A data enabled participatory design approach to address barriers to adoption of the mymobility platform

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Master Thesis

ZIMMER BIOMET · TU Delft · Data-Centric Design

A data enabled participatory design approach to address the barriers to the adoption of the mymobility platform

Designing a strategic roadmap to improve the adoption of a digital platform

Master Thesis
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Executive Summary

With an increasing population and more prevalent staff shortages in healthcare, digital technologies can play a crucial role in bridging the gap to deliver value-based healthcare. Therefore, any additional service integrated into their workflow must either enhance efficiency in delivering care or add significant value to the care provided. Anything less would not align with their context of use and, consequently, would not effectively reach the end-user (patient).

As a market leader in joint arthroplasty, Zimmer Biomet introduced the mymobility care management platform. This platform offers remote patient monitoring, personalized care plans, telehealth services, and real-time data analytics to enhance patient engagement and streamline healthcare delivery. However, the adoption rate of this platform remains low, particularly when compared to the company's broader success in the implant market.

Through an analysis of quantitative patient outcome data and demographic data related to its use, it was found that one of the primary barriers to adoption was the low eagerness among healthcare professionals (HCPs) to use the care-management platform.

By leveraging the usage data currently collected by Zimmer Biomet and conducting qualitative inquiries, barriers to adoption were identified and opportunity areas were mapped. These insights led to the creation of a strategic roadmap designed to boost the adoption of the mymobility platform over the next five years.

Reading Guide

Researcher

You might be curious to learn about the context within which this research was conducted, the methods used in this thesis, along with the key findings. I recommend you to follow this reading order.

1. Introduction
2. Background
3. Methods
4. Results
5. Discussion

Medical Professional

If you are familiar with this research and were involved in this study, you may want to jump directly to the design suggestions.

4. Results
5. Discussion

However, if you are new to this research, you may want to first glance through the Background, read through the approach and design activities conducted and jump to the design suggestions proposed at the end.

2. Background
3. Methods
4. Results

Zimmer Biomet

If you are familiar with this research and were involved in this study, you may want to jump directly to the design suggestions and read through the discussion.

4. Results
5. Discussion

However, if you are new to this research, you may be curious to learn about the approach and design activities conducted in this study, glance through the main findings and see the design suggestions. I recommend you to follow this reading order.

3. Methods
4. Results
5. Discussion

Design Professional

You may be curious to learn about the context of this research, glance through the main findings and jump to the design suggestions. I recommend you to follow this reading order.

2. Background
3. Methods
4. Results
5. Discussion

Abbreviations

AI - Artificial Intelligence

BMA - British Medical Association

COVID-19 - Coronavirus Disease 2019

DCD - Data Centric DesignLab

EHR - Electronic Health Records

EMEA - Europe, Middle East, and Africa

EMR - Electronic Medical Record

EPR - Electronic Patient Records

EU - European Union

GP - General Practitioner

GDPR - General Data Protection Regulation

HEV - Health Economic Value

HCP - Healthcare Professional

HMS - Hospital Management Systems

HRA - Health Research Authority

mm- mymobility

NHS - National Health Service

NICE - National Institute for Health and Care Excellence

NL - Netherlands

Npj - Nature Partner Journals

PI - Primary Investigator

PROMs - Patient-Reported Outcome Measures

RQ - Research Question

ROSA - Robotic Surgical Assistant

RPM - Remote Patient Monitoring

RR - Rapid Recovery

SRQs - Sub-Research Questions

THA - Total Hip Arthroplasty

TU Delft - Delft University of Technology

WAC - World Arthroplasty Congress

ZB - Zimmer Biomet

Contents

1. Introduction

This chapter aims to provide an overview of the joint replacement care path, the mymobility application that forms the focus of my research and the primary stakeholders. Through an introduction of the context the main research question and four sub-research questions would be introduced. To conclude, the chapter presents the opportunity space and provides an overview of the design direction.

The adoption of digital health platforms, such as the mymobility care-management platform, has the potential to revolutionise patient care and streamline the work of Healthcare professionals (HCPs). Despite these advantages, the uptake of such platforms remains low among HCPs. Understanding the factors influencing this adoption is crucial for improving design and deployment strategies (Gagnon et al., 2012). This study explores the effectiveness of a data-enabled design approach in multinational corporations, aligning with the values and needs of healthcare providers during the joint replacement journey. Additionally, it examines whether the platform alleviates the burden on HCPs, identifies specific beneficiaries, and investigates the barriers to adoption. By addressing these questions, this research aims to propose strategies to enhance the usability and acceptance of digital health platforms among HCPs, thereby contributing to more efficient and patient-centred healthcare delivery (Buntin et al., 2011).

The UK: Economic factors in the UK have been tumultuous, influenced by Brexit and the ongoing adjustments post-COVID-19 which saw a transitory halt to the elective surgeries. Elective surgeries are non-emergency procedures planned in advance, often essential for improving patients' quality of life, such as hip replacements or cataract removals. The wait times for these surgeries in the UK have increased due to a combination of rising demand, resource constraints, and the lingering impacts of the COVID-19 pandemic, which disrupted routine healthcare services (Issimdar, 2023; Thorlby, 2023; NHS England, 2021). Additionally, staff shortages and funding limitations further exacerbate the pressure on the NHS, making it challenging to meet the growing needs of patients requiring elective procedures (British Medical Association, 2021).

These factors affect the digital health sector, particularly in terms of funding and investment stability along with shortage of resources. The focus is increasingly on creating ecosystems that facilitate the integration of digital health into existing healthcare frameworks to ease the workflow of care-teams.

Both countries recognise the importance of digital health in enhancing healthcare delivery and patient outcomes. The UK, in particular, has seen a rapid expansion in the use of digital health due to the pandemic, which has acted as a catalyst for accelerating the adoption of tele-health and remote monitoring systems, pushing for greater adoption of technologies that can offer substantial cost savings and improved patient outcomes. The Netherlands continues to build on its structured approach to health technology, emphasising rigorous data management and patient-centred solutions. EU wide there is a massive push for digitising care-delivery.

> "Our capacity and demand is just stupid! We might do 30 surgeries a week, but you're getting 50 patients referred-in every week."
>
> Deputy Service manager, NHS

1.1 Digital transformation in healthcare

With the growing inadequacies in care-delivery, wrought with the problems of shortage of staff and increasing demand(Carlo et al., 2023). It is estimated that the World could lack 10 million health-care workers by 2030, around 15% of today's workforce.

Digital transformation in healthcare involves leveraging new digital technologies to enhance value propositions, enhance efficiency of the service and patient outcomes. Innovations such as Electronic Health Records (EHR) have streamlined the exchange of medical information, while tele-health services have expanded access to care, addressing critical issues like staffing shortages and resource limitations (Gupta Strategists, 2021). Moreover, external events like the COVID-19 pandemic prompted healthcare professionals across the globe to seek new paths for value creation. Yet, the pace of development of technology in the field of healthcare lags behind, in comparison to other fields like manufacturing, finance, retail, aerospace. This has been hailed as the Industrial Revolution 4.0 (The Fourth Industrial Revolution: What It Means and How to Respond, 2024; Kumar, 2023; Rudin et al., 2016)

> "Just the fact that it takes more than twenty hours to be trained to use electronic healthcare records (EHR) indicates that the complexity of working with them often exceeds that of the patient being assessed."
>
> Eric Topol, Deep Medicine

We can attribute this slow pace of development in the healthcare field to the large evidentiary barriers innovators face during implementation (The Economist, 2024).

Care-management platforms are increasingly leveraging innovation to improve patient outcomes and streamline healthcare services globally.

> "Health systems only have the capacity and resources to adopt painkillers, not vitamins."
>
> Josh Liu, Seamless MD

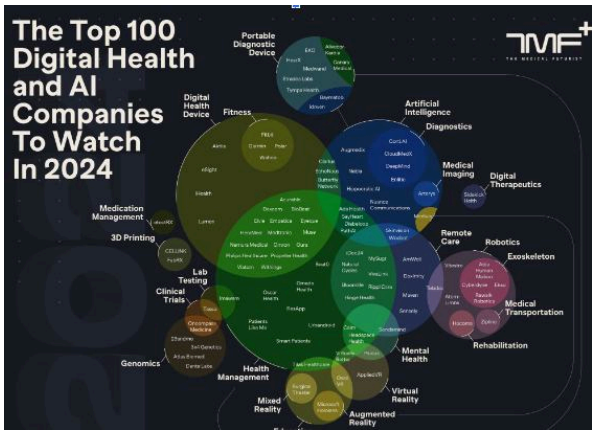


***Figure #1**: Trends in digital innovations*

In Europe, companies like MoveUp and Proximie are at the forefront, integrating advanced technologies to enhance patient engagement and care delivery. MoveUp, for example, provides a comprehensive suite of tools for patient insights, engagement, and real-time monitoring, enhancing collaboration between healthcare providers and ensuring seamless patient care (MoveUp, 2019). North American platforms such as DeepScribe and PicnicHealth focus on optimising data management and clinical documentation, reflecting a trend towards efficiency and accuracy. DeepScribe utilises AI to automate clinical documentation, allowing healthcare professionals to focus more on patient care. Australia's CSIRO is developing specialised apps targeting specific medical conditions, exemplifying a targeted approach. Their knee replacement rehab app offers tailored exercises and recovery monitoring to improve post-surgery outcomes (CSIRO, 2017). In Asia, initiatives like IGES AIM Assessment emphasise comprehensive health data integration(Figure #1), aligning with broader health policy goals. These platforms facilitate detailed health assessments and data-driven insights to support public health strategies (IGES, 2023).

These trends align with global demographic shifts towards aging populations, increased digital adoption, and the cultural emphasis on personalised and accessible healthcare.

As populations age and digital technology becomes more integral to daily life, the demand for innovative care-management solutions that offer personalised and efficient healthcare services continues to grow.

A growing pressure on providers to contain costs with staff shortages and decrease in healthcare funding shifted the burden of care from provider to patient (LeRouge et al., 2014), with a high focus on prevention rather than cure. This also helps them address the problem of scaling resources as a care team.

1.2 Challenge

mymobility(Figure #2) was launched by Zimmer Biomet as a part of ZB Edge, a suite of products and services they offer to enhance the joint-replacement care-path. The first country to implement mymobility in EMEA was the UK. Following which, it was deployed in Italy (in September 2020), Belgium, the Netherlands (in March 2021), Switzerland, Germany, Ireland, France, Austria, Spain, Sweden and South Africa.

With mymobility, hospitals can standardise education across multiple locations and care teams can track patient progress through remote monitoring. This capability allows for the remote collection of pain scores, enabling hospitals to prioritise patients based on their health deterioration rather than their wait times. The implementation of mymobility in Bedfordshire, Luton, and Milton Keynes has significantly reduced hospital wait times, eliminating 104 weeks of waiting by effectively tracking postoperative recovery and increasing bed capacity for planned care admissions. (Crawford et al., 2021)

The goal of this solution is to provide a platform that can be the bridge between the care-team and the patient, help prepare a patient for their joint replacement and also serve as a trusted source of information for their rehabilitation needs post-op.

Around 2018, they did their first launch in the US (Johnson, 2019). Following which, in 2020 (during the pandemic), they brought it to EMEA(Europe, Middle-East and Africa) in a hospital in the UK(United Kingdom) in August of 2020 and consequently to the Netherlands - it was launched in March 2021.

***Figure #2**: The mymobility Product-Service-Solution (PSS)*

To address the needs of various stakeholders in the digital care pathway in joint arthroplasty, Zimmer Biomet has developed ZBEdge. A collection of all the solutions that Zimmer Biomet has to offer. mymobility is one part of these solutions, with a patient-facing and a clinician-facing solution. This platform connects providers with their patients for pre-operative engagement, postoperative check-ins, and remote monitoring of metrics, such as mobility and gait quality, exercise adherence, and heart rate.

ZB offer its customers a degree of customisation of mm. The following are optional features that the hospitals can choose from:

1. 2-way encrypted messaging
2. Telemedicine (video consultations)
3. Gait exceptions
4. WalkAI- Predictive Gait exceptions & patients progress

However, through this research it is often the case that features 3 is chosen and none of the rest. Messaging is a tricky feature which causes a lot of worry in the care teams. With a fear that patients may over communicate.

