be said that most of the concept proposals are both **app + wearable combinations**. The most common value the concepts aim to deliver is **'insight'**, and the most common goal of the concepts is **'self-management'**.
If we look at the differences between the different care phases, one can say that the goals of the concept demonstrators changes slightly over time; there is a shift from pain reducing towards goal setting, to treatment quality. In contrast, the user value becomes more unanimous; insight.
These categories are most popular for a reason, and are therefore considered important factors to take into account in the service model.

## A note on product types

Reflecting on these outcomes, one can say that the most occurring concept types based on their function are rather traditional service forms in current society. A website for example, isn't anything new. Of course, it has to be noted that these concepts originated during 2013-2015, and digital development has taken a flight since then. The concepts from the smart hip category are automatically more innovative due to the use of an internal body sensor. But the apps that are designed with it do not match this futuristic outlook.
On the other hand, the healthcare sector is rather old fashioned in terms of technology and data and OA is occurs mainly with elderly. This means more traditional services can fit quite well. These topics will be further discussed in the innovation analysis of the next chapter .
Furthermore, concerning the resulting goals and values, it is important to evaluate which main goals and user values are important now and in the future for the stakeholders, to further distinguish a selection. This is discussed in the chapter 'Deep dive in the orthopedic care context; Values'.

## Implications on selection criteria

The function analysis can already be used to specify the first guidelines for concept selection. The service model and roadmap will focus on smart solutions. This means **non-digital products are not the primary area of interest**. This makes the concepts Get Well Kit and the Hobby Game less interesting. Even as concept demonstrators that have little focus on service, such as Biomet Smart Assis and Transformo.
Furthermore, self-management and insight have to be taken into account into the service model, since these were considered as important topics in the concept demonstrators.

Finally, since it is unlikely that my final roadmap will consist of a large selection of different wearables and tools, **it is important to also look to the concept proposals on a feature level,** and select and combine different features from within the concepts.

# ANALYSING THE USER

## USER OVERVIEW

Next to the product type overview, the user is a key topic of interest as well. Who are intended as users of the concept demonstrators? What varieties are there? Next to establishing this overview, the user overview intents to show the key users of the future service model. In this way the value analysis can be scoped more specifically.

### Who is a user?

Before executing the actual analysis, it is important to establish what is defined as a 'user' in this context. With 'user' I mean someone who is actively using the concept; **at least interact with the digital interface and implement new information about an aspect of the OA treatment. Preferably, interaction with the physical product takes place as well, if the concept has any.** Someone who is only sending information to a concept demonstrator, or only receiving information, does not count as a user by this definition. This is why the prosthesis manufacturer has mostly fallen out of this analysis.

Figure 20 shows the user overview. The blue circles around stakeholders indicate one or more concepts that have one user. The red arrows between two stakeholders indicate concepts with two active users. The grey triangles indicate concepts with three or more active users. On top of that, there is one concept involving every stakeholder, indicated by a grey dotted line. This figure indicates that most concepts are made with the patient as the only user; 12 concept demonstrators in total.

Table 2 shows in which user group the different concepts belong.

*Table 2: The concepts categorised by user groups*

| 1 active user | | |
|---|---|---|
| **Patient** | **GP** | **Surgeon** |
| The hobby game, Get well Kit, CPRI, Biomet exercise coach, Dance cure, Transformo, Smarthipp, Key control, Futuro Motus, Biomet Healthcoach, Walkaway, Hipconnect | Biomet Smart Assis | Ace that<br>Orient<br>Tilty |

| 2 active users | | | | |
|---|---|---|---|---|
| **Patient & GP** | **Patient & prosthesis manufacturer** | **Patient & physiotherapist** | **Patient & surgeon** | **Patient & family** |
| Integrating exercises, OA guide, Verification center, Biotracker/ Support, OA sense, Aple assistant | Tap<br>Wolk | BCAPP<br>Helpcare | Patient Persona program, Smart Hip Consultation system, Smart Hip App | Activisor<br>Activities |

| 3 or more active users | | | |
|---|---|---|---|
| **Patient, GP, surgeon, physiotherapist & prosthesis manufacturer** | **Patient, GP, surgeon, physiotherapist** | **Patient, GP, Surgeon** | **Patient, physiotherapist & nurse** |
| Smartpatch, Link, Biogoals, Biomet You | Biowalk, Biomet info platform, Biocomm | Solemate | MIO |

| 10 active users |
| --- |
| **Patient, surgeon, GP, prosthesis manufacturer, health ensurer, government, nurse, dietician, informal caregvier.** |
| The Bridge |

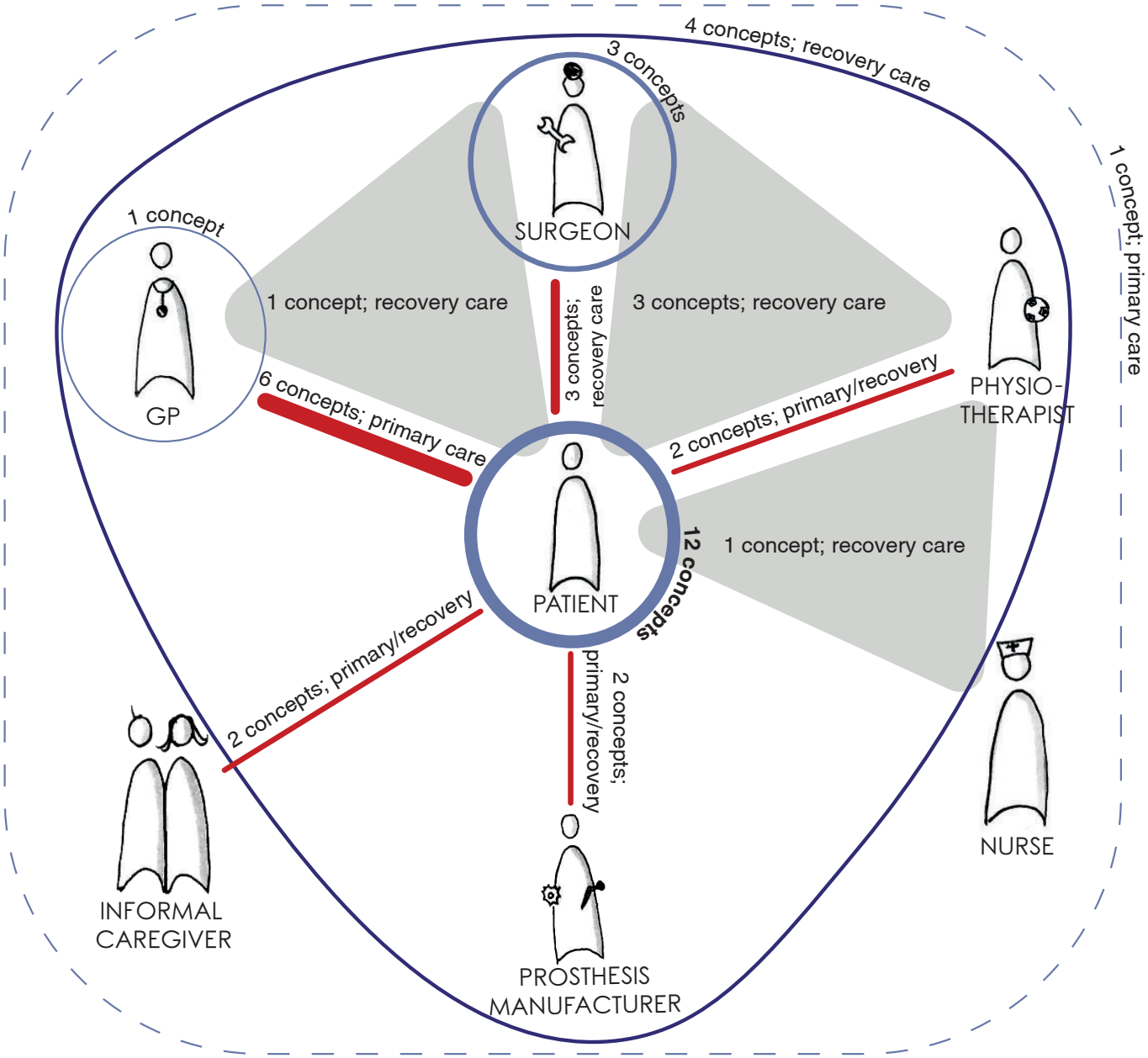



*Figure 20: The user overview*

## AREA OF INTEREST FOR USER ASPECTS

When looking back at the initial assignment, there should be a focus on multi user solutions. This means that **products with only one active user are not favorable.** This group entails a large number of concepts, from which many of them were already assessed as less interesting by the function analysis as well. Of course, the product type analysis showed the importance of looking at concepts on a feature level, and it is still possible that they might entail interesting ones. But it is expacted they are not the primary area of research.

### Identify key users

Figure 20 and Table 2 could help indicate which users are most important. It is no question that the patient should be involved in the service model and roadmap. The twelve concepts focusing on the patient alone stress this even more. Next to the patients, there were multiple solutions for the orthopedic surgeon alone, and one for the GP. These concepts itself are not very relevant additions to the service model since they focus on very specific tasks within the treatment process. However, it does stress that the GP and Orthopedic surgeon are important users. They are also taken into account in many multi user concepts.
When looking at the multi user concepts, one can see that the most common group of stakeholders chosen are the patient, GP, orthopedic surgeon, physiotherapist and Biomet (prosthesis manufacturer). This implies that I should choose these 5 stakeholders as the user focus of my service model. However, when looking at the implied stakeholder relations within the concept reports, one could say that the prosthesis manufacturer only has contact with the other professionals, and the patient does not have direct benefit in a relation with the prosthesis manufacturer. **Therefore it was chosen to focus on the Patient, GP, Orthopedic surgeon and Physiotherapist as key users.** They all have direct benefit in using a service model linking one another's knowledge more efficiently. These key users will be used for further analysis purposes.

### Implications on selection criteria

This decision sets some selection criteria as well:
-The concept should be fitted for multiple user groups
-The concept should give relevant insight for both OA patient and health professional

When taking this knowledge back to Table 2, one could say that the concepts Biowalk, Biomet Info platform and Biocomm have the most interesting user profiles.

# ANALYSING TECHNICAL SPECIFICATIONS

## TECHNOLOGY OVERVIEW

Now that the concept were evaluated on the function they aim to fulfill and the users that are intended, the question rises how these aspects are realized. Therefore, the technical aspects of the concepts were evaluated. Figure 21 shows an overview. This overview does not mention what technologies are used per concept specifically, but it is meant as a summary of all the technological features mentioned in the different concept demonstrator reports.
The figure shows that the 'Sensor' category is by far the most elaborate technology category. Many different types of sensors are used, but the most common ones were the accelerometer and the pressure sensor. Looking at what these sensors measure this makes sense; they measure movement and walking posture, which is directly linked to a person's activity and exercising.

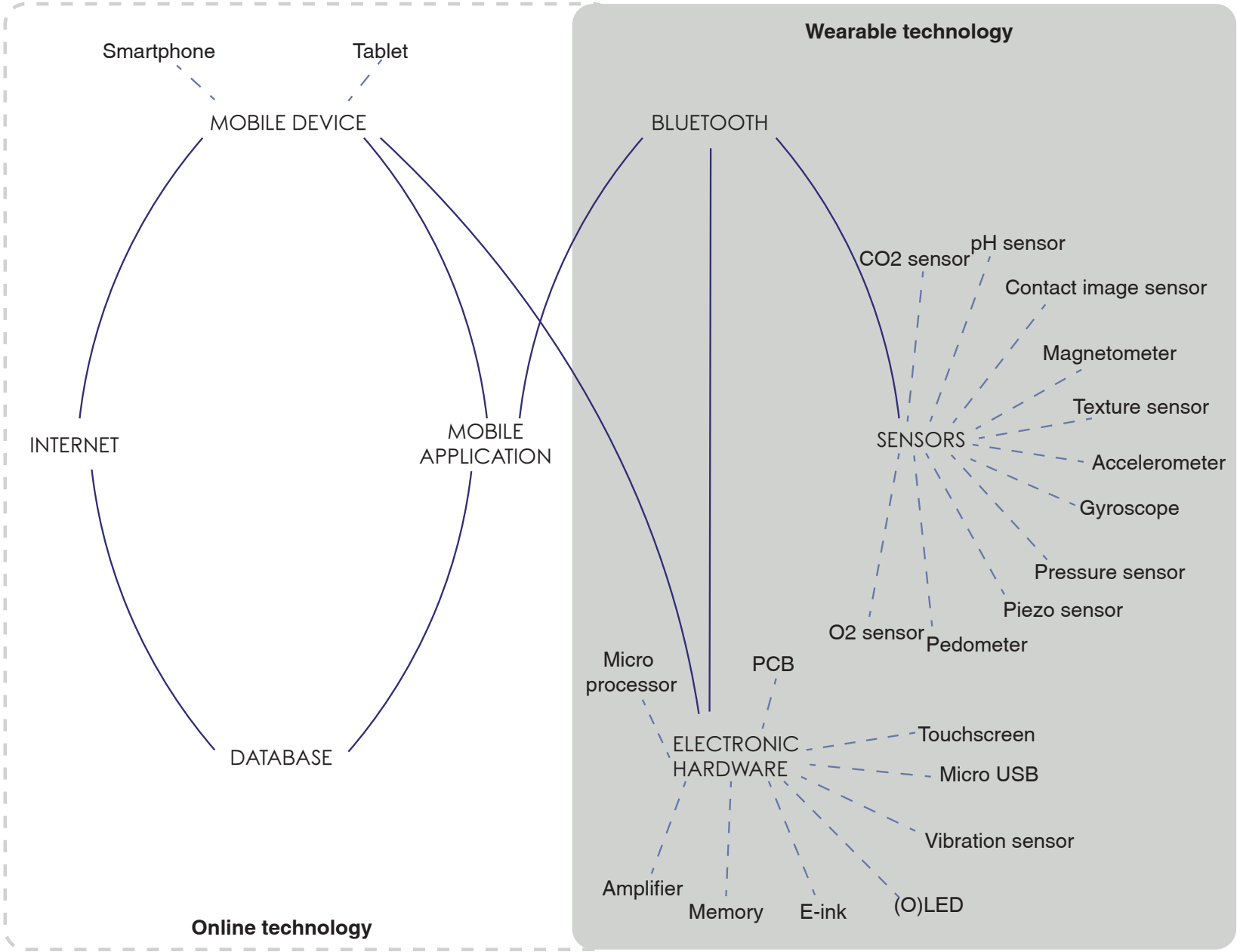



*Figure 21: Overview of technical features*

## DATA TYPES

Figure 21 identified which types of technologies where used to establish the functionalities of the concept demonstrators. But the question remains, what do the technologies actually measure, and in which way do they measure it? Figure 22 aims to answer this question by showing an overview of all the different types of data, which concepts are associated with it and where the sensors to measure this data are located (this can also be concerned as the 'wearable type' feature).

By far most concepts measure some type of movement, both daily activity but also specified to OA related exercises. All movement data is measured with the same group of wearables; a wristband, a legband, a modular item and a sticker. When a concept measures pain levels, this is most often obtained with these wearable types as well. If a concept measures pressure levels, this is always done with an insole. More advanced data such as wearing, loosening and infections is always done inside the hip and are therefore features for the far future. Finally, there is one data type that is not able to be measured with sensors; emotions and experiences. Several concepts such

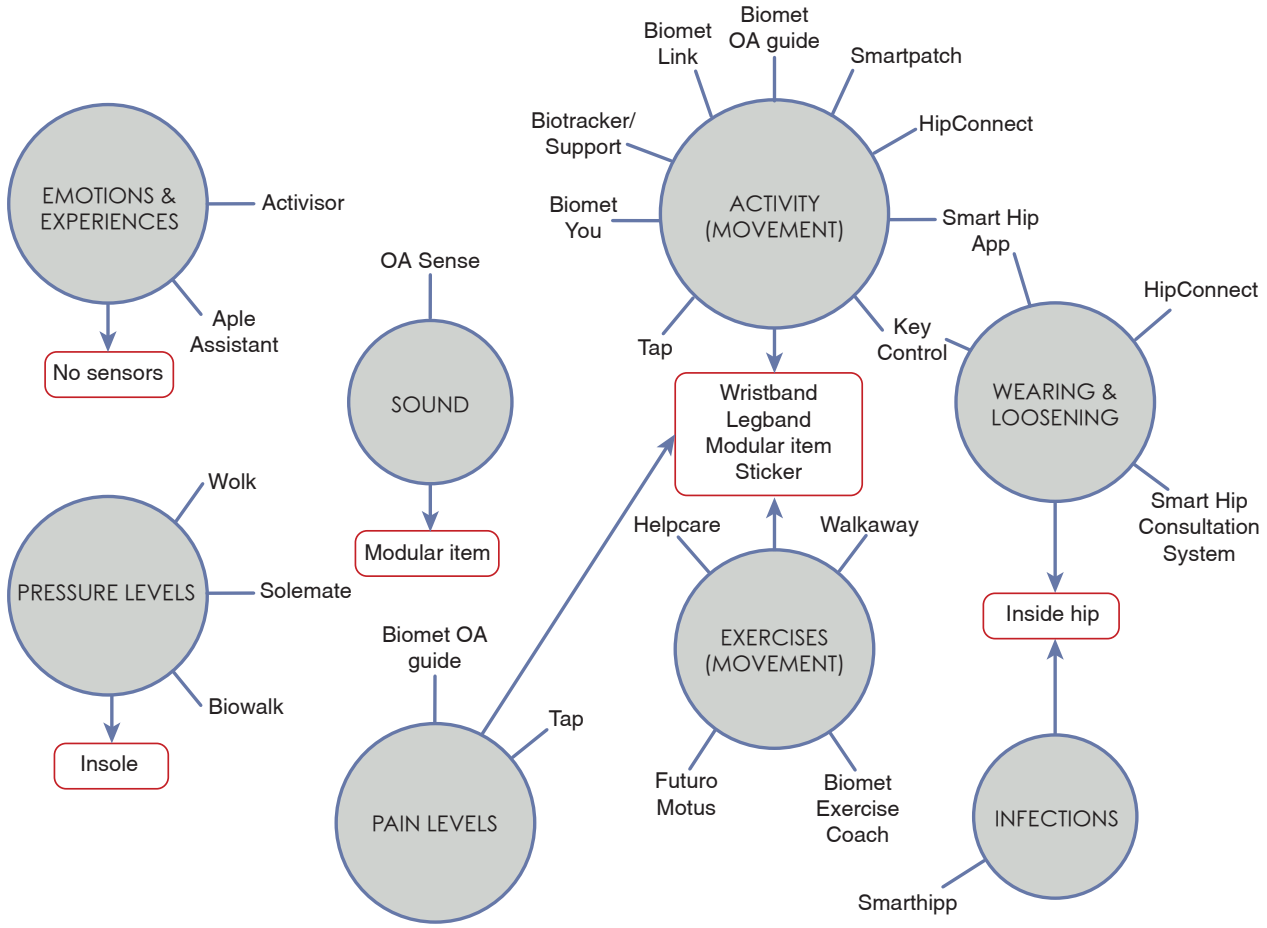



*Figure 22: Data types and wearable types overview*

as Aple assistant use this data type to enhance the treatment process, but it requires active input from the patient. If this type of data is actually valued in the final service model, this is evaluated in the chapter 'Deep dive in the orthopedic care context; Values.'

## AREA OF INTEREST FOR TECHNICAL ASPECTS

What is most apparent from the technology analysis is that by far **most technologies are rather traditional ones.** Bluetooth for example, is a widely implemented technology and is already being overtaken by other wireless contact technologies such as NFC and RFID. Also on the topic of data and internet technology, one can see that the current technical setups fall behind on the current standards. Innovations like Artificial Intelligence and Big Data are not mentioned anywhere as a part of the concepts.
While it was first expected  that the technology aspect could form a driver for the selection of concepts, this turned out to be untrue for the entire set of concepts. While the smart hip idea itself still lies far ahead in the future and is probably beyond the scope of the service raodmap, the concepts build around it provide a minimal technological challenge to develop. In line with these limited innovation possibilities, one could ask himself if an concept like this adds a lot of value to potential users. If a concept does exactly the same as a Fitbit device and app offers, why would a patient choose a new product instead of a proven one? Therefore, **I want to add an extra layer of technological advancements** to the concept (feature) selection, to make sure it fits with the current developments. What developments exactly will be further discussed in the next chapter.

### Implications on selection criteria

In terms of selection criteria, it is important that **the concept acquires specific data** for OA patients and professionals, to add value over other existing services. This means measuring directly at the hip, like Smartpatch and Hipconnect offer with help of a sticker device.Furthermore, it is expected that the final product service will have **movement data** as an input.

# CONCLUSION: PRELIMINARY CONCEPT ASSESSMENT

As a result of analysing the concept demonstrators' functions, users and technologies, a preliminary concept assessment could be made. This assessment is presented in Figure 23 on the next page. The colours next to the concept indicate how interesting the concept is based on the function, user and technology analysis.

**Red** = uninteresting, most likely to be excluded from further analysis.Concepts got the red assessment either because it was a non-digital product, or the target group was limited to one user with no options to expand.
**Yellow** = one feature of the concept is interesting, but the rest not so much. For example the Bridge: it is favourable that the concept involves many stakeholders, but the actual offering is just a business model which does not give much practical features to work with.
**Yellow/Green** = Multiple interesting features with one downside. For example Health coach: the types of data and feedback options are interesting, but it only involves the patient at this point.
**Green** = Multiple interesting features, unfavourable features are not found yet.

As said, this assessment is yet preliminary; with the help of the innovation and value analysis a final selection of concept features can be made.

| | |
|---|---|
| Biomet OA Guide | Biomet Information Platform |
| Integrating Exercises | Solemate |
| Verification center | Activities |
| Hobby Game | Biomet You |
| Tap | Wolk |
| Biotracker/Support | Biocomm |
| BCAPP | Transformo |
| Activisor | MIO |
| OA Sense | Helpcare |
| Biomet Exercise Coach | Smarthipp |
| Aple Assistant | Ace That |
| The Bridge | Patient Persona Program |
| Futuro Motus | Smart Hip Consultation System |
| Biomet Smart Assis | Key Control |
| Health Coach | Orient |
| SmartPatch | CPRI |
| Biomet Link | Walkaway |
| Get Well Kit | HipConnect |
| Biogoals | Smart Hipp Application |
| DanceCure | Tilty |
| Biowalk | |

*Figure 23: Preliminary concept assessment*

# TAKE AWAYS ON CONCEPT DEMONSTRATORS

App + wearable combinations are the most popular product type.

A wearable should measure data directly at the hip to increase relevance for OA stakeholders.

The patient, GP, physiotherapist and orthopedic surgeon will be the key users of the service model.

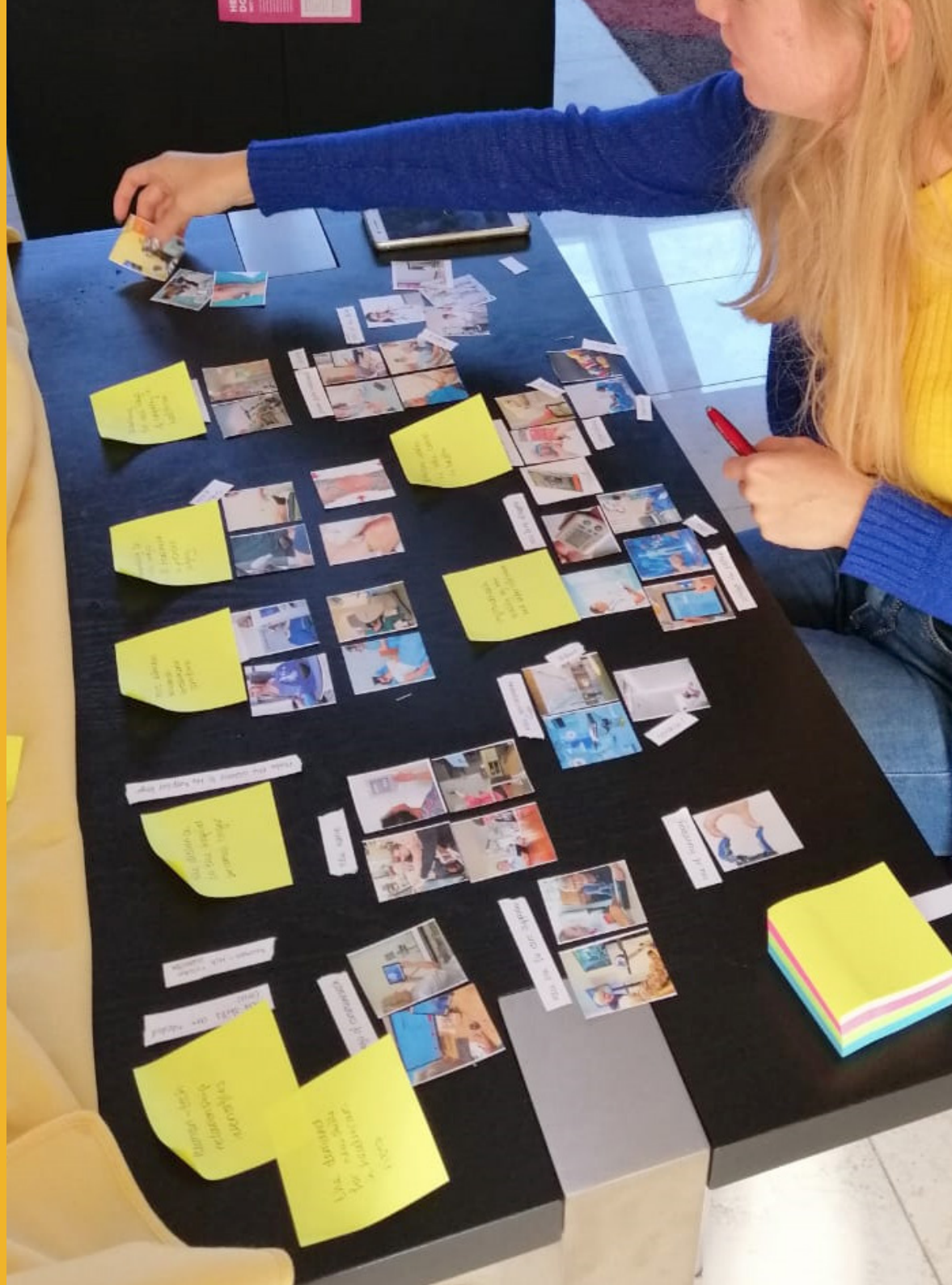
The user values communication, support, personalisation and insight occur in every concept phase . Insight is most popular and thus important to use.

The goal self-management occurs in every concept phase and is thus important to use.

An additional layer of technological advancement will be added over the existing concept demonstrators, when formulating the service model.

# DEEP DIVE IN THE ORTHOPEDIC CARE CONTEXT: INNOVATION

Now that the orthopedic care context and concept demonstrators are introduced, it is time to do a deep dive in innovation. In practice this means performing a trend analysis. This chapter will describe both socio-cultural trends and technological trends within the context of interest. In the end of the chapter, the most important trends are highlighted, which are taken into account in the service roadmap.



# MARKET ANALYSIS

Before one can look into innovation, it is important to specify the market context; the innovation field. What characterises this field and who are the important players?
Since this project focuses on digital innovation for the OA treatment, there are two markets to distinguish; the **prosthesis market** and the **digital health services** market. Developments in both these markets can have influence on the service model and service roadmap.  An elaborate description of both these markets can be found in “Appendix C: Market analysis”.

## Rise of a ‘new’ market

When creating a service model for the OA treatment, it is likely to assume this service is situated in the digital healh market. However, as the concept reports about the smart hip already indicated, the unstable B2C digital health market and stable B2B prosthesis market will grow closer, and overlap in the future (Figure 24) . This creates a new market; the smart OA treatment, with characteristics from both the prosthesis market and the digital health market. The final service roadmap of this project will show the way towards this new market. To get more insights on what developments  will shape this  innovation field in the upcoming years, a trend analysis is performed.

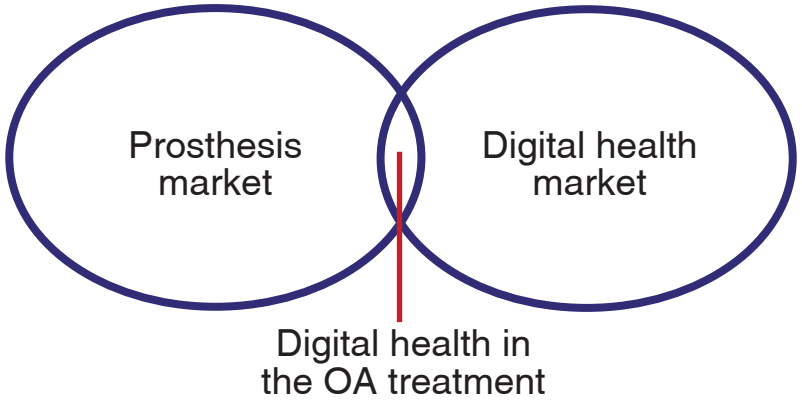



*Figure 24: Two markets are meeting each other*

# TREND ANALYSIS

The book ‘Design Roadmapping’ (Simonse, 2017, pp 16-19) mentions the importance of trend research in the roadmapping process. Performing a trend analysis can ensure the service roadmap does not miss out on signals for changes in the market context. Furthermore, trends can provide new opportunities for value creation. Therefore, an elaborate trend analysis is performed. The first section will dive into al the social-cultural trends, whereas the second section will dive into technological development. **The focus of this trend analysis will be healthcare. This is of course broader than the market context described in the previous section, but most healthcare related trends have influence on the OA treatment context.** Using a larger scope makes it easier to find more diverse trends. From there, examples are used the relate the healthcare trends back to orthopedic care and hip OA.

# SOCIO-CULTURAL TRENDS

To find important socio-cultural trends, a combination of the Trend Topics method (Simonse, 2017, p. 68) and the DEPEST method (van Boeijen et al., 2013, p. 59) was performed. The Trend Topics analysis is a trend analysis method relying heavily on visuals, giving the researcher a lot of room for personal interpretation of trends. In this way, trends can easily be translated towards orthopedic care. As a more structurised counterpart, a DEPEST analysis can fill possible gaps in the Trend Topics, by evaluating a fixed set of subjects.

First, the findings of the Trend Topics analysis are described, and then some important complementary trends found in the DEPEST analysis are discussed.

## TREND TOPICS

The basic idea of the Trend Topics method is to analyse and group a set of visuals on complementary elements, relating them back towards developments in the context of interest. To perform the Trend Topics method, first an online image research was performed. Within the search terms **the following words were used: healthcare, osteoarthritis and service,** both tried in Dutch and English. Using these search terms allowed me to search both general and more specific, to increase chances of result success.

### Performing the analysis

After finding a satisfactory amount of images (around 50 images), a few things could be said even without categorizing. Almost every health related image found involves technology, without specifically searching for it. Technology is taking over the healthcare sector. Next to this, stock photos are dominating the search results. This is to be expected in terms of privacy issues, but it raises concerns about the portraying of healthcare online. These images can set wrong expectations.

Figure 25 shows the following step in the Trend Topics process; the first categorization of images, looking for matching elements. After that, groups of matching images were further specified, but also linked with other groups. Short descriptions of the group characteristics were added as well. Figure 26 shows a digitalised version of the final result of the categorisation process of images. The dotted boxes show the groups of images formed, and the lines between them show relations between categories. Based on these visual groups and relations between them, 11 socio-cultual trends were formulated, which could get a sufficient grip on changing human factors in the innovation field. The 11 trends could in their turn be categorised into 5 trend groups. These are presented on the next pages.

*Figure 25: First steps of the trend topics process*


*Figure 26: Result of the trend topics process*

## TECHNOLOGY LOVES HEALTHCARE

*Image source: Elisa, 2018*

### The human technology relationship intensifies

In the Netherlands, 98% of the dutch society has access to the internet, and 96% of society has a smartphone (CBS, 2018). The use of these appliances are becoming strongly embedded in our daily lives. This means our society is more and more dependent on the online world, and thus technology. It becomes impossible to get through the day without the help of digital appliances.(Royal Haskoning DHV, 2018)

### The demand for new skills in healthcare rises

Hand in hand with the intensified relationship with technology comes the need for new skills (VTV, 2018). Not every citizen knows how to work their way to the digital world, and use apps and tracking items properly. This is especially true in healthcare, were people are more often expected to monitor their health status.(OA) Patients need to be supported in learning how to use these correctly, same for health professionals.

## HOME AS NEW CARE FACILITY

*Image source: UMC Utrecht, 2018*

### More directed care

Healthcare instances and supporting parties are innovating care processes in such a way that people need to visit them less often in the case of long lasting disorders like OA. This is done by the before mentioned self monitoring services, but also by new forms of communication. The e-consult and ‘skype’ consult will decrease the need for a physical visit. (VTV, 2018) If a visit is needed, the right professional will be chosen.

### A patients’ home becomes more fitted for care

With all the digital appliances being present in a person’s home, monitoring becomes more and more easy to do. In the future, someone’s home can automatically track a person’s healthcare status by tracking behavior, and support them when help is needed. (Walker, 2016)

### Hospital stays become shorter

Next to the effort to decrease in hospital visits, healthcare instances are trying to shorten the stay at hospitals. Examples are the rapid recovery program and the fast track surgery. Ultimately, people spent no longer than a day in hospitals for regular surgery procedures. Also, diagnosis can go much faster. (Oosterholt et al., 2017)

INFORMATION DRIVEN HEALTH

*Image source: Bizlogic, 2018*


## More and better information is leading to improved health quality

The amount of health data available about a patient is increasing. In line with this, the healthcare sector is becoming more reliant on this data. To achieved data transparency, data is shared with stakeholders as well. This means more knowledge for all stakeholders, and more effective treatments. (Ismail, 2018)

## Patients want to take better control in health

Since the explosive growth of health related websites like Thuisarts.nl, more health information is available to consumers. (CBS, 2018) This better informed consumer has more insights in how he or she likes to be treated, and wants to make their own choices. This can be on the topic of surgery, medication, communication and treatment procedure. (VTV, 2018)

HUMAN FRIENDLY TREATMENT

*Image source: 201 Fysiosport, 2018*

## Searching for new ways to prevent surgery

Healthcare instances are also innovating on prevention activities, or active support in the primary care phase. An example is 'Netwerk artrose', a new collaboration with OA expert in the North West region of the Netherlands. Their program focusses on using the current joint as long as possible, with extensive exercises (Noordwest Groep, 2018).

## More attention towards treatment comfort

New treatment forms of OA focus on a pain free and effortless procedure. One example is the MBST method, where patients sit in a MRI like machine, and their cartilage cells are stimulated for renewal (Seniorenwijzer, 2018).

REINVENT THE PERSONAL CONNECTION


*Image source: Gelderlander, 2018*

### Searching for new ways of empathy in healthcare

With a shortage in healthcare staff and less time per patient, personal attention is running short. To fill this gap, numerous innovations are seeing the light of implementation. For example a reminder robot shaped like a flowerpot, for people with starting dementia. (Klein Jan, 2019). This loss in empathy can also apply to OA patients; where there is less time to support the patient in exercising.

### The healthcare professional becomes a partner in health

With the patient having increased responsibilities, the health professional gets a more coaching role.  This will change the relationship between patient and professional; and become more equal.
Decisions will be primarily made by the patient, with advice of the professional. (VTV, 2018)

## DEPEST

The DEPEST analysis is performed as an complementary check to the Trend Topics analysis, to make sure that all relevant trends are covered. The DEPEST analysis entailed an exploration on the topics Demographics, Economics, Politics, Ecology, Social and Technology, within the same context used in the Trend Topics analysis.

The DEPEST analysis found four additional trends to consider.
-Rapidly changing healthcare demographics
-Economic effects on healthcare
-Politics force a do it yourself mindset
-A rising demand for personalisation and hyperindividualism

The full description of these trends can be found in “appendix D: DEPEST analysis”.

In sum, these trends indicate a rising pressure on healthcare facilities due to demographics and economic measurements; this is no exception for orthopedic care. Therefore, politics force more personal action from patient, which will more likely be succesful if a personalised approach is adopted.

### Main findings in socio-cultural trends

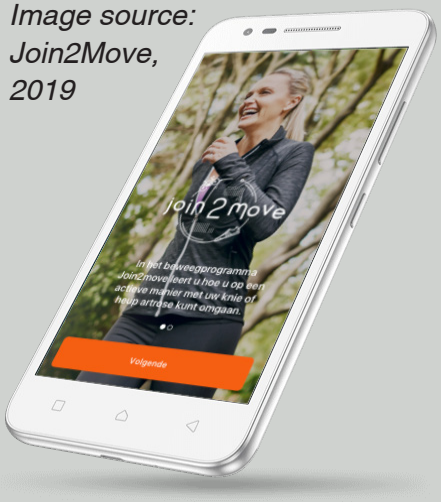
The socio-cultural trends show a changing healthcare landscape towards technology and information, but with the preservation of some traditional values. For example personal contact and empathy. Furthermore, the context of healthcare is changing from external facilities to peoples homes.These developments ask for the improvement of self management possibilities, with new contact options.

# TECHNOLOGICAL TRENDS

Technology scouting is a vital part of the roadmapping process due to its rooting in technology mapping (Simonse, 2017, p.110). Therefore, analysing technology trends is a necessity in this research. Trend and healthcare related instances such as Volksgezondheid Toekomst Verkenning (VTV), Vereniging Nederlandse Gemeenten (VNG), Stichting Toekomstbeeld der Techniek (STT), have composed lists of technology trends for the healthcare sector. For this trend analysis, these lists were compared, to come up with the eight most occurring ones. The three with highest influence on orthopedic care are explained here, the others can be found in "Appendix E: Technological trends"

## FROM APPS TO SYSTEM

*Image source: Join2Move, 2019*




### Health apps

There are more and more apps available which are related to health in the broadest sense of the word. And simultaneously, more people start using these apps making digital health management better featured in society. (DTT, 2019) Examples are the 'Medicatie app', the 'Reanimatie app', 'Risicoscan Van Zorg naar Beter' and 'Moet ik naar de Dokter?'

### Health system

With health apps more integrated in daily lives of people, it is to be expected that these apps become more integrated into the daily acitivies of health professionals as well. This ensures more efficient use of available data (Nictiz, 2018).

## DATA DRIVEN HEALTH

*Image source: CCHIT, 2015*

Data driven technologies are a big topic in the healthcare sector, and this is not expected to decrease soon. With data driven technologies, information can be collected, shared and analysed on a large scale.

### Big Data

Big Data can be described as a large set of data, generated by people and sensors. The availability of this data is online and real-time. The possibilities of generating big data are increasing, which increases the amount of Big Data generated. Big Data is used to personalize services for customers, optimise services with help of customer feedback, and ease the entrance to new markets. It is expected that in the future, more decisions will be based on Big Data, even in healthcare (STT, 2018).

### AI and machine learning

Without actual use of the generated insights, Big Data isn't worth much. Therefore, big data goes hand in hand with Artificial Intelligence (AI) and machine learning. When big data is generated, special algorithms (the AI component) are used to learn from these user insights. This means a system can become 'smarter' over time and is more tailored to user specified wants and needs. (VTV, 2018)

DIGITAL TWINS

*Image source: ECP, 2018*

Related to the trend of using AR and VR in the healthcare sector (Vilans, 2018) is the development of digital twins. A digital twin is an exact model of a the real world. A digital twin for healthcare can be described as a safe virtual environment where healthcare suppliers can test their innovations. (Digitalist Magazine, 2018).This allows them to do 'what if' type of experiments without affecting something or someone in real life. Test the effects of a new type of treatment, for example. Therefore, digital twins can form a bridge between the digital and the physical world.

## Main findings in technological trends

The overview of technological trends shows a broad spectrum of developments, related to making (OA) care process smarter and more efficient. Think about the improved diagnosis of the disorder, analyzing the success rates of different treatments, improving self-monitoring systems for patients and even obtaining insights on the well-being of the entire society in the far future. These trends will have a big impact on the organisation oforthopedic care processes. For example the setup of a consult, or treating OA related complaints.

# TECHNOLOGY TRENDS IN THE CONCEPT DEMONSTRATOR LANDSCAPE

In the 'Technical aspects' section of the concept analysis, an overview of technical features was created. Based on this overview, it was indicated that it was needed to add a additional layer of technological advancements to the technical features of the concept demonstrators. To specifically look back at this overview, and **show how the technology trends can improve on the existing technical features**, Figure 27 was created.
The eight most occuring technological trends were placed within the existing technical feature landscape. To do so, an investigation took place to assess where the technology trends were closely linked to existing features. Eventually, most of the trends were placed as extensions to existing features. The red dotted lines show how the technology trends are connected to the existing technologies.

The connections show that there are two trends connecting to wearable technology, but six trends connecting to online technology. This division indicates there is mostly room for innovation in the 'online technology' section. Especially 'Big data' shows many connections with both existing features and trends; this indicates an important trend. These findings have no direct effect on the concept assessment, but it does indicate which trends could be implemented where in the existing concept setup.

## The downside of technology

The biggest threat towards all the promising technological developments found is the privacy issue. The technologies collect a lot of personal information which is shared via the internet. This needs to happen in a safe manner for the technological innovations to thrive. The following section will discuss innovation barriers more in depth.

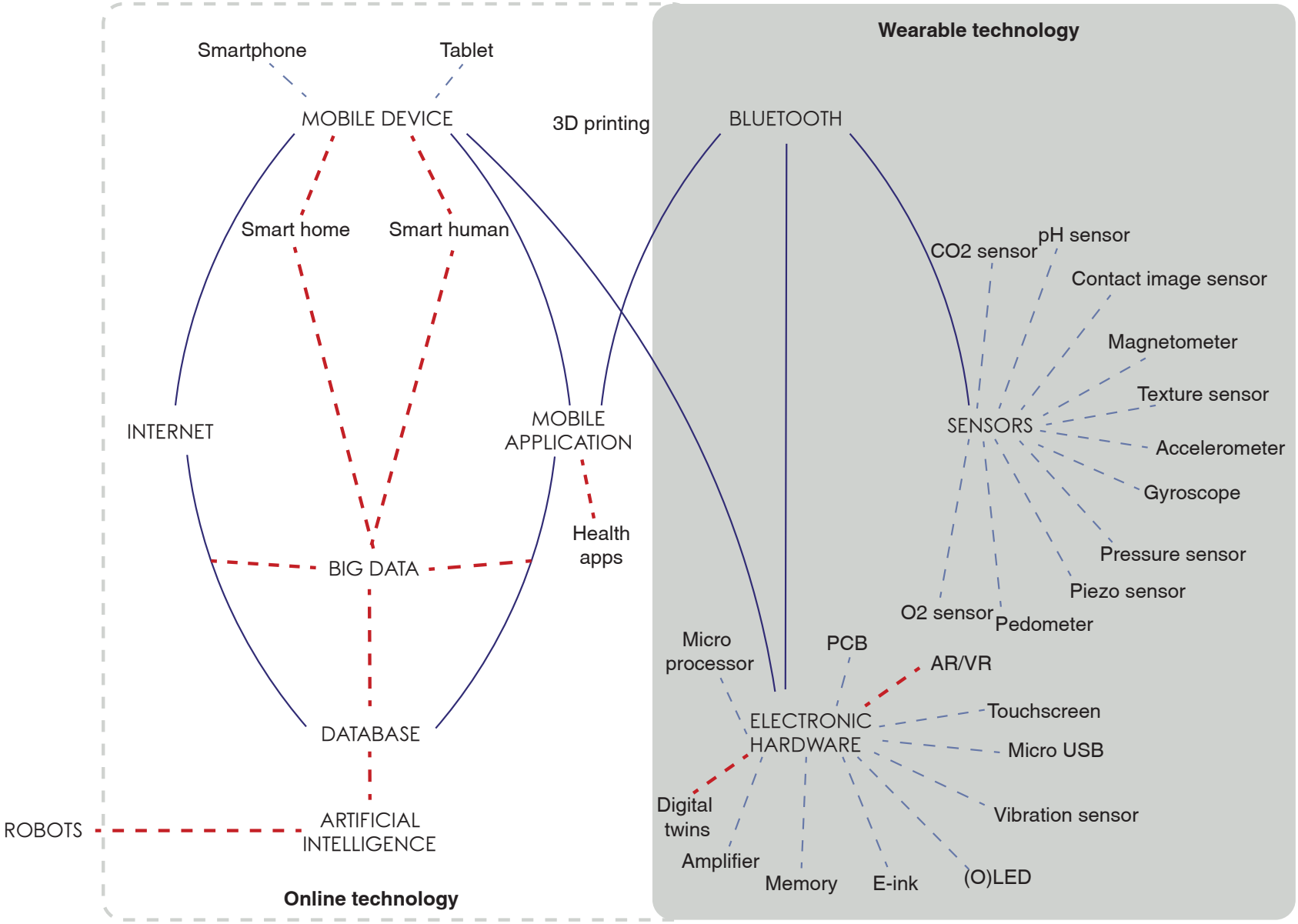



*Figure 27: The connection between the technology landscape and technology trends.*

# CURRENT AND FUTURE BARRIERS FOR INNOVATION

## INNOVATION BARRIERS

The 'Literature review' chapter already revealed that there are six forces that either drive or hinder healthcare innovation, defined by Herzlinger (2006); Players, Funding, Policy, Technology, Customers and Accountability. Only when all six forces are in favor, it is likely a healthcare innovation will be successful. This already shows the difficulty of innovation in the healthcare sector. To illustrate these difficulties, a lot of dutch advisory bodies (VTV for example) write about guidelines for innovating in the healthcare sector. The following section will discuss innovation difficulties in relation to the six drivers more in depth, where advice of dutch advisory bodies are used as input.

### Players and Policy: Regulations

In the last couple of years, a complex interplay between Technology, Policy and Customers has made the innovation practice very difficult, especially for digital service innovation. This is the issue of data privacy. Ever since the introduction of the 'Algemene Wet Gegevensbescherming' (AVG) in May 2018 (Autoriteit Persoonsgegevens, 2018), privacy concerning personal data has received an increasing amount of attention. This is no different for the healthcare sector. Since this sector is handling sensitive personal data, a lot of regulations are used for its protection. This set of regulations make it very difficult to implement new types of action, in communication for example (Zorg op Koers, 2018). On top of this, there are regulations for healthcare purchasing. Healthcare are obliged to follow this, but they are choosing to use processes which even increase the amount of regulations (VTV, 2018).

### Technology: Knowledge gaps

The amount of regulations alone already make innovation difficult. However, there is more. There is a mismatch in innovation possibilities and actual use of these innovations. This is because in healthcare practice is the notion of the 'not invented here-syndrom': healthcare instances tend to avoid the use of existing products standards and knowledge because of its external origin (VTV, 2018). This indicates a lack of knowledge on possibilities in the field.

### Customers, funding and accountability: Effort for change

Next to regulations and knowledge, there is a hurdle in the healthcare practice. Implementing digitial service innovations requires significant effort, motivation and money from healthcare professionals. Due to lack of time and involvement, these requirements are not present. Furthermore, both patients and professionals tend to choose the status quo over new possibilities (Vilans, 2014).This can be attributed to the fact that there is no clear responsible party for the implementation of new digital services. Many stakeholders speak of the importance of eHealth, but interests in this matter lie far apart. Combining this with the knowledge and regulation issue, one could conclude digitalizing the healthcare sector is too big for the healthcare sector alone to handle; is a societal matter (Nictiz, 2018).

## INNOVATION ENABLERS

The section above explained that regulations, knowledge and effort are the three most important determinants for hindering digital healthcare innovation. While this is good to take into account, it is also important to look forward; what guidelines could lead towards successful implementation of digital services? The section below shows guidelines formed by the VTV (2018).

### A learning system

As indicated in the section 'Data flows', the current health data network is too fragmented to use data technologies to its full potential. On top of this, using and reusing data is hindered by the quality of the current systems. Therefore, multiple instances indicate the need for a learning system where all stakeholders share their data. (VTV, 2018, Smith et al., 2013).They argue that only a system like this has potential to use data driven technologies with actual benefits for multiple stakeholders, and eventually public health.

## Technical knowledge and skills

For a proper use of data driven technologies, health professionals need sufficient knowledge of both the possibilities and limitations of data technologies (VTV, 2018). Big data can for example only find correlations, and some of them might be irrelevant or coincidental. Proper knowledge will make sure that the right conclusions are drawn from the data analysis. Furthermore, health professionals need to be trained in new forms of (digital) patient contact (Vilans, 2014). On the side of the patient, they need to be trained to use digital health services properly. Special attention is needed for groups like disabled people, 'analog' elderly and people with dementia. This means there should be a focus on user friendliness of services.

## Monitor effects

To put data driven heath solutions to full use and avoid a push of technology, it is important that its effect on the healthcare system is analysed (VTV, 2018). Does introducing the service lead to the desired outcome? For example, when investments are made to automize communication, cost reductions should be realized elsewhere. Even so, the introduction of data obtaining technologies such as wearables only work if the use of this data actually leads to a measurable effect, such as shortened length of treatment, or a smaller amount of complications (Skinner, 2013). With this knowledge, innovations can be improved more specifically and are likely to become more successful.

Figure 28 summarizes the innovation barriers and enablers mentioned. To work towards decreasing the barriers, two enablers are chosen to tackle within this project, which were expected to have a big impact on the performance of orthopedic care. The chosen enablers are highlighted in grey.

# NEW CONCERNS

The introduction of data driven health will also lead to new concerns; the section below discusses the two most important ones.

## Technical vulnerability

When the healthcare system becomes more dependent on technology, the system becomes more vulnerable. When the internet or power is down for example, it is impossible for health professionals to perform their job, drastically decreasing the quality of care. There should be some form of data backup plan in case of these extreme scenario's, to guarantee a qualitative treatment (VTV, 2018).

## Digital human rights

With the amount of transferring information needed to make data driven innovation in healthcare work, it is possible that these services step over a certain personal boundary. Not everyone wants every piece of personal information shared over the internet. Therefore, the European counsil added two human rights to the European agreement ; the right to not be analysed, measured or coached, and the right to have meaningful human contact (Autoriteit Persoonsgegevens, 2018). Patients can appeal to these rights, which can hinder the use of digital services. Again, there should be a back-up plan for successfully treat these kinds of patients without the growing involvement of data.

| BARRIERS | ENABLERS |
|---|---|
| Regulations; privacy should be concerned | A learning system to support treatment decisions |
| Knowledge gaps by the patient and professional | Teach technical knowledge and skills to all stakeholders |
| Effort for change by the health professional | Monitor effects of data driven health |

*Figure 28: Overview of innovation barriers and enablers.*

# CONCLUSION & IMPLICATIONS

Although the trend analysis presented in the previous sections already presented a selection of trends, it is unlikely the service model and roadmap can tackle them all. Therefore, all trends were assessed on impact on the orthopedic care journey and expected implementation time. Figure 29 shows this overview. The dotted line trends are socio-cultural trends, the outlined ones are technological trends. The expected implementation timings are a rough estimation, since little information was available on this topic. A lot is possible already; it is mostly a regulations issue, as mentioned earlier in this chapter. Nevertheless, the trends plotted in the top left (green) corner have the highest potential when applied in the service roadmap. This means they can be achieved in a reasonable amount of time and have high impact on changing orthopedic care for the better. Consequently, a drastic cut is made in the amount of technology trends to actually apply. The number of socio-cultural trends is higher, since multiple of these issues can be tackled with one technology. The trends are also in line with the barriers and enablers highlighted in the previous section.

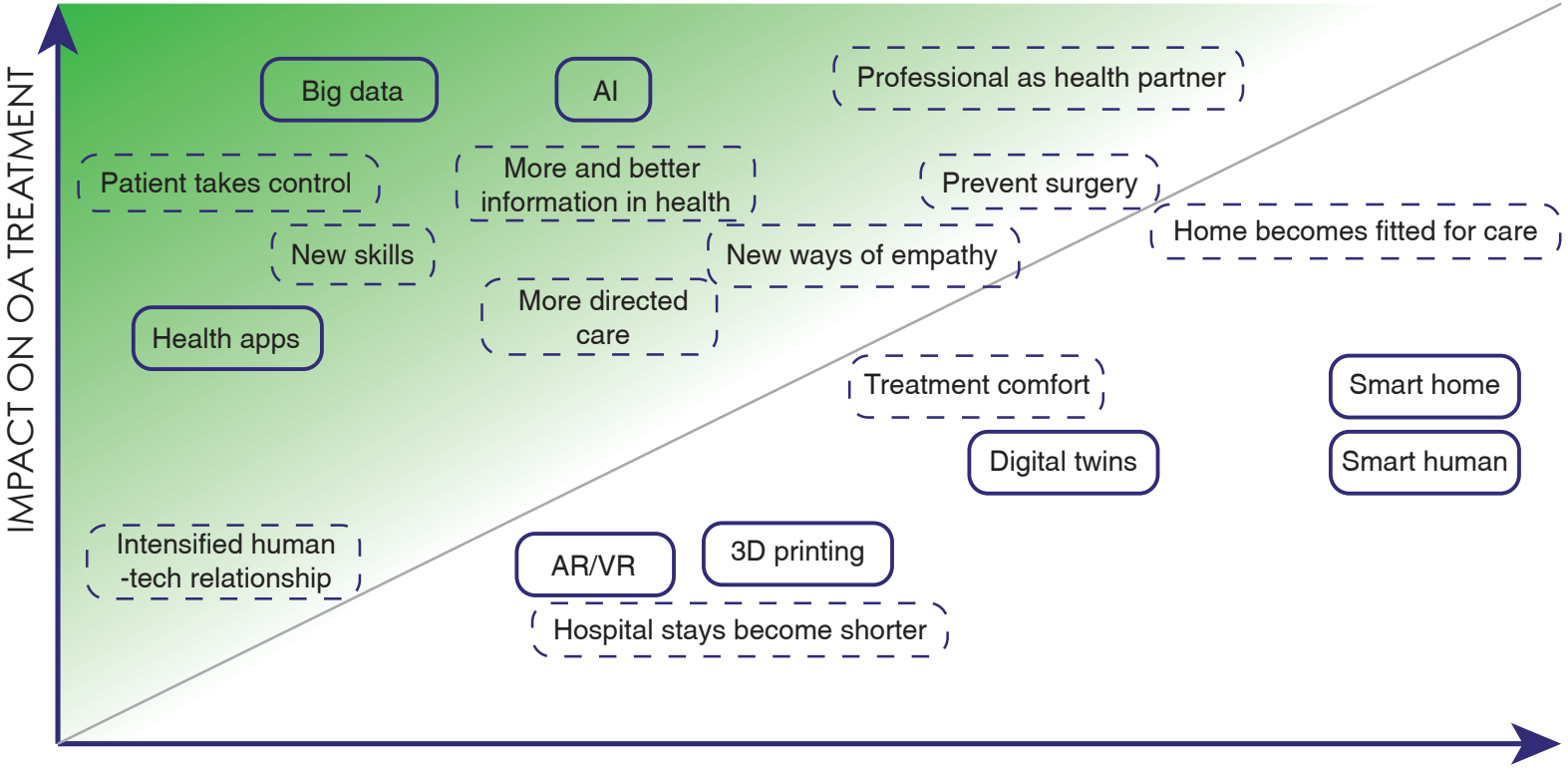



*Figure 29: socio-cultural and technological trends assessed on impact and time.*

# TAKE AWAYS ON INNOVATION

Health apps and data driven health are the most important technologies to integrate in the service model

The context of care is changing from hospital to home

It is important to maintain a human focused approach in a time of technological development

Regulations, knowledge gaps and effort for change hinder the implementation of health innovations

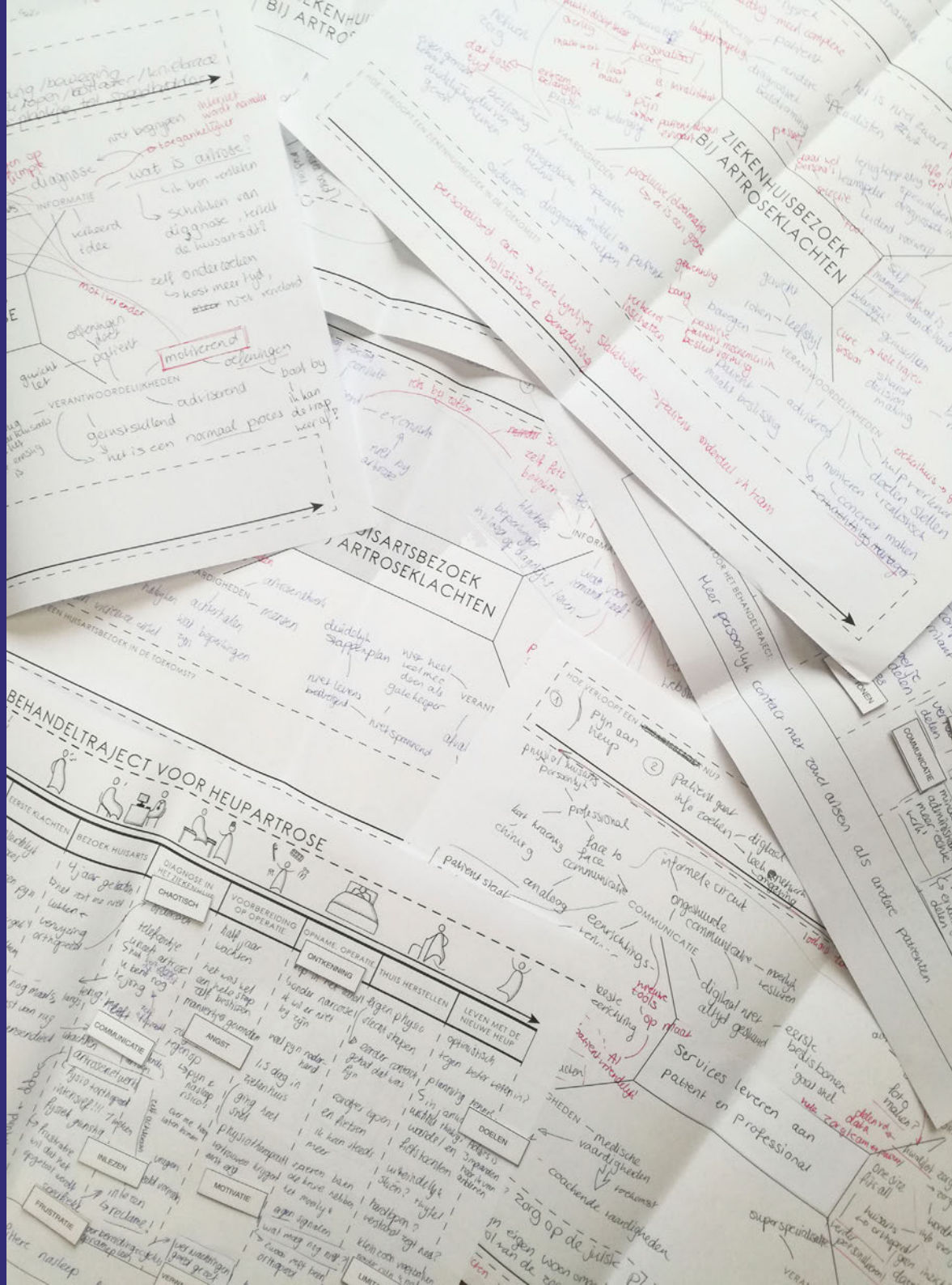
With the creation of smart care services and new ventures from prosthesis manufacturers, a new market is arising

Self management in OA becomes inevitable, but the user needs to be educated to do so. They now lack in skill.

A system that both facilitates learning and learns itself, is vital for the successful implementation of healthcare/OA innovations

# DEEP DIVE IN THE ORTHOPEDIC CARE CONTEXT: VALUES

This chapter builds further on the context analysis, and dives deeper into the values of the key users. This is done by both evaluating existing knowledge in the individual concept reports and group research reports, with stakeholder profiles as a result.



# STAKEHOLDER PROFILES

The chapter 'Introducing the orthopedic care context' analysed the stakeholder landscape and indicated the different roles stakeholders play in the treatment process of OA. Together with the initial conclusion that the patient, GP, physiotherapist and surgeon are seen as the key users for a new service model, one could conclude it is vital to know more about these stakeholder groups. Not just their actions, but their characteristics, values and needs. Where could they use help from a new service model?

## Method

To investigate this topic, **both the individual concept demonstrator reports and group research reports where analysed**. In these reports, a lot of valuable information on stakeholder values can be found. Examples are user tests, interviews, expert interviews, and research on cultural and social aspects in orthopedic care. The full set of findings from the reports can be found in "Appendix F: Social Cultural research".

The report analysis data resulted in 4 stakeholder profiles. The profiles show both the **different 'extremes' within these stakeholder groups, but more importantly, which overlapping factors can be seen between all individuals in the group**. Within these overlapping factors I established three categories:
**Values**; what does the stakeholder find most important in the OA treatment process?
**Characteristics**; how is the stakeholder likely to behave in the OA treatment process?
**Data needs**; what does the stakeholder expect from digital innovations?

Next to the overlapping factors, the reports showed a lot of infomation on knowledge gaps for each stakeholder. These are involved in the profile as well. Each profile is discussed on the next pages.

# PATIENT

A significant number of group research reports used a matrix to establish four patient types. Since this distinction was comprehensible and applicable to this project, it was chosen to be adopted in the profile. See Figure 30 on the next page. The matrix has two axis, one concerning attitude towards advice, and one concerning attitude towards the treatment process.

This resulted in 4 groups:
**-Stubborn pusher:** manages its own process actively, but in their own way, with their own defined goals.
**-Know it all:** manages its own process actively using every detail of medical advice as a basis.
**-Lost in understanding:** gives full control to medical experts, but due to misunderstanding of the advice there is no clear guidance which results in a passive attitude.
**-Passive patient:** does not actively manage its health process and focusses on other things in life.
While these patient types seem very different, they do have some similarities. They all want to feel some sort of control and independency in the process, where on the other hand they value trusted and expertise feedback. Data wise they would like insight in their activities in a way that fits with their lives.

Please note that the distinction of four patient types used in this stakeholder profile is a decision not necessarily based on literature. However, the findings of this research could add to the research by Dekkers et al. (2018) on establishing patient types.

## What are the knowledge gaps of the patient?

In the current treatment process of OA in the hip, the report research has shown that patients experience several problems regarding knowledge. Even before the disorder starts to develop, the patient -*to be*- can receive more effective info on prevention. Next issue is the GP; patients can be overwhelmed with feedback and advice leading into a feeling of insecurity. Third issue is the preparation phase, where the patient needs to process a lot of information about the procedure. And in the final phase, the feeling of insecurity strikes again, when there is little feedback on how the patient is progressing in their recovery.

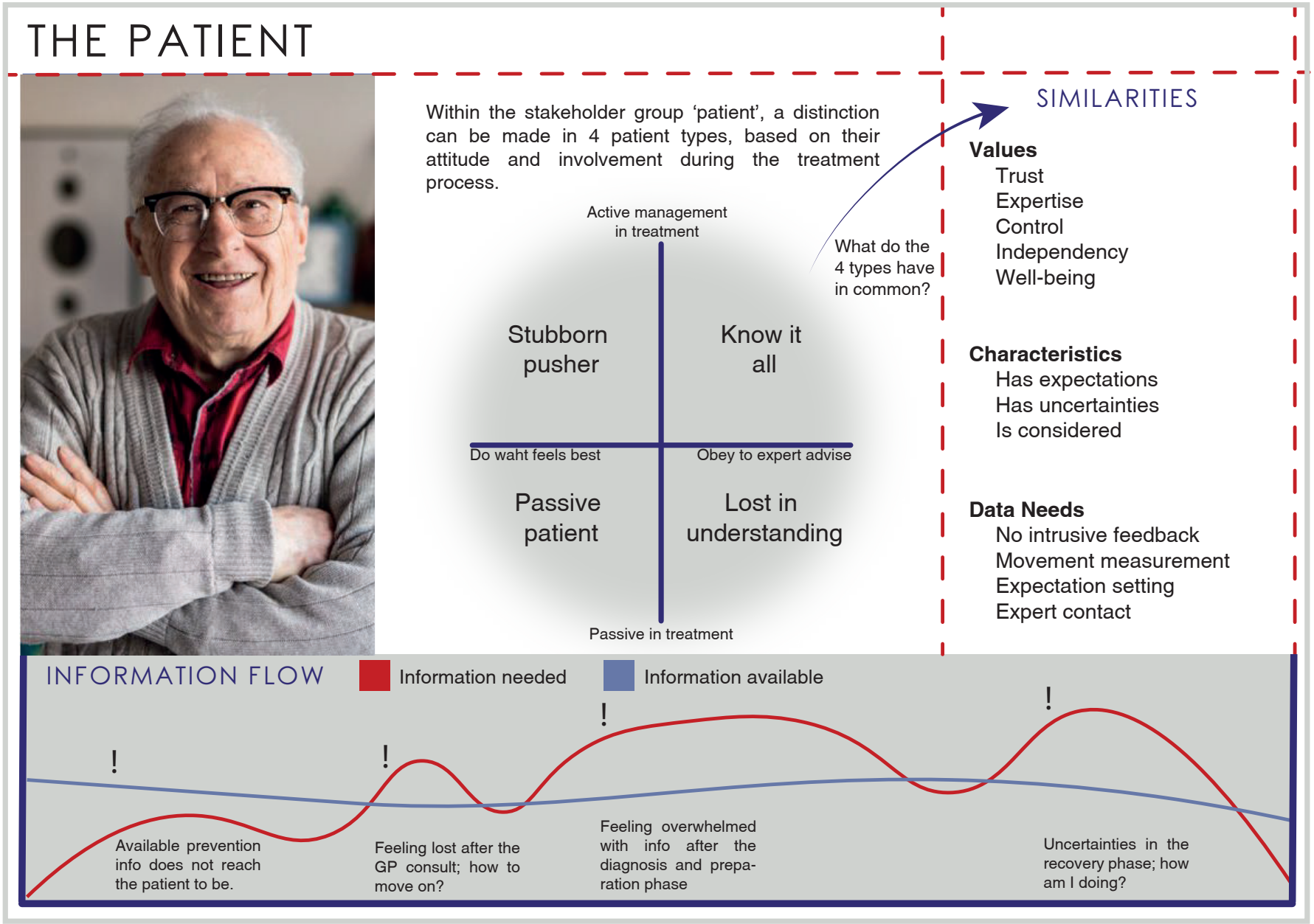



*Figure 30: Patient profile*

## GP

The reports research showed a clear two way distinction among GPs. On one hand is the technology skeptical group, which can be seen as the 'traditional' GP. They often belong to the older generation and have a lot of experience. They fear new digital innovations will be time consuming to implement. On the other hand is the technology embracing group. They often belong to the younger generation of GPs and are used to deal with new technologies. They believe digital innovations can enrich their results. See Figure 31. Despite their differences, they all value personal contact with patients, and want that to be the main focus of their job. Next, they value the feeling of authority, to make sure patients use their feedback. But on the other hand, they expect self-reliance from patients, and come to the GP after some preparation on experiences. To help the GP in obtaining patient experiences, 'soft' data from the patient is useful.

## What are the knowledge gaps of the GP?

For the GP, two knowledge gaps can be determined. First up is the GP consult, where the GP is very likely presented with an incomplete story from the patient side regarding their experiences with the hip. Their second issue lies in the recovery phase; although the GP remains the first source of professional communication for a patient, their feedback on the recovery remains limited to a short progress report by the surgeon.

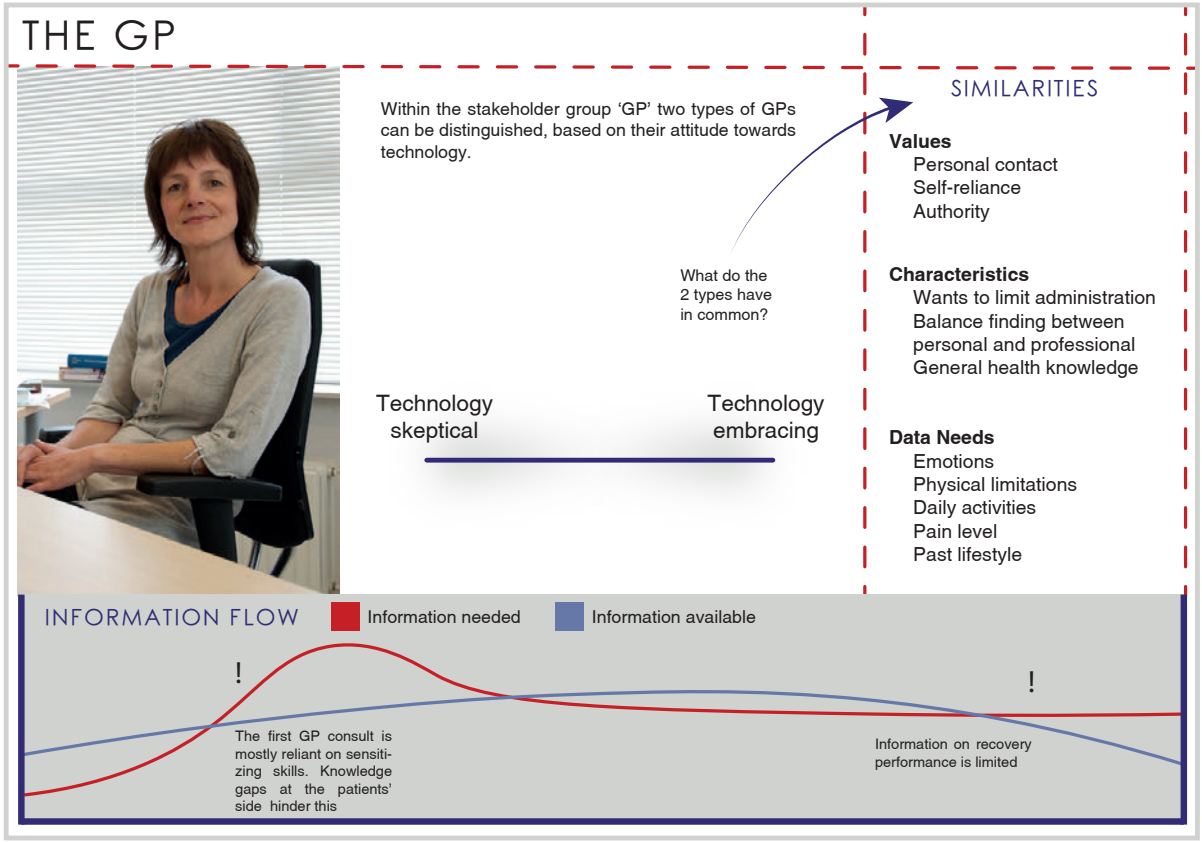



*Figure 31: GP profile*

## SURGEON

The reports research on the orthopedic surgeon showed a similar distinction to the GPs; there are technology skeptical and technology embracing surgeons. See Figure 32. Nonetheless, the profile traits are different from the GP. The surgeon is bound to many regulations, and therefore all about efficiency and wants results as fast as possible. This is why they also value data summaries. Next to this, they value certainty; knowing for sure that the hip is performing well. This gives them the confidence for next surgeries to come.

### What are the knowledge gaps of the surgeon?

For the surgeon, two knowledge gaps can be determined as well. First up is the hospital consult; these are experienced as inefficient by the surgeon since he has a very limited information basis. And second, the insight in the recovery phase is limited to a physical checkup, which gives almost no insight in hip performance.

## PHYSIOTHERAPIST

The reports research showed another two way distinction to the physiotherapist group based on their treatment approach; standardized and perso-

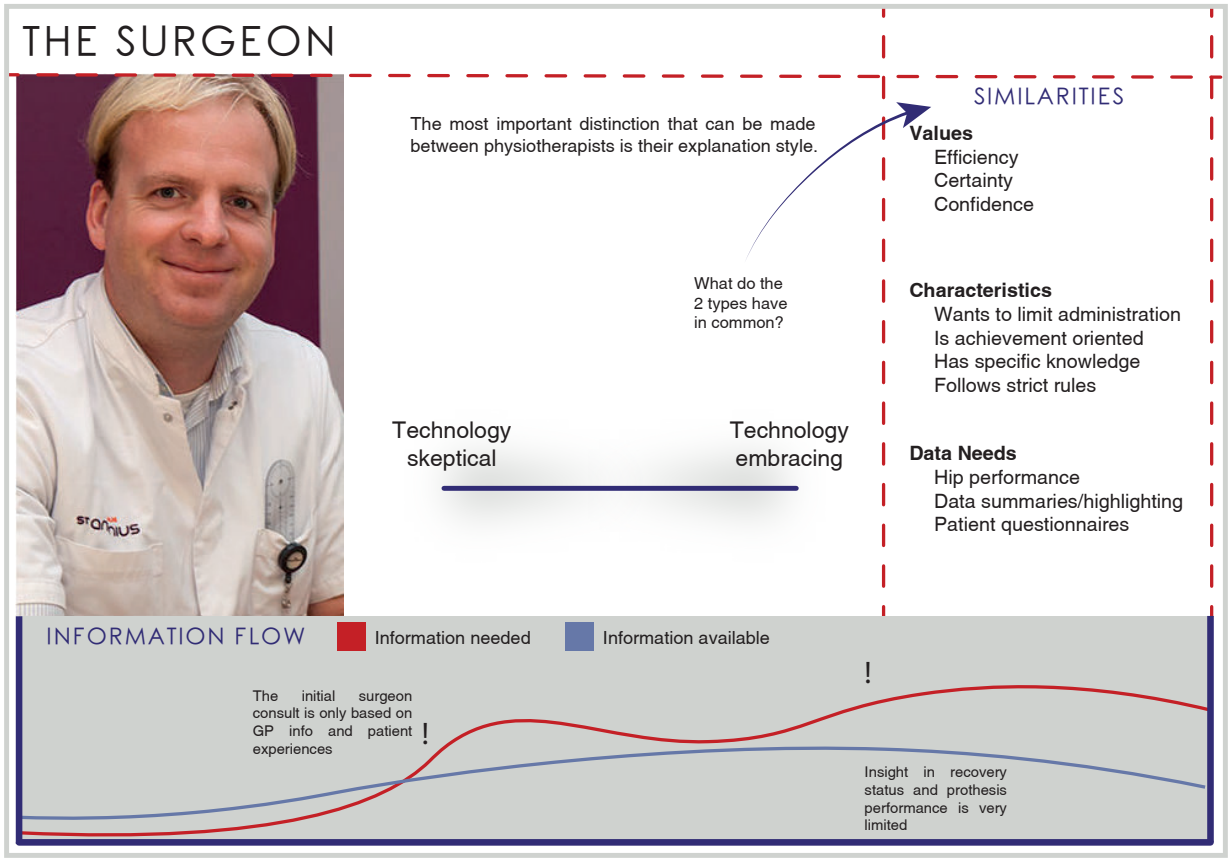



*Figure 32: Surgeon profile*

nalized. The standardized approach means the treatment guidelines are strictly followed, and can mostly be found by either less experienced physiotherapists or physiotherapists within a hospital. The personalized approach means the treatment is mostly formed by own knowledge and experiences and is more likely to be found with experienced physiotherapists in an independent facility. See Figure 33.

Similarities can be found in the fact that they all focus on functional training with exercises tailored to the patient, and motivation is the most vital part of this job. Without motivation from the patient, improvements are difficult to achieve. To make sure feedback is accepted by the patient, personal contact and authority is also considered vital. To support quality of the feedback, they like information on lifestyle and posture.

## What are the knowledge gaps of the physiotherapist?

There are two knowledge gaps to highlight for the physiotherapist. First, the initial consult. Like at the GP, the physio is presented with an incomplete story from the patient side, which can result in an inefficient set of exercises. And secondly, the insights on the recovery process remain limited to experiences expressed by the patient. Again, this could lead to an inefficient exercise program.

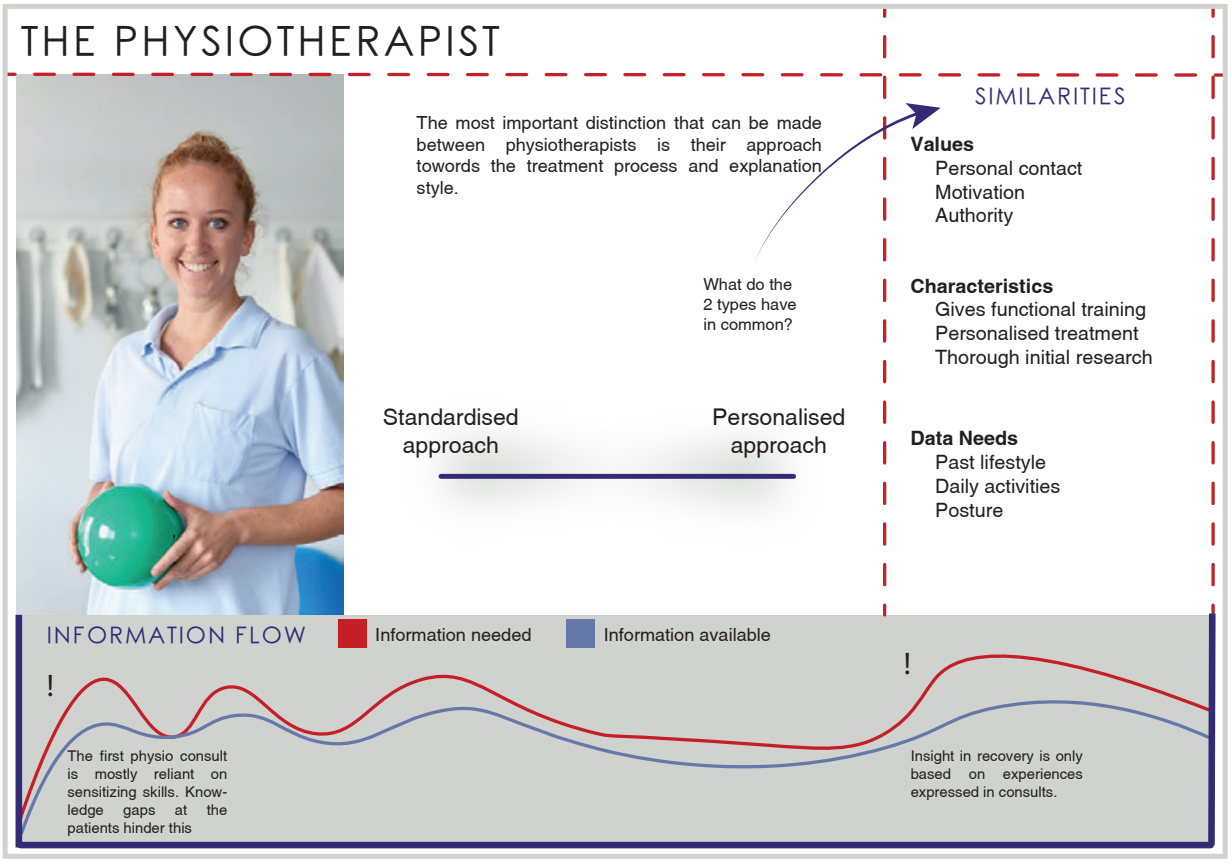



*Figure 33: Physiotherapist profile*

# COMPARING STAKEHOLDERS

Figure 34 shows an comparison overview for the 4 stakeholder profiles. What similarities and differences can be found between them?

## GP and Patient

There is an interesting paradox happening between the GP and the patient. On one hand, GPs value self-reliance, and expect patients to do some research on the topic of OA, make appointments themselves etc. This can decrease the workload for GPs. This goes hand in hand with the independency value of patients, which is positive. However, the self-reliance value also results in wrong expectation setting by the patients, which can be harmful for the treatment process.

## Physiotherapist and Patient

A similar event happens with the physiotherapist as well. The independency value and resulting expectations characteristic hinders a good initial research by the physiotherapist. Therefore, the physiotherapist values self-reliance less. They are more focused on personalizing the treatment to achieve a correct posture.

## Surgeon and Patient

The surgeon is a high level stakeholder and stands most far away to the patient looking at their data needs. They are achievement oriented and are therefore interested in performance. Insight in patient questionnaires is mentioned but not an absolute priority in the near future.

## GP and Physiotherapist

Apart from the self-reliance value, GPs and physiotherapists show strong similarities in profile. They both value personal contact and desire more personal data from the patient (daily activities, past lifestyle, experiences etc). This means they are ‘low level’ and close to the patient.
What these insights do mean is that a patient ‘effort’ is required to generate this data. Entering emotions and daily activities in a system for the GP has no direct benefit for them, which decreases the likeliness they will do it.

## Physiotherapist and Surgeon

Physiotherapists are very different in their relationship with the patient and their values during the treatment process. However, it can be said that their end goals in the treatment process are both focused on function; an optimal usage of the new hip.

## Surgeon and GP

While there is a big difference in patient relationship, the surgeon and GP do have a thing in common. Administrative work is currently a big issue for them, since it is taking up a significant amount of time. This means they are unlikely to perform extra effort in the sense of actively using an extensive new digital data platform.

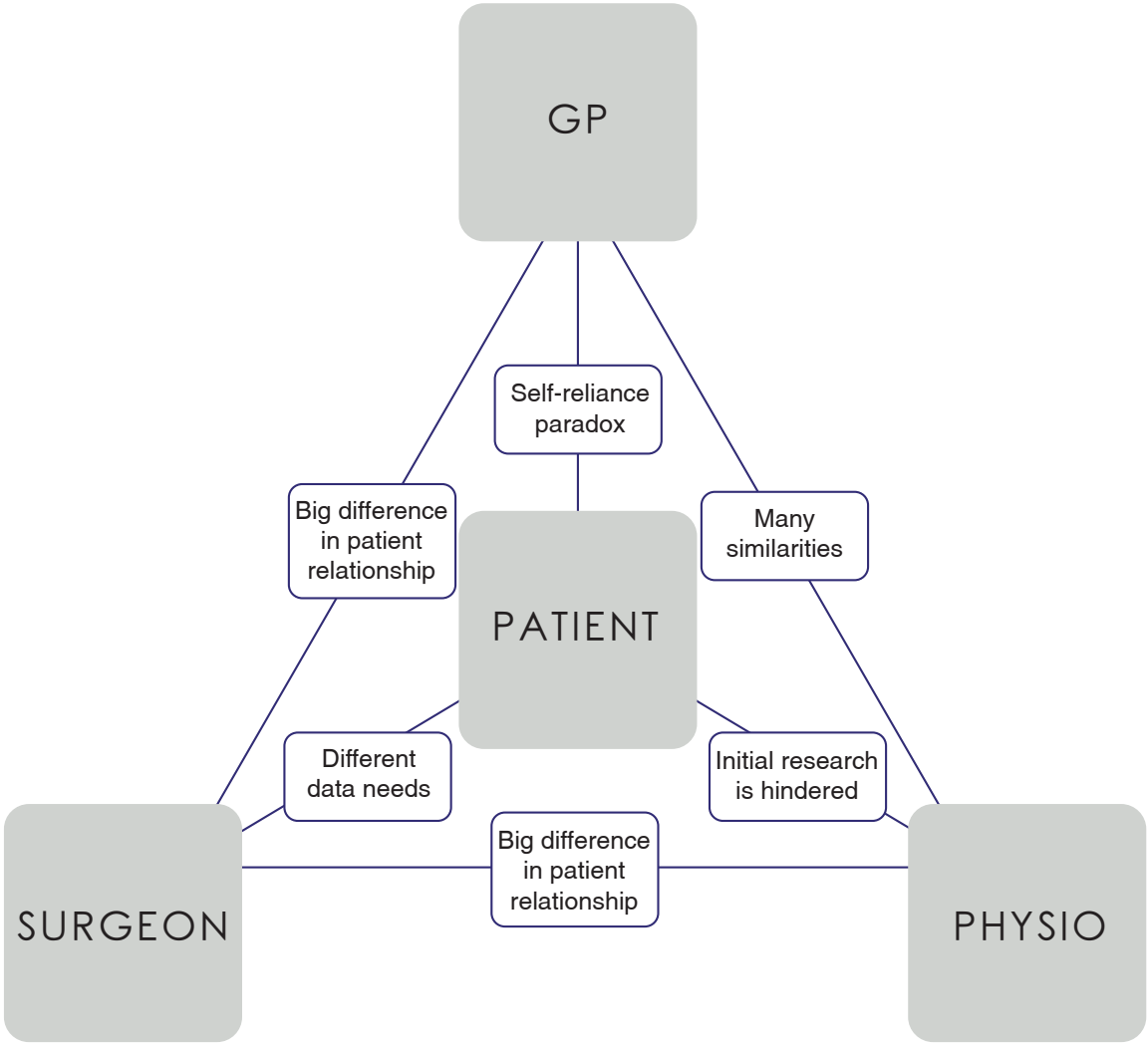



*Figure 34: Stakeholder relations*

# VALUES IN ORTHOPEDIC CARE: INTERVIEWS

After the setup of four stakeholder profiles based on report research, it was time to dive into the field and validate the stakeholder profiles. This was done by conducting interviews. Next to validating the profiles, the interviews could also support in the development of a future vision. Eventually, a theoretic framework is developed based on the findings from the interviews.

## PATIENT INTERVIEWS

Since the patient is the most important stakeholder, it was most important to assess the patient profile (Figure 30) first. This was done by performing four semi-structured interviews with former OA patients, both man and woman. (Neuman & Robson, 2012). The interviews were performed in their own home context. The patients' age varied in the range of 66 to 87 which was a good representative of the OA 'target group'. To perform the patient interviews, a set of questions was set up, accompanied with an interview kit (Figure 35). This kit consisted of an empty patient journey, apart from the treatment phases set by Dr. Ir. A. Albayrak, and a set of key words. The key words could be placed on the patient journey to highlight certain values, concerns, emotions or people. The full set can be seen in "Appendix G: Interview kit"

### Doing the interviews

The interviews turned out to be a sufficient medium to investigate the world of the patient. Where the patient journey was originally intended to be filled out by the patient, it was easier for the flow of the interview to do it myself, so the patient could talk freely (Figure 36). Furthermore, it was expected that the key words could be useful to get the patient to talk about the right subjects, but they did this without help. However, the key words were very useful in reflecting on the interview afterwards. Findings in the patient journey could be highlighted with them.


*Figure 35: Interview kit*

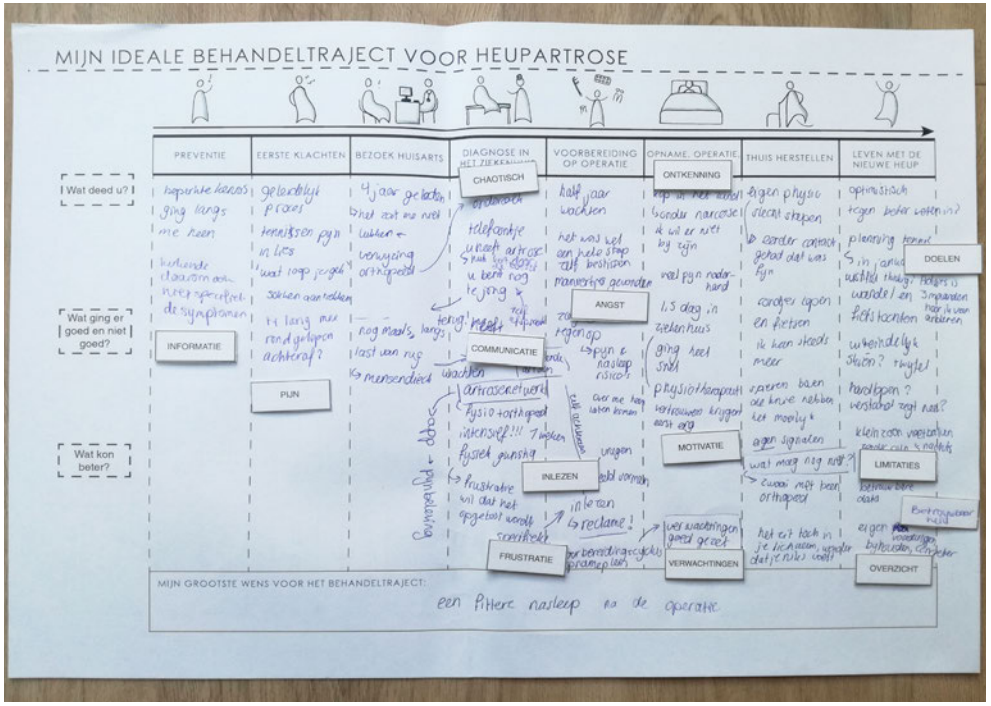



*Figure 36: Filled out patient journey with key words*

# INTERVIEW OUTCOMES

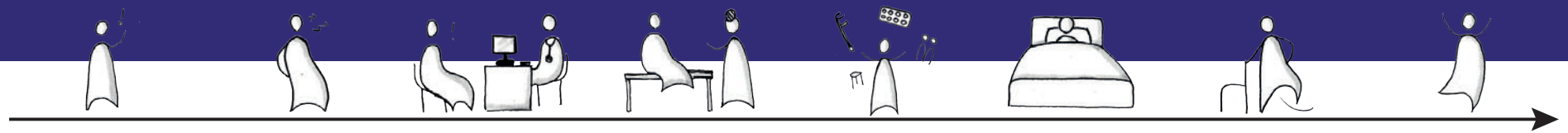
Figure 37 on the next page shows the outcome of the interviews, in the form of a filled out patient journey. In this journey, the most commonly mentioned quotes are written down, even as the most striking ones. Additionally, a list of data needs per phase can be found in this figure. A summary of findings per interview can be found in “Appendix H: Patient Interview outcomes”. Due to time contraints, it was chosen to transcribe half of the interviews for further analysis purposes in the ‘Theoretic framework’ section at the end of this chapter. In the section below, a connection is made between the interviews and the patient stakeholder profile.

## Looking back at the patient profile

When looking at the contents of the patient profile in Figure 30, it can be concluded that the patient profile is valid. All the values, characteristics and data needs came across in the interviews. Not with the same level of importance in every interview, but they were definately applicable. Concerning the information flow, all knowledge gaps were verified *except* the preperation gap. Patients did not feel lost in preparing for THA surgery. However, it can be argued that this gap should be shifted a bit earlier; when obtaining information on the THA procedure before the actual GO on the surgery.

When looking back at the patient type matrix in Figure 30, one could conclude that I interviewed one stubborn pusher, one know-it-all and two passive patients. This says something about their personal attitude, but not their relation with other stakeholders. According to the research by Dekkers et al. (2018), four communication approaches can be distinguised based on competence, autonomy and interpersonal behavior. When anlysing my interview outcomes these parameters can be confirmed. Each patient expected a different style in treatment. This adds the value ‘personalisation’ to the patient profile.

Finally, the importance of both expertise and independency in the patient profile should be stressed. The overall patient wishes for the future were either related to communication with the health professional, or performance during the recovery phase. These seem like two important topics to cover in the service model.



| | PREVENTIE | EERSTE KLACHTEN | BEZOEK HUISARTS | DIAGNOSE IN HET ZIEKENHUIS | VOORBEREIDING OP OPERATIE | OPNAME, OPERATIE, NABEHANDELING | THUIS HERSTELLEN | LEVEN MET DE NIEUWE HEUP |
|---|---|---|---|---|---|---|---|---|
| Interesting findings | Patients were unfamiliar with OA complications and possible risks before they got OA themselves.<br><br>'I heard stuff about it on tv but never paid real attention.'<br><br>One patient who had OA in several joints mentioned: 'Right now I know exactly when pain is OA.' | Patients walked around with complaints for quite some time. Patients felt afraid, they did not know what was going on.<br><br>'I walked around with two broken hips for 6 weeks but I had no idea.'<br><br>'I had trouble getting on my bike'<br><br>'I had problems while playing tennis.' | The GP was visited relatively late<br>There were mixed experiences towards the GP.<br>Most of the time, he was seen as the gateway to the hospital<br><br>'The GP did not take it serious and only advised painkillers'<br><br>'The GP immidiately forwarded me to a physiotherapist, who very quickly realised it was bad'<br><br>'The GP forwarded me straight to the orthopedic clinic'. | The younger the patient, the more complicated the road to surgery was.<br><br>'I could get surgery two weeks later.'<br><br>'I had an emergancy surgery the next day after the diagnosis with an x-ray. It was a relief.<br><br>'I got a phonecall with the diagnosis, but then they left me in the dark. I only knew I was too young for surgery yet. I had to fix own appointment for further explanation.' | When the decision for surgery was made themselves, preparing for the surgery was more difficult.<br>The patients felt sufficiently prepared in terms of knowledge.<br><br>'It was a big thing for me. They were going replacing a bone inside my body.'<br><br>I tried to ignore my fear, and switch to survival mode.<br><br>'I had to take care of many things, but it was doable.' | Surgery was done both with anesthesia and epidural.<br>After that they stayed in the hospital for 4 to 8 days.<br>The physiotherapist was important in the first movements.<br><br>'Fear arose immidiately after surgery, will I be able to walk again?'<br><br>'Attention to exercises was very limited, the physiotherapist had no time for me.'<br><br>'The physiotherapist helped me in gaining trust with the prosthesis.' | Recovery took place both at a care home and at home. Physiotherapy was provided. Some still do therapy, some don't. Their independence was challenged, but family was supportive.<br><br>'I was annoyed by the amount of help I needed'<br><br>'I missed personal contact with other patients or experts, to share my experiences.<br><br>'I forgot to exercise, it did not became a routine.' | Daily life continues, but some things have changed. Insecurity is a major issue<br><br>'I don't dare to go on my bike anymore.<br><br>'I need help in cleaning and I need a scootmobile.<br><br>I had a fear of falling for 5 months after recovery.<br><br>I did not teach myself a proper way of walking so eventually I tripped.<br><br>'I want to start tennis again in January, but I mostly base this on good hopes.' |
| Data needs | Recognise OA quicker: Preventive information | Recognise OA quicker: Symptoms information | Recognise the need for good contact: verified OA information and digital communication | Digital innovation should make sure less time is spent behind the computer, and leave more time for personal contact. ->automated processes | | Express the importance of exercises with personalised warnings<br><br>Build confidence by showing abilities | Perform tasks individually with smart home adjustments | Insight in status on recovery goals with expectation models<br><br>Assure correct movements by movement indicators. |
| | KEYWORDS: Ignorance | KEYWORDS: Pain, insecure, unclarity | KEYWORDS: involvement | KEYWORDS: Relief, frustration, understanding | KEYWORDS: survival mode | KEYWORDS: fear, attention | KEYWORDS: exercises, independence | KEYWORDS: Independence, insecurity, personalisation |

MIJN GROOTSTE WENS VOOR HET BEHANDELTRAJECT:

More personal contact with both other patients and professonals
More attention towards aftercare and exercises
Feeling more fit during the aftermath
A patient who listens to me and takes me seriously.

*Figure 37: Patient journey analysis*

## PATIENT INTERVIEW CONCLUSION

First of all, it should be said that the OA patient is almost impossible to define in one quote. Small nuances in character can have a completely different outcome on behavior and experiences in the patient journey, supported by the research of Dekkers et al. (2018). However, the following could be concluded:

- **The OA journey is a learning process.** The patient has to learn a lot about all types of aspects related to OA; disease information, behavioral advice, exercises, limitations, possibilities etc. Guidance is not always sufficient here.
- The patient **takes action relatively late**. Both in visiting the GP with OA related complaints, or in obtaining the right OA information.
- The patient is **searching for balance** in the treatment process; they want to do things themselves but also need professional help. When to choose what is a skill yet to learn as well.
- While they like independence, **communication** with experts is something every patient values. Especially face to face. They like to be known by their care provider.
- Data needs are nuanced, it is really dependent on someones lifestyle and character. This causes a need for **personalisation** in the support process. Nevertheless, mentioned data needs concerned insight in **treatment status, progress and possibilities** topics.
- The **recovery phase** is critical for patients, since it causes major insecurities. Can they get their old life back? When a patient is younger, they have certain goals, but how to get there and in what time frame, is vague.

In the end, I want the patient to feel as experienced as this interview quote below (an OA patient experiencing OA for the 6th time in her life):

***'Along the way I learnt my own way of doing things. I have my own way of performing exercises, doing things in the house, telling my story to doctors, and recognizing OA complaints. Because of years of experience with OA, I know exactly what my body can and cannot do.'***

# INTERVIEWS WITH HEALTH PROFESSIONALS

To get a full image of the stakeholder field, semi-structured interviews with health professionals are performed as well (Neuman & Robson, 2012). I performed six interviews with health professionals in total; one GP, one physiotherapist, two orthopedic surgeons and two managers at a hip prosthesis manufacturing firm in the area of innovation and services.

To perform the expert interviews, a new set of questions was set up, accompanied with an mind map poster (Figure 38). The subject of the mindmap poster differed slightly depending on the professional to interview. The full set of mind map posters can be found can be seen in "Appendix G: Interview kit".

## Doing the interviews

The mindmap turned out to be an efficient tool to categorise interview findings on the go and keep track of the interview flow. However, following the mindmap too strictly during the interview could break up the flow. After a few interviews I got a lot better at this and the quality of the interviews improved as well.


*Figure 38: Filled out mind map poster*

## INTERVIEW OUTCOMES

After performing the interviews, a summery was made of the most important findings directly afterwards. Due to time constraints, a part of the interviews was transcribed. The interview summaries can be found in ”Appendix I: Health professionals interview outcomes”.

### Comparing interview outcomes to the stakeholder profiles

Just like with the patient profile, most of the content from the stakeholder profiles of the GP, physiotherapist and surgeon could be concerned valid after the interviews.

For the **GP**, it can be said that I interviewed a technology embracing GP, but mostly with the aim of efficiency. The need for personal information was mostly present by trying to shape the treatment to the patient wishes. Thanks to many years of experience, this was very doable. It also diminshed the knowledge gap at the first OA related consult in this case. The second knowledge gap was confirmed however, not much information from other expert was shared.

For the **physiotherapist**, it can be said that I interviewed a physiotherapist with a personalised approach due to the fact that she had years of experience and was not yet confident with technology. All values, characteristics and data needs can be verified, with a special interest in motivating the patient. Here is also room for digital input. Considering the knowledge gap at the intial consult, this one was easily solved for her by asking questions and experience.