1.3 Scoping

The choice of geography was made keeping in mind the duration of the project and the usefulness of the insights. Netherlands was chosen due to the researcher's location and ease of access to hospitals and stakeholders. Also because of the researchers familiarity to the context.

The UK was chosen for the mymobility platform for several reasons: it was the first country in EMEA to adopt the technology, it has the highest number of patient enrolments in the region, and being an English-speaking country allowed for easier feedback collection on proposed interventions, especially beneficial for an English-speaking researcher.

Figure #3 was created after an internal meeting with P1, P2, P3, P4 and P5. Each bubble represents a different system, each governed by a different set of rules. For example, the grey bubble on the left refers to EU-wide regulations and is governed by a different body than the separate countries within the EU.

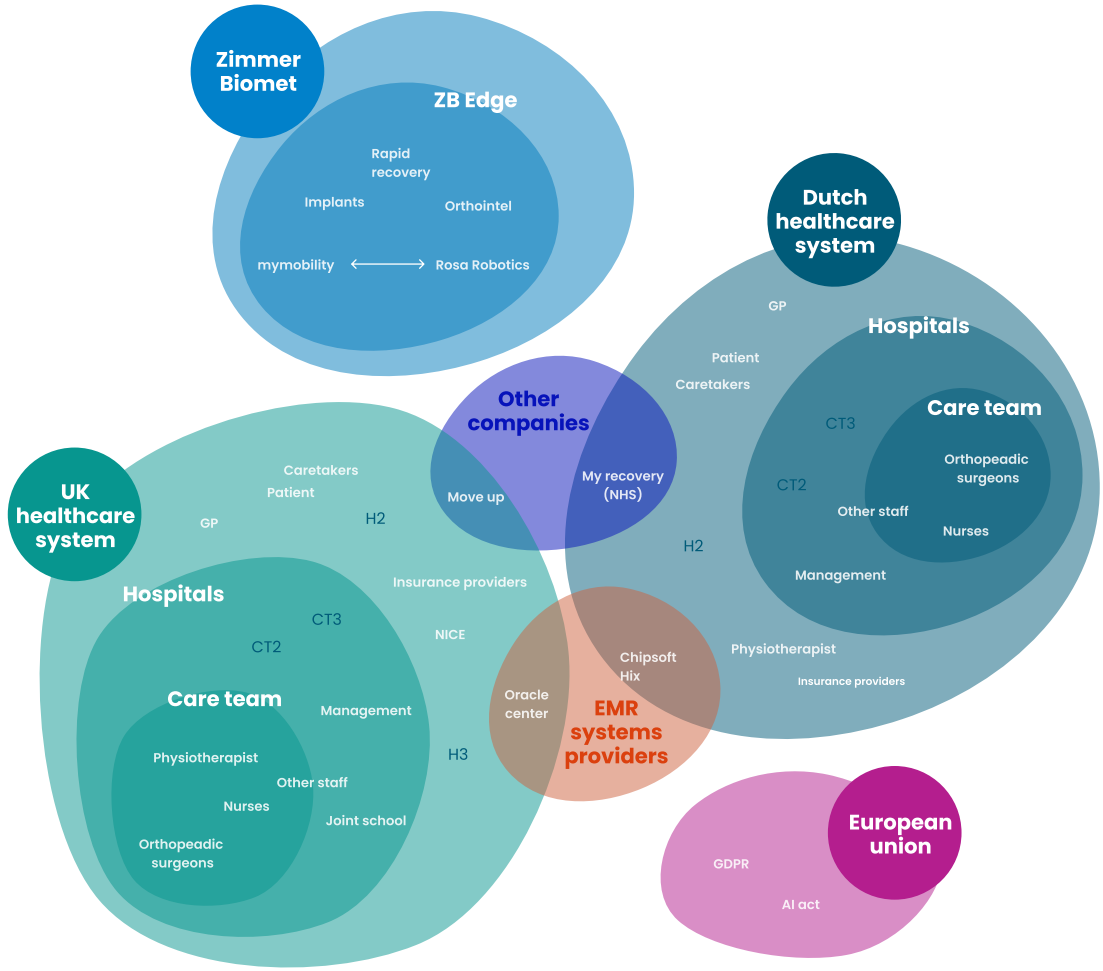


***Figure #3**: Co-created stakeholder map with P1, P3 and P4*

1.4 Healthcare systems

The Dutch and the UK healthcare systems both ensure universal coverage but differ significantly in their approaches, particularly in the care path for joint replacement surgeries.

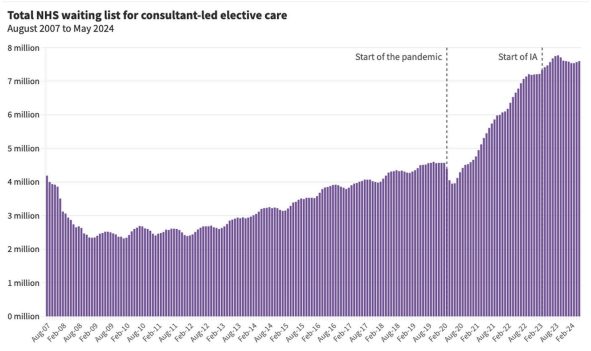


Figure #4: Wait times in the NHS for consultant-led elective care
Source: British Medical Association (2024)

1.5 Problem Framing & Strategy

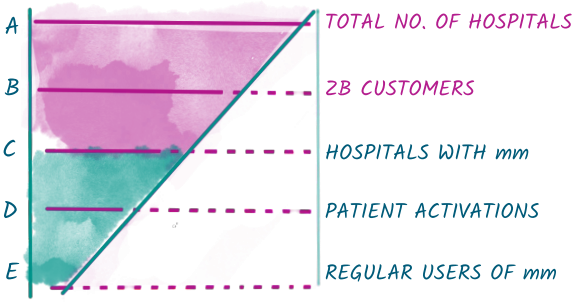


***Figure #4**: Consumer adoption funnel for mymobility*

Difference in models: The Dutch healthcare system follows the Bismarck model, which relies on multiple insurance providers funded through payroll deductions. It emphasises regulated competition among insurers and providers, aiming to balance cost, accessibility, and quality. However, this model faces challenges like rising healthcare costs and staff shortages, impacting service delivery (OECD, 2021; Van Ginneken & Schäfer, 2020). Conversely, the UK's NHS operates under the Beveridge model, which is publicly funded through taxation and provides universal healthcare coverage. The NHS is centrally managed, aiming to ensure equal access to healthcare for all citizens.

Yet, the NHS grapples with long waiting times, underfunding, and workforce shortages, particularly exacerbated by the COVID-19 pandemic (British Medical Association, 2024; Ham, Charles, & Wellings, 2018). This gives more flexibility to the patient but also means a break in the care-path of a joint-replacement patient.

Care pathway: In the UK, the NHS covers the entire care-path. Therefore, to the patient it is seen as one entity that addresses his/her care. In contrast, the Dutch system allows the patient the freedom to choose their rehabilitation specialist.

Adoption takes place at 5 different levels, as marked in Figure #5, namely:

- A: Total number of hospitals that do joint replacements within EMEA
- B: All the customers of ZB, including all the products and services they provide.
- C: Total no. of mymobilitycustomers
- D: Total no. of patient activations (refer to Figure #5 for definition of patient activation)
- E: Total no. of patients who are regular users of mymobility

Figure #4 captures the different levels of customer retention that affect the activation rate of the mymobility platform. Based on the marketing model of mymobility, it is clear looking at Figure 2 that getting a 'buy-in' from the clinicians (enablers) would also have a huge effect in widening the funnel. Based on the Diffusion of innovation theory put forward by Everett Rogers in 2014, I highlight that when mymobility is designed to suit the 'first user' who engages with it, by virtue of the design of the service, it will undoubtedly increase the number of patients engaging with the application. The goal of my research is to increase the value of B and C and as a consequence, decrease the value of A minus E.

The different users/ potential users of mymobility were grouped based on their familiarity towards the platform and the company. Based on this, 4 categories were created:

1. **Healthcare professionals who use mymobility and use other Zimmer products**: After shadowing these clinicians, I would like to conduct semi-structured interviews with them to understand how they onboard patients, what they like in mymobility and what's missing. Through research, their burning issues were addressed to ensure customer retention.

2. **Healthcare professionals who don't use mymobility but use other Zimmer products**: For these stakeholders I would like to see how these implant accounts can be converted to mymobility accounts as well. Through semi-structured interviews I would like to understand what is missing in mymobility and their hesitation to choose it. These interviews would be with the decision makers in the hospital/ healthcare centres.
3. **Healthcare Professionals who use mymobility but don't use other Zimmer products**: I would like to understand what they like in mymobility.
4. **Healthcare Professionals who don't use mymobility and don't use other Zimmer implants**: This category is very hard to identify as I primarily had access to the mymobility team and consequently the customers or ex-customers of mm.

1.6 Research goal

This brings me to the core research question this study hopes to address:
What factors influence the low adoption of the mymobility care-management platform amongst Healthcare Professionals?

Further, some sub-research questions were defined to understand the barriers clearly:

- How can a data-enabled design approach be effectively implemented in the design and deployment of service solutions in a multinational corporation?
- What are the values and needs of the healthcare providers during the joint replacement journey that a digital platform can meet?
- Is the digital platform contributing to reducing the burden on healthcare providers? Specifically, who? And how does it do so?
- What may be the reasons for the hesitation preventing the use of such platforms? How might we overcome this hesitation or design more usable platforms?

1. 7 Key Assumptions

Based on the Figure #5, the following assumptions were made:

- An increase in the number of hospitals with mymobility would automatically increase the number of patients who get access to the application, releasing a big bottleneck in the access to this application for the patient
- The easiest customers to sell mymobility first would be the healthcare institutions who are already Zimmer Biomet customers. They would already have the trust in the company and would be more willing (than non-users) to adopt a new solution that adds to the ecosystem of Zimmer Biomet.
- Keeping in mind the duration of the project and other constraints, it was decided that the core part of the investigation would be towards understanding the barriers to adoption of mymobility for the healthcare providers.

My strategic roadmap hopes to address each of these barriers through the 3 horizons ranging from 2024 to 2027.

2. Background

This chapter aims to provide a more detailed picture of the application and the context of use of mymobility. It also explains in more details the usage of the platform and its offering and how it is positioned in the market.

It presents background information on the digital transformation in health and the introduction of care-management platforms, the joint replacement care-path and the care-management platform- mymobility, to understand the overall problem of low adoption.

This project is a collaboration between Zimmer Biomet and the Data Centric Design Lab (DCD) at TU Delft. The DCD Lab develops tools and methods to facilitate the use of behavioural data as participatory design material. Zimmer Biomet approached TU Delft to help assess the Health Economic Value (HEV) of a digital solution that they provide, called mymobility. Due to time and linguistic constraints, the scope of the project was defined as the Netherland and the UK.

2.1 Zimmer Biomet and mymobility

Zimmer Biomet is one of the leading joint implant providers globally. They occupy a major part of the Orthopaedic devices market, as of 2024 they hold 18.8% of the market share (statista, 2024). Established in 1927 and based in Warsaw, Indiana, Zimmer Biomet is a prominent player in the musculoskeletal healthcare sector. The company focuses on designing, manufacturing, and marketing a wide range of products including orthopaedic reconstructive products, sports medicine, biologics, and products for extremities and trauma; spine, craniomaxillo-facial, and thoracic products; dental implants; and other related surgical products (Zimmer Biomet Holdings, Inc., 2018).

In 2016, as a part of their push towards Value Based Healthcare(Porter & Lee, 2013), Zimmer Biomet acquired a tele-rehabilitation platform called RespondWell (Zimmer Biomet, 2016)(Figure #6). The core proposition of this platform was to provide a tailored rehabilitation plan featuring a video game-like exercise system with digital instructors displayed on-screen and rewards that patients can earn through regular participation and consistency.