For the **surgeons**, the values, characteristics and data needs can be verified as well. From all the health professionals, they were the most pragmatic about the treatment, and more talking about treatment performance than experiences with patients. This is in line with their characteristics. In terms of knowledge gaps, these were in the right moments in the process, but of even bigger importance to the surgeons than anticipated. They see a large role for data to improve treatment quality.

## HEALTH PROFESSIONAL INTERVIEWS CONCLUSION

Since the interviews with the health professionals basically entailed interviewing four different target groups, it was to be expected that the results of the interviews were even more diversethan with the patient interviews. However, this section aims to show the main differences and similarities found, that are important for the next steps of the project.

- The vision about the OA patient is unanimous; a person above 55 who has pain and feels limited in (daily life) activities. OA is limiting but not life threatening.
- The care professional most often sees themselves as an **advisor**, a **manager of expectations** and they feel responsible for **providing good care**. But they all think the **patient has responsibilities** too. In following advice, and making decisions together. This asks for knowledge on the patients side.
- A lot of time is spent explaining things at the moment. Professionals want to provide **more information to patients in an effective way**.
- The second-line care wants to have more information about the patient. The **information flow** from primary care and secondline care is currently insufficient in their opinion.
- Health professionals want to have an **extra communication medium** with patients, to work more efficiently. Not everything is needed face to face, although it is sometimes important.
- All stakeholders think a **holistic approach is important**, but only the second line care expresses a need for more communication with the entire stakeholder set. This is related to the need for information from the second-line care.
- **Digital mediums are seen as an attractive form of innovation.** All professionals call for an digital communication tool. Also (prevention) innovation can be shared digitally. And finally, a digital tool can help in self-management of the patient.
- The professionals want to enable more care from someone’s **home.**
- All professionals found it really important to **personalize** the treat-

ment, often with help of determining the **patients goal**. The professionals differ however in the **degree** of personalization. Some are thinking on the level of categorization, and others are thinking in the direction of tailored healthcare.

- Primary care has the opinion that OA is **straight forward**, especially compared to the other diseases they see. Second-line care sees it as more **complex** and less straight forward.
- There are two camps on the topic of **prevention**. Some experts (especially second line) feel like the patients should **be in sight of health professionals earlier.** However, the GP does not like this idea at all. He does **not want this additional job** over all the prevention jobs he already does. The physiotherapist floats somewhere in the middle.
- In all cases, the professionals were focusing on the **first stages of the patient journey** for future adjustments. **Recovery is more standard**.

# COMPARING CONCLUSIONS

To bring the interview conclusions together, a coding analysis was performed (Corbin & Strauss, 2011). Also see “Appendix J: Code book”. This coding analysis resulted in the formulation of six trade offs for innovation in orthopedic care.

**1**. There is a discrepancy between the view towards OA between patient and professional. Where the complaints and the treatment procedures cause uncertainties and fear for the patient and takes over a large part of their life, the professionals see it as a routine thing. They are aware of the limitations but it is not life threatening. The patient can be heard more. To both live up to the responsibilities of professionals and be more confident in the treatment process, a self-management tool for the patient can be ideal.

**2**. The professional is focused on the first stages of treatment, while the patient mostly worries about the recovery phase. This means there is no great overlap, but they both have interesting reasons for innovation.

**3**. Information flows are far from optimalised. For certain information the patient is too dependent on the professional still. When this information is not retrieved actively, it can cause learning wrong manners, in movement for example. The professional has the information, but has limited time to share it all. Patient monitoring and interventing could be a solution here, but it should not become a ‘big brother’ situation and not put all the weight on the primary care professionals.

**4**. The professionals personalize their treatment and want to move further with this, but this is not notified by the patient yet. Furthermore, the method of personalization differs per professional.

**5**. To increase efficiency, more digital communication is needed, but face to face communication is still valued by both patient and professional. A balance needs to be found.

**6**. On one hand, professionals like to have short communication lines between other professionals, but on the other hand they want to spent a minimal amount of time on establishing and using these lines.

# CONCLUSION: THEORETICAL FRAMEWORK

To summarize the interview findings in a more comprehensible manner, a theoretical framework was created (Figure 39). The previous section highlighted trade offs in the field of the OA treatment. For the framework, these trade offs are called 'tensions' and are chosen as a basis for the framework. The tensions are related to four main innovation topics: self-management, personalisation, communication and information. In their turn, these innovation topics are showing a need for a digital product service for the OA treatment. Finally, three main goals are highlighted that can be achieved by introducing a new service model.

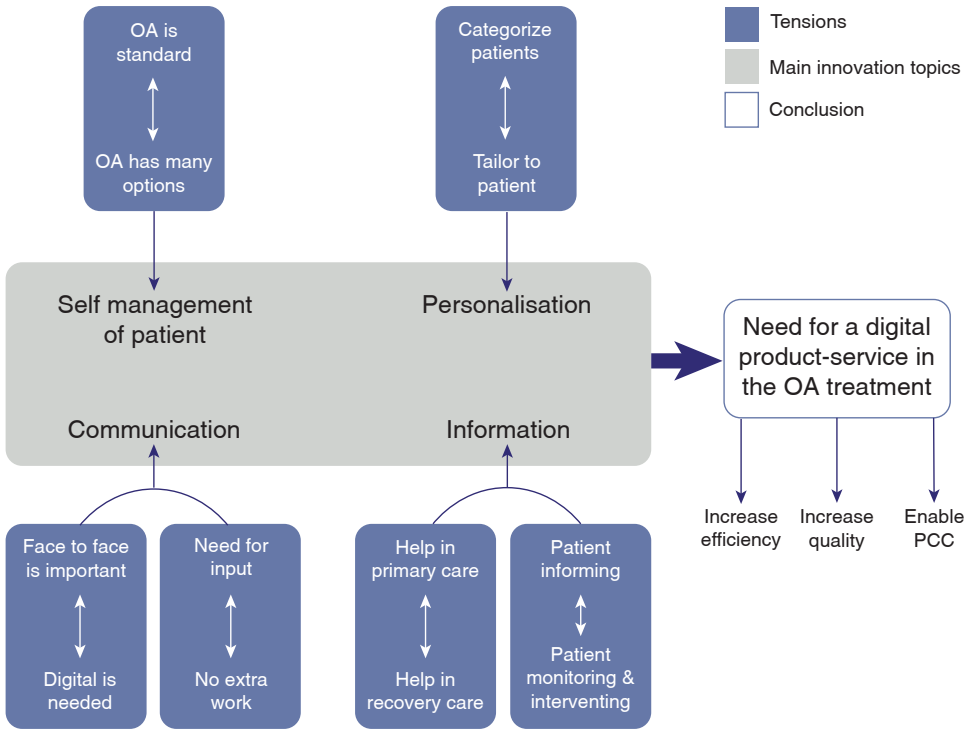



*Figure 39: Theoretical framework*

# IMPLICATIONS

The theoretical framework highlights the important aspects to take into account when creating a new product-service. But what does it actually say in terms of design directions? Findings from the theoretical framework are transformed into design implications below.

- The service model should deal with both primary and recovery issues. Recovery help can be fixed on a shorter term, so start with that and works towards primary care and prevention. This also means the service starts with serving the patient and slowly works towards the professional.
- Information providing both from and towards the patient should have a prominent role.
- Communication with the patient should have a prominent role. Further on, we can build towards communication between professionals; or at least use a service structure that enables communication in the future.
- The trends section already indicated a need for a learning system. The interview section indicates that a learning opportunity should also be applied for the patient and the health professional.
- Decide on a personalization option by categorizing or tailoring, or let it change over time.
- The roadmap should work towards care at home, were the patient is self-managing.
- The product-service can be actively supportive, but it should always be in agreement with the user.

## Implications on the future vision

To have a main guideline to follow in creating a service model, it is important to create a future vision. In the development of a vision, the theoretic framework (Figure 39) could be used as a basis. On the right of the framework, the conclusion of the tensions and main innovation topics is shown; 'need for a digital product-service in the OA treatment'. By solving this need, three achievements can be fulfilled. 'Using PCC in the OA treatment' is the ultimate goal here, indicating a learning process. The three achievements can used to formulate three visions in facilitating this learning process. The formulation of these visions is discussed in the next chapter.

# TAKE AWAYS ON VALUES

Patients need improvements in the recovery phase, whereas professionals have improvement needs in primary care

Information flows are currently insufficient; towards the patient, from the patient and between professionals

A digital medium is needed for communication, information self management and personalisation

The service model should support a learning process for all users.

The surgery is a big thing for patients but a routine for professionals. Patients need to feel that they are understood

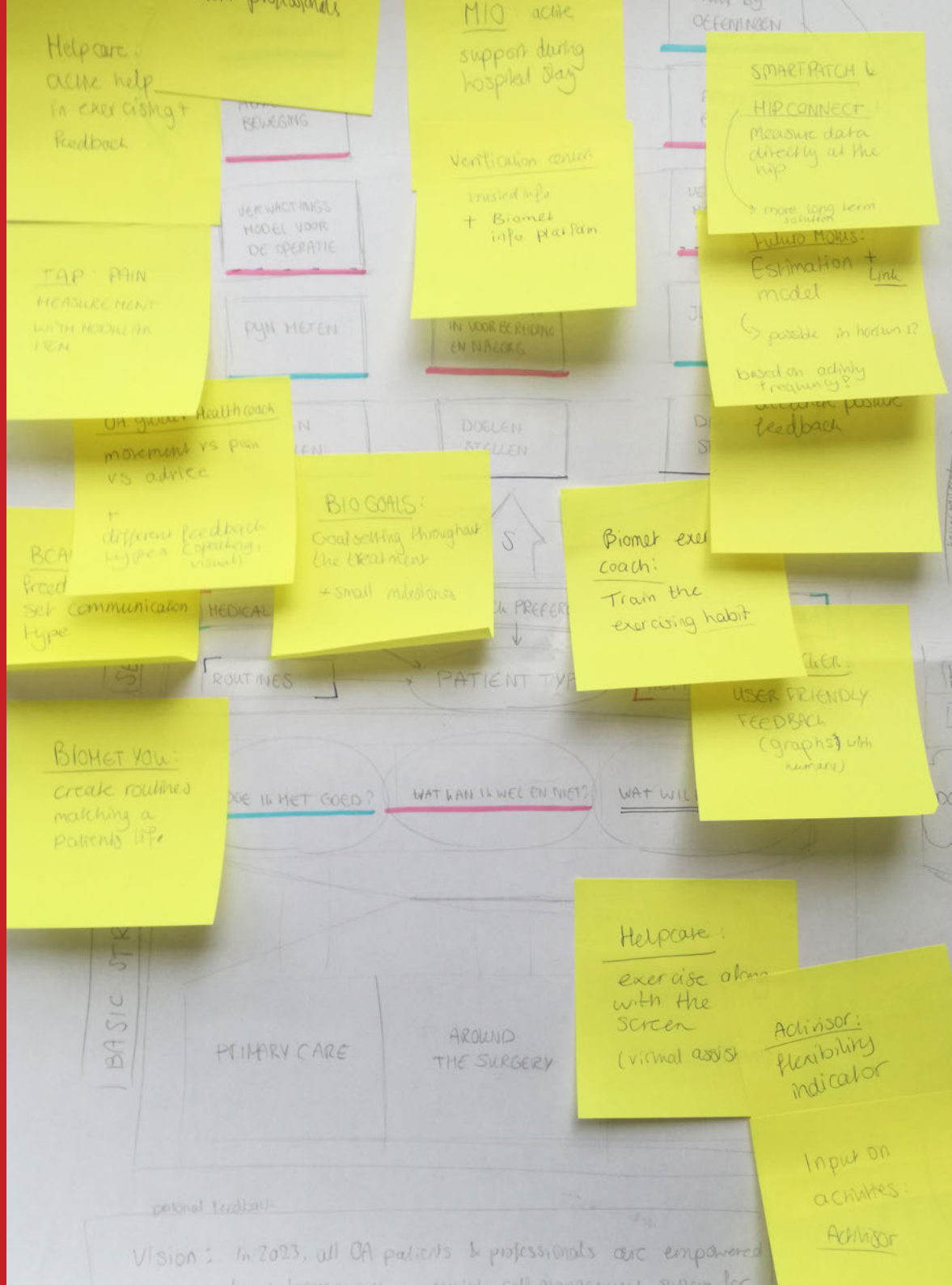
Health professionals want to personalise the treatment in some way; communication, exercises or surgery. Patient ask for this too.

More communication in the OA treatment process is needed. A balance should be found between face to face or digital.

Patients are waivering between the search for independance and help from professionals

# VISION & CONCEPT SELECTION

With the value analysis finalised the research phase as a whole is finalised as well. To round the of the research phase and have a concrete starting point for the design phase, visions were formulated. Furthermore, a concept feature selection is established based on the research findings.



# VISIONS

The previous chapter already indicated that using PCC in the OA treatment is the main topic for the future visions within this project. However, in the creation of a service roadmap, one works with three innovation phases; horizons. To describe future improvements of the service model more precisely, three visions were created in line with the three horizons setup.

## Defining the three visions

To achieve use of PCC in the OA treatment, a learning process is required. More specifically, this process will be called **'shared learning':** learning about the OA patient and treatment, which happens at *all* key users *and* the system itself.

When you start with a learning process, it is first important to get acquainted with the material. In practice this means it should be easy for all users to access the new service model and learn how to use it. Furthermore, it should tackle the professionals' pressing need for efficiency in the OA treatment. Therefore, the vision for horizon one is '**Making shared learning accessible and efficient**'

After the service model is sufficiently introduced, it is time to take shared learning to the next level. This is done by increasing the learning capabilities of the system. In the end, this makes sure the user can learn more about the OA patient and treatment as well. Therefore, the vision in horizon two is '**Making shared learning two sided for quality improvement**'

After both the user and system are advanced in terms of shared learning, it is time to automate and integrate the service model more seamlessly in the organisational processes related to OA. This can also improve the relation between patient and professional even further. Therefore, the vision in horizon three is **'Semi automated shared learning for equal partnership between patient and professional'**

## USING PCC IN THE OA TREATMENT

| HORIZON 1 | HORIZON 2 | HORIZON 3 |
|---|---|---|
| *Making shared learning accessible and efficient* | *Making shared learning two sided for quality improvement* | *Semi automated shared learning for equal partnership between patient and professional* |

# SELECTING CONCEPTS

## Selection criteria

Based on the insights from all the different types of analysis performed, the following selection criteria could be set up for choosing concept features:

1. The concept should possess a digital aspect
2. The concept should possess a multi user aspect; it should be used by the patient, GP, physiotherpist and orthopedic surgeon.
3. Self-management for the patient is supported by the concept
4. The concept should measure relevant data for OA patient & professional
5. The concept should give insight in patient status
6. The concept should give insight in patient progress
7. The concept should give insight in patient possibilities
8. The concept should simplify data flows
9. The concept should improve quality of life for patient
10. The concept should improve efficiency and quality for professionals
11. The concept should prioritise user friendliness
12. The concept should value human communication
13. The concept should possess a learning aspect
14. The concept should possess a personalization aspect
15. Makes the patient feel heard and supported
16. The concept should help finding a balance between independence and professional help
17. The concept should estimate the best timings for certain actions

## Linking concepts to the selection criteria

After formulating the criteria list, the criteria are compared to all the concept demonstrators that are not assessed as 'red' in the preliminary concept assessment. This comes down to a total number of 31 concepts. But which concepts fulfill a certain criteria? And in what way?  Table 3 summarizes this. On the left, the criteria is summarized. In the middle, the one or two concepts that match best with this criteria are placed. And on the right, a short description is formulated; why this concept demonstrator fulfills the criteria best.

A few selection criteria are highlighted in red. These highlighted criteria are not used in further selection steps. This is because (almost) all concepts meet the specific criteria, or none meet them. This means they do not create a critical dissertation for concept selection.

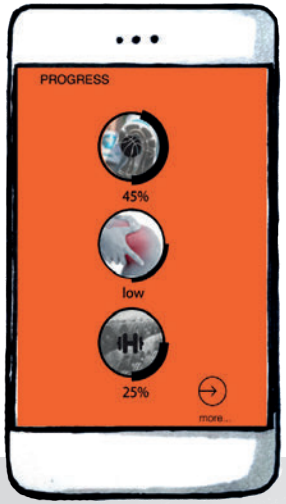
## Reflecting on selected concepts towards the service model

The selection process highlighted 13 concepts from which a feature is chosen to implement in the new service model On the next page Figure 40 shows a visual summary of the chosen concept demonstrator features.

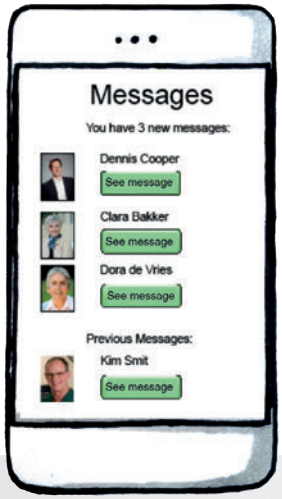
It is important to note that not every innovation aspect found in the value analysis can be tackled with this selection. For example the prevention issue discussed in the conclusion of the interviews. Even so, the technology analysis in 'Introducing the concpt demonstrators' already revealed that additional advancements are needed outside of the concept offerings. In the next chapters, it will be explained how the selected concept features are combined with personal feature ideas.

*Table 3: Preliminary concept selection*

| CRITERIA | WHICH CONCEPT FULFILLS IT BEST? | HOW? |
|---|---|---|
| 1. Digital aspect | **All concepts** | - |
| 2. Multi user | **Biocomm** | The usage setup of biocomm comes closest to the chosen key users in this research |
| 3. Self management | **Health coach** | Health coach allows the users to have access to an elaborate data set with many feedback options |
| 4. Relevant data | **Hipconnect** | Hipconnect has a sticker device that can be placed directly at the hip for hip specific data |
| 5. Status | **Biomet OA guide & Smart hip consultation system** | Biomet OA guide gives good insight in the patient's status by comparing activity data to an optimum line. For professionals, thew smart hip consultation system has a very comprehensible setup |
| 6. Progress | **Biogoals** | Biogoals allows the user to see personal progress with the help of goal setting. It presents progress in context of time too. |
| 7. Possibilities | **Activisor** | Activisor allows the user to choose treatment activities based on personal abilities |
| 8. Simplify data | **Untracable from concept reports** | - |
| 9. Improve quality of life | **All concepts** | - |
| 10. Improve efficiency | **All concepts** | - |
| 11. User friendliness | **Biotracker/support** | Biotracker/support is very visual in setup, with usage of the human figure |
| 12. Communication | **Biocomm** | Biocomm allows patients and professionals to send messages to each other |
| 13. Learning | **Aple assistant & Biomet info platform** | Aple assistant tries to tailor itself to the patient with customisation options. biomet info platform lets the patient learn about OA |
| 14. Personalisation | **Health coach & Helpcare** | Health coach is flexible in the setup of data gathering and feedback, helpcare personalises in activity support |
| 15. Support | **Biomet you** | Biomet You creates an exercise routine matching a person's life |
| 16. Balance | **Untracable from concept reports** | - |
| 17. Best timings | **Futuro Motus** | Futuro motus sets expectation graphs for the future, based on activity behavior |




**Health coach:** Give power to the patient, *custumise the feedback* on OA related data

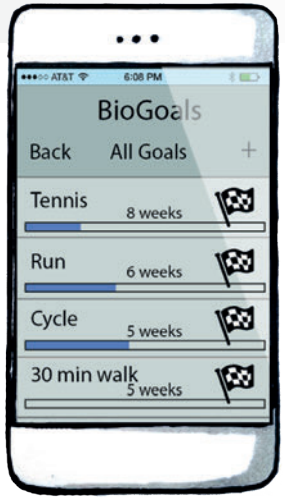



**Biocomm:** *Message sending* between patient and health professional; the GP, physio-therapist and OA surgeon


**Hipconnect:** *The wearable*; A data device placed on the hip; directed data gathering

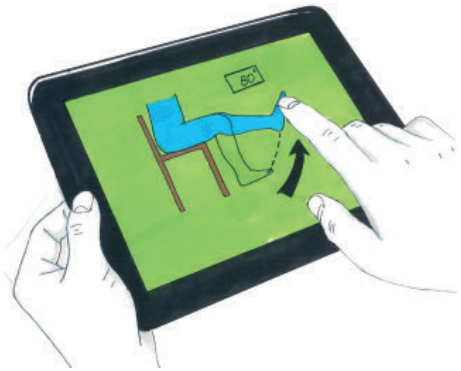

**Biomet OA Guide:** Comprehensibe feedback graphs, *comparing personal data with an optimum line*.


**Smart Hip Consultation system:** The *patient dashboard* for health professionals



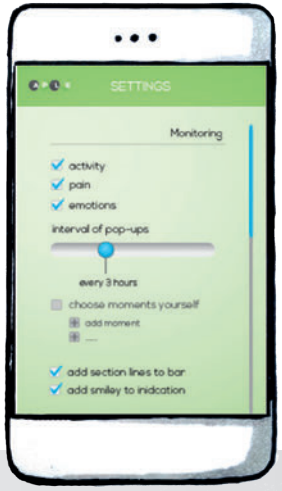

**Biogoals:** *Setting goals* during the OA treatment, regarding activities

*Figure 40: Chosen concept features*



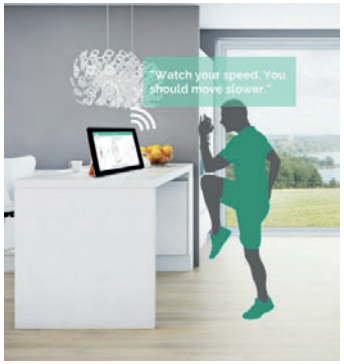

**Activisor:** personalise the service based on the patient's *capabilities*


**Biotracker/support:** Work with *visual* feedback if preferred




**Aple assistant:** *Tailor* the service to user preferences


**Biomet Information platform:** *Information* on OA related topics




**Helpcare:** *Active feed-*back if desired


**Biomet You:** Support matching with the *patient's routine*


**Futuro Motus:** Giving estimations for *future*, based on current activity

# PRODUCT-SERVICE DEVELOPMENT

Now that the concept selection is made and visions are created, it is time to move on to the design cycle. Before a service model can be sufficiently set up, it is first needed to start at a lower level; the design of the product-service itself. This chapter outlines the product-service and also shows the link to the concept selection.

## SERVICE FRAMEWORK

To make clear which main features the product-service should possess, a basic structure for the service functionality was set up; the service framework. The development process of this framework can be found in “Appendix K: Service Development”.

### Setup

The service framework is a block structure, consisting of three blocks. Personalisation, data and communication (Figure 41). These blocks show strong synergy with innovation topics of the the theoretic framework.
Personalisation is the basis, to tackle the personalization need expressed in the value analysis and resulting theoretical framework. Furthermore, having personalisation as the basis will make sure the other blocks are formed based on setting the user preferences. For instance in the next block; the data modules. Going from personalisation to data modules will identify what type of data the user needs. In the data block, a personalized program is set up, providing just the things a user wants to know, tackling the information needs. For example, a patient who wants to keep track of daily goals, or a professional wanting a progress summary of a patient. This data can be shared with others. For a patient, it is the ideal way to identify which things they want to manage themselves, and where they need help. For professionals, it makes it easier to decide what advice is needed to give to a patient.
The final block is communication. This can be both online and offline communication between patient and professional. With help of the personalized setup and data, only the essentials need to be shared with one another. In the end, this setup can serve a PCC approach, since it clarifies the wants and needs of the patient better, and give them a more equal role by obtaining more knowledge.

### Towards a service model

As mentioned, the service framework is a block setup applicable for all users. But it is good to note that *one* block structure is used by *one* user only. To involve different users, more block structures can be connected to one another. This combination process of service frameworks is the first step towards a service model.

# PRODUCT-SERVICE EXPLANATION

The service framework resulted in the realisation of OA Master. OA Master is a product-service aimed at shared learning about the OA patient, improving the positions of patient and professional in the treatment process.
The product-service consists of a on body wearable and mobile app for the patient, and a application plugin for the professional See Figure 42. The body wearable will have the form of a sticker device, as described in the HipConnect concept report. This device can measure hip specific data and send this to the app. From there on, the data can also be sent from app to the professional plugin.

**With the service, the patient can get:**
-Information on OA related topics and the OA treatment process.
-Exercise support
-Feedback on performance
-Digital communication with their doctors

**With the service, the professional can get:**
-A more direct connection with other professionals
-More knowledge about the patient
-Give feedback to patients digitally
-Less time needed for OA explanations

Of course, the the OA master product-service evolves in three horizons, but these are the basic offerings that will provided from the start. In time, the way in which these functionalities are provided are improved, by iterating on the system setup around it.

## Personalisation

It is also important to mention that every functionality of the app, such as help with OA related exercises for a patient, or analyzing the status of the patient as a professional, will be a personalized experience. This will first be done by asking questions to the user, but slowly progresses towards learning algorithms. It is important to mention however, that the user will always maintain freedom of choice.

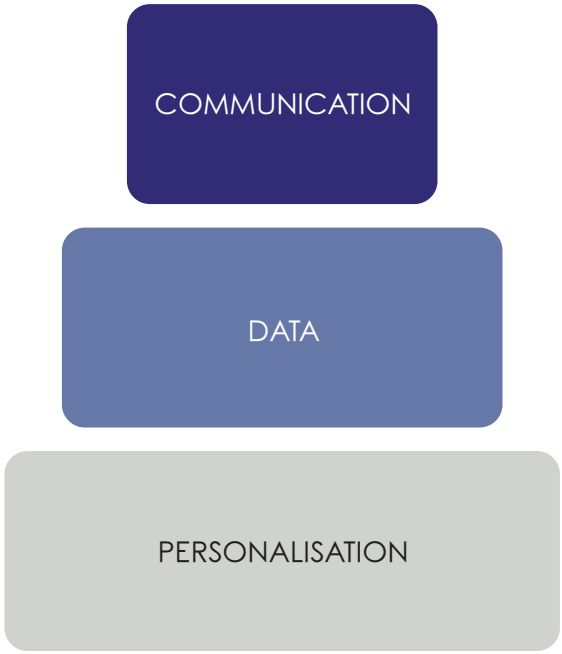



*Figure 41: Service framework*

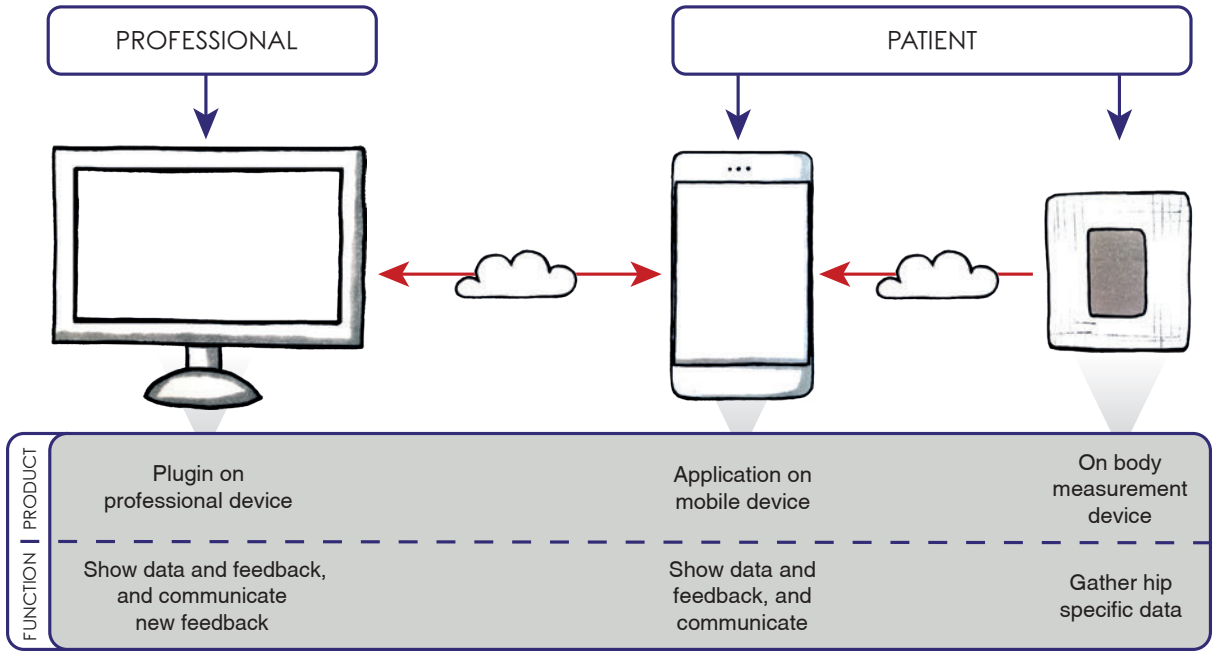



*Figure 42: OA master setup*

# VISUALISING THE APPLICATIONS

As mentioned, the product-service consists (among others) of an mobile application for the patient, and an application plugin for the professional. This section will briefly explain the basic setup of these applications. Next, I will explain the usage of the applications more in depth by describing a scenario and examples from the existing concept proposals.

## PATIENT APPLICATION

### Setup and settings

See Figure 43. When a patient uses the application for the first time he will see a setup menu, with questions related to a patient's character, lifestyle and feedback preferences. These answers determine the setup of the app, mainly the home screen. When a patient wants to change things in the setup or connect the sticker device, this can be done at the settings tab.

### Home screen and data

Based on the answers of the setup, a person sees the widgets he or she finds most important. These can be data widgets, but also chats with the professional. When a patient wants more specific data, this can be found in the data tab.

### Information screen

The information menu shows information topics that are most related to the patient based on the questions, but it is also possible to search for a topic.

### The communication screen

The communication screen shows which members are a part of the OA treatment of the patient; meaning what other professionals can see his data. This screen also shows (group) chat conversations happening between patient and professional.

## PROFESSIONAL PLUGIN

The setup of the professional plugin will look similar to that of the patient, but questions will be more focused on preferences in showing data. The preferences have influence on the setup of the patient information screens.

### The main screen

The main screen will be focused on showing an overview of linked patients. In this way, a professional can immediately see which patient have a notification. When a new patient added the professional to his team, this can be shown as well. Finally, the settings menu can be found here, to change preferences if needed. See Figure 44.

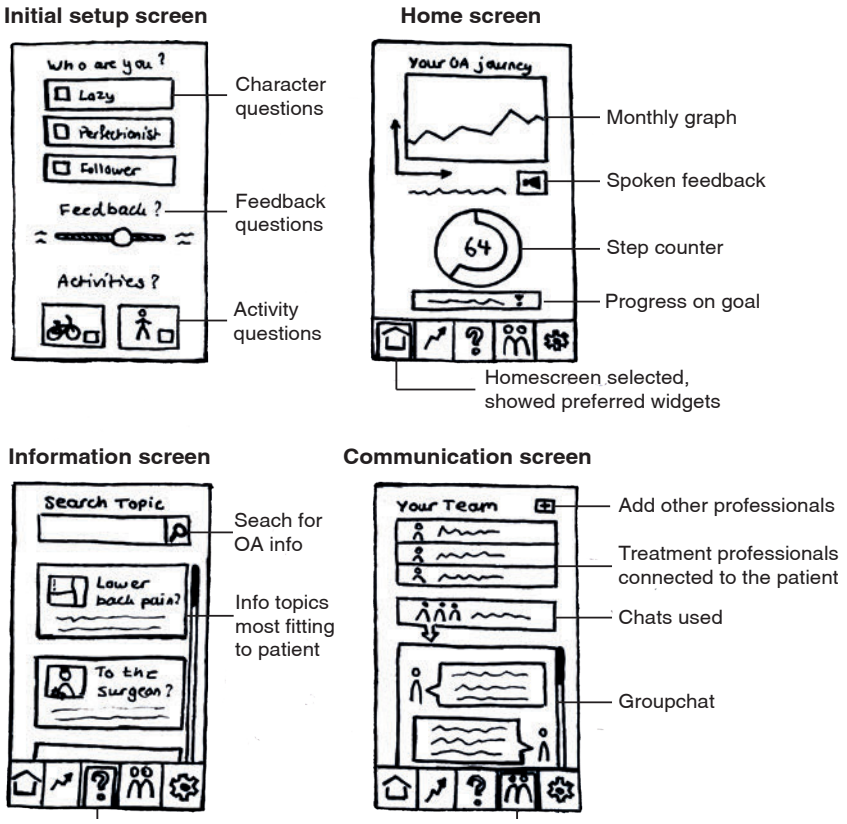
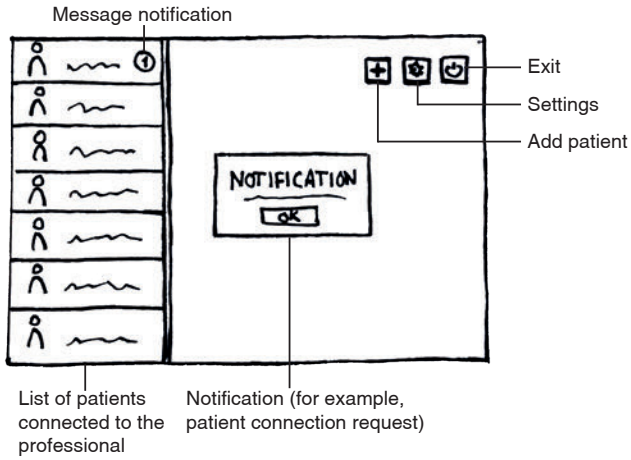



*Figure 43: Patient application screens*



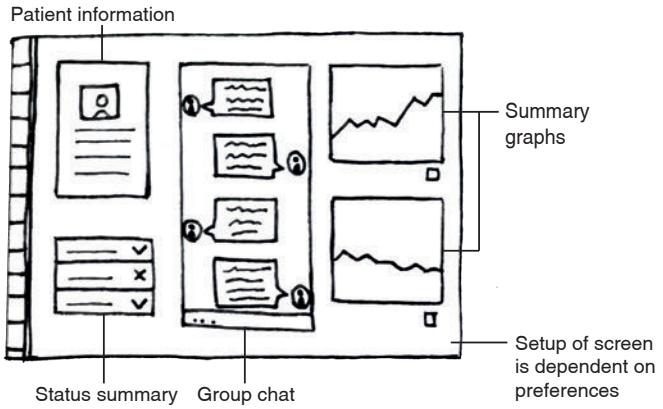




*Figure 44: Professional plugin screens*

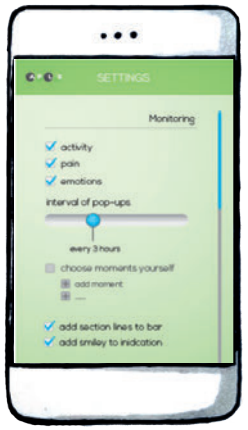



*Figure 45: Setting up the app (Aple assistant)*

## The patient info screen

When a professional clicks on a certain patient, an overview of data is shown, based on personal preferences. If something stands out to the professional, he can send a message about it in the chat function. If the professional wants more info than is shown in the screen, there are 'see more' buttons.
Please note that all professionals, from GP to surgeon will use the same plugin setup, and if two professionals are connected to one patient, they have access to the same information.

# USER SCENARIO

The previous section showed how the setup of the application is proposed. This setup is based on suggestions made in the concept proposal reports. The following section will explain a usage scenario and show where the concept proposals fall into place.

For these examples I will introduce some **main users**;
-Dirk, a 60+ person
-Henk, a friend of Dirk
-Marieke, Dirk's GP
-Vera, Dirk's physiotherapist
-Gerard; Dirk's future orthopedic surgeon

## A story about Dirk and his doctors

Dirk is feeling strange pains in his hip and decides to visit the GP after a few months. His GP, Marieke, suspects OA, and next to her regular referrals she recommends using OA master. She hands him a flyer to order the product online and get more information on the product-service.

After a few days, Dirk receives the sticker device. Well about time, because he is feeling anxious about all this news about possible OA. He follows the instructions by first downloading the app.

In setting up the account, he receives several questions about his lifestyle, needs, and capabilities, and other preferences regarding feedback. To trigger motivation, he is also asked what goals he want to reach.
*This feature is already shown in Aple Assistant, Activisor and the Biogoals concept proposal. See Figure 45.*

In the account setup, Dirk addressed that he needs much information on the topic OA, what lifestyle changes he could implement, for example. Therefore, the app suggests many topics from the information database. The app also suggests some activities Dirk might like, short bike trips for example.

Dirk examines the suggestions and confirms them. He adds Marieke as his GP to become a part of his treatment program.  He also places the product on his upper leg. First up, he reads about some OA related topics; causes of OA and useful exercises to diminish pain. *This feature is already shown in the 'Biomet information platform' concept proposal. See Figure 46.*

Dirk feels motivated to fix his complaints but he is also oblivious. Therefore, he has made sure some notifications are turned on. Based on his preferences and goals, he gets exercise reminders multiple times a day. When he feels less motivated, he uses the active support setup. It is like Vera, his physiotherapist, is standing in the room then. *This feature is already shown in the Helpcare concept proposal. See Figure 47.*

Dirk is very interested to know how he is doing. He likes to check his progress every day. At some days he also likes to zoom out on a monthly level to see his progress. *This feature is already proposed in the Biotracker and OA guide concept proposal. See Figure 48 and Figure 49.*

Henk, a friend of Dirk, is going through the same process. He is less interested in all the graphs and numbers, so his main screen looks a bit different. If he wants, he can tap the buttons for more information. *This feature is already proposed in the Health Coach concept proposal. See Figure 50.*

Dirk also likes to check his progression on his goals. However, when he checks the overview, a his progression on walking is going pretty badly. For some reason, this is also the activity that hurts the most for Dirk. *This feature is already proposed in the Biogoals concept proposal. See Figure 51*

The pain is not that severe, but it is bothering him. He can not find the information he needs in the info topics. So, he decides to send a message to his professionals. This is done in a group chat, so anyone who has time can answer. *The chat feature is already proposed in the Biocomm concept proposal. The group chat is an additional feature. See Figure 52.*

Dirk receives a message from his physiotherapist Vera, who suggests another visit to the GP, and eventually visiting the hospital. Dirk agrees to this suggestion and eventually goes to a hospital consult for the first time. His GP already made sure his doctor, Gerard, already has access to Dirks profile (of course Dirk has to confirm this).


*Figure 46: OA info (Biomet info platform)*

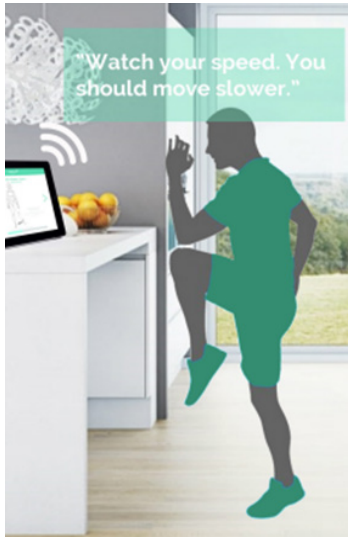



*Figure 47: Exercising (Helpcare)*


*Figure 48: Feedback (OA guide)*


*Figure 49: Feedback (Biotracker/Support)*

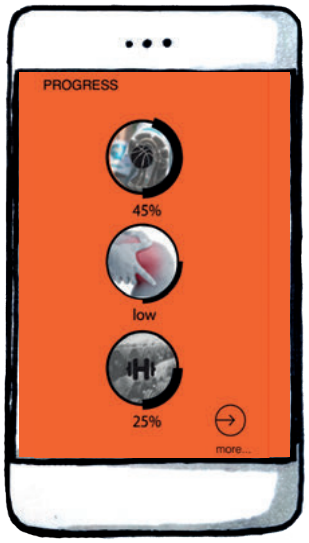



*Figure 50: Feedback summary (Health coach)*

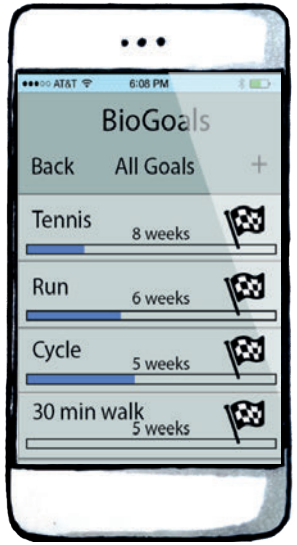



*Figure 51: Goal progress (Biogoals)*

## Professional plugin

The service provider has set up contracts with GP's, physiotherapists and hospitals to create a multidisciplinary workflow covering the entire patient journey. The professionals download the plugin on their work system.

With the initial setup, they are receiving questions on what information they like to receive from a patient. The professionals decide on these different topics and confirm.

Marieke, Dirk's GP, accepts the invite from Dirk to join him in his professionals team.  So do Vera and Gerard at the moment they first encounter Dirk.

All professionals are free to decide when to check upon their patient's progress. But when someone has a message for them, they are highlighted in the list. Vera sees the message popup from Dirk, and clicks his profile. She sees his data summary and the accompanying message. *This feature is already proposed in the Smart hip consultation system concept proposal and the Biocomm concept proposal. See Figure 53.*

Based on the data overview, Vera can see that his activity scores remain constant, but his pain score is increasing. She decides to advice Dirk to go to the GP for a checkup. Marieke refers Dirk to the hospital.

At the hospital, Gerard sees alarming signals of severe OA when he opens up Dirks profile. He advises another three months of exercies. He can sent Dirk a message when he sees his activity levels are dropping. When activitiy and pain levels decrease, he sents another notification to start the THA procedure.

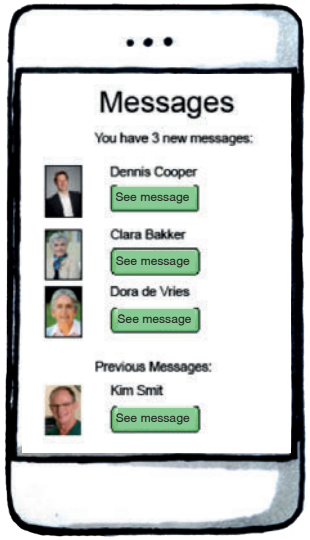



*Figure 52: Sending messages (Biocomm)*


*Figure 53: Patient overview (Smart hip consultation system)*

# THE WEARABLE

As explained at the start of this chapter, the 'product' part of the product service system is a 'sticker' like measurement device, placed on the upper leg (see Figure 54). An on body measurement design like this is explained in the 'HipConnect' concept.  In this concept proposal, the tool was used to receive data from a smart hip. However, in this case, the sticker can measure a person's activity. By placing it on the hip, obtained data is specific for this joint. This principle is already verified in the 'Smartpatch' concept proposal. You can leave the sticker device on for a longer period of time, so the effort of gathering data is very low.

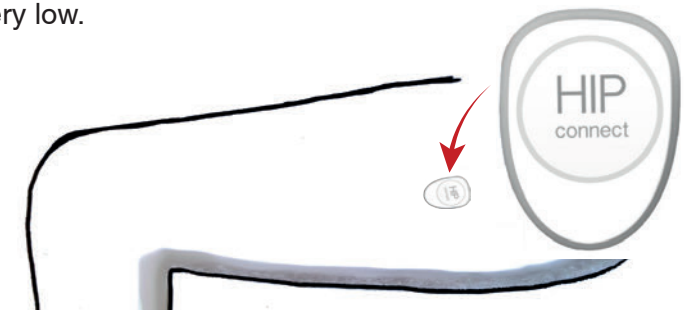
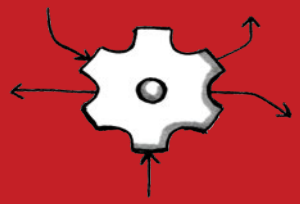



*Figure 54: The wearable (Hip Connect)*

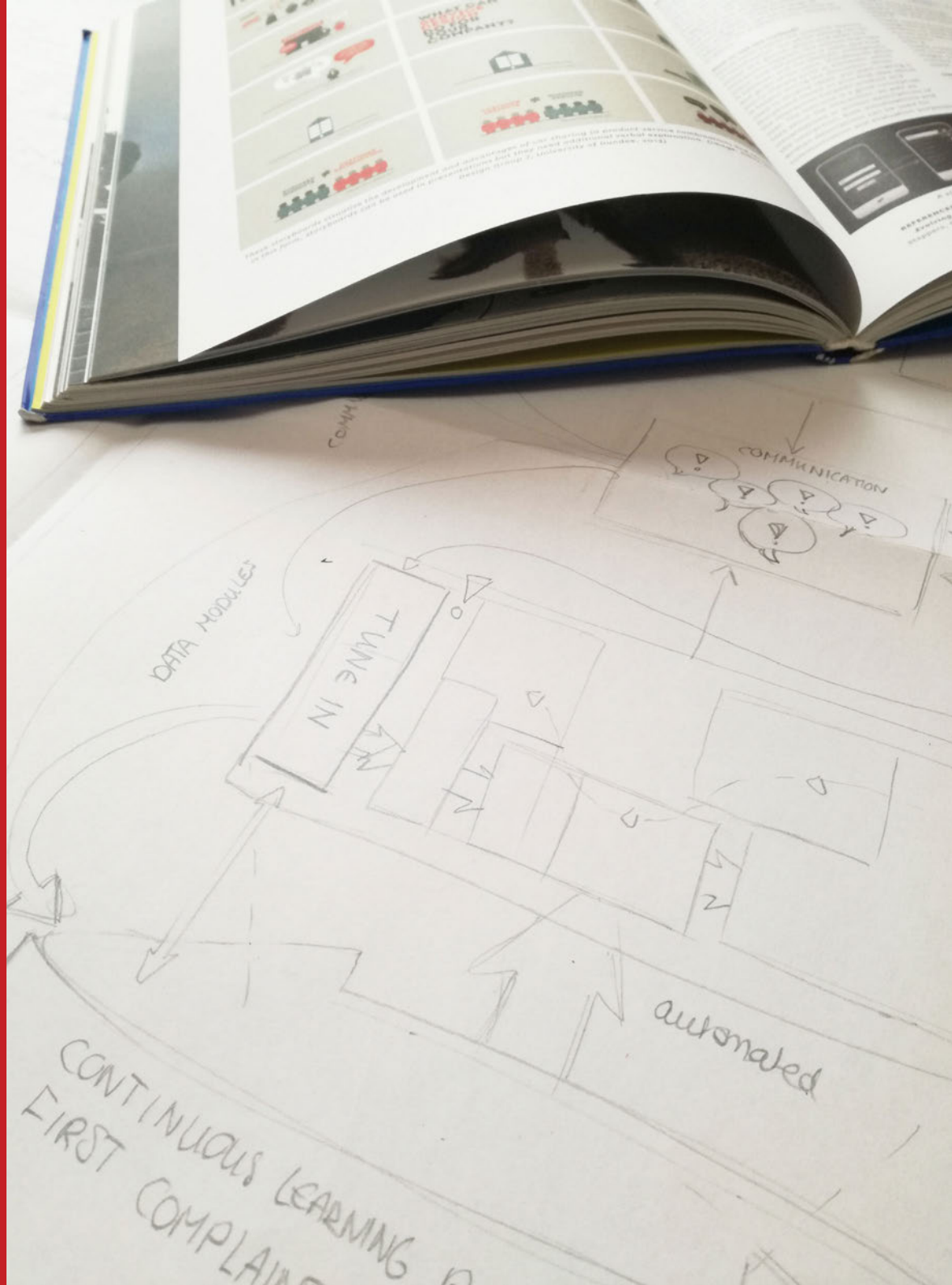
# FUTURE ADJUSTMENTS

The scenario described in the previous section gives an image on how OA master works in practice. However, it does not explain the full treatment yet, nor does it explain future changes. The next chapter will discuss both topics in depth.



# SERVICE MODEL

The previous chapter aimed to clarify what the product-service was about. This chapter aims to look at the bigger picture; the service model. Furthermore, more specific attention to future developments is paid.



The previous chapter already briefly mentioned the future evolvement of the OA master product-service. However, to show the effect of this evolution, it is best to show the improvements in the setup of a service model; In this way, effects on relationships and the system become visibe as well.

# SERVICE MODEL EVOLUTION

Figure 55 on the next page shows the service model evolution. On the top left, the current situation is shown, so before the introduction of a product-service. The three health professionals are displayed on the left sides (the GP, physiotherapist and orthopedic surgeon respectively), the patient is on the right. From there on, the situations for horizon one, two and three are shown. Blue arrows indicate interactions, red arrows indicate internal learning. The section below will elaborate on the setup of the service model, but most importantly, the changes made in each phase.

## From current situation to horizon 1

As shown in the 'now' image, big issues in orthopedic care currently lie within the available communication lines and information division. These can be characterized by fragmented and inefficient. In the first horizon, the separate data flows for the health professionals are now gathered in the middle, as an information sharing and digital communication tool .This is made possible with the help of **introducing the product service**. Since all professionals have access to the same user profile within the setup of the service, all available information is known by all professionals and the patient. This causes an increased learning about OA for the patient, but also more available patient information for the professional; **the basics of shared learning**. The product-service is not meant to take over the physical communication part, but rather compliments it.