***Figure #6**: Respondwell Application*

This platform enables the clinical care team to remotely track patient progress and activity, and communicate digitally with the patient, potentially lowering the costs associated with follow-up visits and clinic-based rehabilitation programs. Respondwell was a care-management platform for physiotherapists to provide remote exercise programs to patients, addressing the need for better instruction and monitoring of home exercises. As healthcare needs evolved, with this acquisition, mymobility expanded to cover the entire surgical episode of care, helping patients prepare for surgery and recover afterwards with medication reminders and progress monitoring (Figure #7).

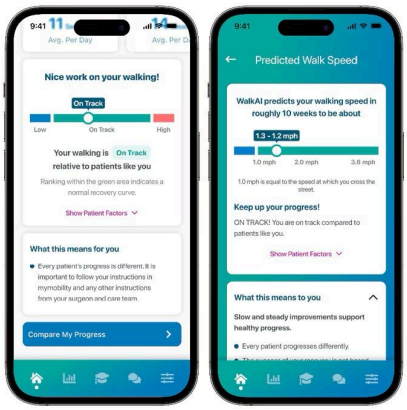


***Figure #7**: mymobility Patient-facing application (for Mobile)*

mymobility is offered along with the umbrella of solutions with the ZB Edge suite of offerings (Refer to Figure #8). These include ROSA (Surgical robot), Rapid Recovery; OrthoIntel and WalkAI.

Over the past 4 years since its launch, multiple studies have been conducted and have shown improvement in clinical outcomes such as a significant reduction in physiotherapy needed, trend towards lowering the emergency department visits. Moreover, some studies with patients should 82% rated it much better than previous medical/ surgical experience with 67% stating a reduction in their anxiety levels relating to the surgery. Moreover, they reported 22% higher pre-operative and one yeah completion of Personal Reported Outcome Measures (PROMs).

One of these offerings also connects with mymobility is Rapid Recovery. Zimmer Biomet's Rapid Recovery program is an evidence-based initiative designed to optimise orthopaedic care pathways, improving efficiency and patient outcomes. The program supports hip, knee, and shoulder replacements, as well as outpatient arthroplasty and fragility hip fracture treatments. Key components include pre-operative patient education, streamlined surgical processes, and enhanced post-operative support to promote early mobilisation and rehabilitation. The program aims to lower care costs, improve patient satisfaction, and increase surgical throughput. Implementation has shown significant benefits, including reduced hospital stays, lower complication rates, and improved clinical and operational efficiency.

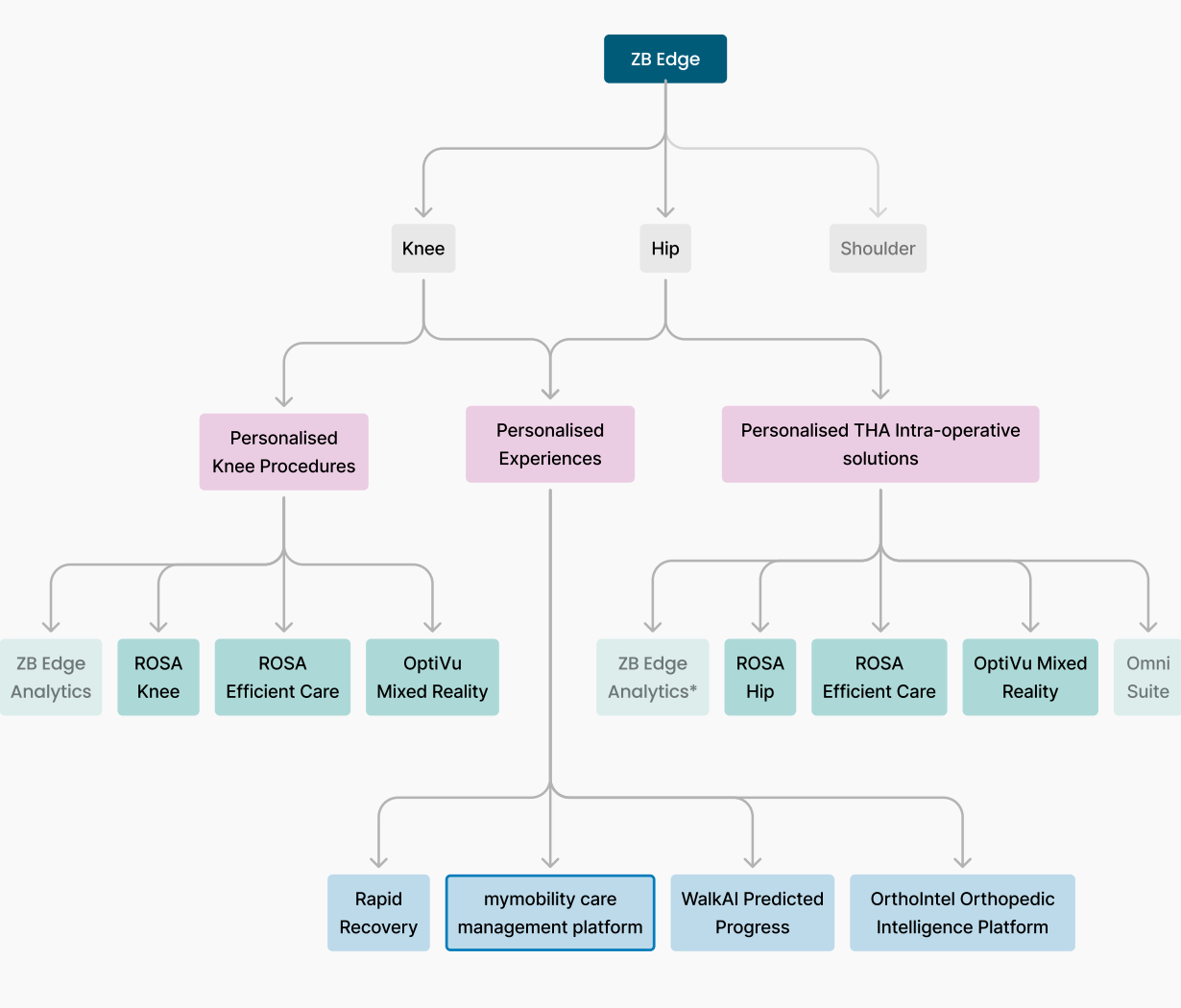


***Figure #8**: ZB Edge suite of offerings*
*ZB Edge Analytics was showcased at the WAC conference

Based on the NICE guidelines for for digital health technologies, mymobility is classified under category 3b of the Evidence Standards Framework(ESF) . Tier 3b is designated for digital health technologies that provide or guide treatment, active monitoring, clinical calculations, or diagnosis. These technologies require comprehensive evidence to demonstrate their effectiveness, safety, and economic impact. The mymobility platform, designed for orthopaedic surgical journeys, incorporates features such as tele-health protocols, remote monitoring, patient-reported outcomes, and AI-driven insights like WalkAI, aligning it with the criteria for Tier 3b technologies.

2.2 Care path with mymobility

The user journey map and patient data-flow (Figure #10a,10b and 10c) details the process from initial pain to receiving treatment, incorporating a digital monitoring solution (mm). It covers GP and specialist visits, potential treatments, hospital and physiotherapist engagement with mm, and patient onboarding and usage. The journey highlights issues like non-engagement and delays, emphasising continuous monitoring for effective recovery.

- Patient feels pain and books an appointment.
- Visits GP and is referred to a specialist.
- Undergoes tests and follow-up consultations.
- Receives conservative treatment or schedules surgery.

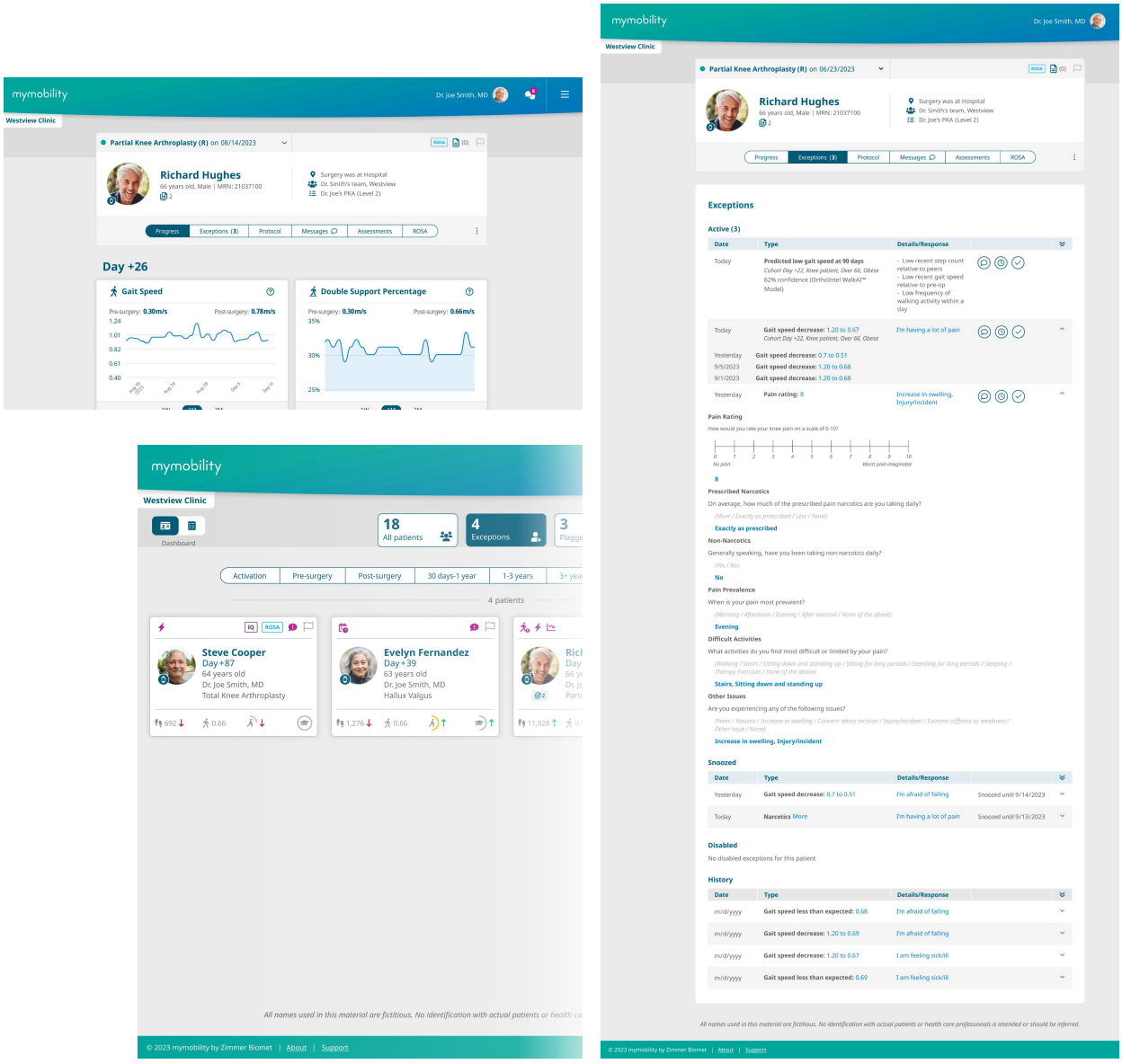


***Figure #9**: mymobility Clinician-facing application (for Desktop)*

- Hospital/Physiotherapist introduced to mymobility, signs contract, and trains staff.
- Patient onboarded to mymobility via self-enrolment and app download.
- Regular use of mymobility app by the patient.
- Monitoring of patient progress through mymobility.