## From horizon 1 to 2

While the initial introduction of the product-service is able to tackle the most current issues in the 'now' tab, the system is not really adaptive (apart from the possibility to change preferences), or doing something with all the valuable information found. This process is started in horizon 2, where the **learning capabilities of the system are radically improved** with help of AI. The system can learn about the patient (and professional), which indirectly causes improved learning of patient and professional. This means a full adoption of shared learning and improved quality of the orthopedic care process. With the learning system feature, the **introduction of a data monitoring party** in primary care goes hand in hand. He can guide the shared learning process but also help with establishing interventions at the right time. No system decisions can be made without approval of the data monitor. Digital communication is well integrated in the care process by now and is often used.

## From horizon 2 to 3

A wish of multiple stakeholders was to be more active in prevention and primary care. In horizon 3 this can be realized, by applying learnings from all previous individual patient cases into the system, instead of learning separately per case. In this way, it is possible tailor the system to a patient quicker, and make more valid suggestions based on previous successes. This establishes a **semi-automated shared learning process**. The new shared learning process also asks for an integration of the service model into the healthcare information systems. The monitoring party is still important, since health related decisions cannot be made without any human intervention. With the system becoming smarter and more elaborate, it is likely a data monitor in the recovery care phase is needed as well.
Digital communication is the most used source of communication, but physical communication is still critical at certain points in time for treatment success.

## Who is the monitoring party?

The monitoring party will primarily be a practice assistant at the GP practice. This person was chosen intervention activities towards a patient most often means visiting the GP.

When the monitoring part of the service model is elaborated in horizon 3, a poli assistant at the hospital can also adapt the job of health data monitoring, and most likely takes care of the people already treated in the hospital or in the recovery stage of the OA treatment.

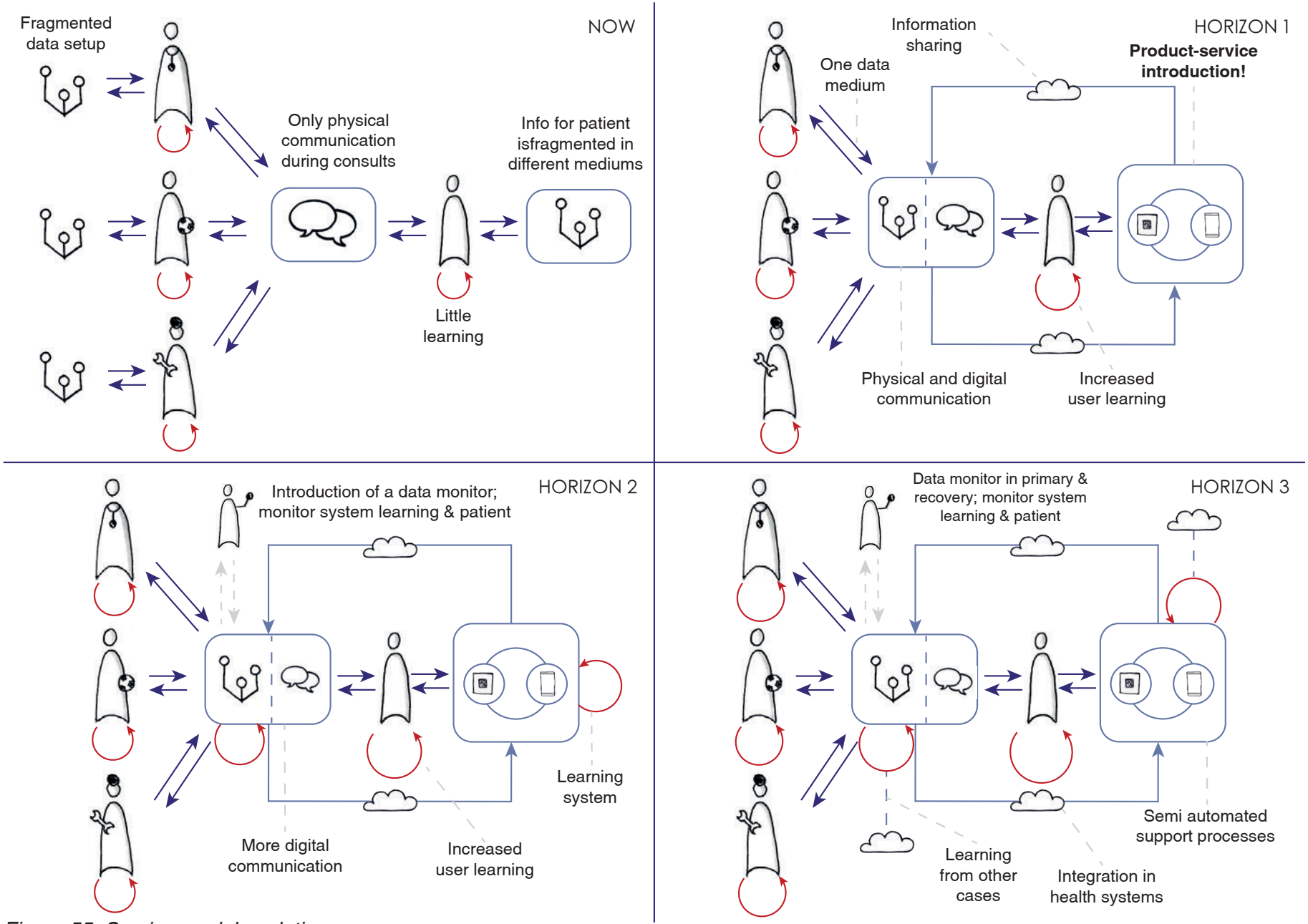



*Figure 55: Service model evolution*

# SERVICE MODEL IN SCENARIO

To illustrate the impact of the service model in practice, a scenario was formulated for each horizon. Each scenario describes an entire THA procedure, from first complaints to full recovery, including some background sales.

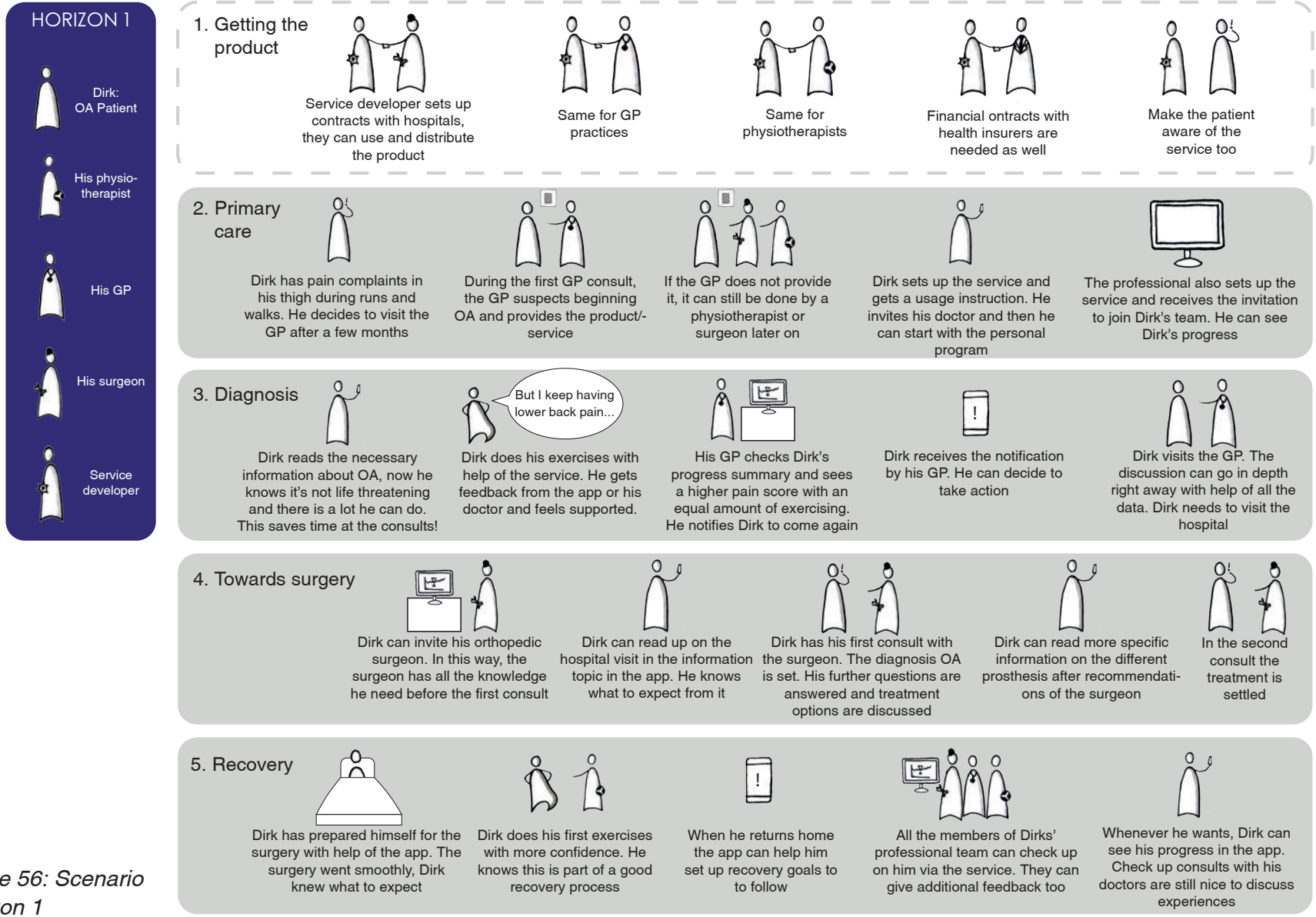



*Figure 56: Scenario Horizon 1*

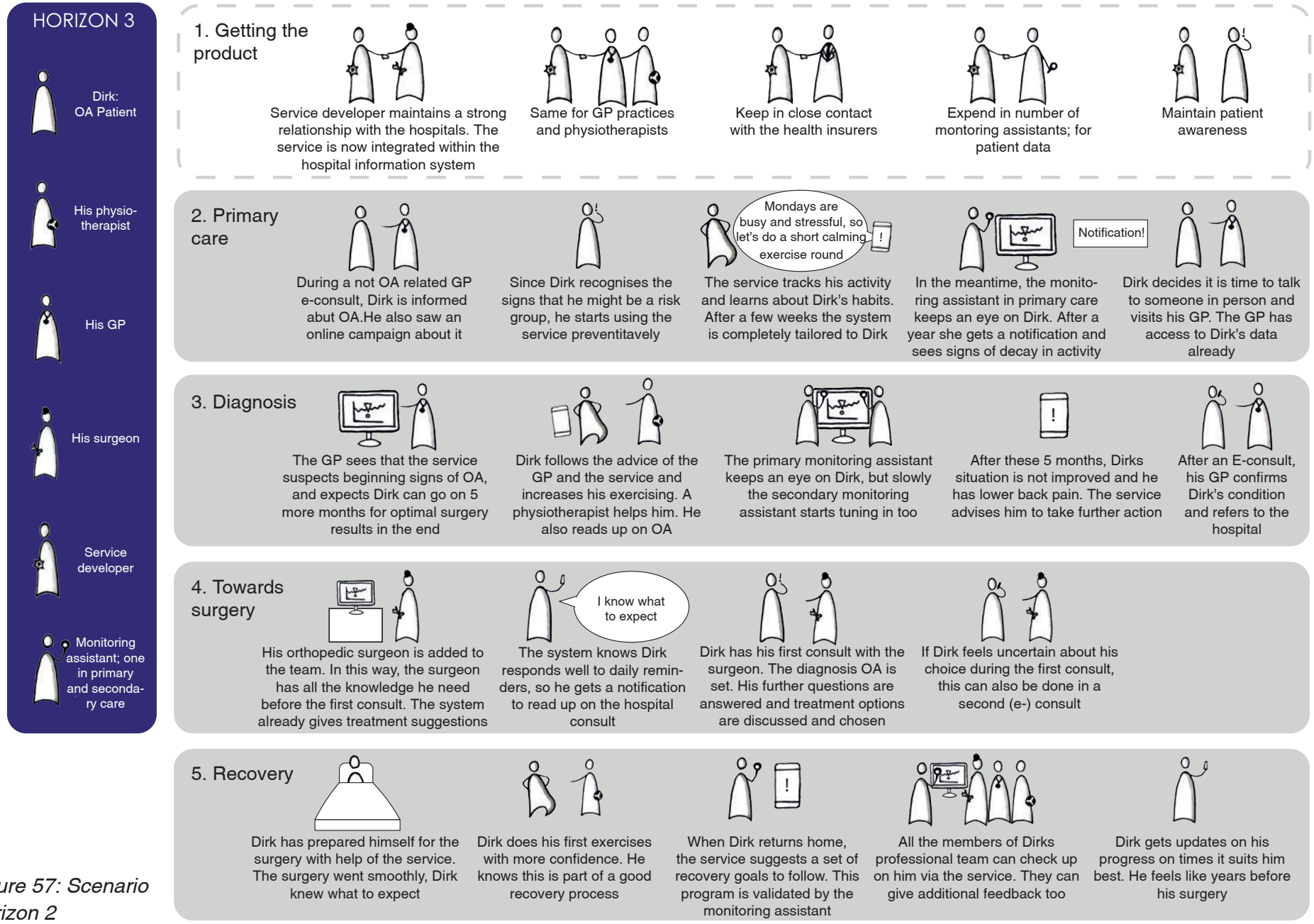



*Figure 57: Scenario Horizon 2*

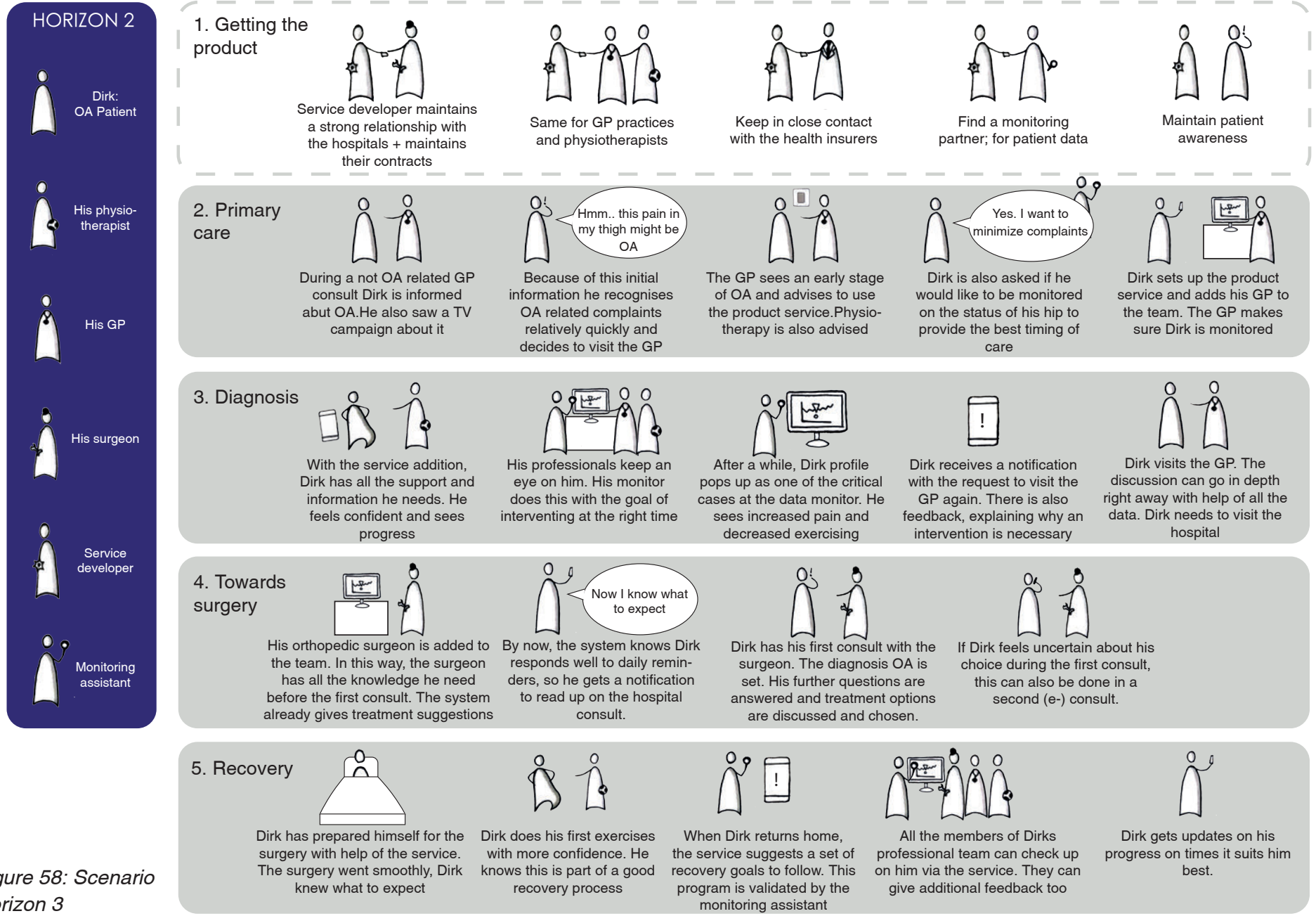



*Figure 58: Scenario Horizon 3*

# INFLUENCE ON DATA FLOWS

With the introduction of the service model, the data flow map shown in Figure 12 will change as well. The service model explanation already showed that the data flows will move from a fragmented setup to a the use of a common medium, and is ultimately integrated into the health information system. Figure 59 and Figure 60 aim to illustrate this.

In horizon one and two, the data flow will look something like Figure 59. The existing data flow is still present, but the service model will make sure the key users of the OA product-service are involved in one similar medium as well.

In horizon three, the data flow will ultimately look like Figure 60. The data flow is simplified to one general health data system, where the service model is a part of. This will make it easy for other possible interesting stakeholders to tune in on the service, the nurse for example.

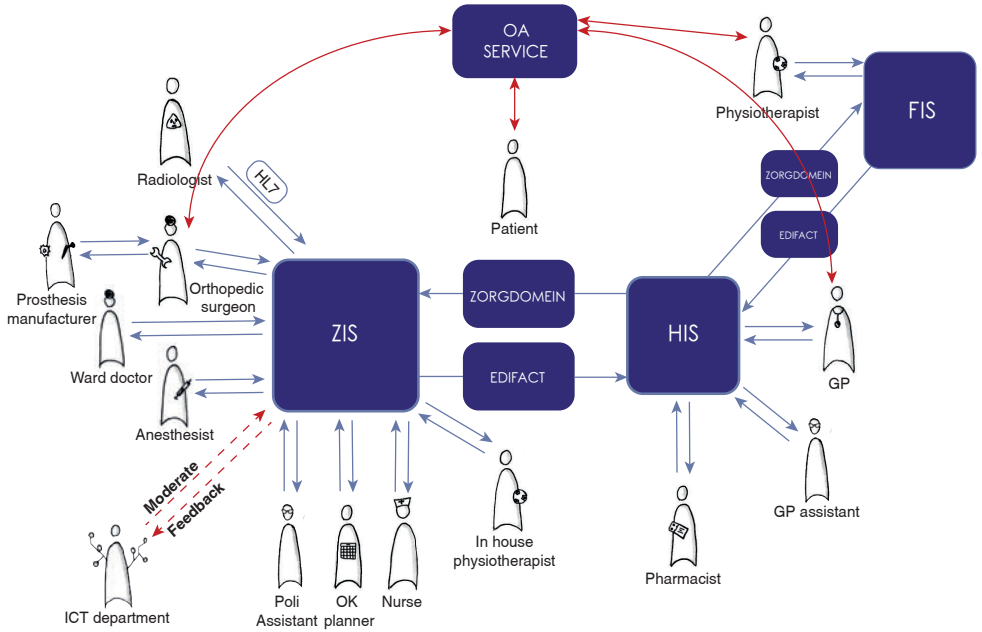



*Figure 59: Data flows in horizon 1 and 2*

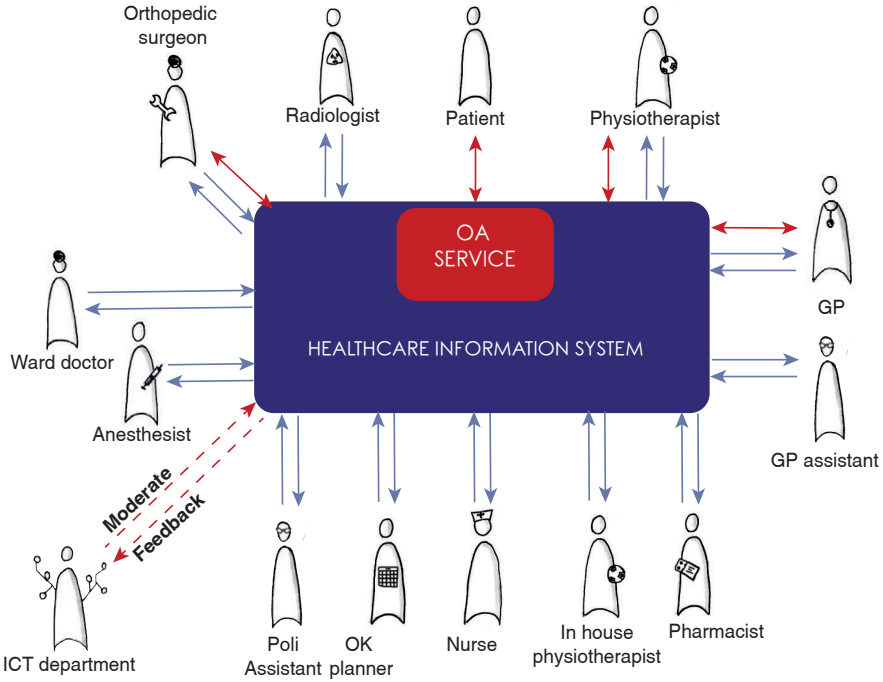



*Figure 60: Data flows in horizon 3*

## INFLUENCE ON VALUES

The service model in Figure 55 shows interactions between users and mediums, but the actual value obtained in these interactions are unclear from this figure. Therefore, value flow maps were created to  aims to show the value exchanges between the different users, in the context of the service model (Figure 61).In these images, the service provider and health insurer/ government is taken into account as well, since these will be actuators of the service model.

The value flows show that with the big changes in horizon one, a value flow will be established that does not endure major changes in the future. Only the introduction of a data monitor has influence on the future value structure. Apart from that, it is expected that the 'amount' of value per exchange increases over time, with help of the back end innovations.

# CONCLUSION & IMPLICATIONS

The service model explained in this chapter can be described as a shared learning journey, focusing on efficiency, quality and integration consecutively. Ultimately, it serves the implementation of Person Centered Care in orthopedic care.
In practice, the introduction of the service model means the setup of information and communication will be updated, with help of a personalised self management system. The most front end changes will happen in the first horizon, to not overwhelm the users too much. The back end evolves steadily in each horizon. The scenarios and value flows illustrate this, by showing that the usage of the service doesn't change too much, but its' user values continuously increase.
The service model will be used as the core of the service roadmap. The setup of this roadmap will be described in the next chapter.

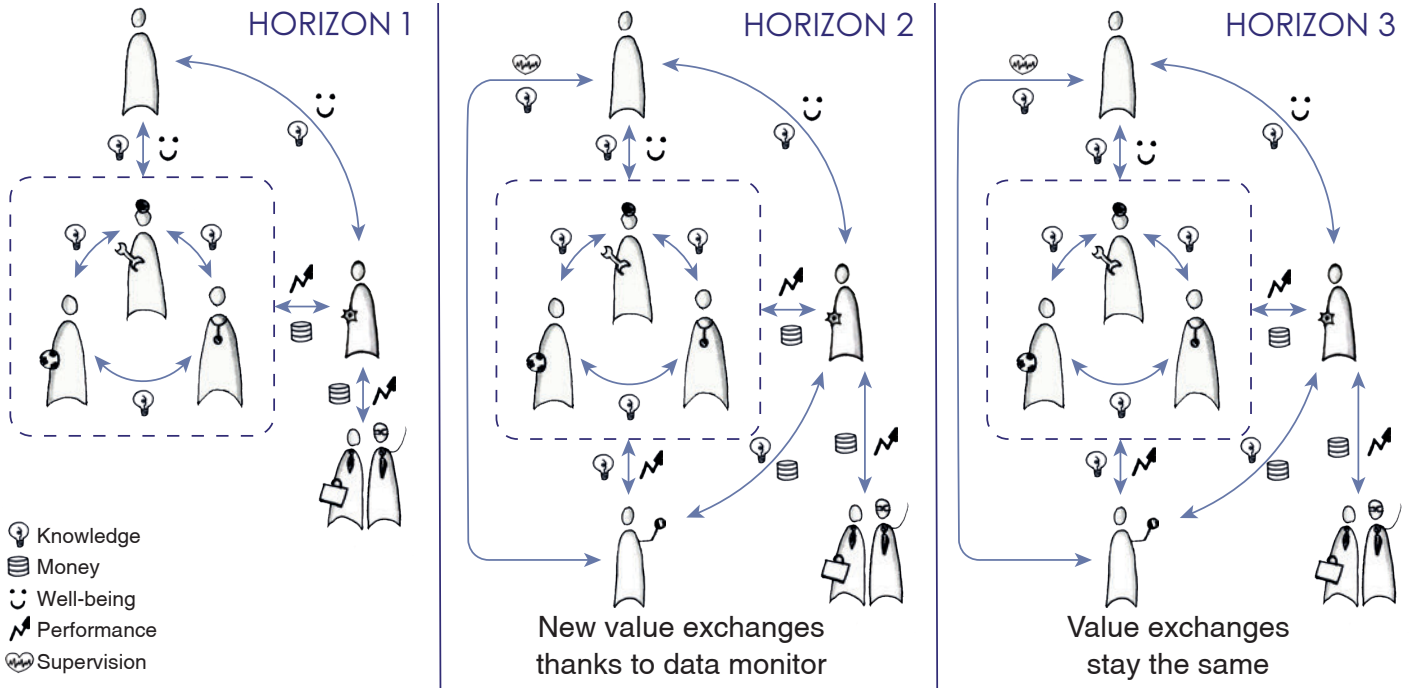



*Figure 61: Value analysis*


# ROADMAP DEVELOPMENT

As a final deliverable, I will create a service roadmap based on the service model. This roadmap consists of two parts. A strategic and a tactical roadmap.
The service roadmap is a document showing the main innovation steps to be taken concerning the service development, together with the critical timings, supporting developments and the future vision.
This chapter explains the roadmap development process and the roadmaps themselves.

# TIME PACING

## Time pacing method: three horizons model

As briefly touched upon in different chapters, the service roadmap will adopt a Three Horizons model approach to formulate future actions (Curry, A. & Hodgson, A. , 2008).
These horizons can be seen as three overlapping life cycles of new innovations. In the first cycle or horizon, value enhancements are the critical activity, and existing technologies and market segments are used to do so.
In the second horizon, it is about user centered value creation, where new value is created to potential users of the product or service, with new technologies and touching upon new market segments.
The final horizon, this new value proposition is offered to users and often concerns disruptive technologies and markets.

## Design clock

To indicate the length of the roadmap and the different horizons, it is useful to indicate the so called design clock. The design clock shows the pace of introducing new innovations in a market.(Eisenhardt K.M. & Brown, S.L. (1998))
What innovation pace is applicable in the market of interest?

For this roadmap, we take a look at the orthopedic care market. The innovation analysis already indicated that this market consists of younger and older industry players. But due to the regulated nature of the market, its innovation pace is rather difficult to predict. In theory, when a market is dominated by regulations, innovation goes slow. However, with all the societal developments happening, healthcare is under pressure to innovate. This can result in a revision of regulations, possibly making the innovation pace significantly quicker. (Source: Interview medical implant firm manager)

So how to deal with the design clock? In this case, professionals in the orthopedic care market were consulted; orthopedic surgeons and a manager at a medical implants firm. They both gave the indication of around 10 years for radical innovations to occur, for example the full use of Artificial Intelligence and the home as main care context. Based on this information, the end of horizon 3 is set at 10 years. In other words, the entire service roadmap will have a 10 year time span.

This implies the service roadmap will have three horizons with a **duration of 3 to 4 years**. This is a relatively slow pace, so it is sufficient for the orthopedic care market. For now, it is expected the second horizon to be 4 years and the other two 3 years. This because it is expected that the shared learning aspect will take time to implement sucessfully in the system.

# APPROACH

The roadmaps created within this project are meant for a large target audience; every stakeholder in orthopedic care. It should be a discussion starter between the different parties involved, concering digital innovation, shared learning and implementing PCC in orthopedic care. In this way, the Smart Care Lab can use the roadmap as a basis for new innovation projects on these topics.

As mentioned in the Time Pacing section, a three horizons approach is used in the creation of both a strategic roadmamp and a tactical roadmap. The differences between these roadmap types will be explained in the next sections.

In developing the service roadmaps, an iterative approach was taken. This meant having short design cycles to be able to continuously reflect and improve on the iteration results. Some explanation on the iterative process can be found in “Appendix L: Roadmapping process”.

# STRATEGIC ROADMAP

The strategic roadmap serves a a summary of the main innovation changes proposed in this project. It only consists of a selection of elements, communicating the main message of the project. Therefore, this service roadmap can be provided to all stakeholders related to orthopedic care, spreading this main message effectively.

## Explaining the different elements

The strategic roadmap consists of the following parts:
- The three horizon **visions**; these are one on one adopted from the 'Vision & Concept selection chapter.
- **Tmings**; these are adopted from the section 'Time pacing' explained at the beginning of this chapter.
-**User values** displayed in clouds; derived from the social-cultural trend analysis. The clouds are placed in a horizon when that user value is considered extra relevant.
-**Stakeholder drawings** to embody stakeholder behavior in the specific horizon.
- A brief **summary** of each horizon. The contents of this description are adopted from the 'Service model' chapter.
- A simplified visualisation of the **service model,** adopted from the service model visual in Figure 55.
-The **future vision** for 2030; this summary vision was explicitly created for the service roadmaps, in order to create an image of the future world.
- A **mountain background** was chosen, to serve as a metaphor for the shared learning process.

Figure 62 shows the strategic roadmap. A true size version of this roadmap can be found at the end of this report.

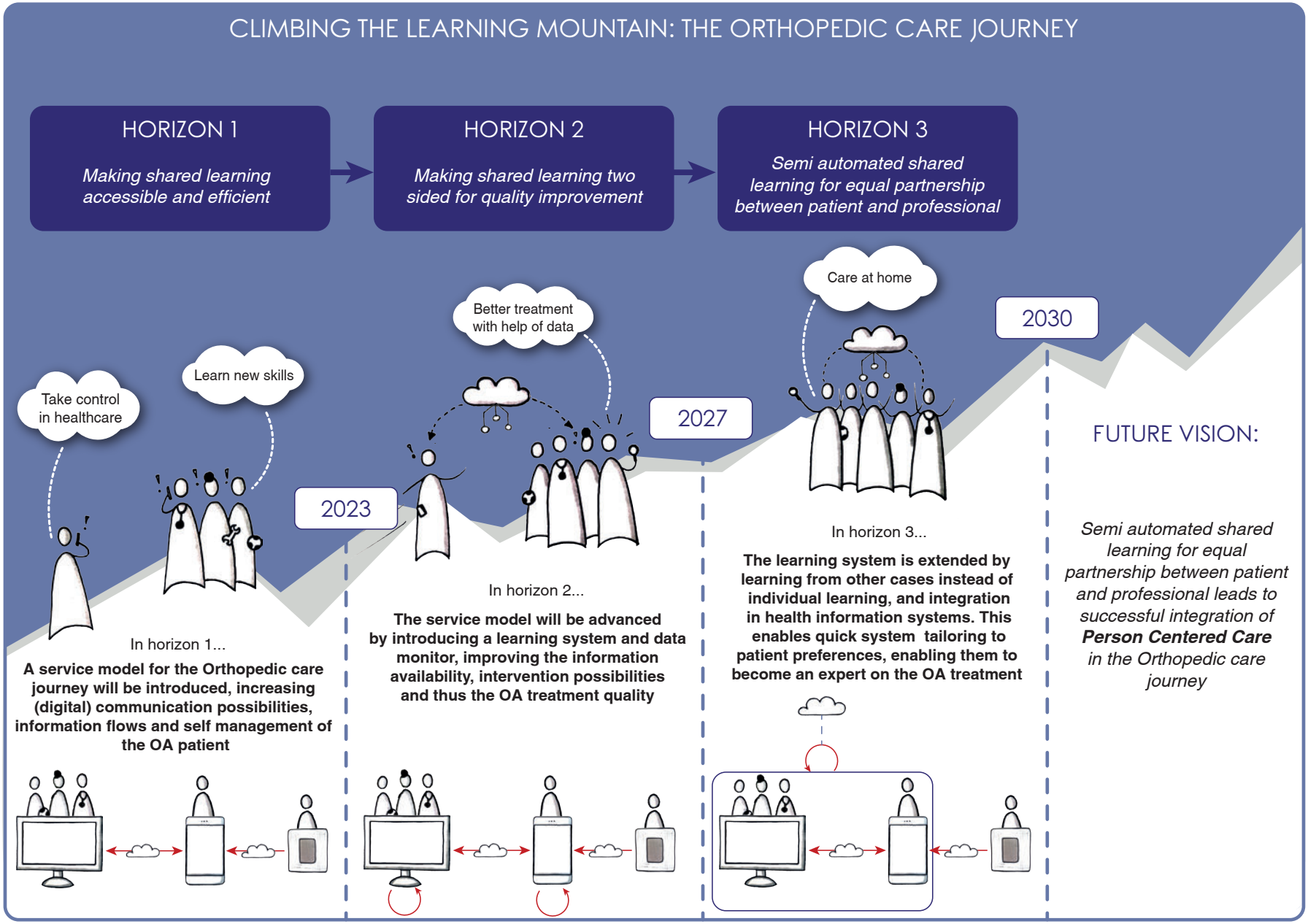



*Figure 62: Strategic roadmap*

# TACTICAL ROADMAP

The tactical roadmap is an in depth version of the strategic roadmap. This roadmap will not only show the service development more in depth towards the future vision, but also stress user developments, technical developments and supporting tranformation enablers. Furthermore, a link with the concept proposals is made. This roadmap can be used for stakeholders in orthopedic care, who are involved in performing innovation activities. They need more background information than displayed in the strategic roadmap.

## Explaining the different elements

The tactical roadmap is structurised into different tabs, immidiately emphasizing the diverse set of information. The tactical roadmap consists of the following parts:

-The **horizon blocks** on top displays the three visions per separate horizon. These blocks also show the timings of each horizon.
-The **'User wishes'** tab displays the most prominent social cultural trends linked to the different horizons. The set of user wishes displayed here is more elaborate than in the strategic roadmap. The user wishes show a strong link with the visions in terms of formulation and subject.
-The **'Values'** tab displays the extremes found in the theoretic framework explained in Figure 39. The tab explicitly means to show from which side to which side of the 'extremes' in values are developing, in relation to the visions and innovation actions.
-The **'Service model evolution'** tab displays the service model and its developments over the three horizons, as explained in the 'Service model' chapter. In this roadmap, the same setup is adopted.
-The **'Concept proposals'** tab consists of 8 of the most characterising concept features, from the 13 features used within the service model. They are placed at the horizon where they are most prominently featured. This does not mean the concept feature is introduced in this horizon, but more when the feature is valued most. Furthermore, links are showed between the concepts and their place in the technology setup.

The **'Technology'** tab consists of both the technology setup and technology trends. The technology setup displays the different tech parts needed for setting up the service model, both data and application wise. Also, the connections between the tech parts and its involvement over time are shown.
-The **'Transformation enablers'** tab shows which supporting mediums are needed to make the service model happen. All the enablers displayed in the grey blocks are elements that will are added to each other in time, the enabler outside the block is only needed in that horizon.
-Finally, the **'Future vision'** on the right displays the main goal that is tried to be achieved with this roadmap.

Figure 63 shows the tactical roadmap. A large version can be found at the end of this report.

Altogether, one can say the tactical roadmap serves as a summary of both my context- and concept research, and my design steps. It shows a 'To-Do list' for implementing a digital service model aimed at achieving PCC.

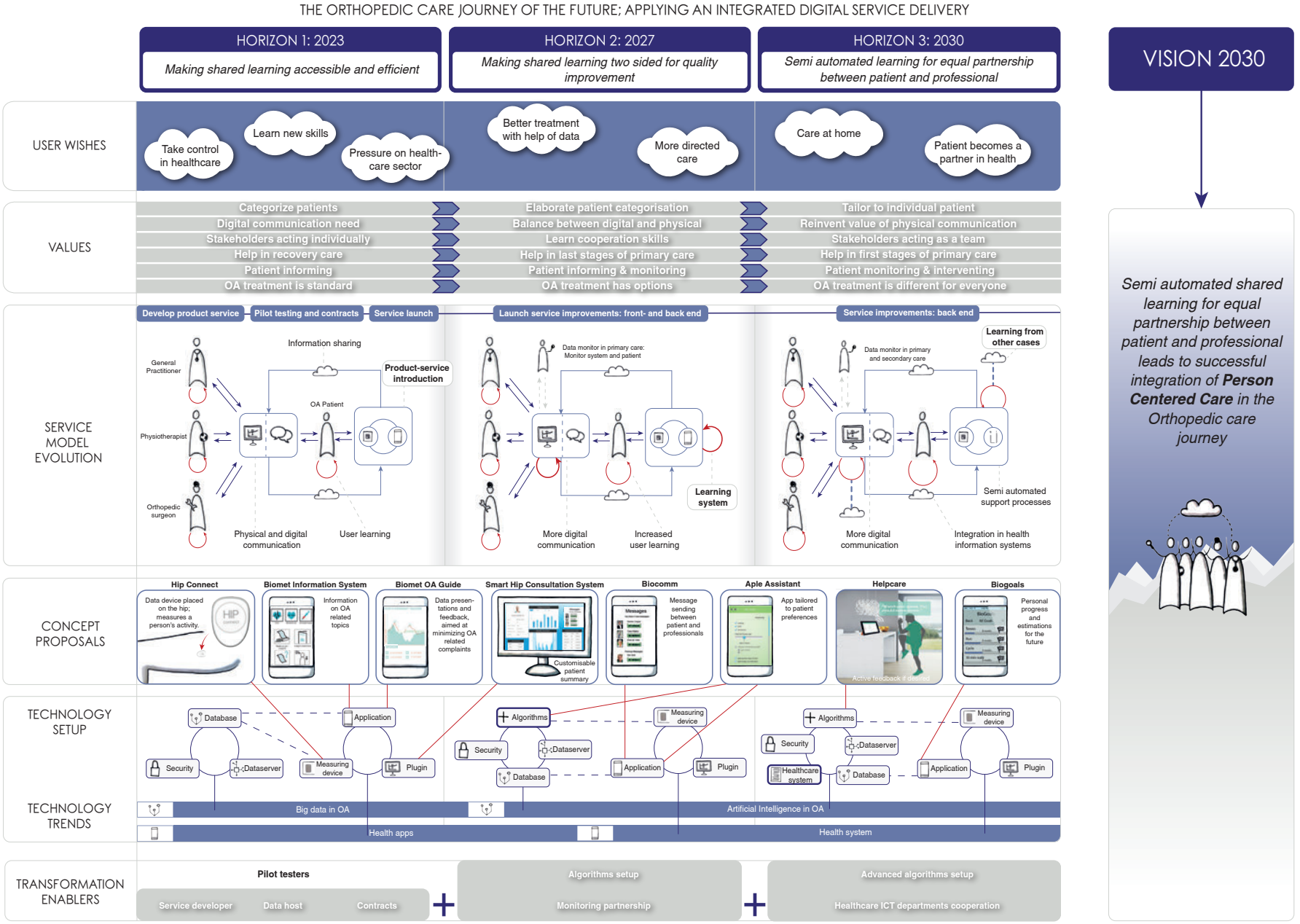
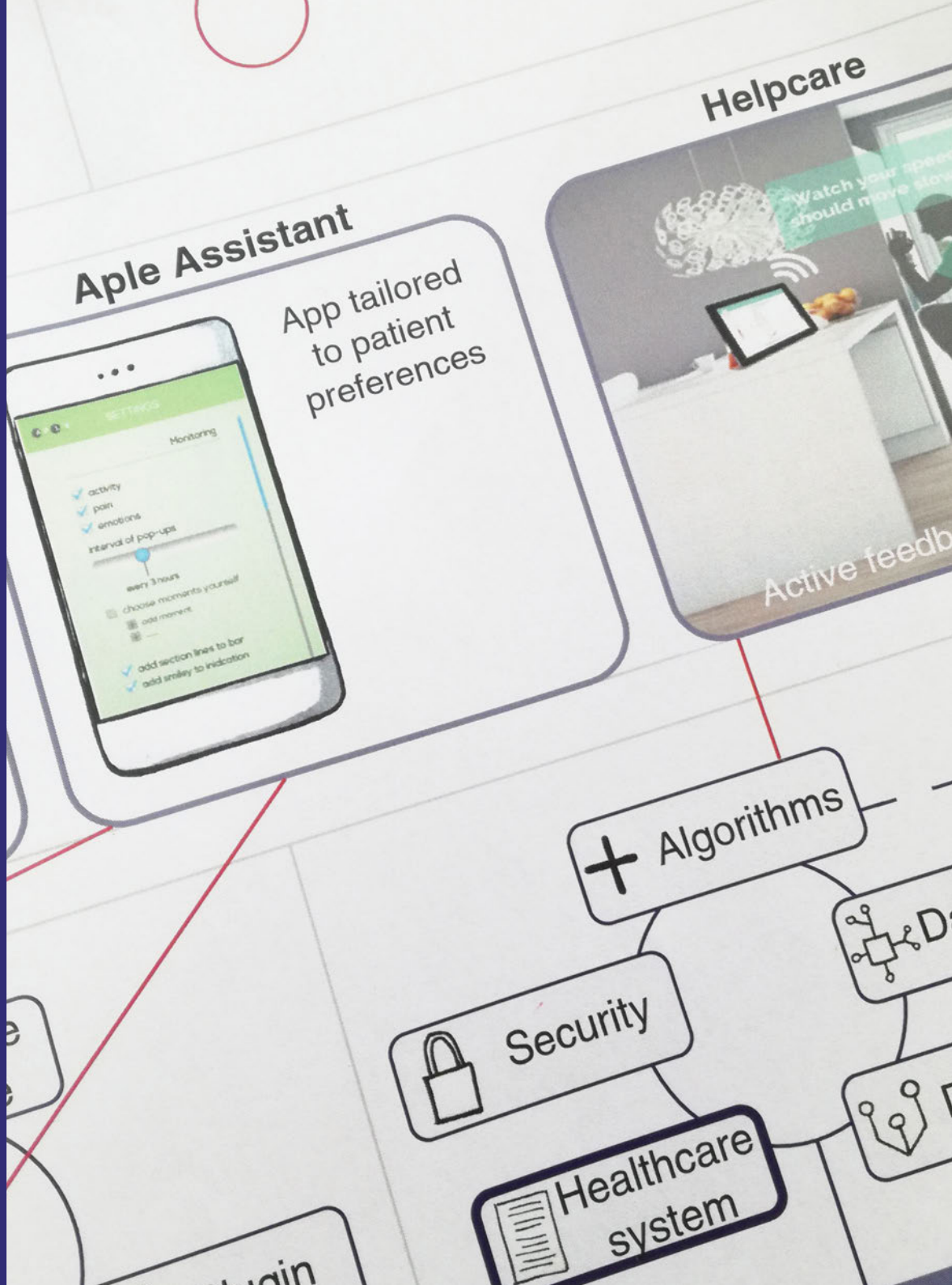



*Figure 63: Tactical roadmap*

# CONCLUSION

This chapter aims to come full circle on the research project. What is the impact of the generated deliverables? And how can the initial research question be answered? Both are discussed here.



## NEW PATIENT JOURNEY

The service roadmap aims to visualise what digital service innovation steps can be taken in the orthopedic care context, during the next ten years. But what impact will these changes have? Some parts of this report have already touched upon this topic, for example the changes in the data flow map, the value flows, or the scenario's. But to really come full circle in this project, it is important to look at the initial context material presented at the start of the project; the OA patient journey.

This OA patient journey aims to show the full treatment process from the context of all the different stakeholders involved; more than just the key users identified in this project. By looking at the innovations proposed, one can identify how the current OA patient journey will change in the future in all its different facets. Figure 64 on the next page shows the current patient journey, and highlights what changes are proposed with red boxes. These changes are also linked back to the roadmap horizons, to indicate how fast these changes are expected.
The figure shows that the proposed innovations have a major effect on the contents of the current patient journey. Changes will happen both in primary care and recovery care, for all key users. Most of these changes will already occur in the first horizon. This is in line with the proposition discussed in the 'Service model' chapter; the basic functionalities will be launched in Horizon 1, but the fulfilling of these functions is radically improved in the next two horizons, thanks to the elaboration of the learning system feature. For the key users this means they only need to endure one major change in their workflow, instead of adopting to a new setup every horizon. Since the proposed innovations are linked to trends and beliefs conducted from the orthopedic care context, it is more likely these changes in workflow are adopted. For example the introduction of digital communication, the introduction of information sharing and more active patient support.

It is good to note that although there are many changes in the OA patient journey of the future, the introduction of the service model does not have big influences on the execution of the THA surgery (the hospitalisation phase). It rather supports the THA surgery in achieving larger successes, or even limiting the need for surgery altogether.

## ANSWERING THE RESEARCH QUESTION

So what can the client of this research project, the Smart Care Lab, gain from these project results? The initial research question of this project was formulated as follows:

***'How can service roadmapping enable an integrated service delivery using digital healthcare innovations?'***

To answer this research question, a set of concept demonstrators was determined within the context for orthopedic care. These concepts were analysed as well as the context, before an accompanying service model and service roadmap were formulated.
This project has shown that a service roadmap is a sufficient tool to visualise the setup of an integrated service delivery. The service roadmap provides an overview of innovations both in the front and back end, and is therefore able to show the development of the service model in many facets. The roadmap also functions as an innovation To-Do list, for all the stakeholders in the OA treatment, but for the Smart Care Lab as well.
The service delivery is integrated, since it allows for multi user engagement in multiple stages of the orthopedic care process. In later horizons, the service model is integrated in the back end as well, by embedding it in health information systems.
To achieve the desired service delivery, a combination of concept demonstrator features and new features was used. The concept demonstrator features were extracted based on a concept demonstrator analysis with 41 concepts aimed at improving the OA patient journey. Main features deriving from the concept analysis are using an app-wearable combination, focusing on insights, with the goal of self-management. New features were added with help of a context analysis, performing a deep dive in the OA treatment. Main features deriving from the context analysis are emphasizing on a need for learning, both for the users and the system, and the need for communication.
The Smart Care Lab can use the service roadmap from this project both in the setup of new research projects, but also as a conversation starter with possible partners in orthopedic care.