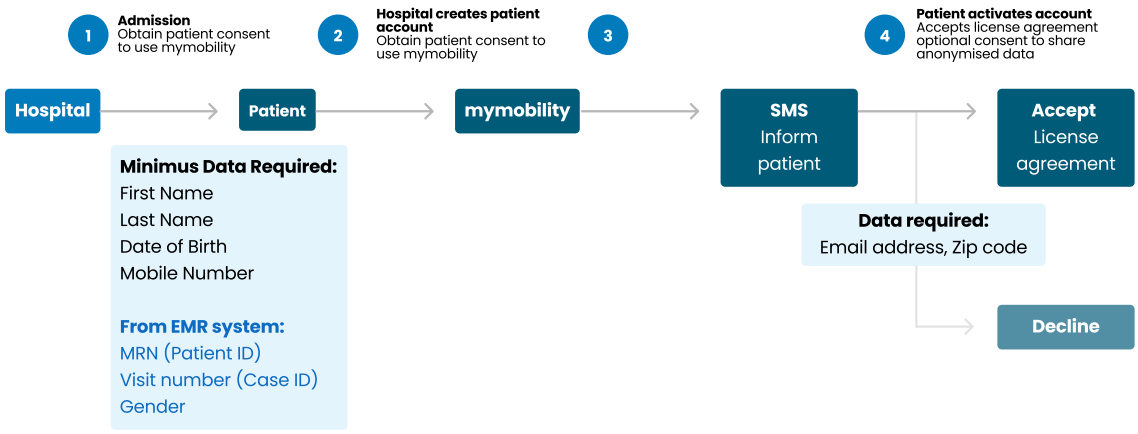


***Figure #10a**: mymobility care-management platform patient-data flow (from Zimmer Biomet)*

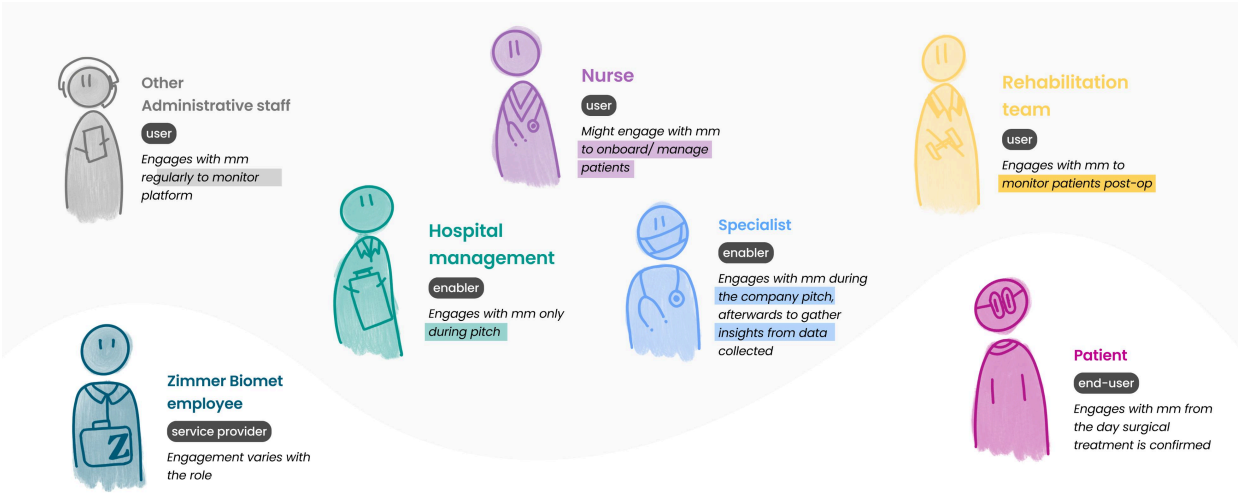


***Figure #10b**: Stakeholders involved in the project*

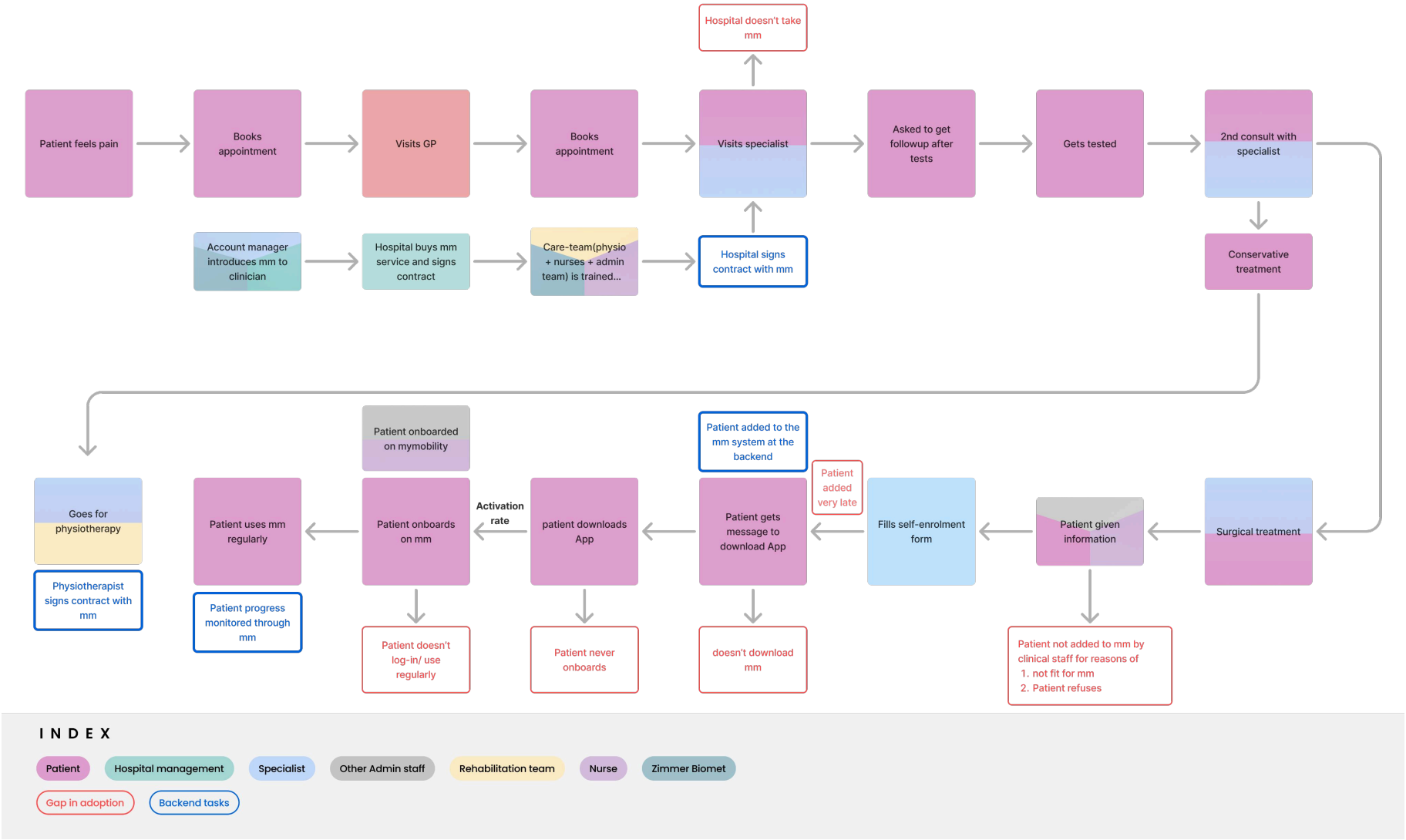


***Figure #10c**: mymobility user journey (for patients & HCPs)*

3. Methods

This chapter aims to provide an overview of the approach undertaken to conduct this design research. The well-known double diamond formed the basis of the process that was followed. It goes forward to describe in 4 sub-chapters the various phases of the double diamond and the specific activities that were conducted for each.

This chapter aims to provide an overview of the joint replacement care path, the application mymobility that forms the focus of my research and the primary stakeholders. Then the problem statement introduces the scope and the four main research questions. To conclude, the chapter presents the opportunity space and the design approach followed throughout the project.

3.1 Approach

This chapter details the processes I undertook to uncover the answers to my research question. Problems in the healthcare domain are considered wicked problems due to their complexity, involving interconnected factors like varying patient needs, disparities in socio-economic contexts, evolving medical knowledge, and diverse stakeholder interests, making straightforward solutions impossible (Rittel & Webber, 1973; Head & Alford, 2015). Additionally, every intervention in healthcare can lead to unintended consequences, necessitating continuous adaptation and re-evaluation (Brown et al., 2010, Viitanen, 2011).

For this empirical study, primarily the Research through Design (RtD) methodology was used(Koskinen, Zimmerman, Binder, Redström, & Wensveen, 2011), an iterative exploration method where the research question is addressed through a design implementation and subsequently refined and redirected based on reflections on the outcomes of the inquiry (Ylirisku, Halttunen, Nuojua, & Juustila, 2009). This method, known as Experience-based Co-design (EBCD), emphasises collaboration between healthcare providers and patients to identify problems and develop solutions together. EBCD facilitates a deeper understanding of the lived experiences of both patients and staff, promoting empathy and shared ownership of the improvement process. By actively involving healthcare professionals, EBCD ensures that the solutions are practical, contextually relevant, and more likely to be successfully implemented within the healthcare setting (Donetto et al., 2015). Engaging users in the design process ensures that solutions are tailored to real needs and contexts, enhancing their effectiveness (Jansen et al., 2020; Laurisz et al., 2023). Data-driven methods provide empirical evidence to inform decisions, allowing for iterative refinements and adaptive strategies (Calabretta & Kleinsmann, 2017).

The fundamental design process was based on the time-tested double-diamond approach by the Design Council (Design Council, 2005, Viitanen, 2011) (Figure #11). This entails two alternating phases of divergence and convergence.

- In the first phase, ie. the Discovery phase, the intention was to expand my pool of knowledge surrounding the problem and its associated context. This included semi-structured interviews with internal (within ZB) and external stakeholders, contextual inquiry with the outside-in method and a review of literature and surveys to understand user needs (Sanders & Stappers, 2008, Viitanen, 2011).
- Following this, in the Define phase, collaborative synthesis was done with stakeholders along with problem validation, eventually leading to the formulation of the research question and its sub-questions.
- In the Develop phase an iterative process was followed with ideation and concept creation, followed by a co-evaluation sessions with hospitals to generate concepts to address the core-needs (Norman & Verganti, 2014).
- Finally, the Deliver phase focused on . This integrated approach leverages diverse insights and iterative testing to create contextually relevant solutions (Design Council, 2005; Sanders & Stappers, 2008; Norman & Verganti, 2014).

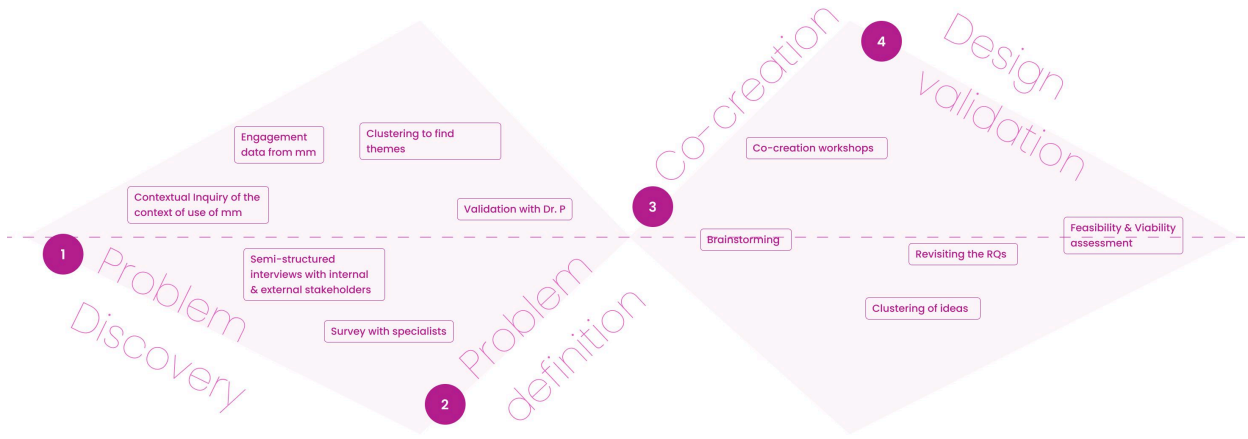


***Figure #11**: Visual representation of the double diamond process followed.*

One major limitation when conducting co-creation with healthcare professionals is the constraint of their limited time availability, which can hinder consistent participation and in-depth engagement (Sanders & Stappers, 2014). This time scarcity often results in fragmented feedback and a less comprehensive understanding of their needs and perspectives (Bate & Robert, 2007). However, in this ethnographic qualitative data-driven approach, reliability of the research findings is enhanced by providing a thick description of the context within which this research was conducted.

The Data, Information, Knowledge, Wisdom framework by Sanders and Stappers (2020) was used. The DIKW framework, which stands for Data, Information, Knowledge, and Wisdom, is a hierarchical model used for understanding how raw data is transformed into valuable insights and wisdom. The application of this framework in the design process can be seen as a method to systematically manage and interpret data to generate meaningful outcomes. This framework was applied as follows:

Data Collection: Activities like shadowing at hospitals, interviews, and surveys gather raw data.
Data Processing: Methods such as contextual inquiry and semi-structured interviews convert this raw data into structured information, captured in problem space notes and insight maps.
Knowledge Creation: Thematic analysis and affinity mapping interpret the information to generate knowledge, providing answers to research questions and identifying key themes and clusters.

Wisdom: Feedback from participatory design and co-creation workshops is used to refine ideas and develop a final strategic roadmap, ensuring that the solutions are practical, viable, and aligned with user needs. By systematically transforming data into actionable wisdom, the design process ensures that decisions are informed and solutions are effectively tailored to stakeholder needs. (Sanders et al., 2020; Stories Told by Data | Flatland Agency, 2020)

Combining these approaches creates value through user involvement in healthcare design (ResearchGate, 2013) and supports systemic perspectives in addressing complex health challenges (Pannunzio et al., 2019).

The following section is divided in four phases, classified based on the double diamond approach (**Figure #11**). Further, each phase is defined by the activities marked in (**Figure #12**).

3.2 Phase 1: Problem Discovery

The key considerations in this phase were to understand the roles of different stakeholder during the service. A significant consideration was exploring how to remain unbiased while observing and understanding the barriers to adoption.

The main goal was to understand who has access to the platform, how they engage with it and how it is integrated within their care path. The problem validation consisted of the following Activities:

1. ***Desk Research***
2. ***Shadowing at a hospital in Terneuzen***: The second step was to get familiar with the service.

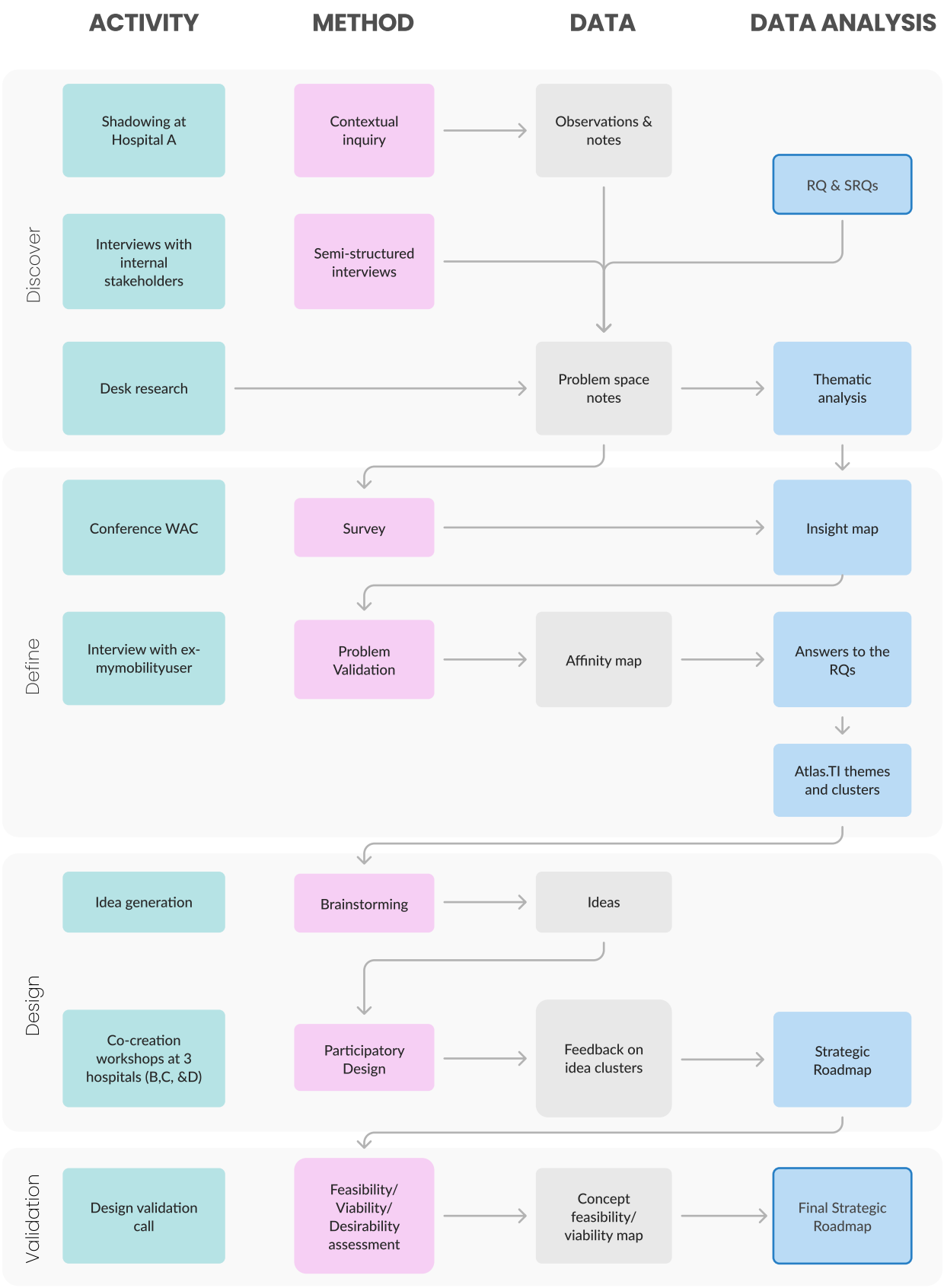


***Figure #12**: Illustration of the whole design process from observations to strategic roadmap, drawing from the framework introduced by Sanders and Stappers in 'Convivial toolbox: Generative research for the front end of design' in 2012*

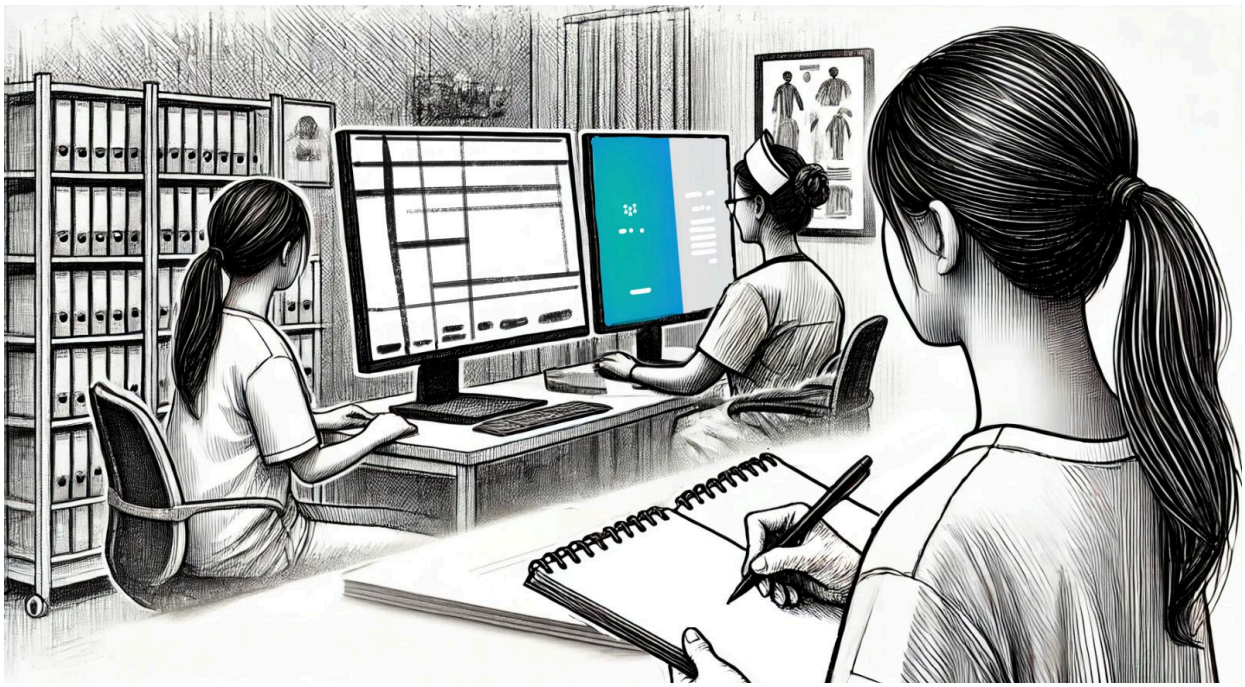


***Figure #13**: Contextual Inquiry at Hospital A - AI assisted image generated by providing detailed account of the of the context of shadowing at Hospital A and a sketch underlay from the visit. Here, the Primary Investigator(PI) is sketching and taking notes while a consultation is taking place with the Rapid Recovery/ mymobilitynurse. The screen on the LHS has the interface of the EMR system while the screen on the right has the mymobility application loaded on the browser.*

This was done with a contextual inquiry at one of the most successful accounts in South Holland, Netherlands (*Figure* #13) with the fly-on-the-wall technique. This hospital was one of the first in NL to deploy mm, they are also using the consultancy service by ZB, Rapid Recovery(RR). The goal of this visit was to discuss some stories about the use of mm, potential issues, and this hospital was one of the first in NL to deploy mm, they are also using the consultancy service by ZB, Rapid Recovery.

3. ***Semi-structured Interviews with various internal (ZB) stakeholders*** (refer to Table #1): Through these interviews, the system map and customer journey was detailed out, further questions were also asked to understand the problems faced during the usage of the application. This included meetings with P1 & P2 to understand the business context within which mymobility currently operates and the differences in the healthcare markets, meetings with the Solutions Architects to understand the nuances between the healthcare systems in the Netherlands and the UK, a meeting with P3, P4 and P5 (Refer to Table #1) gave an idea of the different data points currently gathered through mymobility and lastly, a meeting with P8, who is based in the US to understand the rationale behind the design iterations mymobility has undergone, the company's motivation to boost the adoption of mymobility and the barriers to implementing customer feedback.

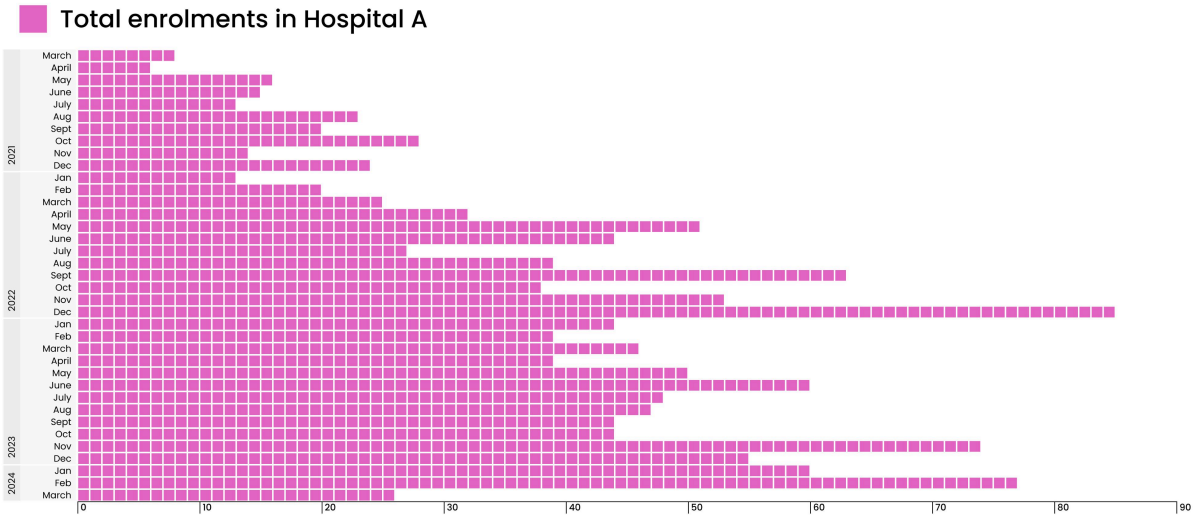
Before the contextual inquiry, the reasons for the peaks and troughs in enrolment numbers (Refer to Graph #1) was inquired with the solutions architect. In Dec, 2022 there is a steep increase possibly due to the fact that patients often want to have surgery in the winter and at the beginning of the year due to health insurance benefits.