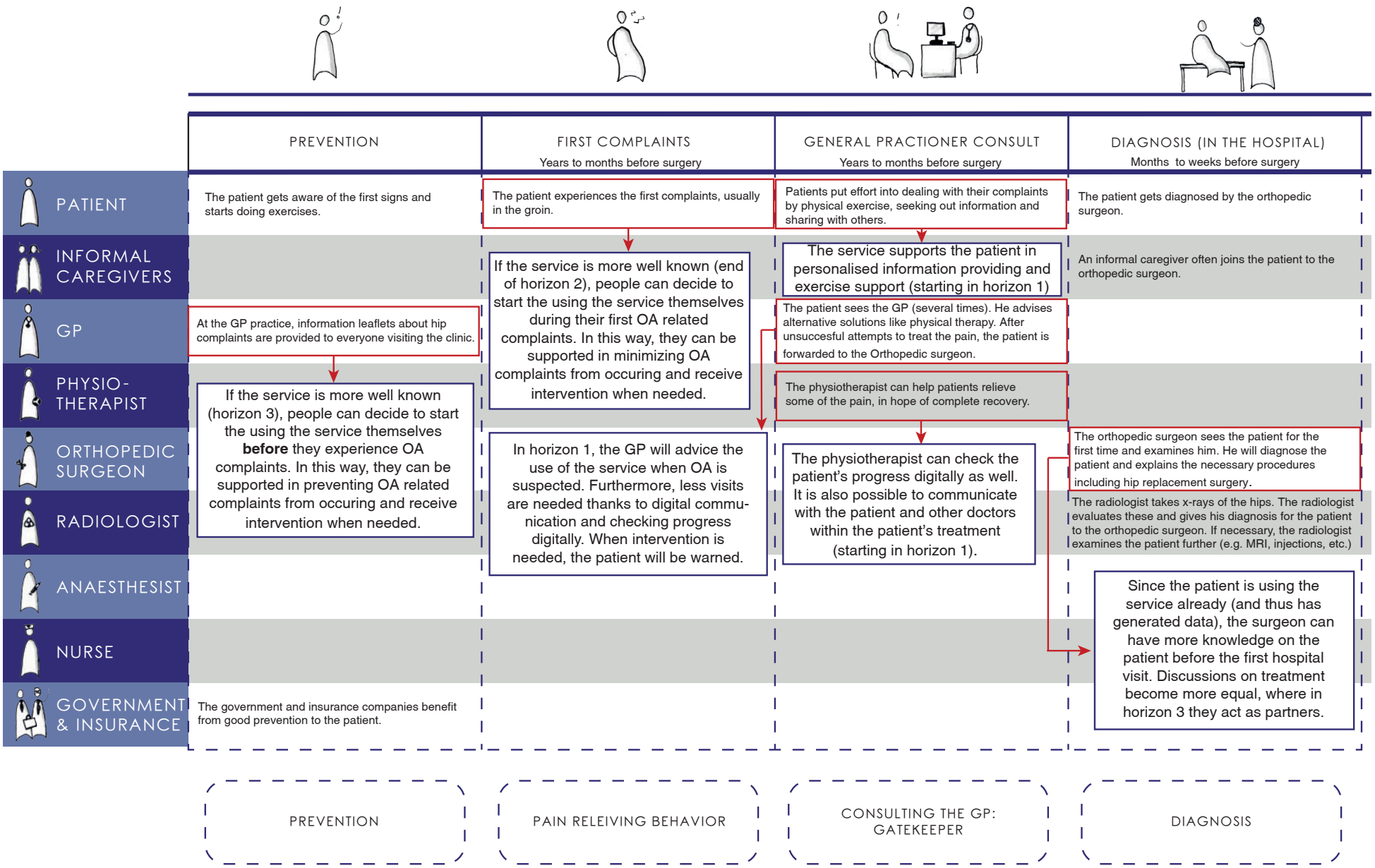
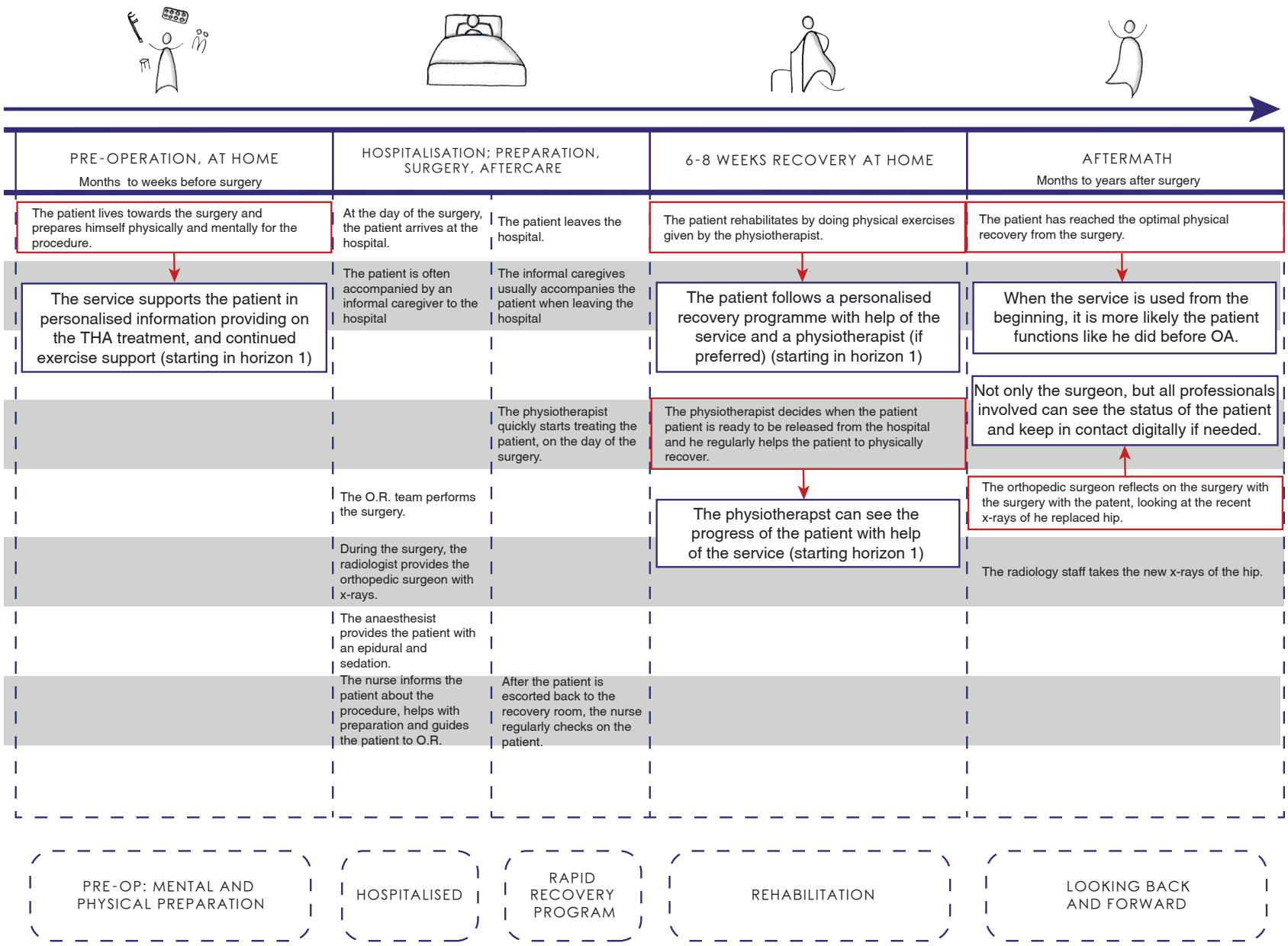



*Figure 64: Future changes to the OA Patient journey*


PRE-OPERATION, AT HOME
Months to weeks before surgery
HOSPITALISATION; PREPARATION, SURGERY, AFTERCARE
6-8 WEEKS RECOVERY AT HOME
AFTERMATH
Months to years after surgery
The patient lives towards the surgery and prepares himself physically and mentally for the procedure.
At the day of the surgery, the patient arrives at the hospital.
The patient leaves the hospital.
The patient rehabilitates by doing physical exercises given by the physiotherapist.
The patient has reached the optimal physical recovery from the surgery.
The service supports the patient in personalised information providing on the THA treatment, and continued exercise support (starting in horizon 1)
The patient is often accompanied by an informal caregiver to the hospital
The informal caregives usually accompanies the patient when leaving the hospital
The patient follows a personalised recovery programme with help of the service and a physiotherapist (if preferred) (starting in horizon 1)
When the service is used from the beginning, it is more likely the patient functions like he did before OA.
Not only the surgeon, but all professionals involved can see the status of the patient and keep in contact digitally if needed.
The physiotherapist quickly starts treating the patient, on the day of the surgery.
The physiotherapist decides when the patient patient is ready to be released from the hospital and he regularly helps the patient to physically recover.
The orthopedic surgeon reflects on the surgery with the surgery with the patent, looking at the recent x-rays of he replaced hip.
The O.R. team performs the surgery.
The physiotherapst can see the progress of the patient with help of the service (starting horizon 1)
During the surgery, the radiologist provides the orthopedic surgeon with x-rays.
The radiology staff takes the new x-rays of the hip.
The anaesthesist provides the patient with an epidural and sedation.
The nurse informs the patient about the procedure, helps with preparation and guides the patient to O.R.
After the patient is escorted back to the recovery room, the nurse regularly checks on the patient.
PRE-OP: MENTAL AND PHYSICAL PREPARATION
HOSPITALISED
RAPID RECOVERY PROGRAM
REHABILITATION
LOOKING BACK AND FORWARD

# DISCUSSION & RECOMMENDATIONS

This chapter reflects on the project as a whole and proposes areas for further research, as well as insights on roadmapping in healthcare.

# DISCUSSION

## Gaps in this research

The service roadmap is set on a ten year timespan with more or less equal length horizons. However, the realization of the roadmap timings are unsure. These can drastically change if regulations concerning health information and privacy (discussed in the innovation analysis) change quicker or slower than anticipated. Furthermore, getting all stakeholders on board of this service model is a key determinant for timings as well. Stakeholders can act different to change than concluded in the interview findings. For innovative healthcare instances like Reinier de Graaf Gasthuis, this isn't a big threat. They have an innovative mindset. But for more traditional hospitals or GP's, resistance is actually likely to happen. These doctors might be less willing to have patients as partners and want to remain an autonomous party. They can also be against the implementation of a new digital medium. If the service model is proposed on a country scale, service initiators must put great effort in creating an open mindset with traditional health professionals in order to succeed.

To keep conciseness in this research, it was chosen to focus my stakeholder analysis on four key users of the service model. However, it is likely that the stakeholders with supportive roles come into contact with (the effects of) the service model. The impact of this contact is not investigated yet, nor is an in depth analysis on the supporting stakeholders performed.

Finally, the third horizon of the service roadmap proposes an integration in health information systems. To illustrate the setup of these data systems, different data flow analysis were performed in this project. However, the integration is much more complex in practice. Extensive research is needed on the connection between the service and existing health information systems to make the service work.

## Notes on roadmapping in healthcare

The literature review has shown that roadmapping in healthcare is a yet uninvestigated area in research. Therefore, I want to contribute by having some remarks on the roadmapping method in this application context.

A service roadmap can be a great conversation starter for stakeholders in the OA treatment. It provides a comprehensible overview of innovation proposals. However, you need further investigation in the complex healthcare

sector when you want to get these service innovations to practice. It is no implementation plan yet. I suspect this applies for all the different areas within healthcare. This is good to take into account when establishing the goals of creating a roadmap for healthcare.
In making a service roadmap for healthcare, it can be concluded that doing context research is essential. Each care sector has different characteristics, which can have major influences on the setup of a service. Topics such as treatment characteristics, desired functionality, user characteristics and values, and applicable technologies are important to investigate.

In this project it was chosen to use concept demonstrators in creating a service model. Concept demonstrators could give direction on decisions made in the project, and the setup of the service model and service roadmap.
However, it can also work as a limiting factor.
In the end it was vital to mix up a set of concept demonstrator features and own insights from the context analysis. This does not mean it is not answering the research question since an integrated service delivery was still possible to create. But it does indicate it is important to look further than the given proposals, if you find it can improve the fit of the service setup into current workflows or beliefs. It would be a waste to not use these valuable findings. Doing interviews helped in maintaining this open view.

# RECOMMENDATIONS

## Further research

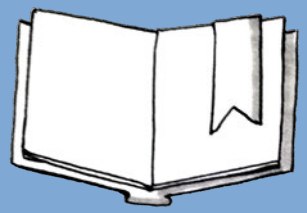
With a project planning of 20 weeks, it is not surprising choices had to be made within the research. As mentioned, I chose to focus on four stakeholders in the OA context. To fully explore the stakeholders, especially the viability in financial terms, in depth exploration and interviews with more stakeholders are needed; such as health insurers.
Next to the in depth exploration of a bigger stakeholder set, the new product-service design can be further explored as well. The product-service is now still very basic in setup, and not explored further in terms of prototyping and user testing. This is vital to test the desirability of the current product-service design.
Finally,  it might be interesting to assess the service roadmap with stakeholders in orthopedic care. This is a challenging task however, since they might be unfamiliar with the usage of roadmaps. But if the roadmap is used as a conversational tool, it might lead to valuable outcomes.

## Projects for the smart care lab

Some of these topics for further research indicate a new research project on its own. Below I will outline some new projects I foresee based on this service roadmapping project for Orthopedic care. The Smart Care lab can take these recommendations into account in setting up projects, both within the OA context, but also in the bigger context of healthcare.

To start, a project concerning the product-service design would be advised. This project can explore the multi user interactions of the new OA product-service in depth, and create a cohesive design for the patient app, wearable and professional plugin based on functionalities explored in my project. I expect this project will fit within the field of ‘Design for Interaction’
Furthermore, it would be interesting to have a project aiming at implementation of the service model. In this project a concrete plan of action and a business model can be created for getting the service into the OA treatment. This project can also make suggestions on branding and marketing. I expect this project will fit within the field of ‘Strategic Product Design’, as well as my project.
Next, I foresee a project focusing on the service back-end to be valuable for the Smart Care Lab. Within this project, algorithms for the learning system can be developed. These algorithms can focus on tailoring the system to the user, but also on improving the presentation of information for the professional, and making suggestions for diagnosis and further actions. This project will involve the use of artificial intelligence and machine learning. Ideally, integration in health information systems is explored as well. I expect this project will fit within the field of ‘Integrated Product Design.’

Ultimately, now that this project has made the first steps into service roadmapping in healthcare, this method can be used for other healthcare contexts than orthopedic care. In this way, the roadmapping method can be investigated further, towards the formulation of healthcare roadmap characteristics. Furthermore, it can help investigate the future potential of more existing concept proposals.



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The main research of this project was conducted via the **68 Advanced Concept Design reports,** created within the Master Program Integrated Product Design at the Faculty of Industrial Design of the TU Delft. The reports were part of the HiPP assignment, performed in 2013, 2014 and 2016. The reports were distributed to me by A. Albayrak.

All supporting references are shown on the right.


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# APPENDICES
## APPENDIX A: OA CONTEXT

### INFORMATION ON OA

#### Causes & Symptoms
While the exact cause of OA is still unclear, there are some factors that influence its' development. (Versus Arthritis, z.d.)
-The most important ones are age and gender. As people get older, joints have simply been exposed to more wear and tear. Especially with jobs with a large physical intensity. Furthermore, women are genetically more likely to get OA.
-Next to age and gender, obesity is also a factor, since this can cause the joints to bear more weight.
-Third is joint injuries; major injuries or operations on a joint can cause OA later in life. And finally, there are also people born with joint abnormalities, who can develop OA at a young age.

#### But how do you recognize OA?
The most common symptoms are the **pain and stiffness** in the joint, where stiffness is the biggest issue in the morning and pain the biggest issue in the evening. Pain can get worse while moving the joint, and the movement is not as freely. It is also possible the joint is swollen. Over time, pain might grow worse when OA is progressing.(Healthline, 2018)
While these symptoms might not be too complex, the fact that pain and stiffness in the joint are the two most important symptoms make sure most people take action relatively late, which also means a late diagnosis of OA. People see it as something common, that comes with aging.

#### Diagnosis
OA is mostly diagnosed by health professionals based on symptoms analysis; experiences of the patient. Next to this, a physical examination is also important. In this examination, the health professional will evaluate the tenderness of the joint, the creaking, swelling, excess fluid, movement abilities, joint stability and muscle weakening. While symptoms and a physical examination is usually enough to diagnose OA, an X-ray of MRI can be performed additionally. (Versus Arthritis, z.d.)

When the pain complaints get worse, it might be decided to form THA surgery. In the case of the hip, the affected joint will be replaced with a prosthesis.

#### THA literature
In the field of Total Hip Arthroplasty (THA), an important development has taken place; the introduction of the Rapid Recovery Program (RRP). The RRP program entails that the length of stay (LOS) in the hospital after surgery is decreased to 2-4 days, instead of the regular 5-11 days (Oosterholt et al, 2017). On top of this, the Fast Track Surgery program is developed, where the LOS time in the hospital is even limited to one day. Fast Track Surgery is made possible by revising pre-operative procedures such as the anesthesia, the surgical techniques, postoperative pain management and postoperative rehabilitation techniques. (Kehlet & Thienpont, 2013).

The development of the Rapid Recovery Program and the Fast Track Surgery indicate that the recovery phase more and more shifts towards the home context. This also raises the question if patient satisfaction is sufficient. In previous research studies, satisfaction is measured by scoring movement abilities in daily life (Hamilton et al, 2013, Bourne et al, 2010). However, Oosterholt et al (2017) argues that the patient satisfaction can be increased by involving digital innovations that both inform the patient and improve communication. This project will follow the line of thought by Oosterholt et al. and look into the application of digital innovations for multiple users in orthopedic care.

## GP consult

The patient is in charge to decide when the complaints are severe enough to visit the GP. The earlier he or she arrives, the better help a GP can give. In return, the GP will perform basic examinations and ask about the complaints, in order to determine if the patients has OA. His initial knowledge during this consult is limited to information of the patient dossier. When OA is suspected, a referral to the Orthopedic surgeon in the hospital is most often made. Sometimes GP's can refer a patient to a physiotherapist. See Figure 15.

## Physiotherapist consult

During recovery at home, a patient can visit their own physiotherapist. Here, the role of the physiotherapist is to provide a treatment program assuring a correct walking posture and other uses of the hip.
As mentioned, the patient is not obliged to visit a physiotherapist, but makes the decision itself. Nevertheless, the value of the physiotherapist is often recognized and therefore visited. See Figure 66.

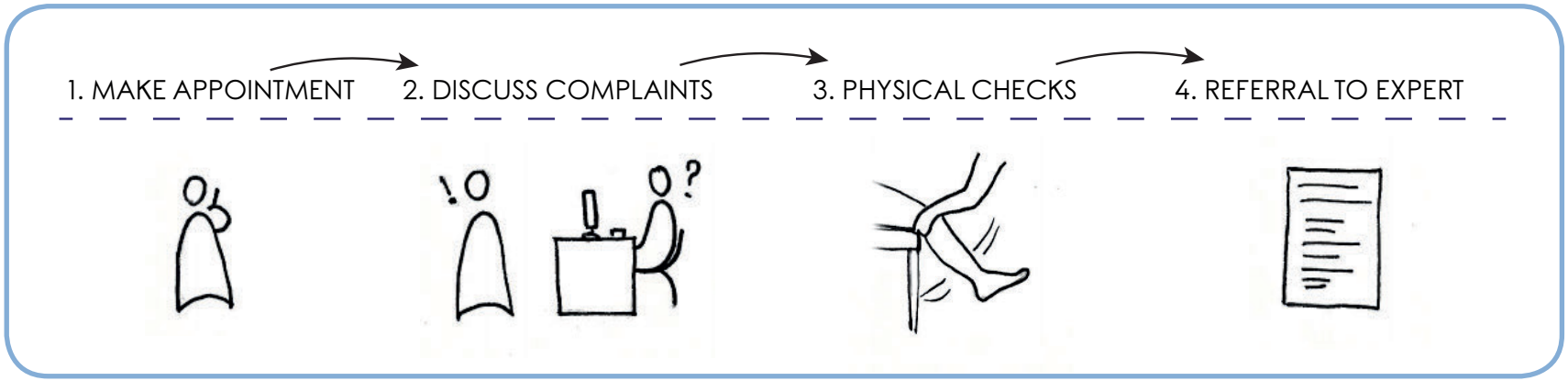


*Figure 65: The GP treatment*

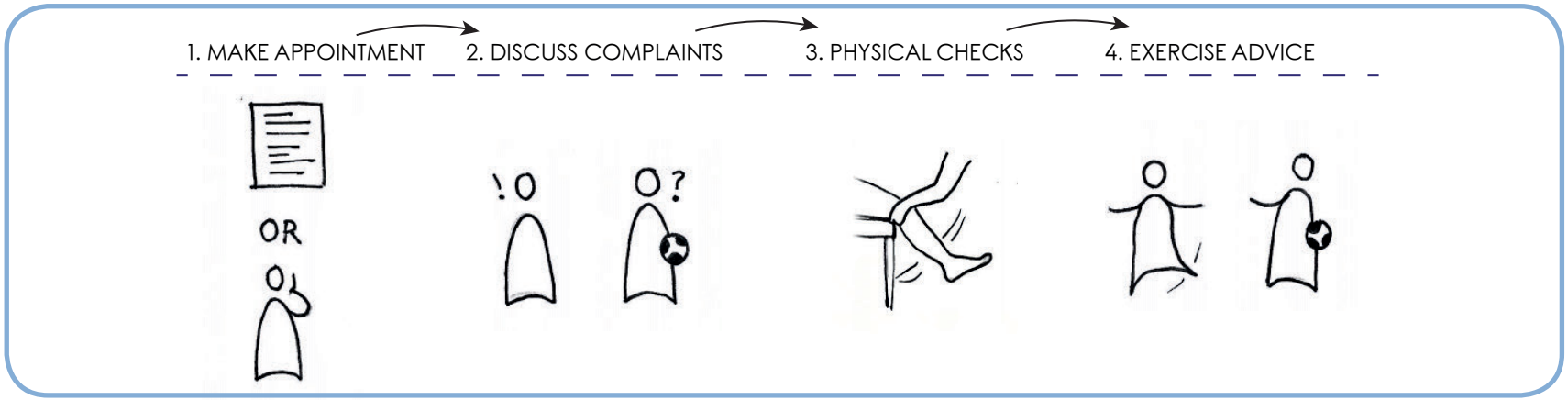


*Figure 66: The physiotherapist treatment*

## OA department in hospital

As seen in the stakeholder map (Figure 11), there are a lot of different healthcare professionals in the hospital stakeholder group. For this stakeholder roles analysis, I will take a primary focus on the professionals operating in the orthopedic care department of the hospital.

Figure 67 shows an overview of the orthopedic care department and the most important support facilities. The orthopedic policlinic itself consists of Orthopedic Surgeons, Physician assistants (doctors in training), policlinic assistants and policlinic nurses. At the policlinic, both general and specialized consultations take place, although the exact structure differs per hospital. Consultations are performed by the Orthopedic surgeons and physician assistants, both to diagnose OA and check up on the patient after surgery. Policlinic assistants take care of the administrative work, while the nurses take care of pre-surgery examinations and other treatment supporting tasks.

As a support in the consult in the orthopedic care department, the radiologist can make x-rays to take a better look at the situation of the joint.
When a surgery has to take place, this happens at the surgery department. The orthopedic surgeon is always responsible for the surgery, but a physician assistant can perform the surgery. They are assisted by a surgery assistant, anesthetist and anesthetist assistant. A surgery can both be planned and unplanned. Unplanned surgery is always an emergency situation, when someone broke their hip for example. In this case, the patient does not have to wait weeks or months on a waiting list, but the surgery happens hours to days later. This is however not the main scope of this project. After surgery, the patient is brought to the nursing ward, were the nurses, physician assistant and orthopedic surgeon are responsible for regular checkups on the patient, and the physiotherapists support in the first exercises.

Figure 68 shows the steps undertaken in the hospital in scenario form.

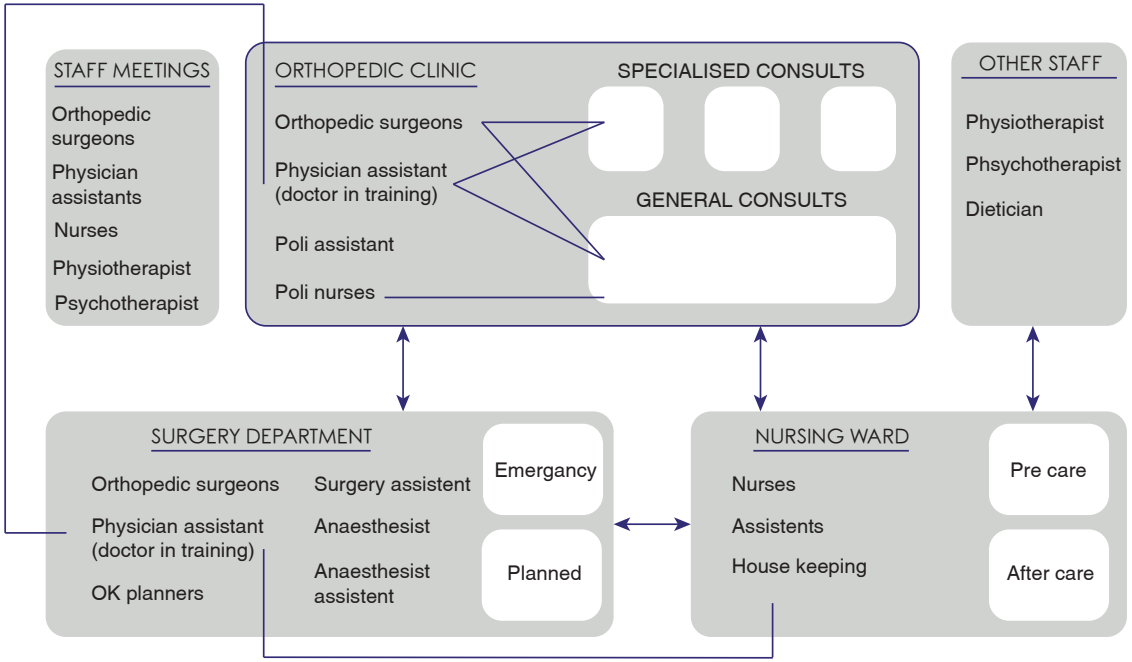


*Figure 67: The Orthopedic clinic and directly connected departments*

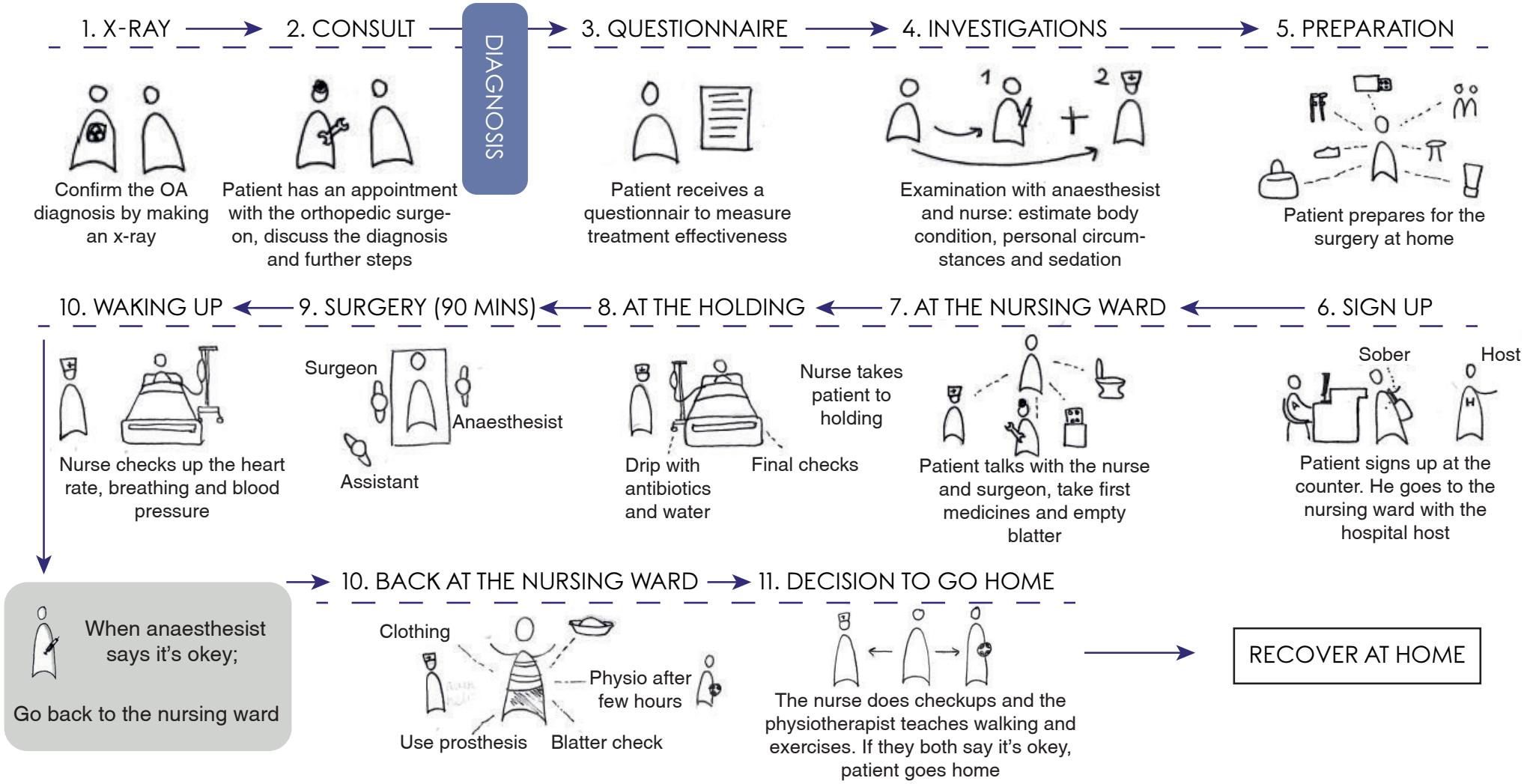


*Figure 68: The hospital treatment*

# SUPPORTING PARTIES

## Prosthesis manufacturer

The prosthesis manufacturer is a supporting party who is in direct contact with the hospitals. They deliver the most appropriate prosthesis for a patient to the hospital in consult with the orthopedic surgeon. This is also in line with regulations set by the health insurers and the government. Although communication with the patient and prosthesis manufacturer is not direct, in the end patients use their product inside their body. This means the prosthesis has a large responsibility in the treatment success as well, and it forces them to continuously improve their products.

## Informal caregiver

The informal caregiver can be friends, family or volunteer cargivers of the patient. They can support the patient both mentally and physically throughout the entire treatment process. For example motivate them in exercising, or perform housekeeping activities. They often accompany the patient to consults as well. Without the presence of informal caregivers, it is very likely a patient needs to recover at a care home. Therefore, they are very important stakeholders in at-home-recovery.

## Health insurer

The health insurer is a supporting party who is in direct contact with all professional health instances, such as GP's hospitals, physiotherapists etc. They determine which treatment options are offered with reimbursement. Since treatment is expensive, it is most likely options from this selection are chosen, which ultimately affects the treatment quality. In their treatment offerings, they like to focus on prevention, because this can ultimately limit treatment costs.

## Government

First of all, the government is the responsible party for the setup of the Dutch healthcare system. Within this system, they set regulations for all stakeholders present in the treatment process. For example regulations which demand higher responsibility from caregivers, the withdrawal for a referral letter to the physiotherapist, or the setting of the health insurance premiums. They also focus on measurements regarding prevention, since this will ultimately lower governmental expenses on treatments.

# APPENDIX B: CONCEPT CATEGORISATION

| CONCEPT NAME | PHASE OF USE | PRODUCT TYPE | FUNCTION DESCRIPTION | DESIGN GOAL | MULTI USERS | USER VALUES | FEEDBACK TYPE | TECH USED |
|---|---|---|---|---|---|---|---|---|
| Biomet OA Guide | Primary care | App+wearable (watch) | watch tracks painscore, app gives informati-on & advice on lifestyle | higher patient satisfaction in primary care, pro-active pa-tient's attitude | OA patient, GP | Transperancy, Insight, persona-lisation | amount of pain, movement in graphs, compa-red to average | mobile device, app develop-ment, bluetooth, e-ink screen, pedometer |
| Integrating Exercises | Primary care | App+sticker sheet | risk questionnai-re+ activity app incorporated in daily routine | patients visiting the GP earlier, lengthen the treatment in a better way | OA patient, GP | awareness, per-sonalisation | exercises related to goals | mobile device, app develop-ment, snaptag code |
| Verification Center | Primary care | website | platform to verify medical informa-tion and connect OA stakeholders | information+so-cial engagement for effective infor-mation providing | OA patient, GP, | expectation setting, insight, communication | website tells if info is trusted or not | internet device, website develop-ment |
| The Hobby Game | Primary care | offline game | collage making + puzzling exercise | self afficacy of patients by setting goals and getting new hobbies | OA Patient | fun, personalisation | - | Contact image sensor, OLED |
| Tap | Primary care | app+wearable (modular item) | input collector on pain experience | improve insight on progression of OA | OA Patient, Prosthesis ma-nufacturer | ease of use, insight | movement and pain level counter + graph in app | accelerometer |
| Biotracker/ Support | Primary care | app+wearable (smartwatch & sock) | monitoring system to gain understanding of OA condition+ give warnings | improve the GP patient relationship by improving self management | OA Patient, GP | insight, direct feedback | mood & move-ment graph with patient icon. Active signals to either take a break or move. | micro usb, accelerometer, microcontroller, pressure sensor |

| CONCEPT NAME | PHASE OF USE | PRODUCT TYPE | FUNCTION DESCRIPTION | DESIGN GOAL | MULTI USERS | USER VALUES | FEEDBACK TYPE | TECH USED |
|---|---|---|---|---|---|---|---|---|
| BCAPP | Primary Care | app | exercise support and OA forum with patients and physiotherapists | let OA patients be in control over their pain | OA Patient, physiotherapist | support, communication | a warning signal to go exercising/ take a break. Answers from expert | mobile decvice, app development |
| Activisor | Primary care | app | Finding OA patient new hobbies, with help of capability input. | improving self development of OA patients | OA Patient, family | support, personalisation | best suitable activities based on movement abilities | mobile device, app development, database |
| OA Sense | Primary care | measuring device | a wireless stethoscope measuring cartilage state by recording crepitus in the knees | provide early diagnose of OA in a cost efficient way | OA Patient, GP | awareness | GP listens to sound | piezo mic, amplifier, bluetooth, ADC |
| Biomet Exercise Coach | Primary care | wearable (leg band) and light bowl | bowl starts glowing if exercise is needed, and shows feedback with colourcoding | implement pre operative training for OA patients, | OA Patient | support, insight, fun | warning to do exercises,feedback on exercise performance with colourcoding | LED, microcontroller, accelerometer |
| Aple Assistant | Primary care | app | app that collects info from patients daily life by asking questions at specific moments | make GP consultations more efficient and helpful | OA Patient, GP | insight, | amont of steps, pain level, emotions | mobile device, app development |
| The Bridge | Primary care | service model | approach that can help bridge the gap between patient and expert with cooperation | improve self management of patients | Patient, GP, physiotherapist, surgeon, Phychologist, lifestyle coach, family and social context, insurance, government, biomet | personalisation | - | - |

| CONCEPT NAME | PHASE OF USE | PRODUCT TYPE | FUNCTION DESCRIPTION | DESIGN GOAL | MULTI USERS | USER VALUES | FEEDBACK TYPE | TECH USED |
|---|---|---|---|---|---|---|---|---|
| Futuro Motus | Primary care | app+wearable (knee band) | knee band measuring the amount of cartilage, and gives feedback through an app + estimated surgery | improve the experience and lower the amount of wear in the knee joint by providing insight | OA Patient | insight, | estimation model (graph) for when surgery will be needed | piezo sensor |
| Biomet Smart Assis | Primary care | Touchscreen | tool that helps GP with standard procedures and provides patient info | enhance the productivity and quality of GP consults | GP | communication, efficiency | - | touchscreen, app development |
| Health coach | Primary care | app | convert data to progress info towards personal goals. Use personal wearable | improve patient satisfaction by managing expectations and emphasizing communication | OA Patient | insight, | kind of data depends on connected device. Lot of presentation options possible | mobile device, app development |
| The Smartpatch | Recovery care | app+wearable (band aid) | a digital band aid measuring patient activity | Motivatie patients in their out of hospital rehabilitation, by goal setting | OA patient, surgeon, GP, physiotherapist, prosthesis manufacturer | insight, personalisation | progress on activites, apart from that not clearly specified | bluetooth, processor, battery, textile |
| Link | Recovery care | app+wearable (wristband) | app gives data on rehabilitation progress, wristband gives reminders | let the patient be in control of their physical condition and rehabilitation process. | OA patient, surgeon, GP, physiotherapist, prosthesis manufacturer | insight | estimated recovery time based on exerecise frequency | LED, Bluetooth, |
| Get Well Kit | Recovery care | information folder | information bundle about the recovery process + tasks divided in 4 phases | motivate the patient by providing user friendly and reliable information | OA Patient | support | - | - |

| CONCEPT NAME | PHASE OF USE | PRODUCT TYPE | FUNCTION DESCRIPTION | DESIGN GOAL | MULTI USERS | USER VALUES | FEEDBACK TYPE | TECH USED |
|---|---|---|---|---|---|---|---|---|
| Biogoals | Recovery care | app+wearable (wristband) | Goals are set before the operation, these are divided into daily milestones for the recovery phase. Wristband sends reminders | motivate patients to keep him moving towards the best possible rehabilitation | OA patient, GP, surgeon, physiotherapist, prosthesis manufcaturer | insight, personalisation | wristband shows active feedback on goal of the day. App shows feedback on goal progress | LED, memory |
| DanceCure | Recovery care | Kinect game | Dance game to play at home, with OA exercises on music | make the recovery phase easier and more fun | OA patient | support, fun | - | xbox Kinect |
| Biowalk | Recovery care | insole+charger | insole measuring pressure, steps, elevation and activity . The charger collects data in a database, accesible by professionals | ensure insight on patients recovery for the orthopaedist to improve quality of the reflecting consult | OA Patient, GP, surgeon, physiotherapist | insight | activity and steps, updates through a phonecall | pressure sensors, accelerometer, Bluetooth |
| Biomet Information Platform | Recovery care | website | website with expert information on rehabilitation | take away uncertainties by well informed patients on the procedure | OA Patient, GP, surgeon, physiotherapist | support | - | internet device, website development |
| Solemate | Recovery care | app+wearable (insole) | insoles which provide feedback on posture and walking pattern via buzzrs and an app. | steer the patient towards good actions during home rehabilitation | OA patient, GP, surgeon | insight | direct feedback on posture with vibrations. App gives further explanation | texture sensors, vibrating motor, bluetooth |
| Activities | Recovery care | app+website | activity planner for patients and their friends in recovery process | keep the social life of patients going to make the recovery more enjoyable | OA patient, family | communication | - | mobile device, app development |

| CONCEPT NAME | PHASE OF USE | PRODUCT TYPE | FUNCTION DESCRIPTION | DESIGN GOAL | MULTI USERS | USER VALUES | FEEDBACK TYPE | TECH USED |
|---|---|---|---|---|---|---|---|---|
| Biomet You | Recovery care | app + wearable | patients create routines matching their habits before surgery, this schedule helps them after surgery. | Since every patient is different, provide them with unique recovery options | OA Patient, GP, surgeon, physiotherapist, prosthesis manufacturer | personalisation | suggestions for activities are displayed on the band, progress on reaching goals is displayed on the app. | touchscreen, bluetooth, accelerometer |
| Wolk | Recovery care | wearable (shoe) | shoes with integrated sensors to measure patient activity. | make recovery a positive experience for the patient | OA Patient, prosthesis manufacturer | support | active feedback by vibrations on the foot | thermochromatic ink, pressure sensors, vibration motor |
| Biocomm | Recovery care | website | communication platform for patients and specialists | personalise the treatment of an OA patient | OA Patient, GP, surgeon, physiotherapist | support | - | internet device, website development |
| Transformo | Recovery care | crutch | smart crutch which offers real time feedback on gait pattern, and is transformable | Support and motivate hip patients by providing feedback on their body posture | OA Patient | support | active feedback by vibrations when posture is incorrect | vibration system, pressure sensor, microprocessor, bluetooth |
| MIO | Recovery care | app | app for medical staff and patient, to provide information and support in both limitations and options in hospital | self management tools can support complication free rehabilitation in the early post operative phase. | OA Patient, physiotherapist, nurse | support, personalisation | pain evaluation + progress to going home | mobile device, app development |
| Helpcare | Smart hip | app+wearable (legband) | track movement during exercises. The app shows feedback on this performance | improve patient understanding of their new hip by setting up a personalised exercise program | OA Patient, physiotherapist | insight | performance. Not clearly specified what is meant by that | piezo, psikick, accelerometer, gyroscope |

| CONCEPT NAME | PHASE OF USE | PRODUCT TYPE | FUNCTION DESCRIPTION | DESIGN GOAL | MULTI USERS | USER VALUES | FEEDBACK TYPE | TECH USED |
|---|---|---|---|---|---|---|---|---|
| SmartHiPP | Smart Hip | infection detector | device that can prematurely detect infections, placed inside the new hip | improve patient acceptance of the new hip | OA Patient | support, security | - | sensors (ph, O2, CO2, glucose), microprocessor |
| Ace That | Smart Hip | training tool | training tool for surgeons to be, using AR. Improves the accuracy of the prothesis placement | improve surgical skills faster by providing feedback after the procedure | surgeon | security | - | augmented reality |
| Patient Persona program | Smart Hip | treatment program | personalise the THA surgery and the use of smart hips | collecting data in multiple stages can improve the hip replacement procedure | OA Patient, surgeon | insight | wear & loosening data | strain gauge, PCB, accelerometer |
| Smart Hip consultation system | Smart Hip | data collection system | data collection system from the prothesis itself towards the surgeon and patient, to use in consults. | improve the post operative dialgue between patient and surgeon, to keep the consults efficient. | OA Patient, surgeon | insight | summaries of activities and hip performance, mostly focused on surgeon | database, sensors (accelerometer, gyroscope, mangetometer) |
| KeyControl | Smart Hip | app+wearable (keychain) | a smart keychain collecting data from the smart hip. Complementary app shows feedback on long term implant failure. | make people aware of the current state of their hip prothesis, to get mentally involved in the personal progress | OA Patient | security | overview of bad activities in form of movies/text in app. Patient can decide himself when to load info on app | bluetooth, vibrating motor, LED |
| Orient | Smart Hip | training tool | make a surgery plan based on CT data+improve surgery itself with coordinates | giving surgeons confidence during hip replacement procedures by giving real time feedback | surgeon | security | - | EMTS, |

| CONCEPT NAME | PHASE OF USE | PRODUCT TYPE | FUNCTION DESCRIPTION | DESIGN GOAL | MULTI USERS | USER VALUES | FEEDBACK TYPE | TECH USED |
|---|---|---|---|---|---|---|---|---|
| Chronic Pain Relief Insurance (CPRI) | Smart Hip | Pain blocker | a pain killer switch implemented inside the hip prothesis, which can be controlled with a remote. | increase quality of life for revision patients | OA Patient | security | - | SSIMOS |
| WalkAway | Smart Hip | app+wearable (hip band) | hipband providing real time feedback, to correct the position of the hip during walking | give patients control over the improvement of their gait | OA Patient | insight, support | progress graphs, step and exercise counter, active vibrations feedback + explanation in app | vibration system, pressure sensor, microprocessor, bluetooth |
| HipConnect | Smart Hip | app+wearable (sticker) | sticker' device that measures wear in the hip prothesis. Feedback is presented in context of the activity | prolong the life of hip prothesis, by using highly personalised, context aware warnings information on hip prothesis wear | OA Patient | insight, awareness | risk of wear with respect of time location and events | bluetooth, IMU sensor |
| Smart Hip Application | Smart Hip | app | app that provides feedback on the status of the hip and effect of actions from the user | feedback from the smart hip implant helps the patient to adapt in the process after hip replacement | OA Patient, surgeon | insight, support | show the prothesis, and pressure levels in relation to activities | mobile device, app development |
| Tilty | Smart Hip | surgery accesory | tool that helps the surgeon with the removal of bone in the total hip arthroplastry | assist and reassure surgeons by means of real time data in THA surgery | Surgeon | security | placement of the hip | bluetooth, LED, PCB, neopixel |

# APPENDIX C: MARKET ANALYSIS

Before one can look into the innovation field, it is important to specify the market interest. What is happening in this field and who are the important players?
Since this project focuses on 'digital innovation for the THA procedure', there are two markets to distinguish; the prosthesis market and the digital health services market. Developments in both these markets can have influence on the service model and service roadmap. The following section will therefore elaborate on both markets. Market research described in the group reports formed the basis for the analysis, and was elaborated upon with help of desk research.

## PROSTHESIS MARKET

The prosthesis market consist of prosthesis manufacturing companies (Figure 69). They are B2B companies that deliver their product to their clients; hospitals. To get a grasp on the setup of the prosthesis market, both a competitor analysis and a Porter five forces are performed.

### Industry players in the prosthesis market

In the prosthesis market, four important players can be identified. Together they own 85% of the dutch market share in knee and hip prostheses (Intrakoop, 2016). What all companies have in common is that they design and manufacture orthopaedic solutions, where prostheses are their main product offering.

- Zimmer-Biomet: Is a fusion of the companies Zimmer and Biomet, which happened in 2014. However, Zimmer was already founded in 1927 in Warsaw, Indiana. Zimmer Biomet operates in 25 countries from which the Netherlands is one, and sells products to 100 countries. Zimmer Biomet builds on their strong history of success to enhance their value towards healthcare providers and patients, ultimately alleviating pain and improving the quality of life.
- Stryker: Is a medical technologies firm founded in 1941 in Michigan. Nowadays, they are operating worldwide and selling their diverse product portfolio involving medical and surgical equipment, neurotechnology and orthopaedics products to over a 100 countries. Stryker names their values integrity, people, accountability and performance.
- Smith & Nephew: Is a British medical equipment company founded in 1856. They have a large product portfolio; next to orthopaedic products they also focus on wound management, arthroscopy products, and trauma and clinical therapy products. Their products are sold in over 120 countries. They value care, collaboration and performance.
- DePuy Synthes: Is an orthopaedic product manufacturer founded in 1895 and a became a part of Johnson & Johnson medical device companies in 1998. Their products are focused on joint reconstruction, trauma, spine, sports medicine, power tools and biomaterials, which are sold in 60 countries worldwide. The company strongly values responsibility and is involved in sustainability, better health and better education.

From these four players, Zimmer-Biomet has the largest market share in hip prosthesis in the Netherlands with 34,9%. (Intrakoop, 2016) The other three companies all have a market share between 10 and 12 percent.


*Figure 69: The prosthesis market field, with relative market shares*

## Porter five forces

Using the Porter five forces method by Porter (2008) can indicate the characteristics of the prosthesis industry. Also see Figure 70 for a summary.

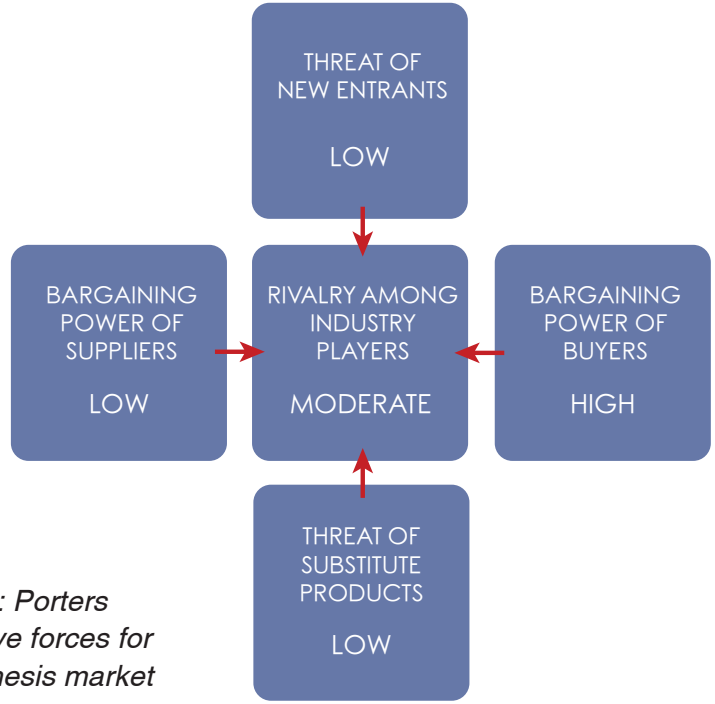


*Figure 70: Porters competitive forces for the prosthesis market*

**Threat of new entrants: low**

A lot of expertise is needed to develop medical equipment like prosthesis, for example on all the rules and regulations of the healthcare market. It takes years to collect all the required knowledge and produce a prosthesis qualified for placement in the human body. Other companies already do this for dozens of years. This makes the threat of new entrants low.

**Bargaining power of customers: high**

The medical staff has great power concerning the choice for a certain product. The surgeon placing the new hip decides what kind of prostheses he/she uses. On top of that, the insurance companies decide what to pay for, this gives them great power to support certain products or not. The hospitals and insurance companies are money wise the two most important stakeholders for the prosthesis manufacturer. Therefore, the bargaining power of customers is high.

**Bargaining power of suppliers: low**
Companies in this industry are mostly in need of material suppliers. To satisfy them in this need a prosthesis company has many suppliers from a big pool of available ones, and competitors in the sector are therefore likely to have different ones. This gives suppliers little power.

**Threat of substitute products: low**
A prosthesis is a product that will not get a functional replacement in the upcoming years. Even though placing a prosthesis a radical procedure, it is the most effective way to deal with severe cases of OA. Of course the prosthesis will be developed further, such as 3D printed prosthesis, but this is likely to be done by the already existing competitor field and those techniques need a few extra years of development. Therefore the threat of substitute products is low.

**Rivalry among industry players: moderate**
The dutch prosthesis market can be considered relatively small. The products that different companies produce are overall very similar in materials and design, due to strict regulations. Furthermore, the product portfolios are almost the same. The main difference between the products are the structure and material of the connection pin that goes into the leg. This is situation is doable because the need for prosthesis is growing as well. However, for the long term it is important for companies in this industry to keep exploring opportunities to offer unique solutions.

## Conclusion
From the Porter five forces one could conclude that the prosthesis market is a **mature and rather stable market,** mostly due to the low threat of new entrants, substitute products and the low bargaining power of suppliers. The biggest point of attention is the bargaining power of customers; companies need to make sure they stay appealing to their current customer, and find a way to drag possible new customers out of their habit buying routines.

*Figure 71: The digital health market landscape*

# DIGITAL HEALTH MARKET

On the other side of the spectrum is the digital health market. This is a booming market where developments follow up on each other rapidly. On the other hand, rules and regulations set strong boundaries in this market.
Before we continue it is important to note what I define as the digital health market. I define this as 'digital solutions that are used by both patients and healthcare professionals'. This means they operate both B2B and B2C. Therefore, consumer focused products such as the Fitbit fall out of this scope, since doctors and other professionals are no active users in this service system. But also apps for professional use only, such as farmacotherapeutisch kompas, fall out of scope as well. Nevertheless, it is good to note that within these two areas, a lot of interesting solutions are being created. The section 'Technological trends' will elaborate on this topic. This section will elaborate further on the digital health market by defining the industry players and the porter 5 forces analysis.

## OA apps

With the current definition of the digital health market they fall out of scope, but it is good to mention that there are already some existing apps that focus on OA specifically. Examples are Join2move, Dr Bart and e-exercise. These apps are all standalone ones, and focus on three topics within the OA treatment; activities, exercises and information. **These apps are meant to be recommended by health professionals, but they do not play an active role as a user of the service system. Furthermore, the apps are merely a provider, and do not collect insight on personal progress.** It is the responsibility of the patient to actively use the app and improve his or her condition. Because of the lack of communication and data, it was chosen to not analyse the apps in further depth.

## Industry players in the digital health market

The digital health market is mostly dominated by so called 'PGO's' (persoonlijke gezondheidsomgeving). See figure Figure 71. These are websites or apps, most often created by small startup companies, where patients can collect and share information about their medical data. Healthcare institutions can share useful data with the patient via the PGO environment.
PGO's are a relatively new product, and therefore it is difficult to determine which one is most used, or most appreciated by the user. But for now, the most prominent PGO's so far when searching the internet are the following;

-CarenZorgt
-Drimpy
-Gezondheidsmeter
-Healpt
-Ivido
-Medsafe
-Patients know best
-Quli
-Samen1plan
-Selfcare
-Zodos
-Zorgdoc
-Minddistrict

While each PGO has their own unique features, all products allow to review someone's medical dossier. Many PGO's offer a medication overview as well, and some form of information source; either by talking to an expert during an e-consult or reading disease information. Additionally, some PGO's offer a form of data collection: either by filling in a journal for the health professional, performing self-measurements or connecting wearables.

Next to the PGO developers, it is important to note some regulating organisations in this market;

**-MedMij:** This is an organisation that establishes the standards for a PGO. These standards are mostly focused on privacy and safety. MedMij allocates quality labels to PGO's which meet up to the MedMij standards, which can serve as a quality indication for users.
**-ViPP:** ViPP is a dutch initiative established to improve information exchange

between health professional and patient. Health institutions can decide to take part in the ViPP project, and try to reach goals such as sharing medication overviews with patients and developing a patient portal. To help achieving these goals, health institutions can receive a grant in exchange. The activities within the ViPP project foster the use of PGO's.
**-Nictiz:** Nictiz is an e-health expertise organisation, doing a lot of research on the digital innovations in healthcare. Health institutions can use this knowledge in their innovation practice.

## Porter five forces (also see Figure 72)

**Threat of new entrants: high**
All PGO development companies are young companies or startups. All companies have relatively little experience in the market, since their products are not widely implemented in healthcare sector yet. This means there is no great base of expertise. Furthermore, this means there is not one big player yet, owning a big percentage of market share. This makes it an ideal time for other companies to enter this market.

**Bargaining power of customers: high**
Health institutions have the power to choose the product they see fit for their organisation. Furthermore, insurance companies can decide which products they support and which they don't.
Since these stakeholders ensure the income flow PGO developers, this situation puts them in a weak position.

**Bargaining power of suppliers: low**
PGO developers are close to non-reliant on suppliers to do business. They mostly need skilled ICT people and proper equipment to create their product. This small set of requirements makes the bargaining power of suppliers low.

**Threat of substitute products: high**
The specific value PGO's can deliver is still somewhat unclear, apart from the fact that it takes away a lot of development time for health institutions. Therefore healthcare institutions can also decide to develop an improved patient portal of their own, if their ICT abilities allow this. Next to a threat from the health institutions side is also a threat from consumer products. There are already many Fitbit like products for collecting personal health data, which are still growing in popularity. Adding medical data to this collection is only one step away. This makes the threat of substitute products high.

**Rivalry among industry players: high**
The PGO market can be considered relatively big. 12 PGO's have already been qualified with the right safety standards, and are still battling for their position in the market. This number only keeps on growing. Finding unique customer value and creating a loyal customer base is essential for survival in the market.

From the Porter five forces one could conclude that **the digital health market is still very young and unstable.** Especially the threat of new entrants and the threat of substitute products illustrate this. PGO's still need to find their unique value in the market and by gathering specific know how by evaluating customer experiences.

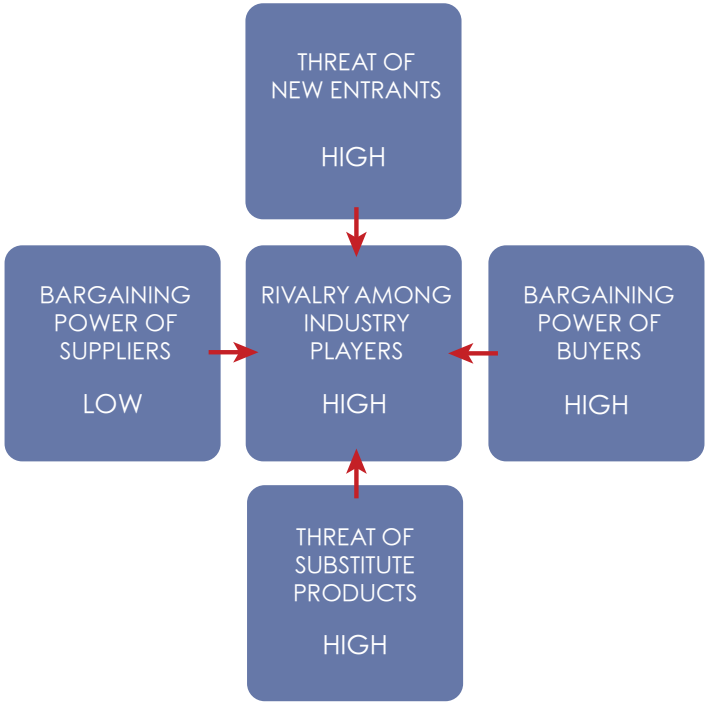


*Figure 72: Porters five competitive forces in the digital health market*

# APPENDIX D: DEPEST ANALYSIS

## Rapidly changing health demographics

There is a growing number of people in the Netherlands (18.1 million in 2040), and especially the elderly population will grow significantly (CBS, 2016). This will mean that the number of people with geriatric disorder will significantly increase. This puts pressure on the entire healthcare system. Furthermore, the number of elderly having multiple disorders will grow as well. This makes the demand for care more complex. The fact that household sizes decrease will increase social issues such as loneliness, especially for elderly. This has a negative effect on a person's well-being (Figure 73) (VTV, 2018).
The growing differences in population density put pressure on the healthcare utilities; declining regions have more elderly and thus a higher demand for care. (Wortell, 2018)

*Figure 73: Less caregivers per elderly. Image source: Omroep Zeeland, 2017*

## Economic effects on healthcare

The dutch healthcare sector remains under pressure due to the limited numbers of staff. Its reputation as a stressful profession will not be cleared so easily. In combination with the higher demand for care, this will make the healthcare sector search for efficient ways of working even more (STT, 2018). Next to the search for efficiency, the economic growth will make sure that an increasing amount of companies will operate 24/7, with growing consumer expectations as a result. While the healthcare sector is already active 24/7, they need to face these higher expectations and fulfill all health related needs at any given moment (Figure 74) (Bos, 2018).


*Figure 74: High quality care 24/7. Image source: Guus Schrijvers Academie, 2018*

## Politics force a do it yourself mindset

The government is pushing citizens to take more initiative in managing their lives, where the government is moving towards a facilitating role. This forces citizens to find help in their own network (family, friends, neighbours, etc) with informal care. It also causes the rise of self-management; monitoring your own health status by measuring your blood levels for example (Figure 75). Even for the healthy people in society, Fitbit like products are immensely popular (VNG, 2015)).

## The demand for personalisation and hyperindividualism

Ever since individualization has grown to a hot topic in society, the need for personalization has grown with it. Everyone is unique and people are searching for ways to express this. Even in healthcare this demand is noticeable, for example in diagnosis and treatments. Personalization asks for flexibility in product offerings and new forms of interaction (CBS, 2017). Some instances are even taking the personalization trend to the next level and are speaking of hyperindividualism; products and services that completely shape themselves towards your preferences themselves, by learning over time (De Bruijn, 2018).

*Figure 75: Self monitoring blood pressure. Image source: Haga ziekenhuis, 2019.*

# APPENDIX E: TECHNOLOGICAL TRENDS

This appendix displays the eight technological trends found based on a comparative analysis on trend lists by trend and healthcare related instances.

## 1. Health apps

There are more and more apps available which are related to health in the broadest sense of the word (Figure 76). And simultaneously, more people start using these apps making digital health management better featured in society. (DTT, 2019) Examples are the 'Medicatie app', the 'Reanimatie app', 'Risicoscan Van Zorg naar Beter' and 'Moet ik naar de Dokter?'


*Figure 76: Example of a health app focusing on exercising*
*Image source: Join2move, 2019*

## 2. 3D printing becomes an commonly used technique

The demand for personalization and efficiency in healthcare is resulting in the rise of 3D printing. 3D printing is an additional manufacturing method where a 3D part is built out of thin layers of material printed on top of each other. It is already commonly used in other sectors, but the healthcare sector starts using it more and more for generating e.g. braces (VTV, 2018). However, its possibilities are bigger, since it is also possible to print on a nano scale, and print with smart materials that change shape (4D printing) (STT, 2015). 3D printing is a perfect fit for the healthcare sector, since it allows the low volume production of custom made parts, and thus generates personalized products (Figure 77). Furthermore, since there are many 3D printing facilities and even a growing number of consumers owning a 3D printer, production can be decentralized even to a patients' home. This does increase the risk of unsafe products.

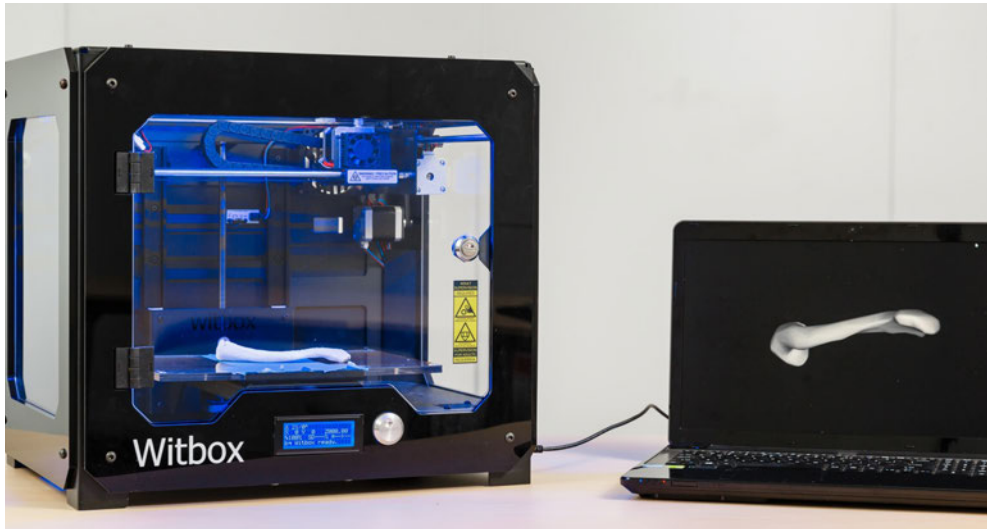


*Figure 77: 3D printing body parts. Image source: Netwerk Acute Zorg, 2018*

## 3. Robots will play an important role in healthcare

Robots in healthcare will be implemented on an increasing scale, in all shaps and sizes. They will ensure that some physical tasks can be automated. For example more precise surgeries with microrobots inside the body, performing physically heavy tasks, and interacting with elderly (Figure 79) (Vilans, 2018). In sum, robots will support in entertainment, human actions, and improve the performance rate of certain tasks. (CBS, 2018) However, while robots can be of great help, they will stay subordinate to humans at least for the upcoming years. This has to do with the fact that patients can have

unexpected wishes and behavior, and the fact that health professionals have better abilities for empathy, creativity and solution orientation. Nevertheless, more than half of the dutch society is open towards diagnosis by robots, if it can improve the process quality; higher accuracy and speed. But the feeling of interpersonal contact should not get lost (VTV, 2018) .

## 4. The smart home

As mentioned before, the implementation of new technologies will enable care related activities in the home context. This can for a major part be realized with the help of Internet of Things (IoT). IoT can best be described as a system of interconnected appliances, objects and people, which are able to share data with each other without needing human interference (STT, 2015). The technique is already applied in smart thermostats for example, which decide themselves when to turn on and off. Also monitoring wearables use IoT In the upcoming years, this technique can be taken to the next level. By using sensors, environmental controls and connected mechanics one can provide automated mobility and lifestyle support (Figure 78). Furthermore, both health professionals and informal caregivers can monitor the patients from a distance. (Digitalist Magazine, 2018).

## 5. The smart human

The use of microchips inside the body is increasing, which means humans are becoming cyborgs. Technologies inside our body can be used to either take away physical limitations, strengthen the body, or monitor its condition right at the source. For example, a hart monitoring sensor can analyse fainting behavior and act upon it. Another example are artificial senses which can be applied when original senses are not functioning properly.
The rise of smart human technologies will fade the boundary between humans and machines. This boundary will fade even more with the development of Brain-Computer interfaces (BCI). This means hardware and software that can enable brain controlled products. This can have major benefits on the self-controlling abilities of physically disabled people (Figure 80) (STT,2018).
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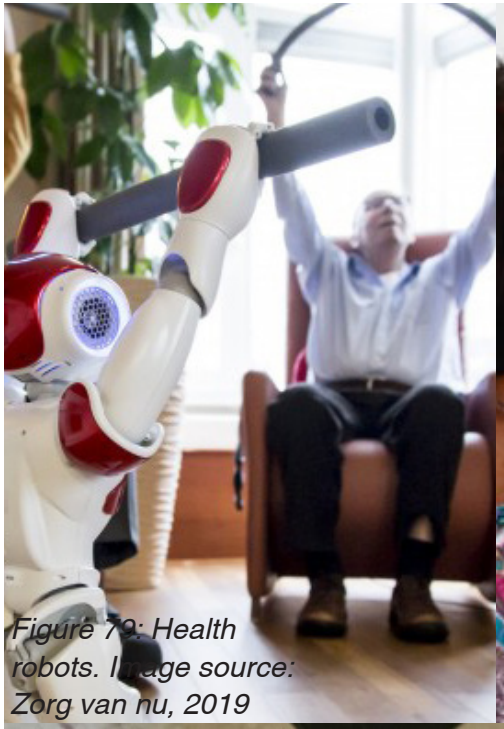


*Figure 79: Health robots. Image source: Zorg van nu, 2019*

*Figure 78: Smart home with health adjustments. Image source: EW Installatietechniek, 2011.*

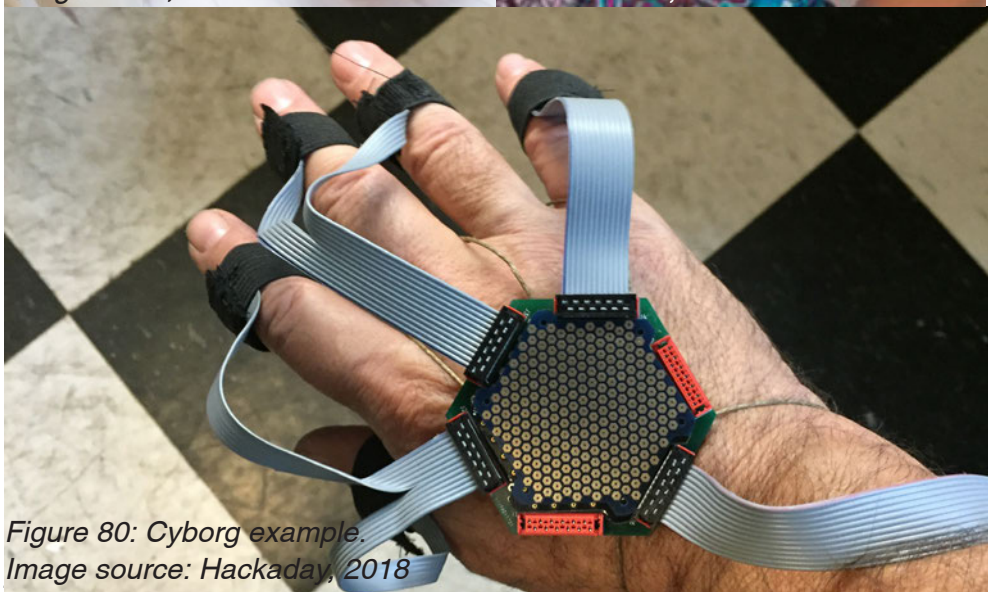


*Figure 80: Cyborg example. Image source: Hackaday, 2018*

artificial worlds are created which interact with the user.(Vilans, 2018) AR and VR are become more accessible and normal for consumers since the technology becomes more affordable; with VR glasses, but also with your smartphone for example. With this accessibility also comes a broader applicability, where the healthcare sector makes use of. First of all, it can cope with cases of loneliness, were people can have contact with others via VR. Furthermore, VR can be used in operation preparation and pain distraction for patients (Figure 81). AR can be used in the support of performing daily activities of elderly, but also as a training tool for health professionals. While these applications can greatly improve the quality of care, there are question marks about the mental and physical effects of usage, and a possible case of privacy violation (VTV, 2018).

*Figure 81: Using VR in the hospital treatment*
*Image source: ICT & Health, 2018*

## 7. Digital twins

Related to AR and VR is the development of digital twins. A digital twin is an exact model of a the real world. A digital twin for healthcare can be described as a safe virtual environment where healthcare suppliers can test their innovations. This allows them to do 'what if' type of experiments without affecting something or someone in real life (Figure 82). Therefore, digital twins can form a bridge between the digital and the physical world.

*Figure 82: Using digital twins to analyse a patient. Image source: ECP, 2018*

## 8. Data driven health

Data driven technologies are a big topic in the healthcare sector, and is this is not expected to decrease soon. With data driven technologies, information can be collected, shared and analysed on a large scale. There are several different data technologies, which will be explained first before the application in the healthcare sector is discussed further.

### Big Data

Big data can be described as a large set of data, generated by people and sensors. The availability of this data is online and real-time. The possibilities of generating big data are increasing, which increases the amount of big data generated. In their turn, software applications are able to recognize patterns and relations in big pools of generated data and thus generate diverse insights fast. Big data is used to personalize services for customers, optimise services with help of customer feedback, and

ease the entrance to new markets. It is expected that in the future, more decisions will be based on big data, even in healthcare (VTV, 2018).

**Data Analytics: AI and machine learning**

Without actual use of the generated insights, big data isn't worth much. Therefore, big data goes hand in hand with Artificial Intelligence (AI) and machine learning. When big data is generated, special algorithms (the AI component) are used to learn from these user insights. This means a system can become 'smarter' over time and is more tailored to user specified wants and needs. This is called machine learning. AI analysis improved by machine learning is a lot faster than the human analysis capabilities. For example, AI systems are capable of analyzing a CAT scan 150 times faster than a radiologist. (Vilans, 2018)

With the help of data techniques such as big data and AI, major improvements in healthcare can be achieved. Think about the improved diagnosis of disorders, analyzing the success rates of different treatments and improving self-monitoring systems for patients which will be completely personalized over time (Figure 83). But one can think bigger. Data driven technologies make it possible to respond to country scale incidents, for example the spread of infection diseases  or air pollution (VTV, 2018). Readings from different sources can be linked, analysed and shared to come up with more precise measures. Furthermore, data driven technologies can give insights on the well-being of the entire society using the same strategy.
While these effects all sound very promising, the actual implementation of data driven technologies in healthcare are running majorly behind compared to other sectors.

*Figure 83: Analysing patient data*
*Image source; CCHIT, 2015*

# APPENDIX F: SOCIAL CULTURAL RESEARCH

This appendix contains notes that were made while reading the individual concept reports and the group research reports.

**VISITING THE GP**

The main reason for visiting the GP for OA is pain.
Persons only want to see the doctor when it was absolutely necessary; not out of fear or lack of time, but they don't want to bother the doctor with minor complaints.
However, the patient is often too late with their first consult, not realizing the severity of the pain.
Contact with the GP is formal
There is no relation between the patient expectation towards the hip replacement and the satisfaction with the GP consult. Expectations about the treatment can become higher, without affecting the satisfaction rate with the GP.
Non-surgical treatments lead to less treatment satisfaction from the patient
There are OA treatment guidelines for the GP, but every GP deviates slightly from this in their treatment choices (medication, advice, examimation).

**OA TREATMENT**

Motivation to undergo OA treatment in primary care is intrinsic.
Overall quality of OA treatment is good, however, patient miss a personal aspect within the (primary care) treatment. Others say a personal aspect is only for mental problems.
Some patients feel passive in the treatment process (lots of visits, limited results)
The 'How am I doing?' Question is very difficult to answer for patients without regular professional checkups.
The fast track hip replacement program makes patients overconfident. They have their functionality back in one day. This is dangerous for the recovery process, because surgery still took place.

**HOSPITAL VISITS**

Studies showed a loss of identity for the patient inside the hospital.
Hospital visits can be overwhelming in terms of information
Mixed feelings towards hospital: the experience with doctors treatments and service is positive, but in the end they don't want to be there because of the association with illness.
Hospital professionals have authority, patients just follow

**OBSERVATIONS ON BEHAVIOR IN THE HOSPITAL**

People enter the hospital building not exactly knowing where they are supposed to be. They expect the appointment letter will guide them. Otherwise they ask personnel.
Patients act nervous in the waiting room.
Hospital personnel acts friendly and patiently.
Patient is most often accompanied by another person for support.

**SHARING INFO WITH OTHER PATIENTS**

Many people with OA have others with OA in their direct surroundings. However, they do not share experiences with their complaints.
Some patients are, however, interested in knowing other patients complaints (experiences) to get more insight in dealing with OA.
It is debatable if the target audience will share their experiences to other patients in an online environment.

**COMMUNICATING WITH HEALTH PROFESSIONALS**

the patient appreciates online contact with health professionals
patients are likely to obey to what health professionals instruct them to do, they know best
There is a lot of trust in the health professional in terms of helping.

**PAIN MEASUREMENT**

There is no specific tendency from users to track the pain experience.

**FRIENDS AND FAMILY SUPPORT**

Although patients recon that their friends and family is supportive, tangible

support by friends and family towards motivation is often referred as limited. The patient motivates him/herself to do the exercises for example. Friends and family do help the patient if needed, by helping in housekeeping tasks that are not possible to perform by the patient, for example.

**EXERCISES/MOTIVATION**

- Motivation to do them is 'going back to normal': the end result.
- The exercises themselves are not so much the problem, keep doing them time and time again is.
- Discipline is key to keep doing them, but patients can use help here.
- Feedback on exercise performance is not always needed. It is nice to hear it from physiotherapists from time to time. A simple right/wrong indication could also help.
- However, patients do have difficulties remembering the correct execution of the exercise.
- Some patients mention motivational feedback will help them, some don't need it.
- It is most difficult to push through when no result is felt by the patient
- Origin of motivation depends on social physical and mental state of the patient
- To improve the personalization for the exercises at home and the feedback of restrictions of movement, better feedback to the patient and to the physiotherapist is needed

**SELF MONITORING**

If self-monitoring happens manually (eg inserting emotions) there is a trade-off by receiving a reminder but not being intrusive in daily lives (some people cannot use their phones at work).
patient appreciates self monitoring; less doctor visits
Findings suggest that a positive attitude positively influences planning and problem solving, and that social factors and the ability to reach defined goals strongly affect ability to perform tasks. Anxiety, depression and stress negatively influence self-management. Reaching goals is important do participants, but not all have the ability to reach goals.

What feedback would OA patients desire from their hip?
We can conclude that patients want to have feedback on the hip prosthesis mainly to adapt to the needs of the hip. The frequency of feedback can be weakly correlated to the number of times the patient thinks about particular situation. The patients preffered digital channel for immediate feedback due to quicker accessibility. But there is no clear preference for a channel for different situations and hence we can conclude that it is a personal preference. The patients desired passive feedback with a slight inclination for textual feedback, but overall visual and textual were almost the same. We can clearly conclude that although patients desire more feedback, but they want to be able to decide when to access the feedback.

*P: 'Daar is namelijk heel veel twijfel over goh, als ik dit nou doe, heb ik dan morgen heel veel pijn of niet. Het zou fin zijn als iets je waarschuwt. Iets dat weet van, dit kun je nu aan door bepaalde metingen, dit kun je aan en ga er niet overheen want dit zijn de gevolgen.*
*S: Ja precies, je lichaam geeft namelijk al heel mooi signaal wanneer het mooi geweest is,maar ik denk dat je juist daarmee misschien nog wel beter in kaart zou kunnen brengen of, wanneer wordt iets teveel voor een patient. En dat je aan de hand daarvan, van bepaalde registratie, dat je zou kunnen weergeven en dan voor de patient ja hoe zeg je dat, Dat het gewoon voor de patient echt wat oplevert. Bijvoorbeeld, welke beweging, sport of activiteit welke belasting met zich meebrengt. En dat zo'n product bijvoorbeeld kan aangeven van he, dit is voor jou de grens. En dat ie jou maandelijkse activiteit registreert.*
*P: Dat ie bijvoorbeeld aangeeft zo lang heb je nog met je eigen heup als je zo doorgaat'*

**PATIENT VIEW TOWARDS EHEALTH**

Younger people prefer to do some research on the internet about their conditions mainly to be sure if a visit to the general practitioner is required at all.
• Older people prefer to visit the general practitioner directly rather than look for information
online. Thy may use it for limited purposes, but still hold a visit to the gene-

ral practitioner as the most reliable solution.
• Younger people understand much better how the internet works, and therefore, are careful to verify
the information they read from multiple sources before reaching any conclusions.
• Older people find it a bit more difficult to accept information as it is provided and would like to verbally discuss it, something which is not possible on a website or an app.
• The app is uniformly less preferred due to less ease of use and inaccurate depiction of anatomy,
indicating a lower acceptance as a reliable and frequentlyused source of information.

**PREFERRED PRODUCT TYPE IN PRIMARY CARE**

A target group was presented with three concepts for OA treatment in primary care.
1)based on collecting and viewing data, 2)a support mechanism which gave a signal when users were too active. 3) share activities and tips with other OA patients.
Number 2 had by far the most positive response: the target group was enthusiastic about the fact that it could keep their activity in check, many mentioned that was a problem for them.
The study confirmed the need for a method of personal data presentation focused on the elderly transform raw data in a way they know how to act upon it.

**ACCEPTANCE OF A NEW PRODUCT**

'Location' and 'Activities' score relatively low on the average acceptance rate compared to other types of data. 'Time' is accepted to be used as a parameter for any purpose. It doesn't matter whether or not the data is being shared anonymously for 'Time', 'Distance', 'Steps taken', 'Weight' and 'Muscle contractions'. 'Location' and 'Activities' are not accepted being used as non-anonymous, since they are not accepted on the average acceptance rate and have a strong correlation.

The factors that influence the adoption of smart hip are- Feeling normal, Control over the device, Communication with device, Appearance, Society (how the patient with device affect the people around him/her). Feeling normal is ranked as most important. Appearance and society come next.

**GOAL SETTING**

This activity needs to be performed with guidance from health professionals. If patients set goals on their own, they tend to be too pessimistic.

**INTERACTION WITH DIGITAL MEDIUM**

Presenting information visually and highlighting text can improve recalling of information

**PRIVACY**

One patient reflected on the topic of privacy as follows:
*Nee ze mogen alles registreren, maar ik vind het idee niet fin dat iemand anders kan meekijken van, waar ben je geweest, wat voor activiteiten heb je gedaan zegmaar, Gewoon puur voor de registratie van bewegingen, belasting enzovoorts, dat is prima. Ook als het ten goede komt van het onderzoek, prima. Zou me niks uit maken ik zou zelfs test patient willen zijn. Want ik gun iedereen een goed stel heupen. Alleen met registratie van tijd en plaats zegmaar, ben ik niet zo heel kapot van.*
*Je weet gewoon niet wat er met je informatie gebeurd, want je hebt bijvoorbeeld tegenwoordig het EPD, maar daar kan ook gewoon een zorgverzekeraar bij en dat dossier inzien en dan ziet hij zo en zo en hoeveel kilometer ik gewandeld heb en deze en die activiteiten gedaan. He luister, dit gaan wij niet meer sponsoren, die nieuwe heup van jou. Je doet maar een extra eigen bijdrage, ik noem maar wat. Dat zou ik wel jammer vinden. Aan de andere kant zullen deze gegevens nodig zijn om het product te laten werken. Dus ik zou er wel tot zover in meegaan dat ik nog wel een beetje privacy heb.*

**EMOTIONS**

Three different emotions were most frequently mentioned regarding OA treatment during patient interviews; uncertainty (what can I do), anxiety (afraid

to have pain), expectations (future improvement).
An supportive device during rehabilitation would give a feeling of trust and control.

**PERSONA**

Patient matrix; stubborn pusher, know it all, passive patient and lost in understanding. This is in regard to their self-management behavior and following expert advice.

**BUSINESS MODEL**

No clear preference between hiring and purchasing an OA related product.

**FEEDBACK (expert interview)**

Personalised feedback can be a very motivating way of providing feedback. There are different ways of personalizing, for example personalized messages, or right timing (fitting with personal schedule)

(questionnaire) system feedback is valued as an important feature in PSS, but also professional feedback is important

**MOVEMENT MEASUREMENT (expert interview)**

There are already many different sensors available to do this. The goal of using these sensors should be measuring the movement of joints. Measuring muscle activity is much more complicated.
Movement of the knee for example can be measured by wearing a band around the ankle and upper leg and by calculating the movements between these two sensors, the movement of the knee can be measured.
For patients with osteoarthritis, movement itself is already very important. There are two types of movement: aerobics and exercises. Sensors which people can wear all day through without noticing it can then behave sort of like an activity coach. This way of sensing can for example tell the patient to move more when there's not enough movement during the day, or to move less, when the joints might be overloaded. Deconditioning is very bad for patients.

**OA COMPLAINTS (GP interview)**

When patient's have osteoarthritis, it doesn't mean that they can't do anything. It is the degree of complaints that causes this. I know people who have huge osteoarthritis, who still do some jogging, because they haven't done a surgery. So I know when someone has osteoarthritis, I don't need an orthopaedic for this. I can coach the patient and describe some treatment to reduce the pain level. In this case the osteoarthritis doesn't disappear, but the complaints do. Sometimes I have doubts about the diagnose, then I ask a expert about it. I can send the patient to do a MRI scan. There are different kinds of patients, some have osteoarthritis for 20 years and just take a paracetamol and continue with their activity. One day they stumble over a doorstep and then they start have complaints. Other patient's visit the GP immediately, when they start having complaints. Everyone is different

**Rapid recovery program (expert interview)**

"*People were willing to participate in the rapid recovery program, but were reserved with the exercises they should do". Patients had to walk several meters only 20 minutes after the operation. In their perspective this was something that felt strange and dangerous. Their minds were fixed around the idea that you should be in the hospital for 7 days and recover gradually: you shouldn't rush things because it will be bad.*
*However, the Rapid Recovery program shows that moving your hip a lot by doing daily exercises is very beneficial for a quick recovery of the hip. Not moving your leg would only cause it to become stiffer and can even result in dangerous complications. Yet this was hard to believe for people because they were stuck in this specific cultural view about the medical procedure. This attitude causes patients in typical hip replacement programs to recover in a slower rate because they are inclined to move less.*
*Therefore the doctors at Reinier de Graaf have patients walk several meters just after they have had surgery. The patients get very motivated by this and their view upon the whole medical procedure changes. They understand it's not necessary to stay in the hospital for seven days and they do not consider it highly important anymore. Because they are motivated*

*they will also move more and do more exercises. In contrast, patients who did not have the Rapid Recovery program are more likely to stress about the fact they have to "move again the next day" and stress hinders the healing process. If you keep patients in the hospital for seven days, they will feel sick for seven days. This shows that the way doctors establish their medical program influences the process of rehabilitation a lot. Over time people will gradually change their opinion about the whole procedure: the meaning changes. Relating this to information channels and retrieving information one can consider that doctors have altered their ways of producing information channels, as it will benefit hem during the in-patient process. People and future patients are becoming aware of emerging technologies in the medical world.'*

**GP NEEDS REGARDING DATA**

*Info from the past*

Most GPs mention a need for information on: profession, sports activities, medication, other physical disorders, lifestyle, other surgery

Current info

GPs indicate they would like the following information from patients (next to the consult) (top 4)

- pain level
- daily activities
- physical limitations
- emotions

They determine the treatment strategy.

Other issues to tackle next to pain treatment:

-obesity
-sports
-patient expectations
-patient involvement in process
-patient experiences

*Diary use*

3 out of 4 GPs says a diary would enrich the treatment strategy of the GP

Most referred to daily activities, exercises and pain levels

GP opinions towards eHealth services differ. Some find it useful to share information and stay in contact with the patient, some feel it has less quality than face to face contact. 'no tool can replace a doctor', or have privacy concerns

Some GPs feel they should be able to choose what information is available for a patient online.

Within eHealth, there should be a difference in what patients and GPs can see as data.

GPs like to do their own diagnosis instead of using the diagnosis of the online informed patient.

Currently, GPs use apps for healthcare regulations.

• Thre is a need for more and better automatic linking with systems of other health care professionals to exchange patient's data. Such as with hospitals, medical centres, pharmacies, and 'Zorgdomein'

• Many GPs want a (better) patient portal. To enable patients to make their appointments online, by themselves . They believe patients can do a lot themselves

• GPs find the cost for maintenance and management are too high

**GP VALUES**

Dealing with administrative and compliance procedures for health insurance companies is a big annoyance.

The data the GP needs to collect digitally is too much and of little use

Face to face contact is imperative

Authority and status

Balance between being personal and being an expert

GP=first medical person patients deal with. They play an important role in sensing patients complaints, symptoms and referring them to specialists. They are supposed to have a broad knowledge about pathologies, symptoms and how to deal with patients in an emphatic way.

**SURGEON NEEDS REGARDING DATA**

They are interested to see how the hip 'performes'. However, in the sense of data presentation they mostly value the highlighting of unusual factors, a summary on general rehabilitation scores and outcomes of patient questionnaires.
Characteristics such as achievement orientation, aggressiveness and extroversion are proved to be prevalent in the field. However, an interview illustrated a softer side, were self-scepticism was valued and personal ownership of leadership not recognized. Nevertheless, surgeons in general are focused on efficiency, confidence
and certainty. The occurrence of medical mistakes cannot be avoided and still remains a difficult topic for
discussion in the medical field. Stephan Vehmeijer reflected that the introduction of Patient Data Tracking
Technologies could close information gaps concerning the patient's recovery after surgery. In his opinion,
this would improve patient care and could provide insights about different patient groups. However, the attitude
towards the implementation was only positive as long as the future Smart Hip will assist him in placing it perfectly.

**PHYSIOTHERAPIST**

- The physiotherapist focusses on the pain experience patients indicate, and movement limitations in the joint.
- The physiotherapist needs to perform their own research before a discussion with the patient can take place.
- Mental coaching is a big part of the physiotherapy job
- The influence of digital information is a problem for physiotherapists. It sets wrong expectations and makes the initial research difficult for the specialist.
- The physiotherapist has a clear value in the OA treatment process for patients
- The patients 'story' only becomes clear after a longterm period. The info available at initial consults is too little.
- Experiment at the physiotherapist showed that the physiotherapist was not increasing a patients motivation to do exercises, only increase performance quality.
- Based on walking style and painfree movement, physiotherapist decides the desired duration of therapy. OA department gets feedback on this process, but limited.
- The recovery treatment process can differ a lot between physiotherapists. (different explanation styles)
- Training is mostly functional (make sure patient can move properly)

**BIGGEST ISSUES DURING PRIMARY CARE**

- The patients' expectations about his/her condition are wrong due to internet research (plausible but did not notice this in my interviews)
- On the other hand, the responsibility of the patients is counted upon in primary care (yes!)
- The patients' ability to set or achieve goals (not very present, more recovery)
- The lack of efficiency in the consults with the GP, caused by the short time of the consult and the unprepared patient (not remembering certain things).

**BIGGEST ISSUES DURING RECOVERY**

- Motivation during the recovery process.
- Information providing prior to the surgery is changing; more transperancy is needed
- Perception of care is becoming more and more individual
- The rehabilitation environment is not adopted to the situation
- Patients are frustrated with needing help
- Patients can feel socially isolated
- The patient and their personal surroundings are not fully prepared/ do not fully understand the THR procedure
- Available information is not applicable in specific situations
- Patients have set wrong expectations about the recovery process.
- Patients are not sure how they are performing in the recovery process

# APPENDIX G: INTERVIEW KIT

## Interview questions patient

Dank voor het deelnemen aan dit interview. Ik ben voor mijn afstudeerproject bezig om een toekomstplan op te stellen voor het behandelproces van artrose. De bevindingen uit dit interview zullen bijdragen aan het opstellen van het toekomstbeeld. (toestemming vragen voor het maken van een geluidsopname)

Als leidraad zal tijdens dit interview een tijdlijn gebruikt worden van het behandelproces voor (heup)artrose. Deze zullen we straks stap voor stap gaan invullen.

Maar eerst een paar vragen los van deze tijdlijn:
(1. Kunt u kort omschrijven wie u bent en wat u doet? Leeftijd? Activiteiten?)

2. Kunt u kort iets vertellen over uw artrosebehandeling?
Wanneer begonnen de klachten?
Hoelang duurde het voordat u een nieuwe heup kreeg?
Waar en wanneer werd u geopereerd?
Hoelang duurde het herstel?

3. Welke digitale apparaten gebruikt u?
Waarom deze? Waarvoor gebruikt u ze?

4. Hoe staat u tegenover het gebruik van digitale (communicatie)middelen in de zorg?

En dan nu de vragen met de tijdlijn. Deze tijdlijn is opgedeeld in 8 fases. Ik zal nu een aantal vragen stellen waardoor de poster stap voor stap aangevuld kan worden. Ook heb ik hiervoor losse kaartjes met steekwoorden gemaakt, die kunnen helpen bij zowel het verrijken als het highlighten van bepaalde zaken. Ook zijn er lege kaartjes, daar mag u zelf steekwoorden op invullen.
5. Zou u voor iedere fase kunnen aangeven welke dingen u heeft gedaan tijdens deze fase?
Met wie had u contact en waarvoor?
Welke dingen deed u los van het contact met experts?

6. Zou u nu bij iedere fase kunnen aangeven wat er tijdens deze fase goed ging, maar ook wat (het vaakst) misging? Bijvoorbeeld in communicatie, informatie, etc.
Waar liep u tegenaan?
Of waar ergerde u zich het meeste aan?
Welke zaken belemmerden u in het goed doorlopen van uw behandeling?

7. Zou u nu kunnen aangeven bij iedere fase wat u hier anders zou willen zien? Zowel zaken die u zelf zou willen oplossen, als zaken in relatie tot doktoren en andere specialisten.
Waar denkt u dat de oplossing ligt voor het aangegeven probleem?
Welke activiteit(en) zou(den) anders aangepakt moeten worden?

8. Zou u nu, op basis van uw aantekeningen op de vorige vraag, uw ultieme droom/doel/wens kunnen aangeven voor het verbeteren van de artrosebehandeling?
Wat is het allerbelangrijkste dat moet veranderen?
Dit waren de vragen. Dank u voor het antwoorden hiervan.
Heeft u zelf nog aanvullingen?

## Interview questions health professional

Dank voor het deelnemen aan dit interview. Ik ben voor mijn afstudeerproject bezig om een toekomstplan/service roadmap (afhankelijk van voorkennis) op te stellen voor het behandelproces van artrose. De bevindingen uit dit interview zullen bijdragen aan het opstellen van het toekomstbeeld. (toestemming vragen voor het maken van een geluidsopname)

Als leidraad zal tijdens dit interview een mindmap gebruikt worden van uw meest betrokken fase in de behandeling voor (heup)artrose. Deze zullen we straks stap voor stap gaan invullen.

Maar eerst een paar vragen los van deze tijdlijn:
1. Kunt u kort omschrijven wie u bent en wat u doet?

2. Hoelang bent u al werkzaam in deze functie?

3. Hoe zou u de relatie die u hebt tot een artrosepatient omschrijven?

4. Wat is voor u het meest kenmerkend voor een artrosepatient? Wat heeft hij/zij nodig?

5. Welke digitale (communicatie)media gebruikt u nu binnen uw werk/de zorg?

6. Hoe staat u tegenover het gebruik van digitale (communicatie)middelen binnen uw werk/binnen de zorg?
(Wanneer van toepassing: Hoe gaat het implementeren van nieuwe producten/services hier in zijn werk?)

En dan nu de vragen met de mindmap poster. De poster bestaat uit 3 onderdelen. Ik zal nu een aantal vragen stellen waardoor deze poster stap voor stap aangevuld kan worden. We zullen hierbij gaan werken van de huidige situatie naar de toekomst. We focussen ons hierbij op de (belangrijkste fase noemen van blad). Tijdens het invullen van de poster kunt u hardop praten.

7. Zou u bovenaan het blad kunnen aangeven welke stappen er nu worden doorlopen binnen (belangrijkste fase)?
Welke handelingen worden uitgevoerd door u?
Welke zaken worden onderzocht bij de patient?

8. En dan nu de mindmap. Binnen uw meest betrokken fase zou ik graag verder willen gaan op de onderwerpen communicatie, informatie, verantwoordelijkheden en vaardigheden. Zou u nu bij ieder onderwerp de eerste dingen die in uw hoofd opkomen van de huidige situatie kunnen opschrijven?
Met wie vindt de meeste communicatie rondom de behandeling plaats en waarom?
Welke informatie heeft u momenteel nodig van de patient en andere stakeholders?
Welke vaardigheden zijn nu het belangrijkst in het uitvoeren van de behandeling?
Welke verantwoordelijkheden heeft u tov de behandeling?

9. Zou u nu met een andere kleur kunnen aangeven welke zaken in de toekomst verbeterd kunnen worden? (zowel nieuwe woorden als omcirkelen van opgeschreven zaken)
Welke verantwoordelijkheden/vaardigheden zullen moeten veranderen of verbeteren?
Welke informatie mist en welke wordt minder belangrijk?
Hoe/wanneer/met wie zou communicatie moeten plaatsvinden?

10. Zou u nu, op basis van uw aantekeningen op de vorige vraag en uw tijdlijn uit het eerste deel (uw belangrijkste fase) opnieuw kunnen vormgeven voor de toekomst?
Wat is het allerbelangrijkste dat moet veranderen?

Dit waren de vragen. Dank u voor het beantwoorden hiervan.
Heeft u zelf nog verdere aanvullingen?

## STEEKWOORDEN

| | | | |
|---|---|---|---|
| AFSPRAAK MAKEN | INLEZEN | COMMUNICATIE | VOORTGANG |
| PIJN | FAMILIE | BETROKKENHEID | FEEDBACK |
| BEWEGEN | VRIENDEN | TEVREDENHEID | DOELEN |
| SLAPEN | SPORTEN | PERSONALISATIE | OEFENINGEN |
| ONTKENNING | HUISARTS | VERWACHTINGEN | ZELFSTANDIGHEID |
| FRUSTRATIE | PHYSIOTHERAPEUT | INFORMATIE | CONTROLE |
| BEGRIP TONEN | CHIRURG | LIMITATIES | VERANTWOOR-DELIJKHEID |
| OPLUCHTING | MOGELIJKHEDEN | ONZEKERHEID | VAARDIGHEDEN |
| REGELEN | CONSULT | MOTIVATIE | PROCES |
| ANGST | OVERZICHT | CHAOTISCH | ZELFVERTROUWEN |
| | | | |

*Figure 84: Key words sheet*

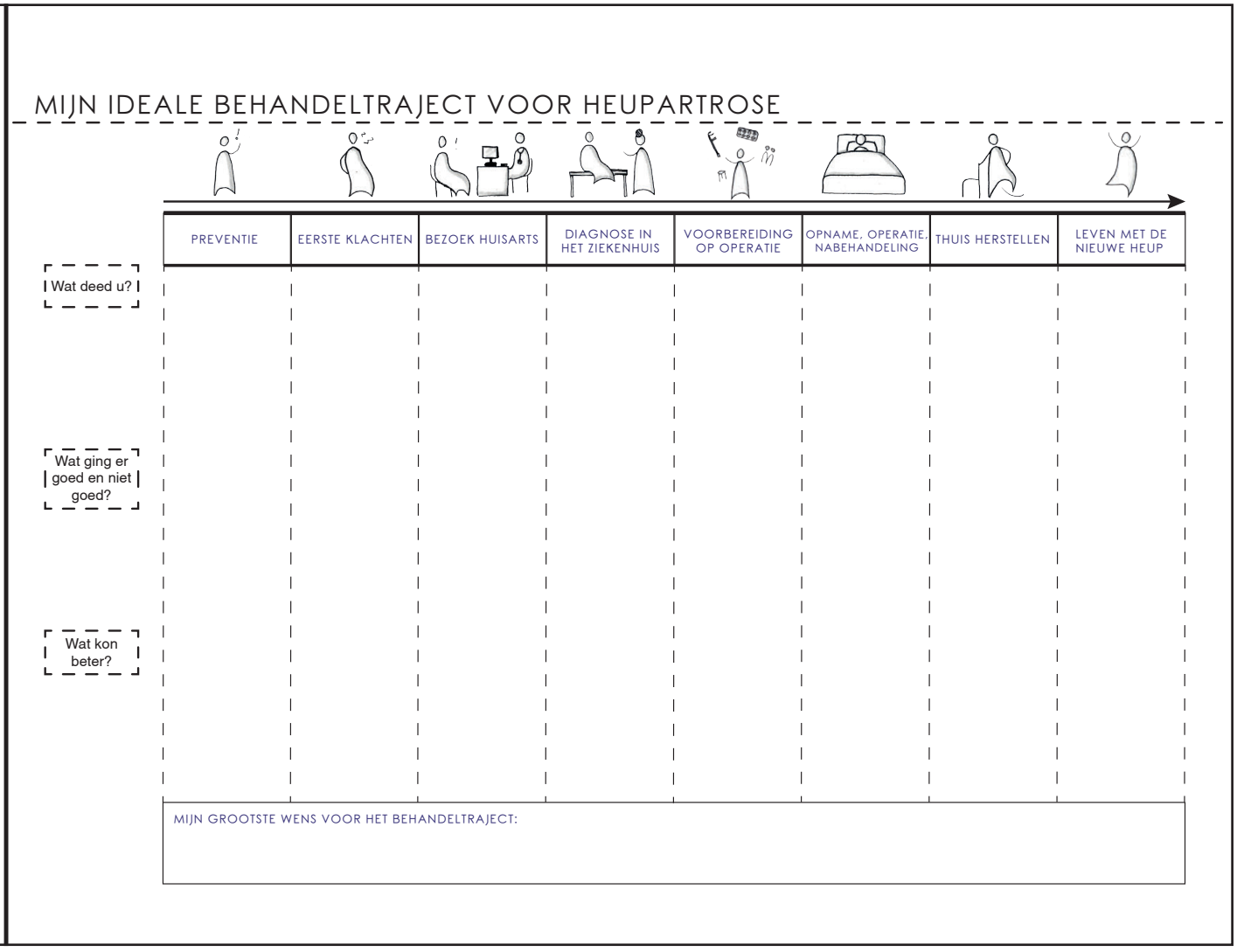



*Figure 85: Patient journey to fill out*

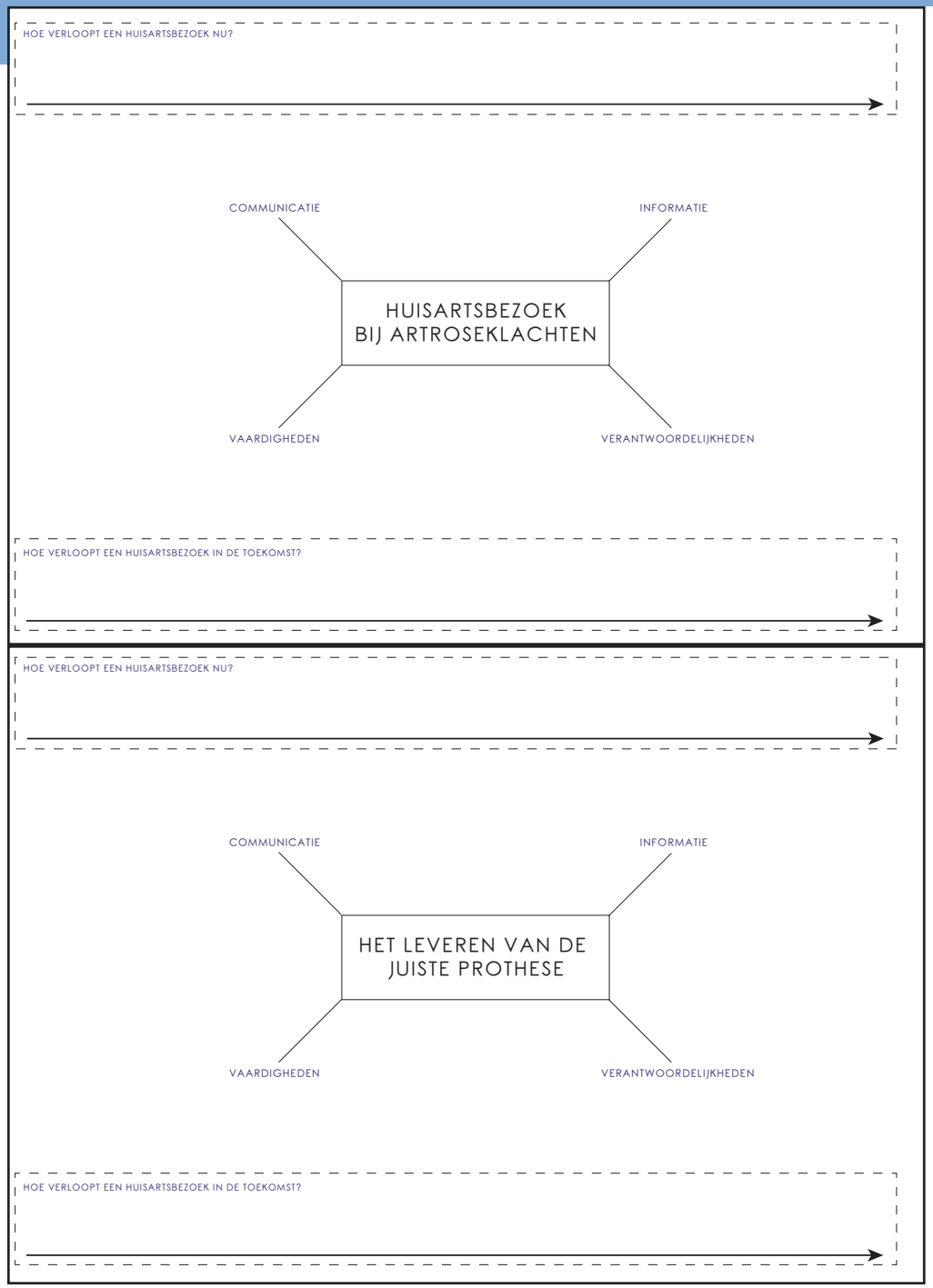



*Figure 86: Health professional mind maps*

# APPENDIX H: PATIENT INTERVIEW OUTCOMES

## INTERVIEW 1 - SUMMARY

Mrs W, 73 years old. Has pins in both her left and right hip after they broke two years ago.Lives alone in a senior apartment with no internet.
Walking is difficult even though the hips are treated, she has mostly creative hobbies in and around the house.