Similarly, the reasons behind peaks and troughs in the enrolments of the other accounts was also inquired, this was due to the following reasons

- Sudden spikes in enrolments can often be attributed to the waiting lists.

	Role	Functions	Tasks
1	**Admin**	Performs the task of enrolling the patient, communicates with other care-team members to ensure smooth deployment of mm.	• Enrolling patients • Communicating with care-team members to ensure smooth deployment of mymobility
2	**Nurse**	The main user of mymobility, involved in patient assignment & discharge, dashboard monitoring, patient comymobilityunication, and onboarding.	• Assigning & discharging patients from mymobility • Regularly monitoring the mymobility dashboard • Speaking to patients about their mymobility experience • Monitoring messages regularly • Helping with onboarding if patients are stuck
3	**Clinical (Specialist)**	Limited engagement on the platform, focuses on responding to exceptions and reviewing patient performance.	• Responding to exceptions • Reviewing monthly/weekly/ yearly patient performance
4	**Clinical (Physiotherapist)**	Monitors exceptions, reviews overall performance, and suggests modifications to exercise videos.	• Monitoring exceptions • Reviewing overall performance over time • Reviewing exercise videos • Suggesting modifications specific to their practice

Table #1: Different roles identified in the care-team



***Graph #1**: Total no. of patient enrolments on the mymobilityApp by Hospital A from their first patient enrolment - March, 2024*

Title of Stakeholder	Code	Date
Marketing Manager Technology & Data Solutions EMEA	P1	27.02.2024-
Senior Marketing Manager Evidence Generation and Insights EMEA	P2	01.03.2024
Program Development Manager EMEA	P3	06.03.2024
Technology Support Manager	P4	
Product Systems Specialist EMEA	P5	
Solutions Architect - Netherlands	P6	15.03.2024
Solutions Architect - UK	P7	19.03.2024
Director Project Management - healthcare technology	P8	09.03.2024

***Table #2**: The participants interviewed*

***Figure #14**: AI generated image of the World Arthroplasty Congress where the research was conducted*

***Figure #15**: Hand-out with sticker voting, designed for the survey*

3.3 Phase 2: Problem Definition

As marked in ***Table* #1**, the problem validation process consisted of the following activities:

1. clustering the findings from the previous research activities and mapping the insights to identify themes. A summary was generated from this.
2. Based on the previous findings, a survey was conducted among specialists (enablers) to validate the barriers they experience most
3. These themes were then developed into a problem map (*Figure* #24**)**
4. Problem validation was done by reviewing the identified gaps in the mymobilityservice with Dr. P, an ex-mymobility user who now uses the Patient Journey App.

The conference participants were mostly joint replacement surgeons. As these stakeholders are tagged as enablers, my goal was to find their implicit needs and motivations through my research. Although I received that feedback, a limitation of the research method is that the feedback is not gathered from the end-user of the platform. I would argue however that from the insights from interviews and observation, one of the greatest bottlenecks to the adoption of a digital platform is convincing the surgeon, even if the end-user isn't the surgeon herself.
A user diagram was made to illustrate the different roles occupied by users of mymobility (within a healthcare organisation) (Figure #10b).

3.4 Phase 3: Conceptualisation

***Figure #16**: Toolkit for the co-creation workshop*

Administrative staff, nurses, the rehabilitation team, and patients regularly use mm for monitoring and managing patient tasks. Hospital management and specialists are enablers. Zimmer Biomet employees, as service providers, were having varying levels of engagement depending on their specific roles. I started with a rapid brainstorming session with a friend. Ideas were generated based on the clustered identified from the themes and clusteres generated from the insights mapping. Marked on the **table #3** are a list of hospitals who were chosen. The selection of the participants was done to ensure a diverse set of hospitals with high and low volume of patients.

***Figure #17**: ChatGPT DALLE-E assisted image generated by providing detailed account of the of the 3 co-creation sessions. The prompts detailed the setting along with the details of the type of participants.*

Hospital C is a specialised hospital with more attention given to quality of care delivered, while Hospital B is a multi-speciality hospital with joint-replacement being one of many care-paths they service, the same for Hospital D.
The choice of hospitals was representative of the diverse set of hospitals that mymobility caters to in the UK. Maximum variation sampling was chosen (Patton, 2015) based on the follwing:

- Diff. patient volumes
- Covered different geographies
- Had an experience of with & without other ZB products

These were some key considerations for the planning:

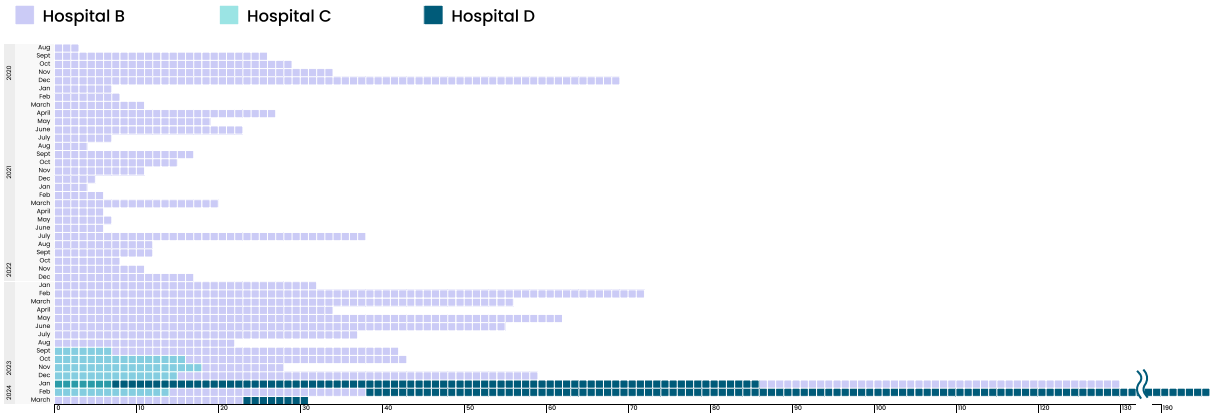
- The goal of the research was put together by me and communicated by SA via e-mail
- Co-creation sessions were set-up after the discussion
- Contextual inquiry of the accounts was done prior to the workshops
  - Understanding the number of patients enrolled
  - The features chosen by the hospital
  - Their history with mymobility
  - For Hospital B, a brief interview was done with the specialist to familiarise him with the context of the research

The clusters generated from the insight mapping done previously informed the idea clusters.

The original research question was revisited and the How Might We(HMW) statements were generated from it. With each of them addressing a different value mentioned in the research question.

- For each cluster, the ideas were made into a card-deck and organised based on the HMWs they address.
- Finally, the set of material used for the workshop small handout was created to capture some detailed info needed from the stakeholders

The audio files were transcribed and any PII was removed, they were then uploaded to DoveTail (AI platform for transcription and coding). Then quotes were gathered and themes were identified with the three co-creation sessions.

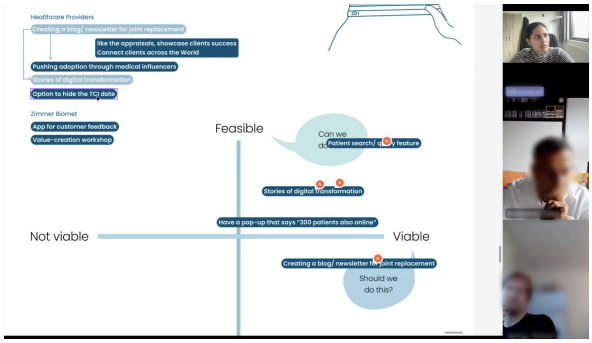


***Graph #2**: Total enrolments in Hospitals B, C and D in UK*

	Hospital	Volume of patients (hip + knee)	Values (in order of priority)	Role	Years of experience (yrs)	Participant code
1	Hospital C	3000/yr	Quality of care> Time efficiency> Well-being of HCPs	Consultant, architect	30	SA
2				Junior operations manager -small + large joints	6	OM
3				Phyio + service improvement lead	18	P
4				Business change analyst	36	BCA
5				Digital Product Manager	21	DPM
6	Hospital B	200-300 (varies)	Quality of care> Time efficiency> Well-being of HCPs	Admissions coordinator	42	AC
7				Medical Secretary	30+	MS
8				Patient Pathway coordinator	20	PPC
9				Pre-assessment nurse	14	PN
10				Consultant, orthopaedic surgeon	30	C
11				Consultant, architect		SA
12	Hospital D	3000/yr	Time efficiency> Quality of care> Wellbeing of HCPs	Deputy Service Manager	34	SM

***Table #3**: Co-creation workshop participants*

3.5 Phase 4: Design Validation

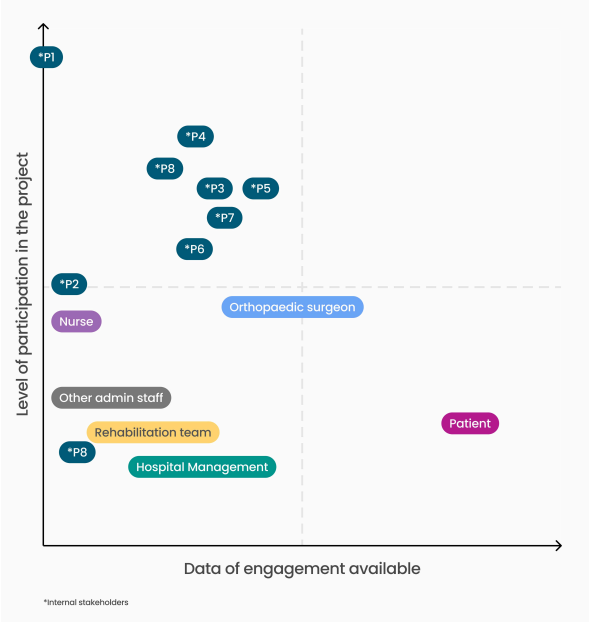


***Fiigure #18**: Viability & Feasibility call with P1 & P3*

Based on the key insights gathered from the research, a roadmap was generated to highlight the values mymobility should strive to achieve and the timeline and actions required for the same. This roadmap, along with the innovations were tested for viability and feasibility with P1 & P3. This was based on the IDEO framework for measuring Desirability, Viability and Feasibility(DVF) of a design solution. Here, the desirability refers to the The design validation stage consisted of the following activities:

1. **Desirability:** The co-creation sessions were voice-recorded and each concept was verbally narrated to the participants (**Figure #166)**. Based on the positive or negative reactions on the concept-clusters, the ideas were generated to fit within the horizons defined in the previous phase **(Figure #28)**. The ideas with positive reception were improved through discourse.

2. **Viability & feasibility assessment**: After testing the desirability of the ideas, now the viability and feasibility assessment was done with two internal stakeholders. One of them is the EMEA Marketing Manager and the other one is the Technology Support Manager. These two were chosen as they have the most suitable combination of understanding the business value of deploying a design and the feasibility of building a solution. With this review, I was able to place the ideas on a matrix and make a decision on which of the ideas should be developed further. The call was conducted on Teams with FIGMA as the tool for gathering the feedback.



***Graph #3**: Graph highlighting the level of participation in the project Vs the data of engagement with mymobilityavailable*

3.6 Process overview

At the end of the project, I reflected on the level of participation and data of engagement available to serve as a tool to measure the degree to which the participatory and data-enabled approach could be practiced within the scope of this project. The illustration shown in Graph #3 highlights the Data of Engagement Vs Level of participation graph that indicates the disparity in the available behavioural data of the care-team.

As is clearly visible, there was more participation from the internal stakeholders. The lowest level of participation was from the patients and the hospital management. This was due to the scope of the project, as detailed in section 1.3.

4. Results

In this chapter we look at the strategic roadmap that would help mymobility facilitate more efficient and seamless care for patients receiving joint replacement surgeries. It starts by explaining the problems identified in the adoption of the mymobility platform and validation of the same. Then it exhibits the generation, evaluation and consequently the validation of the Product Service Solutions(PSSs) that constitute the horizons along with the necessary actions Zimmer Biomet needs to undertake in order to realise the future vision of the mymobility platform.

The following section is divided in four phases, classified based on the double diamond approach **[Figure #11]**.

4.1 Discover Phase: Thematic analysis

The thematic analysis was overlayed with the findings from the scoping review done by Nascimento et al in 2023. This was done at the end of the Discover phase (**refer to Table #1**).

***Figure #19**: 130 page long patient hand-out given to a knee-replacement patient at Hospital A*

From the thematic analysis, I gathered the 7 most prominent barriers faced by healthcare professionals in the adoption of digital platforms. They include the following:

1. **Fear of increased working hours and workload**:
   a. Time to convert acquired information to technology-based format
   a. Time to select, purchase, and implement systems
   b. Dual workload
   c. More time needed per patient
2. **Lack of training and educational programs leads to a negative experience:**
   a. Non- user-friendly interfaces
   b. lack of provider engagement in the process
   c. Need more flexibility in training processes
3. **Personal or psychological issues:**
   a. Professional skepticism
   b. Uneasy using technology
   c. Lack of human interaction
   d. Unclear limits of interaction between patient and professionals
   e. Doesn't account for cultural and/or social diversity in patients

***Figure #20**: Handout designed for sticker voting at the conference.*

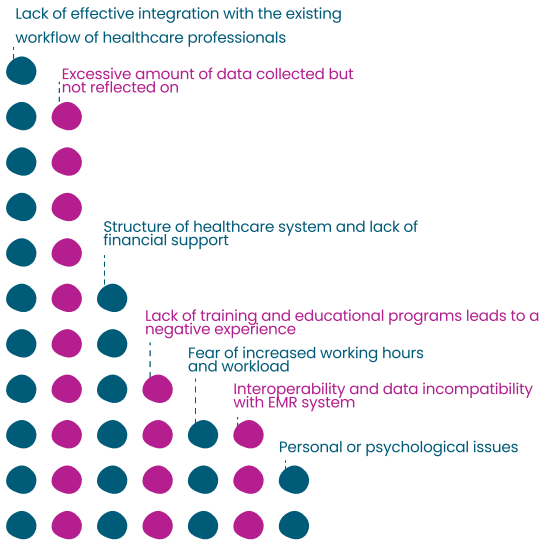


***Figure #21**: Survey results from the World Arthroplasty Congress*

4. **Structure of the healthcare system and lack of financial support**: This refers to any one or more of the following;
   a. Limited information sharing
   b. Lack of funding resources
   c. Management, including strategic plan to implement technologies
   d. Lack of incentives to engage with such a platform
   e. Uncertain over return on investment

5. **Interoperability and data incompatibility with EMR system**: This refers to any one or more of the following;
   a. Dual effort to transfer data from one system to the other: Currently the level of EMR integration offered by mymobility(with additional cost) is limited to the sharing of the surgical date & Patient Identification across systems
   b. EMR system provides some of these features already
   c. Bugs in the integration with the EMR/ HMS/EHR system

6. **Lack of effective integration with the existing workflow of healthcare professionals**: This refers to any one or more of the following;
   a. Need excessive input from healthcare professionals
   b. Bad design leads to potential loss of productivity
   c. HCPs not involved in the design process

7. **Excessive amount of data collected but not reflected on**: This refers to any one or more of the following;
   a. Frequently collected data is not explored and processed
   b. Data collected is not shared with the care-team effectively

> "So if you don't have that automated connection, you have to copy, paste everything. Yes. Well, that's what I would call a barrier!"
>
> Dr. P, Physiotherapist (ex-mymobilityuser, currently uses Patient Journey App)

The participant was asked to choose which one these barriers are the biggest roadblock to their use of digital platforms in their workflow. Although the planned format for this research was analog, plans quickly changed when I experienced short attention spans at the conference to engage in a conversation. By switching to a digital medium, ie. an iPad image where the answers were ticked, the participant engagement was boosted by 300%.

4.2 Define Phase: Problem mapping

Affinity mapping was done with all the problems identified through the research (***Figure* #22**). With this, I could now conduct problem validation with the ex-mymobilityuser and create the affinity map. Some of the problems that were repeatedly reinforced through multiple sources of information were

- **Lack of EMR integration**: This emerged through desk research, shadowing at Hospital A, shadowing during online training sessions, survey conducted during WAC and the talk with Dr. P. Currently the EMR integration ZB offers is at a level
- **Inefficient service walkthrough** and not made to fit seamlessly on a digital platform
- **Fear of patients over-communicating** can push back the customer from choosing or engaging with the messaging feature on the application
- **Structure of healthcare system/ lack of financial support** can be a set-back for the introduction of new digital platforms within a hospital

> “For each patient, I spend at least 10minutes to transfer the data from the chat to the EMR system.”
>
> Nurse at Hospital A (A nurse trained for the Rapid Recovery program)

Within EMEA, mymobilitycurrently operates in a total of 11 countries. Each country has variation in the joint replacement care-path. Within the scope of my research itself these variations became apparent and quickly made the system even more complex and the design problem even more wicked! These variations can range from smaller challenges like variations in the terminologies used in UK and NL for surgery date; in the UK they call it to-Come-In(TCI) date while in NL (and other countries) they call it surgery date to larger differences in the care-path like the existence of Joint-school in the UK, a place where patients go after they have a TCI date. This is where they get the information they need pre-surgery and can get their questions answered. While this level of variations in the markets ZB services can be a drawback of scaling-up, it can also be leveraged to apply the good features of one context to the other through their products.

4.3 Key barriers to adoption

4.3.1 Variability in context of use of mymobility

Healthcare system

Within EMEA, mymobilitycurrently operates in a total of 11 countries. Each country has variation in the joint replacement care-path. Within the scope of my research itself these variations became apparent and quickly made the system even more complex and the design problem even more wicked!

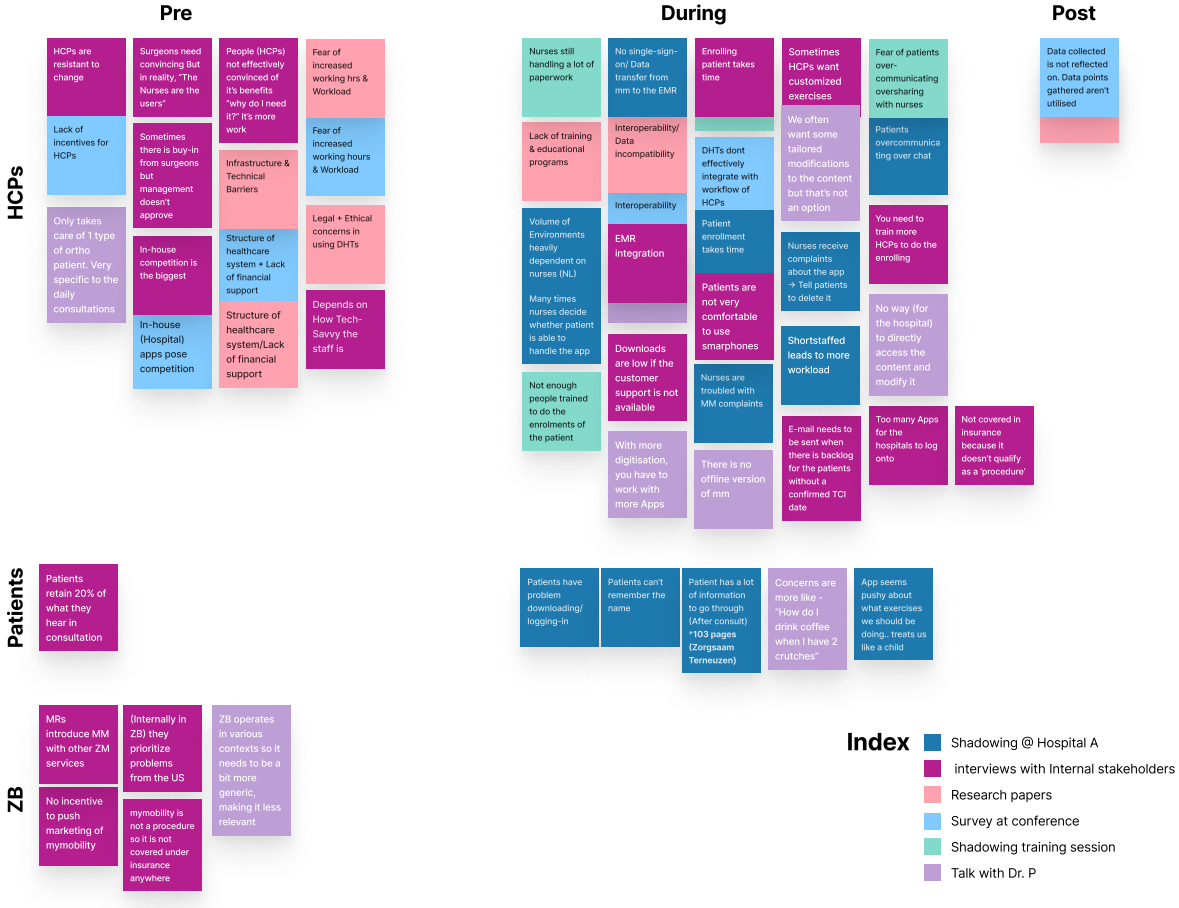


***Figure #22**: Insight map combining insights from the different research sources*

These variations can range from smaller challenges like variations in the terminologies used in UK and NL for surgery date; in the UK they call it to-Come-In(TCI) date while in NL (and other countries) they call it surgery date to larger differences in the care-path like the existence of Joint-school in the UK, a place where patients go after they have a TCI date. This is where they get the information they need pre-surgery and can get their questions answered. While this level of variations in the markets ZB services can be a drawback of scaling-up, it can also be leveraged to apply the good features of one context to the other through their products.

Roles occupied within a healthcare organisation
As illustrated previously in *Figure* #10a, it is visible that within a care-team there exist variations in the users of the mymobility application. Here, users refer to someone with any engagement with the application, from high to low. Most often these can be categorised based on 3 functions(refer to *Table* #1). The diversity in roles and tasks within a healthcare organisation hinders the adoption of mymobility. These varied needs can lead to conflicts in application design and functionality, therefore making it difficult to create a one-size-fits-all solution. By separating the sections of the App based on the user-role, you can overcome the following challenges:

- **Complexity in organising Training:** As the platform UI stays the same, trainings are planned in batches. With Ux that is tailored to a specific role, you can have shorter, more precise training modules thereby improving ease of training.
- **Inconsistent User Engagement:** Varied levels of engagement mean that less frequent users might struggle with familiarity, reducing overall efficiency.
- **Resistance to Change:** Users may resist new technology, particularly if they perceive it as complicating their tasks, with occasional users like clinical specialists being especially resistant.
- **Coordination and Communication:** Effective communication among diverse roles is challenging, and for the care-path that mymobility facilitates, they can enable that engagement by separating the Ux.
- **Customisation and Flexibility:** Balancing the need for a customisable application with a user-friendly interface is difficult and can impact user satisfaction and adoption rates.