**What happened?**
Marga went through an emergency procedure. Everything started after she fell of  a sidewalk. After that, she 'walked around' with broken hips for 6 weeks, although she did not know it. She was in severe pain and couldn't move. The GP did not respond or come by, but only advised pain killers. Eventually, her children called 112 and they brought her to the hospital for hip surgery a day later.
Recovery happened in a care home and lasted three months. She had great support from her family in the form of visiting, and altering her home while she was away.
Currently, she has the physiotherapist stopping by once a week and a social case worker to help her with cleaning and clothing.

**What did not went well/could go better?**
-Everything needs to go 'quick, quick, quick!'
-The doctor does not even look at me, but to his computer screen. A lot of time is lost in administration, instead of the real job.
-I miss personal contact, I want to talk to someone about how I feel, and share my emotions. My friends have a lot of big problems themselves, and I tend to listen their stories instead of telling my own. Afterwards I feel bummed. Its these types of moments I miss a partner as a listening ear.
-There is little concern for my other disabilities (cerebral infarct, wheelchair). Docters mostly seemed to find it awkward.
-I find it annoying that others have to help me all the time. I want to do things myself.
-The operation itself felt as a relief; my pain would be gone. But immediately afterwards I feared I couldn't walk again. This was the most important thing for me to be able to do.
-The physiotherapist in the hospital had no time for me, so I lied in a hospital bed all the time for 4 days. I only stood in a standup chair for a while.
-During the nights there was little support. I once spent an hour lying on the bathroom floor after I fell before any help arrived (this was at a care home)
-In the care home there were other patients, but I was barely allowed to see them. We had to eat in our own rooms. Therefore I missed a 'partner in crime', this would have helped a lot for me.
-My children think I am too clumpsy for a mobile phone. I tried it once and it failed miserably. However I am not opposed to digital care. As long as it makes sure that the doctors have more time for me, that more things go automatically.
-motivation to do exercises with the physiotherapist is not the problem, but sometimes I am just too tired. I don't do exercises by myself very often.

**Biggest wish:** more personal contact with health professionals and other patients

**Reflection:** Mrs Worwood has a high demand for care, she has multiple disorders and expects valuable consults with professionals. In her opinion, high quality is face to face, not fancy technology she does not understand. However, at home she wants to be independent.
In the end, a digital service could help her indirectly; more data for the professional means better and more personal help for her.
What Marga needs most is a companion in health. A smart home would also help her.

## INTERVIEW 2 - SUMMARY

Mrs L, 87 years old. Has had a total hip replacement to her left hip in 2013. Lives alone in a terraced house with no internet. ('I am not from that generation') Her treatment procedure went relatively quick. She had problems with

getting on her bike and it felt serious. After seeing the GP, and the physio twice, the physio decided she needed to visit the hospital. In a matter of a couple of weeks, the diagnosis was done with help of x-rays and the surgery took place. 'I did not have to wait long. Apparently it was a quiet period.'

Mrs Logman is a real persisting person; 'as long as the mind still works properly, I want to do everything herself'. She does not complain often and likes to solve her own problems before anyone else helps her. She faces uncomfortable situations like the surgery with a survival mindset; just let it happen, and think towards solutions.

**Important notes:**
-There is a mismatch in the relationship between doctor and patient. The doctor does not know what the patient wants to know (in what level of detail). Furthermore, there is often a difference in the story of the doctor and the hardcopy information they present. This can cause confusion and an insecure patient.
-The doctor should know the feedback preferences of the patient. Some want to know every detail, some just the outlines
-The doctor should give a unified story.
-The health professional should give more emphasis towards doing exercises. 'In the beginning I was just doing them regularly, with help of a physiotherapist. But in the phase after recovery at the care home, you are already able to walk, so your most important goal is completed. This makes you stop doing your exercises. In that short amount of time at the care home, exercises have not become a daily routine.
-I think I should have been warned about the importance of exercises during recovery. This should happen right after surgery. Currently it is, surgery, and you are out of sight. After a while I started to 'sloffen' with my treated leg. I was not pulling it up right. In the end, this caused an accident where I fell on the floor and dislocated both my shoulders. If I knew I should focus more on my exercises to prevent 'sloffen' this would not have happened.
-Just like the consult, I think the exercises should fit with the patient
-Downside of my treatment is that I have less confidence in doing my daily activities. For example, I don't dare to go biking anymore, even though my leg is now capable of doing it. You feel very conscious about what you are not able to do, and you get an extra fear of falling. This feeling lasted about 5 months for me. Now everything feels normal, but my fear for biking is still present.
-digital solutions can help if it makes sure a consult runs more smoothly, with less time typing behind the desk.

**Biggest wish:** more attention for aftercare

**Reflection:** Mrs Logman could be described as someone with a low demand for care. She visits the doctor only when needed because she does not want to bother him and wants to be as independent as possible. She does not mind that a consult with a health professional feels businesslike, although she does mind if digital mediums are in its way.
I think a support in her confidence after the surgery might have made her realise what she was able to do. Maybe then she would have the courage to ride a bike again.

## INTERVIEW 3 - SUMMARY

Mrs B-V, 79 years old. Lives with her husband in an apartment building. Has had an elaborate medical history. Especially her right hip was problematic, after her first surgery in 1988 she has had several revisions and walked around with a spacer for several months (basically she had no hip for a couple of months). Her left hip was treated in 2012, and in the years after that both her knees were treated. Currently she also experiences shoulder problems, and has some mild symptoms in her fingers and ankles.

She likes to stay active in the elderly community, she visits the community center and church regularly. She also has a scootmobile, which allows her to get out of the house.
In the house of Mrs Brands-Visser is a computer, however she does not use it herself. 'If I do one thing wrong it has big consequences.' She does use Facebook together with her husband which she likes a lot for connecting with old pals. She has a mobile phone but it has no internet. The husband takes

care of the e-mails.
In line with this limited use of digital media is an aversion towards digitalization in healthcare. ‘I don’t like it because I do not understand that world. I want good personal contact and not all that secondary stuff.’
Mrs Brands carries a piece of paper around with her entire hospital history. She can show this to anyone who might need to know more about her past experiences. This is very important to her.

**Important notes concerning the journey:**
-Currently, I can signal the symptoms of OA very quickly. This is because I had it in a lot of different parts in my body. This gives me a lot of experience. It also helped that I used to work in a hospital and discussed my complaints with colleagues (the complaints started very long ago).
-I lost power in my joint. This made me insecure. But in the end, I might have waited too long with taking action. I come from a big family where small illnesses were common and not considered serious, so I thought this was the same.
-The pain kept on being present, so eventually he visited the GP. He referred me straight to the hospital. With my second hip, I went to the GP a lot faster.
-I like my GP a lot, because I am not a number. He knows my story. Sometimes I make a double appointment to have extra time with him.
-I like it when I can come in and doctors and nurses wave at me; ‘Hi Mrs Brands!’ they know me and this is important to me.
-I had several complications in my hip caused by infections. This frustrated me a lot, because during my initial hospital stay I could see that the hygiene levels were not on point.
-Once, quickly after a surgery I had a nurse coming at my hospital bed, insisting me that I should stand up and shower myself. This felt impossible to me, but I did it. After that she insisted that I would sit while I really felt I should lie down again. I got very angry and eventually I ended up in my bed. When I discussed this with my doctor, he told me I was not allowed to leave the bed for three weeks! The nurse did not know about my condition and thought I was a regular hip patient. This is why it is so important to me that the people who treat me know me.
-I sometimes don’t feel like doing my exercises. But I am tough on myself and do it. The fact that I do not want stiff joint motivates me.
-I have physiotherapy every week in a group and I practice at home. I know that I cannot perform every exercise correctly but I find my own way of performing the exercise. This is all based on my experience with OA.
-I tried an electrical bike, but after all my revisions I don’t dare to go on it anymore. If I fall, I will have to be in a wheelchair forever. Although the most recent surgeries were successful I have to be cautious.
-I cannot do everything myself in housekeeping anymore, but I want to do as much as I can by myself.

**Biggest wish:** Doctors need to listen to the patient and take the patient seriously.

**Reflection:** Mrs Brands is highly self managed, she will make sure people know her story by finding her own ways of telling it. Not knowing her story has caused bad experiences. However, she also has a high demand for care, due to her multiple disorders and her need for a personal relation with the health professional.

## INTERVIEW 4 - SUMMARY

Mr vd V, 66 years old. Lives with his wife in a semidetached house. Has just retired recently as an ICT manager. He had his THA surgery two months ago (September 2019) after a primary care phase of 4 years.
Since he is retired he has a lot more free time and joined a lot of different associations to still contribute. He still ends up doing technical jobs in the end there, but he is okey with that. He also has a lot of sport related hobbies (walking, biking, skiing, tennis, soccer with his grandson).

Since his experience in the IT world he is very much involved in the online world (on the table were a high end laptop, tablet and smartphone). ‘If I need to know something I will look it up!’
In line with this, he is fine with the digitalization of the healthcare sector: ‘I appreciate that I can look up the preparation tasks before a con-

sult, and that I can make appointments online. It gives me a better overview than the traditional way. I don't have to remember everything.' However, privacy is his biggest concern at the moment. 'I once saw passwords written on postits, placed on the computer where everyone could see. This means everyone could enter the patient system! This does not give a feeling of security to me. Not that I have super personal information in that system myself, but I expect others with mental issues do. It does not enhance the reputation of the system.'

**Most important notes concerning the journey:**
-My knowledge of OA was limited before I started the treatment journey myself. Therefore I did not recognize the symptoms in the beginning.
-My first complaints progressed gradually. The first signals happened during tennis practice, I had pain in my thigh and couldn't move freely. Some people also said I had a strange walk but I did not notice that.
-When the complaints stayed present I visited the GP for the first time. He referred me to the hospital for a checkup. Eventually I got a phonecall: diagnosis OA. I was stunned that they did it over the phone. I had to make an extra appointment for further explanation.
-I was too young for surgery, so they said there was not much they could do and they let me go. I was on my own again.
-Pain in my back made me go back to the GP again after a while. Then I was referred to the Mensendieck and to the hospital again. The mensendieck helped me to to improve my posture. I turned out I teached myself some bad correction habits in my walking. Doing this therapy improved a lot.
-Furthermore I was admitted to the Netwerk Artrose founded by the Noordwest ziekenhuis groep. This meant intense physiotherapy with guidance of surgeons and physiotherapists for 7 weeks. Physically this helped me a lot in preparing my body for a fast recovery. An urge to solve my physical issues kept me motivated.
-Eventually I made the decision myself to do the surgery. I did a lot of online research about the different types of prosthesis and discussed this with my doctor. It was annoying however, that the information sources about prosthesis felt like advertisements.
-I had a lot of different 'manners' to be able to do the things I want. My own way for putting on socks for example.
-Deciding on the surgery felt like a big thing and I was not looking forward to it. I was most afraid of the pain and the aftermath of recovery. Also I had read several things about surgery risks.
-I decided on anesthesia because I did not want to hear sawing in my bones. Afterwards I felt pretty dazed for a long time, I did not like this.
-I only spent 1.5 day in the hospital. This was quick but the help of the physiotherapist gave me confidence to proceed with my recovery at home, by myself.
-The hospital set my expectations right. This was based on meetings in the 'opnameplein', with my doctor, flyers and online information.
-I recovered at home with help of a physiotherapist I knew from before my surgery.
-I base my activities on my own signals. I try to walk and cycle gradually longer and listen to my body. I only asked the doctor once; what am I absolutely not allowed to do?
-I feel optimistic about my further recovery. I want to start tennis again in January (based on what others have experienced I consider this a realistic timeframe). I also want to do long walks and cycling routes. Skiing and running I am not so sure. I read this is intense on your hip.
-I would like to track my own recovery progress. Now it is all based on my own signal reading, but I also forget a lot. I want to have a better overview and make my progress more concrete.
-It is very important to me that data is verified.

**Biggest wish:** a fitter aftermath after the surgery
+ progress track

**Reflection**: Mr vd Voort has a high demand from doctors: he wants to know specific information and recognizes this need himself. On the other hand he is involved in the process so the basic information is well covered. This makes sure his self-management skills are sufficient.

# APPENDIX I: HEALTH PROFESSIONALS INTERVIEW OUTCOMES

## INTERVIEW 1: MANAGER LEADING HIP PROSTHESIS FIRM -SUMMARY

**Core business of a prosthesis manufacturer**
'Our core business is to produce prosthesis and deliver these to hospitals that have a contract with us. We are responsible for training and educating the hospital staff to use the prosthesis right' (=safe & effective) Sometimes we train and educate indirectly; by training the hospital staff to correctly inform patients about the surgery procedure.'

**View towards the patient**
'The OA patient is not a typical patient as you know with diabetes, or heart problems. The disease is not life threatening, and people have relatively less fear about the disease. People slowly get used to the pain and other complaints, and therefore the threshold to visit an expert is difficult to define for them. Furthermore, preventive activities are difficult to perform. Education and information can at least help in the treatment process.'
'The THA surgery is a big, life changing event for the patient, but for the hospital it is a routine job.'

**New business ventures**
'Times are changing; 10 to 20 years ago, hospitals had no idea how they wanted to treat the patient. Today they do. This changes the educating role we have.' Therefore want to move beyond our core business, and deliver a total package to our clients. This also means the inclusion of services. Furthermore, the definition of clients is more broad; instead of our direct clients (hospital staff) we want to deliver to the patient.'
This has several reasons. On one hand, there are financial motives: 'the pressure on the companyis rising. Hospitals expect lower costs for prosthesis, so we are trying to broaden our flow of income by offering services in all types shapes and forms. However, this adoption goes slow. I expect it will take ten years before services are fully adopted.
On the other hand we see ourself as the ideal candidate to help the patient. 'We are content specialists, and can deliver information other parties can't. We already tried several service offerings in US hospitals, where we provide the patient with specific information via their Apple device, before and after the surgery.'
'All the ideas are there, it is mostly about implementation. From 200 interesting ideas, far less than half is further developed. And even less are implemented. We just cannot move away from our core business so easily and do services only. We have to make choices.'

**Relationship with the hospital**
'While we are responsible for training & education, the surgeon is responsible for the surgery.'
'Our own skills need to be on point before we can do anything in relation to the hospital.'
'Some hospitals see us as a too commercial party to be directly involved with the patient process. Of course, they can develop services themselves, but if they cooperate with us they can use the expertise of globally successful companies.'
' In the future we want more effective communication with the hospitals. We think this can be done by standardizing this communication system. This will save time.'

**Improved surgery**
In the future, we want to personalise the operation for the patient, with a prosthesis made to measure. This means the materials a hospitals has to have in stock can decrease.'

## INTERVIEW 2: PHYSIOTHERAPIST - SUMMARY

Interviewee is physiotherapist since 1986.
She sees about 5 OA patients a week, so it is a frequent disorder.

**Role**
She sees her role is mostly advising. And this advising role is, in her opinion, broader than just exercise advice. She thinks a holistic approach is important for a physiotherapist. Therefore, she also gives advice about lifestyle and food. However, she does alter her advice in relation to the patient. 75+ people often need more and specific advice than 55+ people.

**The OA Patient**
The OA patient is often older, and is not so much involved in the digital world. Therefore, a lot of things are done analogue. What is so typical about the OA patient is that it primarily needs to be activated instead of deactivated. People with overloaded joints are advised to take rest next to exercises. But OA patients need to be motivated to get active. This changes the role of the physiotherapist.

**The digital health world**
In the practice they use a digital patient system, this is the case for every physiotherapist. Next to this they have a patient portal, where patients can enter questionnaires about themselves and see additional information. However, this comes later on in the treatment process. They also can provide the patient with an app, but she doesn't see the use yet since it only holds 3 exercises. She sees no use in recommending it. So personally, she gives paper notes to her patients with exercises on it. She has colleagues who enter it on the computer system and make a printout out of that, but she did not have to time to teach this to herself. The notes work fine since many of her patients are analogue elderly. It is important to her that she can give something physical to the patient. She thinks she really needs to make a step forward in the digital world to be future ready, because the analogue elderly will extinguish. But she really needs an afternoon or so to sit down and learn it. At the moment, something else always pops up. She also isn't 100% sure if the digital way is more efficient than writing a note, it is just a different way of doing it.
New digital products are implemented via the advisory body (physiotherapist federation).

**The consult**
The patient can get to the physiotherapist in two ways, either by themselves or by the GP referral. With the referral, there is already information available, when the patients come themselves (which happens regularly) an initial consult is needed, with questions about the complaints. Also initial research will be performed based on the complaints. The conclusion will be therapy fitted to the patient. This consists of practice therapy based on posture and movement. They also give advice about supporting tools, exercises with special equipment, and massages if needed.

For filling out the mindmap, we decided to rephrase the main action as physiotherapy before the surgery, instead of after the surgery. It was argued that a physiotherapist has more impact before the surgery than after, since they can prolong the road to surgery. With after surgery treatment, everything is more standard in her opinion.

**Information & communication**
Available information is based on the referral letter. She has no direct contact with surgeons or GPs Otherwise, the patient provides all the information in real life. According to ms Boot, this is sufficient for her. Communicating through the patient portal is only in certain long term cases. When there is no initial information, more time is needed for initial research, but she doesn't mind this.
During the consults, she tries to personalize communication per patient. Everyone is different, and everyone has different goals. She tailors her consults based on this info. She thinks patient like that they are being heard.
Information that is often missing, is about the diagnose. People are often diagnosed with OA and have no idea what it means (what is OA?). They immediately think the worst and the wrong things: 'I'm worn out!'. They can also be scared by the diagnose. She is not exactly sure in which way the GP informs the patient about OA. The scare might also cause that they forget the majority of the information, in her opinion.
Therefore, she likes to inform patients about the diagnose thoroughly, and emphasize that OA is a normal process. It is not something to be afraid of, or dangerous like cancer.

**Responsibilities**
As said, Ms Boot indicates her responsibility is majorly giving advice in an holistic way. But furthermore, comforting is important as well. This is done by stating the non-dangerous nature of the disorder as stated above. And finally, she sees a motivating responsibility for herself, to do the exercises. This is done by the personalization aspect. When she knows the personal goals it is easier to stimulate the patient in an effective way. She also expects the patient to take some responsibilities, in actually doing the exercises and taking care of their weight. She also advises to go back to the GP when she thinks the complaints are severe. She cannot do a direct referral to the surgeon.

**Skills**
First of all, she needs a lot of subject related knowledge (anatomy and treatment, when to do what). But communication skills are needed as well. It is important to take complaints seriously, and also be affirmative.

**Future**
In the future Ms Boot sees opportunities to make OA information better accessible online. Currently this will be challenging, with the analogue elderly, but in 10 years these will be significantly less present. This can deal with the uninformed patient. She also thinks more interactive exercise support will be nice, to make the patient more motivated in doing exercises.
She also sees opportunities for a new way of communication next to the consults. For example exercise reminders, or progression movie clips. However, she does not want it to become patronizing. The patient should decide it for themselves. All the new communication means are also meant for motivating the patient. This is deeply related to the treatment success.
With new communication and information sources, it is very important to learn new skills as well. ‘Because I should be the one pushing a button, to send reminders. She needs to learn how to do this and integrate this in her routine.

## INTERVIEW 3: MANAGER LEADING HIP PROSTHESIS FIRM - SUMMARY

Interviewee is senior manager in service development department. He has worked there for 15 years. The services are mainly focused on supporting (the optimization of) the treatment process.

OA is not a chronic disease, of a life threatening one, but it can be a major influence on daily life. OA surgery is a treatment with a relatively high success rate, which can help getting this life back.

We want to deliver more with the same resources, so efficiency is really important. An example is the referral from GP to OA surgeon. You want to prevent that patients who don’t really need surgery yet visit the surgeon. This means the GP should make sure the referrals he or she makes are correct, without filling unnecessary time at the hospital.

We expect standardization of certain processes is needed. Of course, this might go against the personalization trend, but to make room for this, standardization is the first step. By standardizing 80 %, mainly the inside clinic procedures, you can personalize the remaining 20%, mainly outside clinic procedures.

The effects of health monitoring products are there. If people have a step counter on their wrist they will automatically move more. Now it is up to the second challenge, getting it into full use.

The target group of analogue elderly is extinct in 10 years. We shouldn’t bother too much about what is exactly fitting for our target group in terms of digitalization. Currently, people getting a new hip are between 55 and 70, and these people know how to handle a phone or a tablet. We should trust that they are able to work with smartwatch type products.
Everyone is talking about prevention, but in some cases it will be inevitable to do surgery. Furthermore, it is our core business. So in my opinion, the future will be all about selecting the right moment, ‘the optimum’, for patients to take

action as a supporting party. 'When you do this in this moment, it will make sure that you feel exactly like before your hip complaints at this moment after surgery.' This is how trends like big data and AI can be put into good use.

We measure new ideas based on an effort & impact scale. We want maximum impact with minimum effort. It is important to keep it real for new ideas to work (think about the application context and don't continuously dream without limitations).

**Communication**
Current communication procedures can be defined as mainly unstructured and face to face. Also, it is mainly a one way track, with patients receiving information in the form advice or a folder, for example. In the future, new communication tools are needed. These tools need to be customized to make it patient friendly (use AI). This can give more direction to digital communication. We won't think it is weird to talk to the doctor over skype. In the end, this is the more patient friendly way if it will make sure the

Of course the patient is the central factor, but multi-disciplinary meetings are difficult because of the differences in hierarchy. However, the team is still the one responsible for good care.

**Information**
You have several kinds of information flows; from patient to professional, from professional to patient, and between professionals. From patient to professional this is a big issue; it is mostly storytelling and talking about pain. Hard data is not present here. In the future, this storytelling should be translated into hard data somehow, to improve quality.
The professional-patient information is characterized by overload. Patients are piled with information during a stressful situation and are expected to remember all this information.
And finally, between the professionals, it is all about data relevancy, is the right data being transferred between the GP and OA surgeon, this is an issue. Currently, the data structure is fragmented, so all the information about a patient is in different places. In the future, there should be more unified information sources, to enease data sharing in both directions.

**Responsibilities**
The responsibilities are shifting from doctor to patient. The authority of the OA surgeon is becoming less. This asks for a revision of the OA surgeon role in the future, and not every surgeon will appreciate this.
Furthermore, there is a society responsibility, concerning quality and price.

**Skills**
Skills are shifting as well, from medical skills to coaching skills. However, doctors should never be underestimated, they still need to be capable to perform a decent surgery.
Another skill needed is the digital skill. People need to learn how to deal with new digital products. And with this new skill comes the rise of possibilities, which raises the question about legislation.

**Future care procedure**
We always focused a lot on optimizing the surgery and the processes inside health facilities. In the future it is time to evaluate the phases before and after more.

**'Care at the right place'**
The patient is responsible for their own living area, for preventive action and post clinical recovery. The role of the care provider goes from practitioner to coach.

## INTERVIEW 4: ORTHOPEDIC SURGEON - SUMMARY

Orthopedic surgeon specializing in hand and wrist Osteoarthritis.
Most of his patients have OA in the thumb. Furthermore, one third of the people aged above 55 will experience complaints here. So it is a very frequent disorder.
Around 30 to 40 people come to a consult every day. You can very much call this 'production'.
They have the expertise, so they are the 'curing' party. They are the ultimate

source for fixing the complaints.

**Current situation**
People can end up at a consult with an orthopedic surgeon in two ways. First, the referral from a hospital. And second, the referral from the specialized hand therapist network. This is however only the case for pantients with OA in the thumb. For the hip for example, the road is much more standard, and it is always the GP doing the referral. Then a consult, where the patient and orthopaedic will look for an alternative cure. Surgery is only performed in 20% of the cases.
Often a brace is used. They now have 3D printed braces which they are very enthusiastic about.

**Communication**
Communication with the patient mainly happens during the consult. However, they also use video consults if necessary.
There should be much more communication between primary and secondary care. Accidentally he had a phonecall with a GP during our interview. This showed that GP & surgeon are already in more intensive contact than just a digital referral. But it can be much more.
For the topic of hand OA, there is already a 'network hand therapists' which has very frequent contact with each other. They also use the Silo app. This can make sure the patient is in the best fitting treatment procedure at the right moment.
In the future, the orthopedic surgeon wants to have sight on possible patients in a much earlier stage. This also means the patient does not have to go back and forth between primary and secondary care. This saves time and costs.

**Information**
But what does that more intensive communication looks like? In his opinion, there should one summery showing all important criteria. Important criteria are the patient persona (research by tessa dekkers). And what non operative policy to use. 'We want to be able to estimate what intervention would do to a patient. Meaning increase predictability. Would an operation help?'
This information is not yet there. In fact, the flow of information from GP to surgeon is not complete yet. GP and surgeon cannot look into each others system.

**Responsibilities**
OA surgeon with a hand specialization means mostly a talking and explaining job. This is because the low amount of surgeries needed. Most can do with alternative cures such as braces.
This search for alternative cures means they need to be involved with innovation practices a lot. They need the newest information to help patients the best way possible. However, hey only work with evidence based medicine, so they cannot use certain innovations such as pills or needle treatments, which have no research backup.

**Skills**
Since patient communication is such an important part of the job, many skills lie in this corner. The patient should be able to explain the disease, the operation, the alternatives to an operation, the complications and risks (recovery takes 6 months without using your thumb. This is extensive). And most importantly, check if the patient understood everything correctly, and accepts the treatment. This one is also the most difficult. Patients say they understand, but at the next consult, they do not remember a lot .

**Future**
As said, the surgeon should be involved earlier in the process; during prevention and primary care. It is not clear yet who should take responsibility here, since both parties will claim they are too busy. But for now, he sees an educating role for the surgeons, and an alarming role for the GP.
This development can make sure the expedience of the treatment is increased, in this has a positive effect on efficiency and costs.
Furthermore, he mentioned: in 10 to 15 years, we won't be operating from this building. Care will take place at people's homes, with holograms and such. We will do continuous monitoring to determine when an intervention will be necessary. Then we will also look at lifestyle and pain indications. This monitoring system can also help in performing preventive actions.

Reflection: the OA procedure is seen from a very professional angle. There is not much talking about personal experiences, but all very process and research focused. Efficiency was indeed very much key.

## INTERVIEW 5: GP - SUMMARY

Interviewee is GP for 14 years. She sees a person with OA related complaints every day.

In her opinion, the OA patient defines itself by people in their late 60s which have an active lifestyle. They feel very limited in their daily life. Of course, older people are also stopping by with OA related complaints. But it hinders them less. Then some advice is just enough.
For the younger patient, more effort is needed as a GP. She tries to help the patient here by looking at personal goals. If a person wants to do a 10KM walk again, she incorporates this in her treatment.

At the practice, they use e-consults. She thinks this is efficient and helps dealing with staff shortage. Also, patients ask about these possibilities. However, she does not get patient questions which are OA related.

**Communication**
There are several important contact persons for the GP.
First of all, the patient. These are mostly seen in face to face consult. But, as mentioned, digital communication with the patient will be important to deal with staff shortage and efficiency.
Second, the GP is in close communication with the GP assistants. They have an additional role in communicating and advising with the patient. Often, the GP communicates through the GP assistant, in diagnostics for example.
Third is the physiotherapist. They are not in direct contact with the GP, but is possible in the form of a referral letter or advice. They do have physiotherapists in their practice downstairs. They have a short line with them, which is considered accessible and beneficial. Many of her patients actually go to these physiotherapists, so if something is wrong she hears it directly (face to face).
And finally, the orthopaedic. She does not speak to them directly, only via referral letters.

**Information**
There is information provided by the patient and given to the patient. Information provided by the patient is about complaints, limitations and the influence of the complaints on daily life. Especially the last one is very important, to personalize the treatment an use this to motivate the patient.
Information given to the patient is first diagnostics information. She sees an improvement here, if radiology images are shared online with GP comments, it saves a consult.
The information provided to the patient is a lot of info about OA itself. People are often scared about OA and this is not needed. She also often refers to Thuisarts and the website of the 'Artrose netwerk'

**Responsibilities**
She concerns herself a waste pit when it comes to responsibilities. Many hospital tasks have been transferred to the GP. It becomes busier and busier. It is possible since the GP is obliged to know a little bit about everything. But they don't hear from the orthopaedic in return.
The role of gatekeeper in OA is used in a basic way, but not much is done with the position in her opinion. There is no need though. Because the treatment process is not really exciting. There is a clear procedure and it is not as life threatening as cancer, for example.

**Skills**
When it comes to skills, there are two main topics. First up is communication skills; figure out the limitations and motivate the patient to get active. It should not become a vicious circle. Second is knowledge on the disease; perform joint investigation, recognize complaints, give injections.
Digitally, she needs to keep up with developments but she does not see this as a big issue.
**The topic prevention**
When I asked about the topic prevention, it was her opinion that the GP already covers this topic a lot. Of course, they can spend a sentence on proac-

tive signaling and information. But extensive prevention is not their task. She sees no benefit in prevention for the GP. It will only result in more patients and more work. In her opinion, it is a secondary care issue, not something for the GP to solve.
She thinks information can be more extensively provided by the government. Like the quit smoking campaigns. In the end it will stick.

**Future**
Increase efficiency for the GP by new communication channels that decrease the amount of consults. More attention towards OA information, to educate the patient.

## INTERVIEW 6: ORTHOPEDIC SURGEON - SUMMARY

Interviewee is orthopedic surgeon for 32 years, specialized in the hip. He is the future director of the new orthopedic center in Delft. In this new institute, different expertise sources related to orthopedic care will be housed under one roof. Since he is moving to a management position he treats less patients, but he used to do 30 patients a day. This is both new ones
He has always seen himself as a help giver and an advisor for the patient. He is not making the decision for surgery. A patient does. But if he thinks it is really not wise to do surgery, he won't let the patient do it. In the end, his expertise makes the call. This can sometimes cause some friction with patients, since they have become more open in sharing their opinion, and they are equipped with more information. But they have to understand what an orthopedic surgeon knows and where he could help. Some think they know it all or that they have no say in decisions. And this is not true.

He describes the OA patient as someone who is not particularly ill. But he is in pain, and experiences limitations in function. Especially the relatively younger patients. There is an important distinguishing to be made between the older patient, who is often more likely to accept the OA related complaints, and the younger patient, who is less likely to accept it. They have a lot to lose still in terms of activity, whereas the older patient does not do any sports anymore.

The term patient centered care and shared decision making is a hype terminology in his opinion. In the 30 years that he is an orthopedic surgeon, he is always making decision in cooperation with patients, hence his vision as a help giver. These thoughts come from outside the consult room. And they do not exactly know what is going on in there.

In terms of digital technologies, he thinks it is very important. But it is not implemented in a sufficient way at the moment. They have a pilot with the video consult and they have a patient portal. And that is it. But it is really necessary to implement this. The way the hospital treatment is already fifty years old, but everything that needs to be discussed in this old consult setup does not fit at all anymore. There is much more information available and much more tools. But ten minutes is not enough to explain this. Rolf formulates this with a nice anology:

**'We are now implementing a Porsche motor inside a fifty year old car. This does not work at all.'**

And he thinks that by setting up a new way of treatment, with more digital tools is the key to create a new frame where the 'Porsche motor' can fit in. The video consult is a good example. This can reduce the amount of consults and traveling efforts and time needed. 'Some things you don't really need a consult for, just a result of a scan.' In this way the actual consult can be filled with relevant things for face to face communication.

The thrive to innovate on this topic comes from the hospital itself. They see the need for change. The patient follows by nature. They are at peace with the way things go, although you do see that patients are annoyed with short consults with info that could have been told with a call, or waiting in the waiting room. So they will have benefit too.

**Communication**
Currently, the surgeon sees the patient mainly face to face, but as mentio-

ned, the communication lines should be more digitalized.
The current communication between professionals is mostly written information in referral letters. Here lies one of the biggest pain points. Because the communication lines should be much shorter between different professional stakeholders. In this way, one could adopt personalized care; tailored treatment for a patient. Where the patient can be exactly the same in sense of an x-ray result, a patient experience can be totally different. One can feel everything is all right, one can feel completely invalid. Care professionals should take this into account to deliver better care. The shorter communication lines should be low threshold. Teleconsulting is the way to achieve this. For the first stages, this should be mostly for the more complex patients.

**Information**
Currently the information is a from professional to patient and back, and between professionals. The information to adopt personalized care is already available, it is just not shared with other stakeholders yet to make it happen. In his opinion, it is very important to have a holisitic approach. You need to know the entire contaxt of a patient, there are the complaints, but it is important to know there is a person around these complaints, influencing the treatment effect significanty.
It is and will be important to provide the patient with information; what is it, what are the treatment options? Comfort the patient, and making decisions together. A self management tool can be very important here. To make sure he learns the skills to become a 'leidend voorwerp'; an equal partner in health. A bit of feedback on activities is vital here.

**Responsibilities**
Both the patient and the professionals have responsibilities and this does not change so much. As said, the surgeon is in charge of advising, motivating, setting goals and managing expectations. The patient is responsible for adopting its lifestyle and in the future working with a self management tool, to take more active part in decision making.
The self management tool is not something that will work for every patient. The more passive patient needs to be supported more in decision making. This is a tricky process because you don't want to judge the patient wrong.

**Skills**
Skills are both communicative and knowledge. It is also important that a surgeon is affirmative(bevestigend) and daring to take decisions, but also highlighting knowledge boundaries.  Talking to patients and other stakeholders is extremely important but this takes time. There is a boundary to buzz of efficiency in healthcare.

**Additional notes on the future**
In his opinion, there will still be a hospital in ten years. It is however likely that specialisations are more fragmented instead of in one large building. Of course, more things could take place at home, but not everything.
The orthopedic should be involved in the entire care journey.

**The future summarized**
Personalised care is fully adopted, and the patient is one of the partners in the collaboration process. The holistic look towards the patient is also vital.

# APPENDIX J: CODE BOOK

| Code | Explanation | Example |
|---|---|---|
| Professional is advisor | All professionals in the OA treatment take the role of an advising party. Both in treatment options as in helping the patient back on track. | 'I try to be advising. In lifestyle.' |
| Professional is motivator | To make sure the treatment is successful, the professional tries to motivate the patient perform new behavior. For example in doing exercises. | 'With a teacher in front of me I do things quicker too.' |
| Importance of exercising | Both professionals and patients express how doing exercises helped them with OA complaints, but also in recovery. | 'When someone does their exercises well, he recovers faster.' |
| Holistic view towards treatment | Professionals express that they look at more than OA and their primary duty in the treatment. | 'The orthopedic is an expert in movement. We know about the entire patient journey.' |
| Let patients do things at home | Professionals and patients express the importance of battling OA in the home context. | 'And then I could recover at home, it was so nice to be home!' |
| Recovery phase is standard | Some professionals believe that there are not many treatment options in the recovery phase. | 'There are not many options in the recovery phase. The plan of steps is clear.' |
| OA is a routine procedure | Professionals express that they deal with OA very frequently | 'I see someone with OA every day.' |
| OA treatment has large impact | Patients express that the entire OA procedure has a big impact on their daily life | 'The THA was a big thing for me. They were going to put a saw in my hip!' |
| Patient has responsibilities | Professionals think they are not the only one who play a part in the OA process | 'I expect the patient to do his exercises.' |
| Expectation setting | The patient having the right expectations of the OA treatment, most often based on professional information | 'When I look back at the treatment and how I was informed, I can say it was as I expected. |
| Primary care is critical | Professionals express that good primary care and prevention determines treatment success and quality | 'I want to know the patient early on.' |
| Prevention by monitoring and intervention | Some professionals express that they want to monitor possible patients and prevent if needed, to help patients the best way | 'When we see a value is critical, we can send a request for further investigation.' |
| information | that prevention should mostly be done by effective information transferring about OA | as an advice campaign by the government. Just like quit smoking.' |
| OA surgery is not option one | Professionals express that they always look for alternative options to surgery first. Ideally they don't operate at all. | 'I always try to explain patients that knees are not cut open right away, when they have a little pain.' |
| Association has demands (external demands) | Professionals express that some innovations are forced upon them by their associations | 'Our association is pushing on digitalization.' |
| Innovation is initiated by professionals (internal demands) | Professionals indicate that they see need to innovate themselves | 'We are trying to install a Porsche motor in a fifty year old car. That doesn't work.' |
| Ask for additional effects | Professionals try to learn more about the patient than just the OA complaints. Other diseases or affecting events for example. | 'There is a person behind the OA patient.' |
| Need for patient information | Professionals express they need more information about the patient to improve their treatment, this can come directly from the patient or from other professionals | 'The transferal of knowledge from the GP is insufficient. Of course they do the referral letter, but no knowledge about the patient'. |
| Every patient is different | Professionals express they see every OA patient as a different person, and they don't try to generalize, but tailor treatment to patient | 'I always see a new patient as a unique patient.' |
| Categorise patients | Professionals express they want to use patient groups to enhance their treatment | 'We should work with color coded patients, like in management.' |
| Patient age influences treatment | Professional express that they treat 55+ patient differently than 75+ patients | 'With younger patients I go to the speed ladder. I don't do that with older ones. |
| Younger people feel more limited | Both 55+ patients and professionals express that they still want to do many things but these are made impossible by OA | 'I used to walk 10K very regularly, but that felt away. I really wanted to fix my issue. |
| Digital morons will extinct | Professionals express that 75+ patients are less important to take into account in the future | 'Digital morons, they are a dying species.' |
| Use goals for motivation | Both patient and professionals express the use of goals in the treatment process. These can be a massive motivator in | 'I always ask about someone's goal and involve it in my treatment. Then he knows where he can work towards.' |

| | | |
|---|---|---|
| Patient has demands | Both professionals and patients express the patient has certain he wants to see fulfilled in the treatment process. For example a certain type of amnesia. | Patients come to me because they want to see the orthopedic. |
| Acceptance of OA | Older patients often accept the OA complaints as they are, and are not actively improving. Younger people do not accept it. | 'They say, well, I am old already.' |
| experts know patient | Patients express that it is important for them the professionals know their story, and they don't need to repeat it every time | 'I want the doctor to know my story.' |
| Information from other professionals is sufficient | Professionals in primary care say they have enough information from secondary care | 'The GP only sends me a short referral letter, but I am fine with doing my own research. I don't need it that much. |
| Short communication lines are useful | Professionals express it is useful to have an accessible communication medium between other professionals, to discuss a patient | 'I can walk downstairs to the physiotherapist practice, where some of my patients go as well. That is really nice.' |
| Need for physical presence of patients | Professionals and patients express that some consults need to happen face to face | 'We cannot cut out all consults in total. Some things I want to discuss in real life.' |
| Make decisions together in treatment | Professionals express that patient should informed well enough to make decisions within the treatment together | 'The patient comes to me with ideas, but often I can think along and shape a lot.' |
| Taking patient seriously | Patients express the need for a listening ear and empathy from the professional | 'They just gave me the diagnose and hung up on me. What? I had so many questions.' |
| Some communication does not have to be face to face | Professionals express that some information can be shared in a non-physical consult | 'When I can show the x-ray online, I don't have to do a physical consult.' |
| Patients need expert opinion | Patients express that they need the expertise from professional to make decisions in the treatment process | 'I was debating between some surgery options for quite some time, but I needed the explanation of the surgeon.' |
| Digital medium for patient support | Patient and professional express that a digital tool can make sure a patient is helped where he or she needs it. | It would be nice if I could measure myself every day. To know what my progress is. |
| Data improves treatment quality | Professionals express that more data about the patient | 'When I can save all the data from hand braces, next time the brace can be even better.' |
| Self-management tool is needed | Patient and professional express they see the implementation of a self-management tool as a positive thing, for progress feedback and learning about OA. | 'To make sure patients can make good decisions, something like a watch would be great. Then they get the feedback they need.' |
| Data is efficiency | Professionals express that data can make sure processes go quicker, diagnosis for example. | 'With data I could formulate a diagnose and treatment plan much faster.' |
| Digital communication is efficiency | Professionals express that digital communication mediums make their job more efficient | 'If I could communicate more in e-consult of video consult, I can save a lot of time |
| Efficiency in healthcare is needed | Professionals express that with the staff shortage, limited money and growing patient numbers ask for efficiency | 'We have less doctors and more patients in our practice. We have to think about efficiency. ' |
| Patient does not understand OA | Professionals express that patients often have wrong ideas about what OA is | 'Patients either have no idea what OA is, or they think the worst of OA.' |
| Patient forgets things | Professionals express that it is difficult to make information stick to patient in just a consult. | 'Often when patients come to the next consult, I have to repeat myself.' |
| Need to explain about OA | Professionals express that a lot of their time is spent explaining information about OA. | 'Most of my time in the consult is spent explaining what OA is, and what there is to do about it.' |
| Learning (bad) habits | Patients express that they are forced to learn new ways of doing things in dealing with OA. This is not always the right manner. | 'I tripped because I did not learn the right way of walking.' |
| Insecurities during recovery | Patients express they have great moments of insecurity during the recovery process. | The first thing I thought after the surgery was, 'will I be able to walk again?' |

# APPENDIX K: SERVICE DEVELOPMENT

This appendix shows iterations towards creating a service model. Some of these iterations took place before the finalisation of the research cycle, as a way to reflect on my research.

## CONCEPT MATRIX

Looking at the initial findings from the stakeholder profiles, combined with the initial findings from the interviews, several parameters can be found when looking for extremes in desired service model characteristics. First of all, a big difference was found in the patients attitude towards communication, concluded from the interviews. This resulted in the following axis:
**self-reliance-active helping**
Second, it can also be concluded that all stakeholders are looking for some form of personalization; both in data, treatment and communication. Therefore an axis was formed with the counterpart of personalization:
**Standardised approach-personalised approach**

### Creating a matrix

To relate all these parameters back to the concept evaluation, a matrix was formed. The perceptual map (van Boeijen et al., 2014, p. 87) was used as a basis. The self reliance-active helping axis could give insight into what form of patient self-management was chosen in the concepts. Second, the personalization axis, refers to the data and communication retrieval and presentation abilities of the concepts. Initially, concepts falling in the self-reliance-personalised quarter was perceived as the 'best' concept type.

### Matrix results

Filling in the matrix (Figure 87), shows a more or less equal distribution between standardized-active helping, active helping-personalised and self reliance-personalised. There were also some concepts in self reliance-standardised.
Seeing the matrix filled in like this made me realise the self-reliance-personalised category isn't necessarily the best, or the only category I can choose from. It is the ultimate goal I am striving for in creating a service model. Therefore, you can also see it as horizon 3 of the service roadmap. However, stakeholders need to be 'thought' how to adopt this attitude. Starting with a service concept in the upper right corner might cause confusion. Therefore, it can be interesting to use different areas of the matrix as horizon areas. Move towards a self-reliant way of managing the THR pathway, starting with active


*Figure 87: Concept matrix*

# PRODUCT SERVICE SYSTEM ANALYSIS; FIRST ITERATION

After creating boundaries and evaluating the concepts with it, I wanted to analyse the concepts in further depth. I did this by setting up a Product Service System analysis form. This form consists of three layers, product, service and system, where I could evaluate the concepts on different levels. Figure 88 shows the first version of the Product Service System.

## Approach

When filling in this system, I started out in the Product category. Here I evalu ated which product types were present, and can be seen as an extension of the product type overview in 'Introducing the ACD concepts'. Here I also look at which type of wearable is used. Then, I make the connection to service, to identify what the different products actually measure. Next, in the service layer, I transform these data measurements into service goals, and relate these to each other again. Finally, I attempted to combine these findings in the system layer.

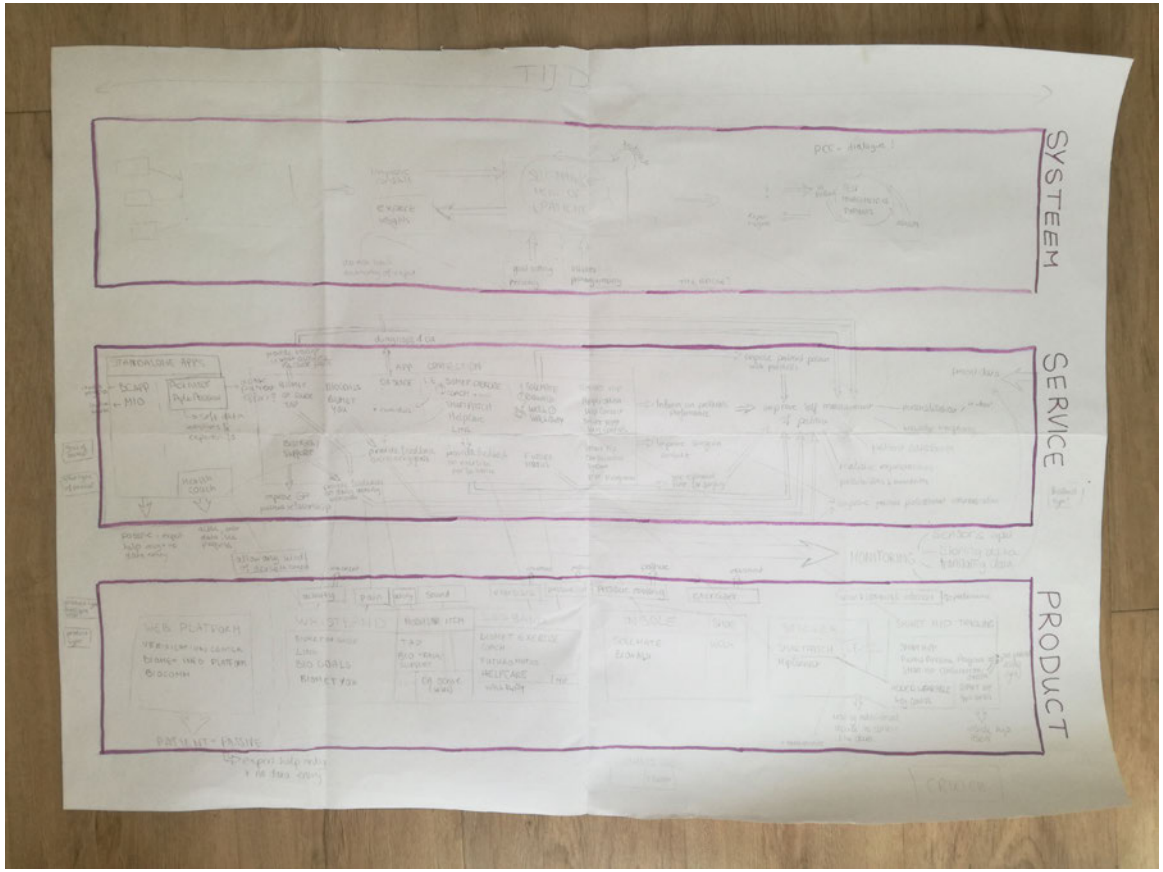



*Figure 88: First product service system analysis*

# OUTCOMES OF THE FRAMEWORK

## Product layer

There were eight product types found in the concept landscape.
Most product were found in the wristband-legband group, where the modular item group could be placed in between (it can act as both). It was interesting to see that although the product was the same, it was designed to measure very different things. Daily activities, exercises (both movement) pain, cartilage sounds and pressure (posture measuring).
As a contrast, it was interesting to see that the insole and shoe category all focused on pressure monitoring. Most of the time with real time feedback.
The sticker category focused on exercise measurement, but since this is a part of your daily activity, I see broader applicability.
Another unique category is the smart hip tracking category where the prosthesis is used as a measuring device. The hip measures wear loosening and infections.
The category that stood out from the others was the web platform category. There is no data entry in this product type and the main function of the product is asking experts for help. The patient adopts to a passive role here. Therefore, I could conclude that asking an expert for help is the most passive form of self-management for the patient. This does match with my findings of the boundary matrix, that active helping should be the first step towards self-management.

## Service layer

So, with what service goal in mind were the concepts created? 10 different goals were found:
-Improve patient posture with prosthesis
-provide feedback on exercise performance
-provide feedback on daily activity behavior
-provide feedback on (recovery) goals
-improve GP patient relationship
-provide inside in what activities cause pain
-diagnosis of OA
-give estimated time for surgery
-Inform on prosthesis performance
-Improve surgeon consult

These goals lead to the following two main goals:
-improve self-management of patient
-improve patient professional relationship

Self management was by far the most popular category. When analyzing the goal self management further in the concepts, it consists of the elements realistic expectations, patient satisfaction, knowledge transperancy, showing possibilities and boundaries, and personalization.
There were also some standalone apps to be found in this layer, but they either focused on retrieving expert feedback or obtaining soft data (emotions). This requires active effort from the patient, since this data can only be obtained by actively answering questions instead of automatically measuring.
Furthermore, it was interesting to see that concepts who were in the same product type group, did not necessarily have to be in the same service goal group.

## System layer and moving on to a second attempt

While the layer system served as a nice concept analysis, using my findings from the first two layers for the system layer yet prove to be difficult. This made me realise another attempt at this visual was needed for more effectively use insights towards the system layer. This time, it would be less concept focused.

# PRODUCT SERVICE SYSTEM ANALYSIS; SECOND ITERATION

For the second attempt I **started out with the service layer** (Figure 89). First thinking about the value I would like to offer made me think in possibilities, rather than in the somewhat restricted forms of the concepts.

## Service layer: value offerings

When filling in the service layer, it was found that all the values I wanted to deliver evolved around two questions that cause the patients' biggest insecurities: '**Am I doing good?' And, 'what can and can't I do?'** When evaluating how these questions could be answered, it was found that this could be done by both 'hard' data (numbers) and existing information and guidelines. The influence of soft data (emotions) was fairly limited, but focused on personal topics as experiences and routines.

## System layer: first attempt at a service framework

The different types of service offerings that answer the two questions could be organized after the treatment process guideline in the system layer. This results in the setup of **different 'modules'** that patients can decide to use or are advised to use. On top of this choice of modules, patients can decide on their feedback preferences. The data that is obtained can be communicated with health professionals to improve communication.

## Product layer: hardware requirements

But what hardware is needed to realise these services and possible system? First, a movement sensor is needed, which measures movements specifically from the hip.

To do something with the results of these movements, **benchmarks** are needed. First the capacity of the patient's body and already developed guidelines on this topic (is this person above, below or on average in their physical abilities?). Next up are benchmarks for surgery and recovery (when is surgery required and when is recovery fully realized?). And finally, **routines of the patient** (does an advice fit their life?).

To present the comparison between data and benchmark, a presentation medium is needed. Most likely this is done on an interface with help of a database.

And finally, **knowledge on the procedure** is needed. What happens when, what should you do when, which exercises are fitting etc.

## The topic of prevention

In the formulation of the system layer, I added the prevention phase, but I started questioning if this made sense. Prevention is something that is very difficult to achieve. It is also in the limits of my project scope, since it is not exactly a real part of the patient journey. It is about patients to be. **Therefore, it was decided to focus on prevention only for the far future.**

## Conclusion on the second iteration

The second iteration helped me to get an idea of what my service model could look like. Therefore, I wanted to evaluate the scheme I developed in the system layer more in depth, without thinking too much about the concepts.

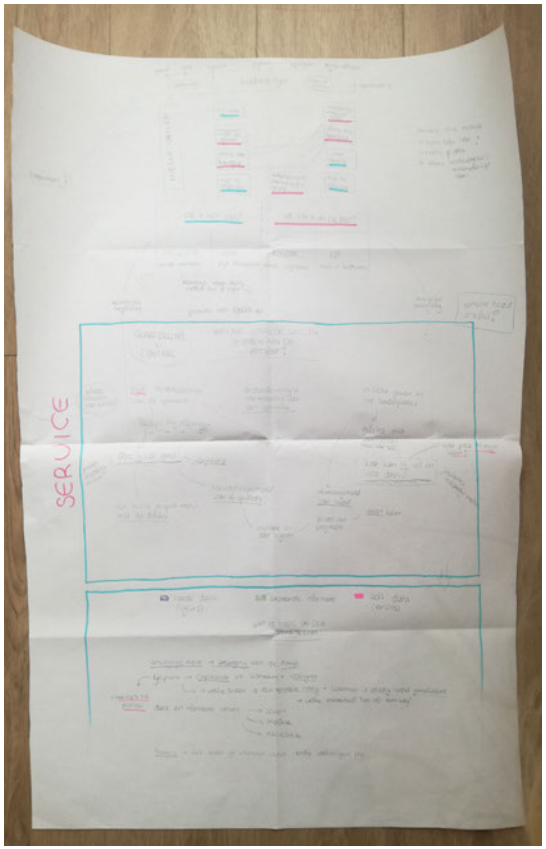



*Figure 89: Second Product service system analysis*

# PRODUCT SERVICE SYSTEM ANALYSIS; THIRD ITERATION

To evaluate the system layer of the previous PSS analysis, the drawings in Figure 90, Figure 91 and Figure 92 were made. Here, I tried to think in horizons. What would it look like if a system like this evolved over time? I also used my findings from my trend research in this activity. Furthermore, I wanted to look how I could highlight person centered care into the scheme. The following sections describe the setup of each scheme.

## 'Horizon 1'

(Figure 90) The basis of the system are the three main phases of the OA treatment: primary care, around the surgery and recovery care. Around these phases evolve three questions which are critical in every phase: **Am I doing well? What are my current options and limitations? And 'What do I want?**' this question is new, and focusses on user wishes.
Compared to the previous setup, the feedback layer is now transformed into the patient type layer and is placed at the basis. This gives the scheme a strong basis of person centered care. Determining the patient type is done by describing routines, feedback preferences, communication preferences, activity preferences and importing available medical data. Based on this information the system is personalized. On top of this, patients can choose what type of data modules he or she wants to use.
Health professionals in their turn can see this data according to their preferences, making sure that a consult already has a rich information base to start off from. This will make sure more time is available for communication.

## 'Horizon 2'

(Figure 91) So, where can the system improve in a later stage of development? According to my trend research, there is an opportunity for Artificial intelligence in healthcare, to learn **more about the patient and further personalize the system.** The patient type layer can remain the same in setup, but is becoming richer in information over time, by learning about the patient. This has an effect tailoring of the data modules. In their turn, patients can learn more about themselves and become more independent in a time where less and less time is spent in a hospital. The health professionals can learn from this specified data retrieval, and give advice with higher quality and efficiency.

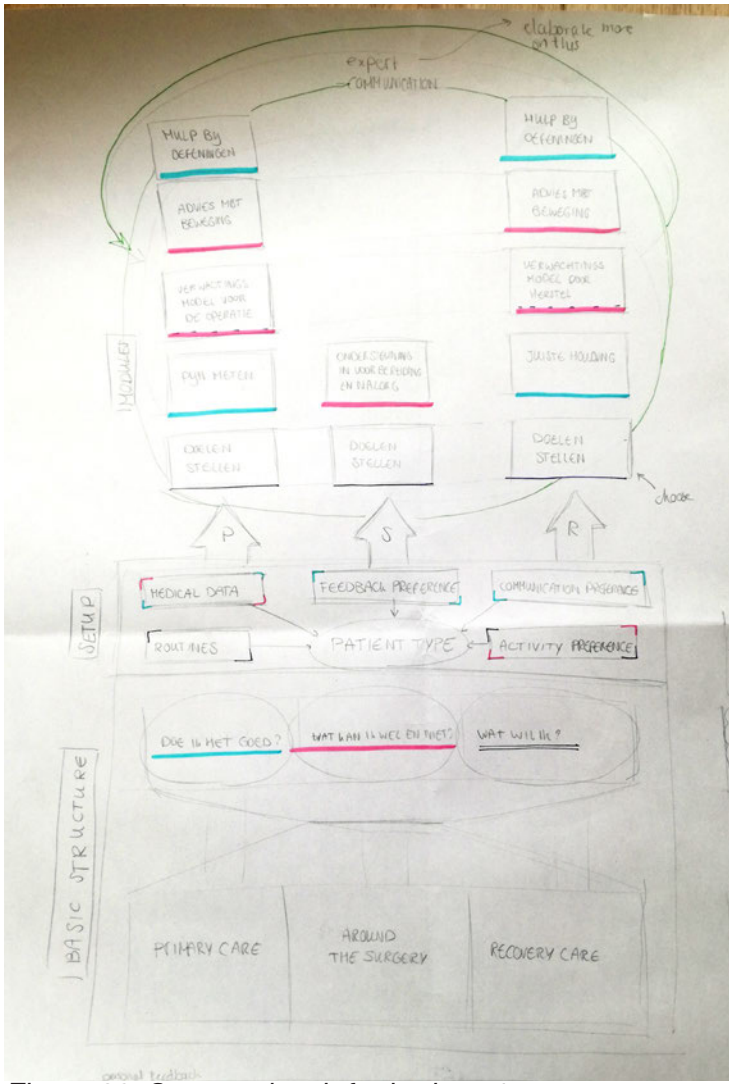


*Figure 90: System sketch for horizon 1*

## ‘Horizon 3’

(Figure 92) But what is the improved version of a learning process? An **automated learning process.**

In horizon 3, knowledge on many different patient experiences is used as a knowledge basis, and further learning continuously happens in the back end.

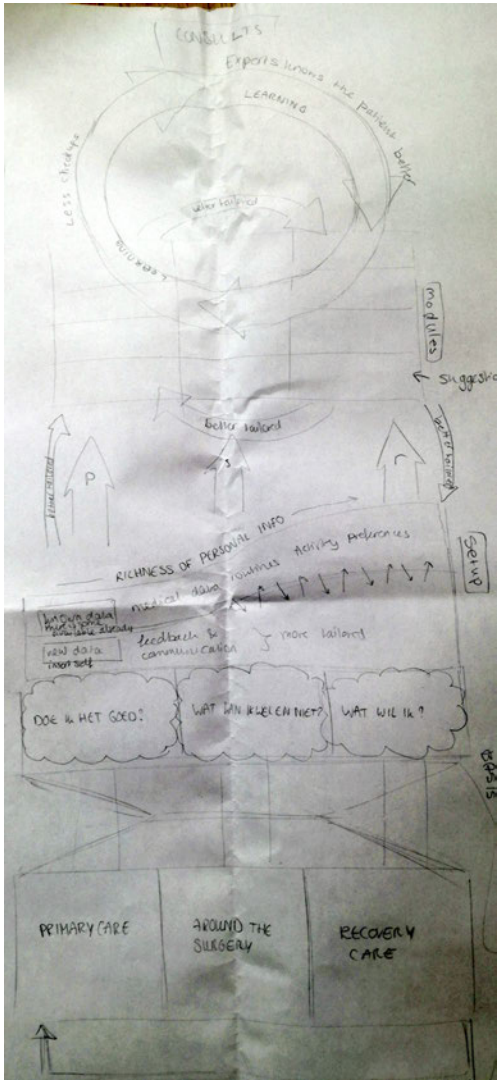



*Figure 91: System sketch for horizon 2*

Combining this knowledge with already obtained knowledge on a person’s lifestyle, someone can be personally supported starting from the first OA related symptoms. In their turn, healthcare professionals care recognize high risk patients earlier, and tailor their communication even more.

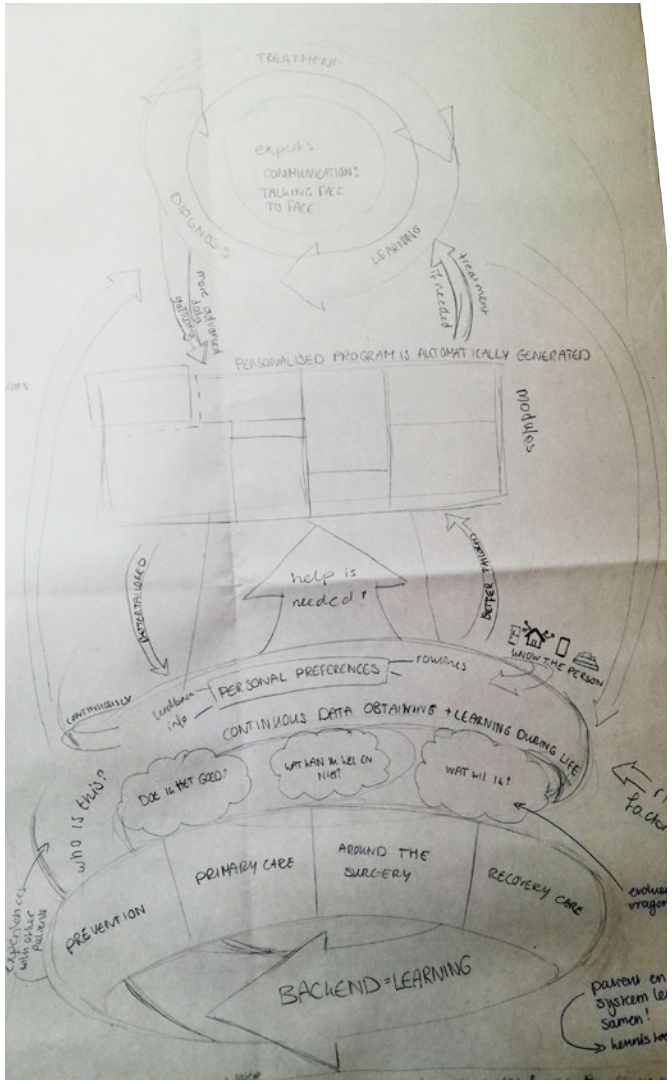



*Figure 92: System sketch for horizon 3*

# APPENDIX L: ROADMAPPING PROCESS

## Iteration one

The first iteration was meant to think about the setup of the roadmap, and to indicate knowledge gaps in my work. First, sketches were made to think about which elements I wanted to display and where. This also allowed me to think about the differences in information between the tactical and strategic roadmap.

Next up was creating a brain dump for the tactical roadmap (Figure 93). I concluded that it was easier to first go in depth on my tactical roadmap. In this way I could extract a summary out of this document for creating a strategic roadmap, rather than the other way around.
I used the first setup of the sketches made earlier as rows and columns and

| | HORIZON 1 | HORIZON 2 | HORIZON 3 |
|---|---|---|---|
| Vision | Efficiency by accessibility as a learning basis | Improve Quality by learning | Equal partnership between patient and professional |
| Value proposition | Communication & efficiency | Communication & efficiency & quality | Communication & efficiency & quality & comfort |
| Stakeholders | Patient, Physiotherapist, GP and Surgeon *Supplier:* Start with hospital but move to GP as well | Patient, Physiotherapist, GP and Surgeon *Supplier:* Transition from surgeon and GP to monitoring partner. | Patient, Physiotherapist, GP and Surgeon *Supplier:* Monitoring partner fully taking over. |
| Market | Patient taking control and learning new skills | Longer distance to hospital | Care at home |
| Product/service | Self management tool valuing (real) communication and information providing for first learning steps from users | Self management tool learning about its users and the other way around | Self management tool knowing its users Making all stakeholders journey experts |
| Technology | Big data | AI | Smart home & human |
| Resources | Service developer & database | Monitoring partner | |

*Figure 93: First roadmap setup*

*Figure 94: Roadmap in postits*

used text on post its to fill in the blanks. As a final step I did my first attempt on searching for connections. Figure 94 shows the first result.

**Findings**
-It turned out I needed to detail the product/service more in depth.
-Elaborate on service idea by drawing more relationships. Where is the money?
-What does the service give for patients and professionals? I should explain more about user benefits in the roadmaps.
-Keep on tuning the visions
-Add a final future world vision

## Small second iteration

After reflecting on the setup and contents of the roadmap, I iterated on my first tactical roadmap setup. First by iterating on my visions and by creating an end vision:

Furthermore, I drew an elaborate set of sketches on the product service; use setups, value flow improvements, scenario's etc. This could help me to improve my focus of the roadmap, and highlight the impact of the service model.

These additions improved the quality of the tactical roadmap setup, but it still did not feel satisfactory.

**New concerns after iteration 2:**

-The product-service should be described both with text and visuals in the strategic roadmap to be clear.
-The tensions should be included in the roadmap
-Launch timings should be more clear
-Integrate the concept demonstrators into the roadmap
-Connections between different elements should be more clear, either in visuals or in formulation

## Third and fourth iteration

After discussions with my supervisors it was decided to make a first digital version of both roadmaps, shown below (Figure 95 and Figure 96)
These iterations were discussed with my supervisors again and changes were proposed on layout, titles and content. For example the decision to add the concept demonstrators in the tactical roadmap and the change of category names. With this feedback, the roadmaps in the main chapter were created.

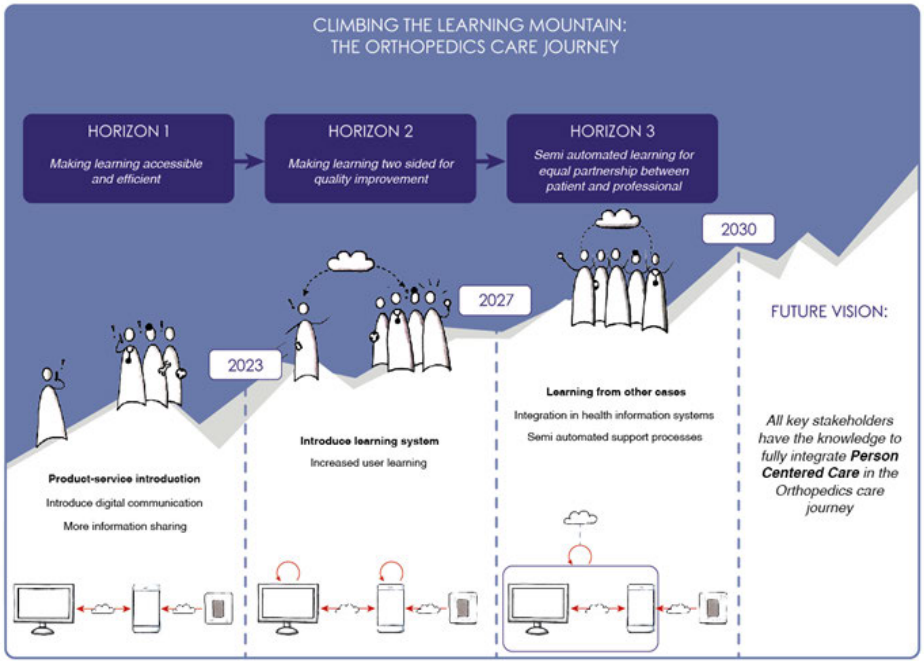



*Figure 95: digital setup of the strategic roadmap*

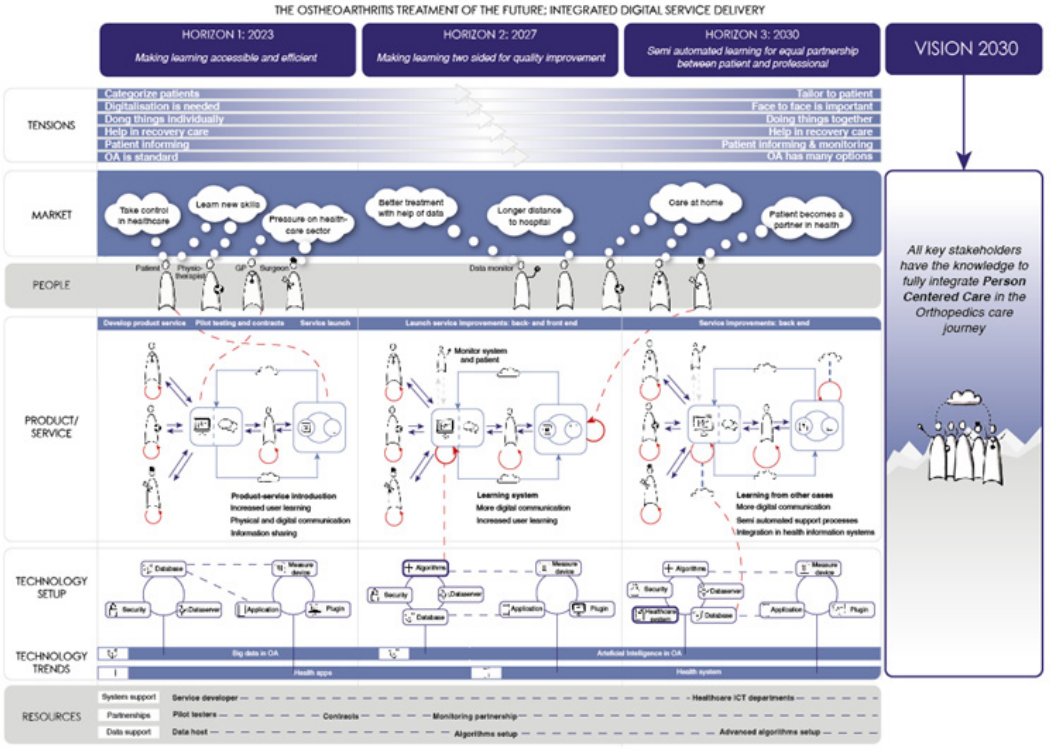



*Figure 96: digital setup of the tactical roadmap*

# CLIMBING THE LEARNING MOUNTAIN: THE ORTHOPEDIC CARE JOURNEY

## HORIZON 1

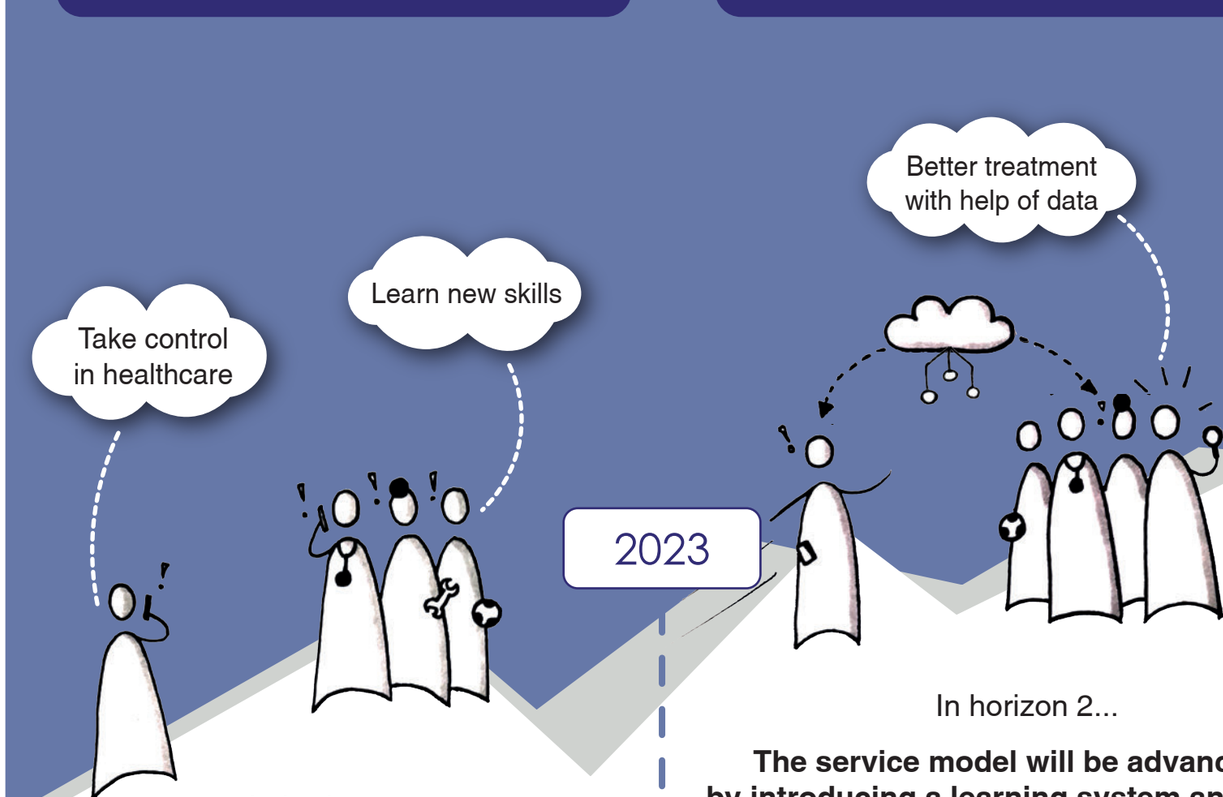
*Making shared learning accessible and efficient*

## HORIZON 2

*Making shared learning two sided for quality improvement*

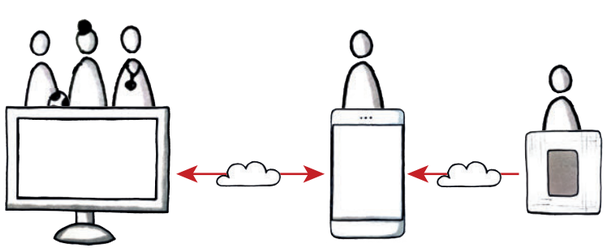
## HORIZON 3

*Semi automated shared learning for equal partnership between patient and professional*




In horizon 1...

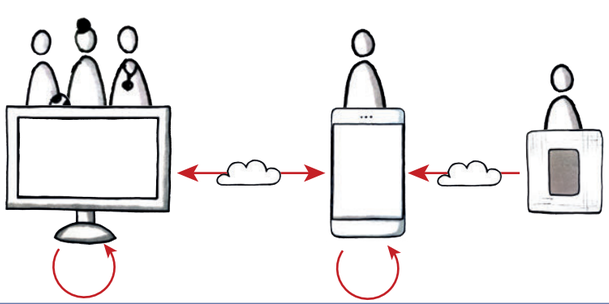
**A service model for the Orthopedic care journey will be introduced, increasing (digital) communication possibilities, information flows and self management of the OA patient**





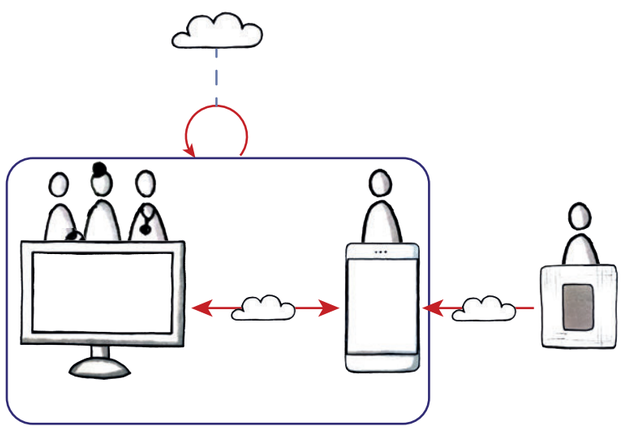

In horizon 2...

**The service model will be advanced by introducing a learning system and data monitor, improving the information availability, intervention possibilities and thus the OA treatment quality**




In horizon 3...

**The learning system is extended by learning from other cases instead of individual learning, and integration in health information systems. This enables quick system tailoring to patient preferences, enabling them to become an expert on the OA treatment**




## FUTURE VISION:

*Semi automated shared learning for equal partnership between patient and professional leads to successful integration of* ***Person Centered Care*** *in the Orthopedic care journey*

# THE ORTHOPEDIC CARE JOURNEY OF THE FUTURE; APPLYING AN INTEGRATED DIGITAL SERVICE DELIVERY

| | HORIZON 1: 2023 | HORIZON 2: 2027 | HORIZON 3: 2030 |
|---|---|---|---|
| | *Making shared learning accessible and efficient* | *Making shared learning two sided for quality improvement* | *Semi automated learning for equal partnership between patient and professional* |

## USER WISHES

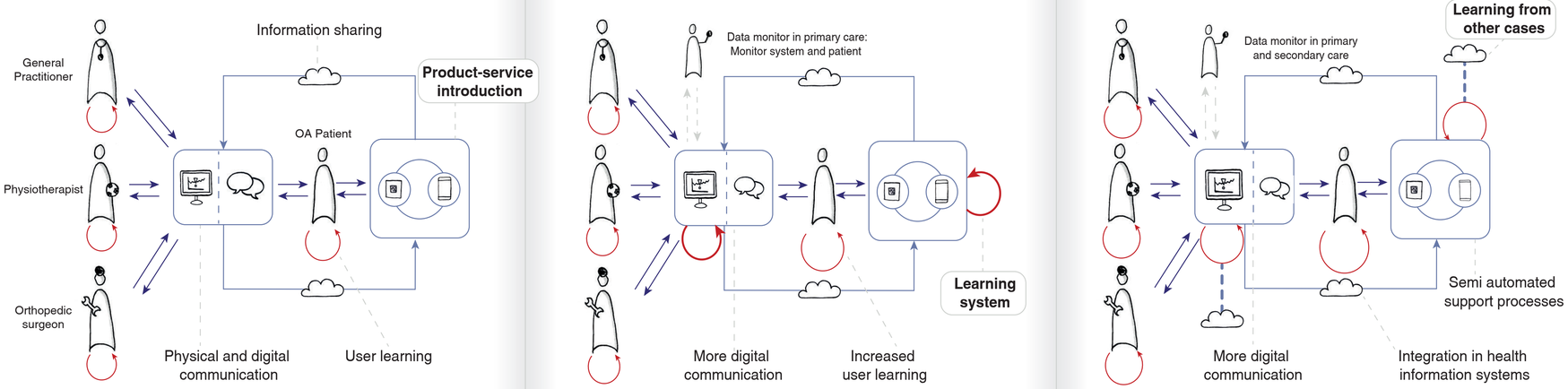
- Take control in healthcare
- Learn new skills
- Pressure on health-care sector
- Better treatment with help of data
- More directed care
- Care at home
- Patient becomes a partner in health

## VALUES

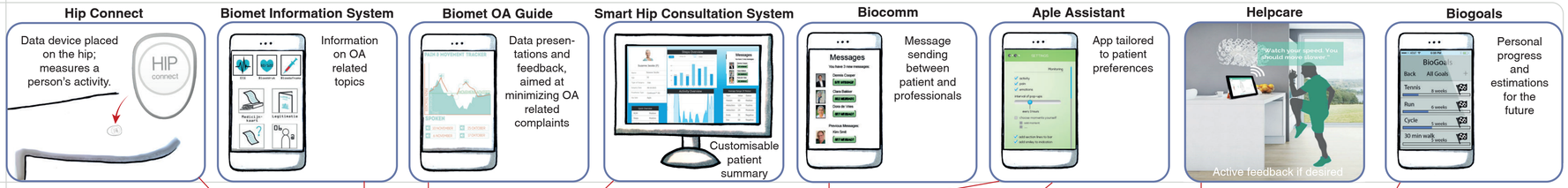
| | | |
|---|---|---|
| Categorize patients | Elaborate patient categorisation | Tailor to individual patient |
| Digital communication need | Balance between digital and physical | Reinvent value of physical communication |
| Stakeholders acting individually | Learn cooperation skills | Stakeholders acting as a team |
| Help in recovery care | Help in last stages of primary care | Help in first stages of primary care |
| Patient informing | Patient informing & monitoring | Patient monitoring & interventing |
| OA treatment is standard | OA treatment has options | OA treatment is different for everyone |

## SERVICE MODEL EVOLUTION

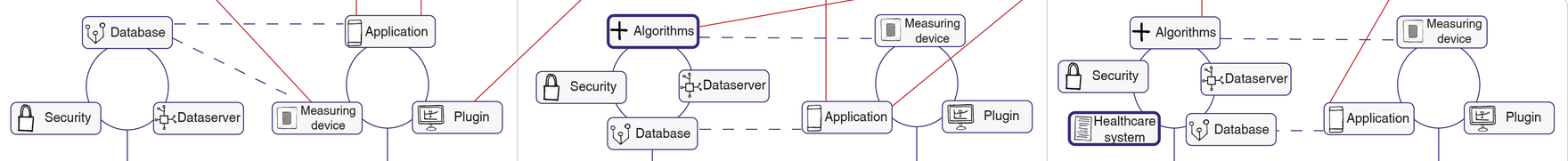
**Develop product service** — **Pilot testing and contracts** — **Service launch** — **Launch service improvements: front- and back end** — **Service improvements: back end**



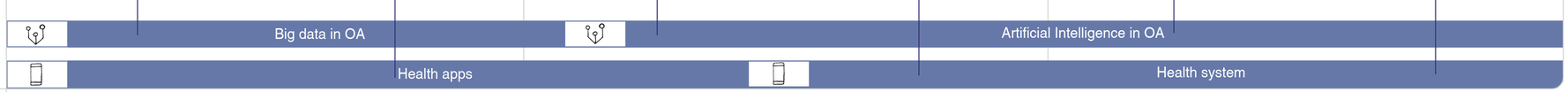

## CONCEPT PROPOSALS




## TECHNOLOGY SETUP




## TECHNOLOGY TRENDS




## TRANSFORMATION ENABLERS

**Pilot testers**

Service developer — Data host — Contracts

+

Algorithms setup

Monitoring partnership

+

Advanced algorithms setup

Healthcare ICT departments cooperation

## VISION 2030

*Semi automated shared learning for equal partnership between patient and professional leads to successful integration of **Person Centered Care** in the Orthopedic care journey*

DESIGN FOR our future

TU Delft

PIM 2968 11/11/19

# IDE Master Graduation

## Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

**USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT**

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

### STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name
initials
student number
street & no.
zipcode & city
country
phone
email

[redacted]

Your master programme (only select the options that apply to you):

IDE master(s): ( ) IPD ( ) DfI (★) SPD

2nd non-IDE master: _____

individual programme: __ - __ - _____ (give date of approval)

honours programme: ( ) Honours Programme Master

specialisation / annotation: ( ) Medisign ( ) Tech. in Sustainable Design ( ) Entrepeneurship

### SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair L.W.L. Simonse dept. / section: PIM/MOD

** mentor A. Albayrak dept. / section: ID/AED

2nd mentor _____

organisation: _____

city: _____ country: _____

comments (optional)

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

**Procedural Checks** - IDE Master Graduation

TU Delft

## APPROVAL PROJECT BRIEF

To be filled in by the chair of the supervisory team.

chair L.W.L. Simonse date 11 - 11 - 19 signature

## CHECK STUDY PROGRESS

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: _____ EC

Of which, taking the conditional requirements into account, can be part of the exam programme _____ EC

List of electives obtained before the third semester without approval of the BoE

YES all 1st year master courses passed

NO missing 1st year master courses are:

name _____ date - - signature _____

## FORMAL APPROVAL GRADUATION PROJECT

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: APPROVED NOT APPROVED

Procedure: APPROVED NOT APPROVED

comments

name _____ date - - signature _____



Initials & Name L.M. Bernards Student number 4368495

Title of Project Service roadmapping of Smart care solutions

# Service roadmapping of Smart care solutions

project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 02 - 09 - 2019 14 - 02 - 2020 end date

## INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Person Centered Care (PCC) is currently an important subject within the healthcare sector. PCC means actively involving patients in their health care and decision making process (Wildevuur & Simonse, 2015). Several developments have caused the rise of PCC. For example, there is an increasing number of patients in healthcare institutions with a simultaneous shortage in healthcare staff, while quality needs to remain intact (van Meeuwen et al., 2015). Next, patients have better access to health data and information on the Internet, making them seek for more active involvement in their health management (Geerse et al., 2019). PCC has the potential to deal with these developments. However, changes in the healthcare sector such as PCC, ask for new approaches. Therefore, stakeholders in healthcare are more actively collaborating with designers. Their design methods can help develop new approaches and support healthcare change.

An example of a design method used in healthcare is the development of care pathways and care pathway models. These are (visual representations of) actor networks that give insight into care procedures, and make them manageable and initiate improvements (Oosterholt et al., 2017 , Simonse, Albayrak & Starre, 2019) Another example is the creation of patient journeys, which has a strong connection with PCC. This method derived from the customer journey method and is defined as a 'comprehensible representation of a health service and its procedures, including relationships and feelings from a patient perspective.' (Simonse, Albayrak & Starre, 2019).
A final example is the roadmap, a method that can be used to identify improvements within pathway models and patient journeys. A roadmap is defined as 'a visual portray of design innovation elements (user values, new product/services, technology applications) plotted on a timeline.' (Simonse, Hultink & Buijs, 2014). It is often used as a communication tool and a future innovation plan.

Previous research results with design methods in healthcare show a high potential for the implementation of digital innovations (van Meeuwen et al., 2015). Digital innovations have the ability to efficiently embed PCC in care processes. Currently, most digital innovations are single user solutions. Next to single user solutions, multi user solutions are in development as well. These solutions are complex services where multiple active users and data are involved. These solutions have the potential to enrich diagnoses and treatments even further, and thus improving quality of care in an efficient way.
Several digital innovation concepts with multiple users have been developed within the context of the HiPP project, a collaboration between the TU delft, Reinier de Graaf hospital and Zimmer Biomet. However, these concepts are still fragmented and complementary service models are lacking, which impede implementation. The Smart Care lab at the TU Delft wants to investigate the cohesion between these multi user concepts, to develop a service roadmap maximizing their future potential for the healthcare sector.

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introduction (continued): space for images

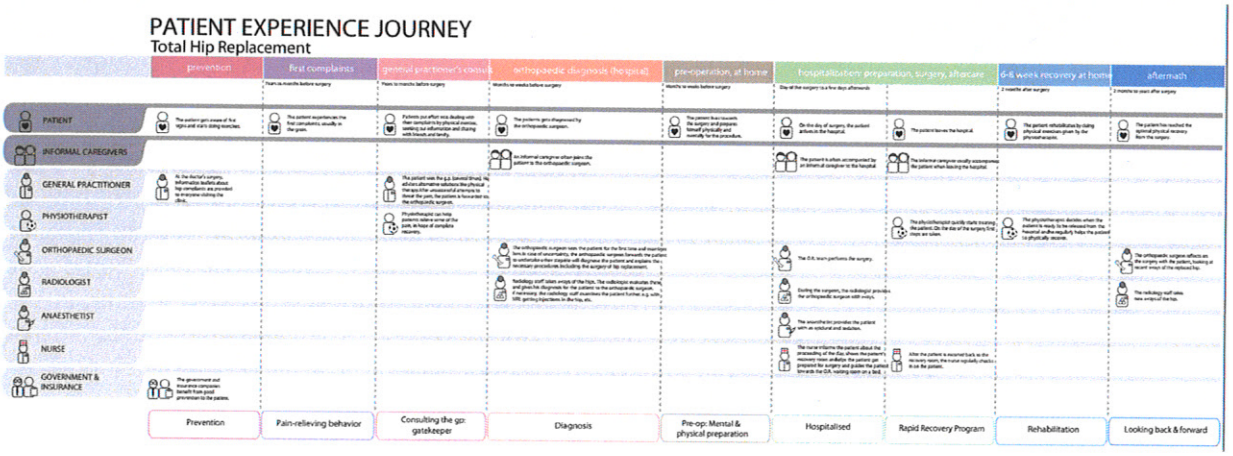



image / figure 1: Example of a patient journey (by A. Albayrak)

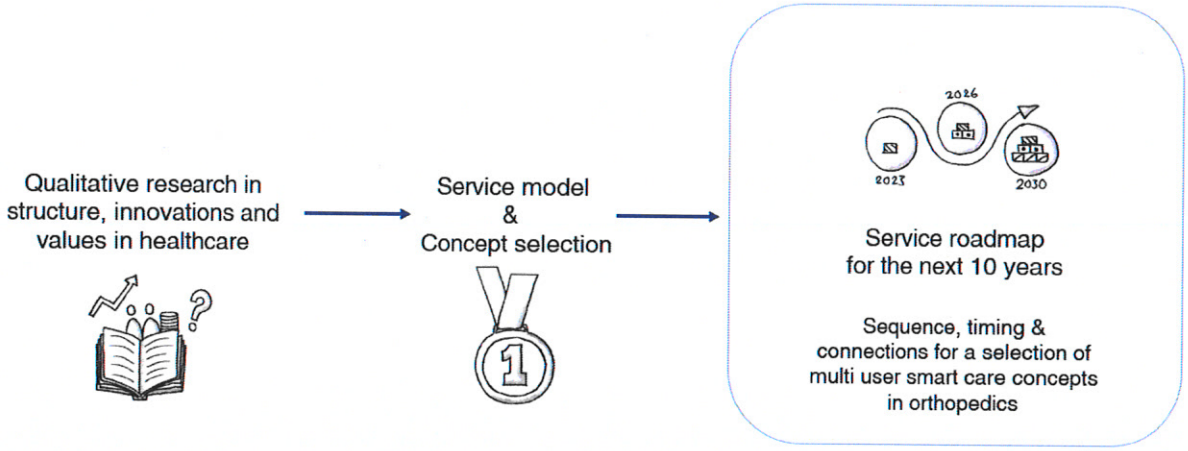



image / figure 2: Proposed project flow (discussed in assignment)

## PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

This project will zoom in on existing concept proposals within the topic of smart care in orthopedics. Over the past 7 years, numerous of these projects have been carried out during the Master course Advanced Concept Design at the TU Delft as part of the HiPP project. Basic categorization mapping showed that more and more of the resulting concept proposals consist of smart care solutions with multiple users, containing sensors, data and internet technology. However, the concepts are generated separately from each other which make them fragmented on a system level. There has not been looked at the common ground between the concepts in terms of service delivery. Investigating the cohesion between the concept proposals could significantly raise their potential to innovate the patient journey in orthopedics.
The formulation of a service roadmap for the smart care lab can help communicate the cohesion between concepts and their innovation potential to eventually achieve an integrated care service delivery; meaning a service model where all service elements and stakeholders are taken into account. Service roadmapping is yet uninvestigated in the field of healthcare, but it is the perfect tool to show product-service innovation concepts in the context of time, and the connections between these concepts.

In conclusion, this project will investigate how service roadmapping can enable an integrated service delivery with multi user smart care solutions. The concept proposals from the Advanced Concept Design course will be used as demonstrators in this case study. The final roadmap can be used by the Smart Care lab to show clear innovation potential to stakeholders, and the roadmap development process can also be repeated in other implementation contexts.

## ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... . In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

For my graduation project I will create a service roadmap for the Smart Care lab, for the upcoming 10 years. This means my roadmap will show the sequence and timing of implementation, for a selection of concept proposals about multi user smart care in orthopedics. Next to this, I will show the relations between concepts in this service roadmap. A patient journey created for hip replacement patients in previous research will serve as the target context for my roadmap. Therefore, the creation of a service roadmap can also show where, when and how the patient journey is improved in the next 10 years.
To come up with a selection of concept proposals, I will perform qualitative field research into the current organization, innovation activities and values in the healthcare sector, focusing on orthopedics. This research allows me to both validate which concepts have high implementation potential, and develop a service model as a basis for the roadmap. In this project, a high potential proposal means it has strategic fit with the future goals of the important stakeholders, a strong patient centered character, a link with innovation developments in the healthcare field, and a strong cohesion with other concepts, allowing to add to each other's' strengths and build up on each other in time, continuously improving the patient journey in the future.



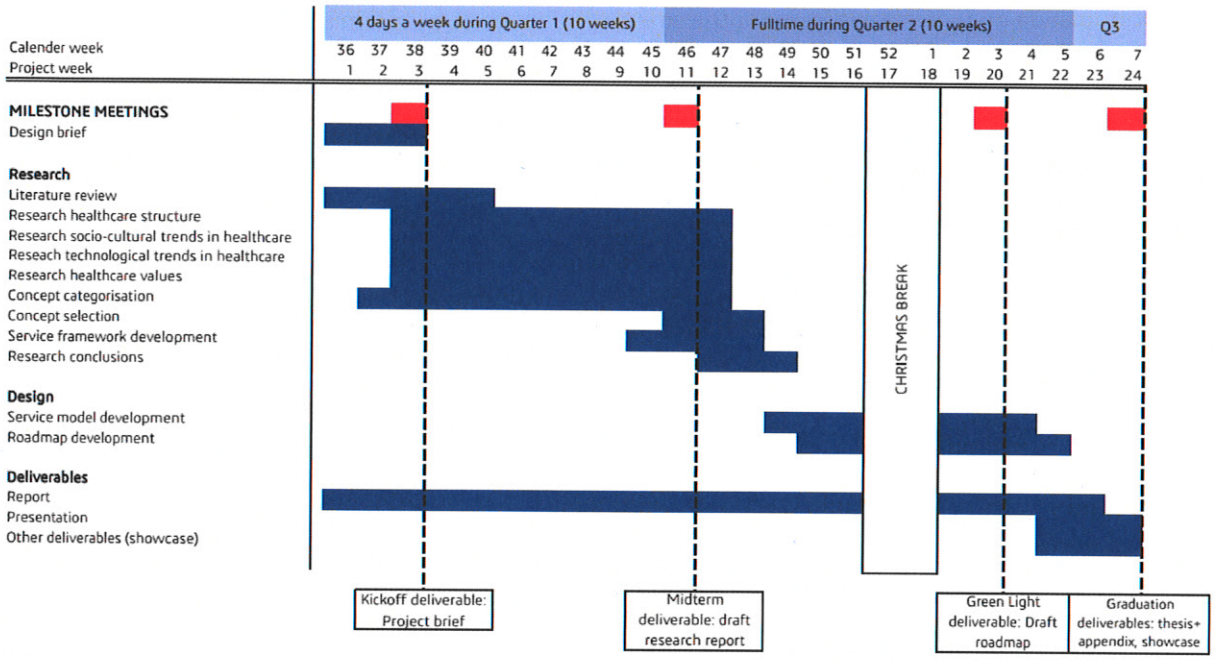
Initials & Name L.M. Bernards Student number 4368495

Title of Project Service roadmapping of Smart care solutions

## PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 2 - 9 - 2019 14 - 2 - 2020 end date




For this project I have the following approach. I will start with a research phase, consisting of a literature review and an investigation of the healthcare structure, trends and values in healthcare, with special interest in orthopedics. This investigation will be done with both information obtained in the concept reports, but also by speaking to relevant stakeholders. At the same time, I will develop a concept categorisation to help me towards a concept selection. This investigating and categorising will be a back and forth process. I will present my draft research report during my midterm presentation, after which I can finalise my research conclusions, concept selection and service framework. In the design phase I will translate my findings towards a service a roadmap, with help of a service model. Again, this will be a back a forth process between service roadmapping and service modelling. I also expect the service modelling will be a design process, since the concept reports are fairly limited on this topic. During my green light meeting I will present my draft roadmap after which I have time for finalisations of my roadmap and thesis.

Since this is a research project, time wise I put emphasis on the research phase. This will take up at least half of the project. Furthermore, this planning keeps in mind my parallel working activities in quarter 1 (student assistant at PO1), which will take up approximately 1 day a week. I also planned for a Christmas holiday.

During my project, I have weekly update meetings planned with my mentor. Next to this, I will also plan meetings with my chair regularly and sent digital updates if needed.

## MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... . Stick to no more than five ambitions.

I see my graduation project as an opportunity to test my research skills. Hereby I mean the process of 'digging'; finding out what the real basic problems within the case are, and how they are caused. Up till now, almost all the research I performed was done in the context of a project group assignment. I liked to do it in this context, and also felt confident doing it, but to perform research as an individual process is an ultimate test case for me. Especially drawing conlusions from research will be a big challenge; I want my conclusions to enable a translation towards design that creates value for the stakeholders involved. This means drawing sharp conclusions from my research is crucial. In previous projects I saw that I have the ability to draw important conclusions, but I think I can improve in formulation of them, which will consequently improve how fundamental the conclusions are in relation to the design problem.
To help me in this translation process I want to include a roadmap in my design process. Again, I made roadmaps before, but always in group context. Also I was sometimes doubting the fit and amount of value the created roadmap brought to the receiving stakeholders. Therefore, I want to evaluate and improve my ability to create a roadmap myself and increase the amount of value the roadmap holds.
The creation of the roadmap is also a great way to test my visualisation skills. I have never felt strong in creating high quality visuals, but I am trying to train myself in this for the last semesters. For my graduation project, I want to support my research in a visual manner, by creating informative and quality visuals with a consistent style.

Resources:

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Oosterholt, R. I., Simonse, L. W. L., Boess, S. U., & Vehmeijer, S. B. W. (2017). Designing a Care Pathway Model – A Case Study of the Outpatient Total Hip Arthroplasty Care Pathway. International Journal of Integrated Care, 17(1), 2. https://doi.org/10.5334/ijic.2429
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Simonse, L. W. L., Hultink, E. J., & Buijs, J. A. (2014). Innovation Roadmapping: Building Concepts from Practitioners' Insights. Journal of Product Innovation Management, 32(6), 904–924. https://doi.org/10.1111/jpim.12208
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## FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.



Initials & Name L.M. Bernards Student number 4368495

Title of Project Service roadmapping of Smart care solutions