Data incompatibility inter and intra-hospital
Data incompatibility is a well documented barrier for the adoption of digital platforms. Data incompatibility in healthcare refers to the inability of different health information systems to effectively share, exchange, and interpret data due to variations in data formats, standards, and terminologies. This incompatibility can hinder the seamless integration of patient information, leading to fragmented care, errors, and inefficiencies in clinical workflows. This incompatibility can be with different healthcare providers (eg. hospitals and rehabilitation clinics or between hospitals), or between different applications/ platforms within a hospital, "Even if each provider of this discipline would offer a platform to them and they would accept it. We we would have like 21 platforms in this hospital and then to give access update, train people and manage secure access for each. Not going to happen!"- Dr. P. (about the diversity of digital systems in a hospital)

> "globally, between countries, there are much bigger differences. So then that probably results in a more general app which isn't too detailed. But if you go fully digital, you need to be detailed."
>
> Dr. P, Physiotherapist (ex-mymobilityuser, currently uses Patient Journey App)

"There is one thing, if the patient is going for a hysterectomy for eg., it would be nice to know beforehand so we can change the schedule of their surgery already" - SM, Hospital D (about what information they would like to know from the patient)

> "Ask them what they wanted and they'd give you the longest list.. and then they would never even activate their login."
>
> 1P, Hospital C (about what the care-team wants to interact with on mm)

Between hospitals or healthcare providers, there is no data compatibility so from the patient perspective, as they move about in the healthcare system they have to share their medical history multiple times.

Patient types
Variation in patient types refer to the variation in Patient diagnosis and treatment: From the perspective of the specialist, mymobility can only be offered to the patients from their Out-Patient visits who are undergoing the surgical treatment, that too specifically knee and hip (soon expanding to shoulder). This means many patients who are undergoing conservative treatment can't benefit from mymobility.

- Level of affinity to using a smart-phone. While this is slowly diminishing with the passing of the generation, you can still see a difference in the preferences of people towards the regular use of the smartphone, the kind mymobilityrequires.
- Medical literacy: While this is not a predominant theme emerging from my research, it has been indirectly captured through the nature and volume of inquiries received by the healthcare providers from anxious patients. This is natural considering the information load the patient experiences during this phase **(refer to *Figure* #19)**. "They(Patients) ask questions that I know are in the book and I know they've had the book but they've not read it or they've forgotten it." -Physio, Hospital C (on information overload for patients)

"if you see 20 patients back to back all in mymobilitythat's pretty easy, but that's not reality. You have a mixed consultation, patient with foot problems, with a prosthesis or with knee problems but now the screen timed out..."

Dr. P, Physiotherapist (ex-mymobilityuser, currently uses Patient Journey App)

"So these are the employees who will benefit not at all by working harder for the institution. So those incentives don't incentivise the people you're trying to incentivise...."

2C, Hospital B (on the incentives for nurses to increase mymobilityadoption)

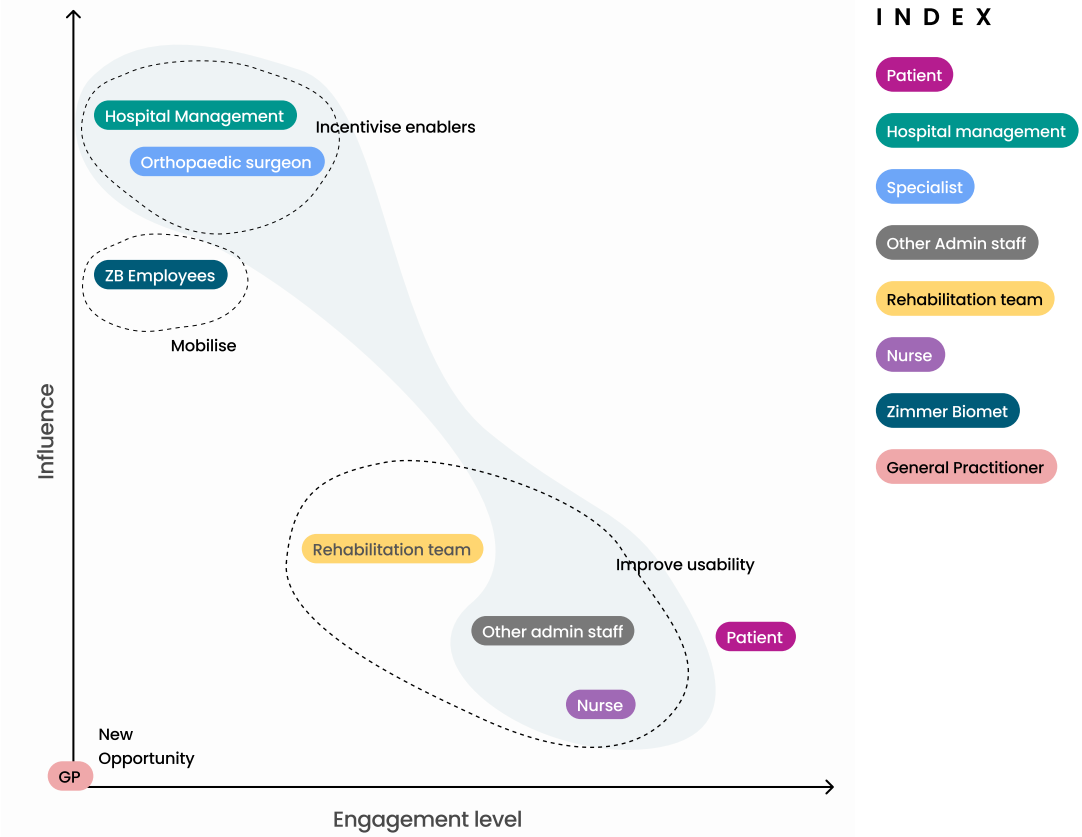
4.3.2 Lack of motivation for care-team to increase patient engagement

As highlighted in the previous section, mymobility as it is currently designed, is adding to the workload of the healthcare professional. A truly great service is one that is so intuitive and user-friendly that it requires no training at all, allowing users to seamlessly integrate it into their daily lives without a steep learning curve.

Every minute spent by the HCPs is precious and they have to justify spending those extra minutes in learning and using a care-platform. Sometimes the incentives are provided through certificates provided to the care-team for their participation in the training, this helps them with their appraisals. Minutes that can be spent on the care of other patients. Therefore, it is key that we provide them with a service that doesn't require a time-commitment outside of their hours of work.

Graph #4 displays the influence Vs Engagement levels of the various stakeholders. The grey coloured shape denotes a single care-team (as previously displayed in ***Figure* #10b**). Currently the lack of incentives for the frequent users of mymobility(Nurses, admin staff and the physiotherapists) can reduce their motivation to encourage more patients to onboard/ engage with the application. With this graph we see the following opportunities:

- Improve usability of nurses, admin staff and rehabilitation team: The HCPs with the highest level of engagement on mymobility
- Incentivise enablers: By improving usability, therfore efficiency of the care-teams, you incentivise the enablers as ZB is already providing evidence of better clinical outcomes.
- Mobilising ZB to initiate this transformation
- New opportunity to open access to mymobility through the GP.



Graph #4: *The relationship between the different members of the care-team*

4.3.3 Lack of effective feedback loop

ZB currently maintains a customer feedback sheet where multiple employees of the company can report their complaints pertaining to the application. However this is an internal file and the entries are mostly made through internal usability testing or through Voice Of Customer(VOC) feedback most often reported by the solution architects.

> Ah for Rapid Recovery they actually had that... they showed us the build.
>
> P, Hospital C (About the demo account of the hospital build)

There is also a big scope to improve the cross-team collaboration within ZB Edge. With Rapid Recovery having independent Solutions Architects and sometimes independent points of contacts within the hospital. There is a wealth of data (customer feedback) on what works well, in the product and also in the communication with the care-teams that isn't shared across different teams.

This siloed approach within the organisation means each department functions independently, without engaging in cross-functional collaboration. Breaking these barriers within ZB Edge can help enhance organisational synergy. Encouraging cross-product collaboration can mitigate these issues with adoption and compliment one-another, fostering a more integrated and cohesive working environment.

4.3.4 Low motivation to independently market mm

As highlighted in the previous section, mymobilityas it is currently designed, is adding to the workload of the healthcare professional.

This feedback is then categories and labelled based on the urgency, regular backlog grooming is done by the project management team who also look at the reoccurrence of these complaints across multiple customers and geographies. These are then reviewed by the advisory board panel and the decision is conveyed to the product development team.

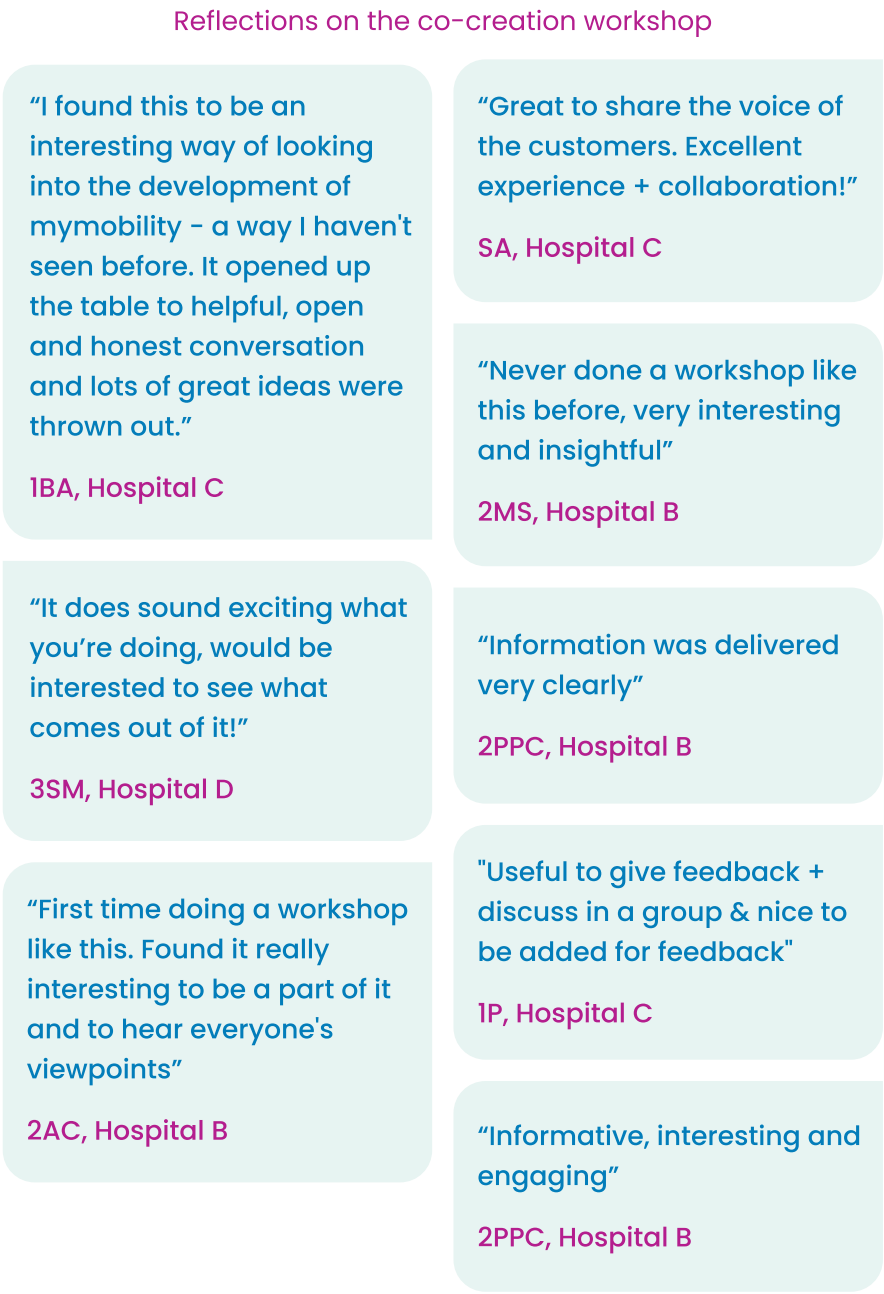


Figure #23: *Quotes from the reflections of participants of the co-creation workshops*

The current business model for mymobility doesn't generate any revenue, it is a product that helps Zimmer Biomet to provide services across the continuum of care. Therefore, independent resources have not been allocated to market it by itself. This is also why there is low impetus to boost the adoption of the platform as it merely serves as one of many product-service-solutions provided by ZB.

"mymobility isn't marketed separately, it is marketed as a whole, as ZB Edge. The account managers aren't used to marketing digital technologies, they are used to the physical products." - Solutions Architect, Zimmer Biomet

4.3.5 Challenge of 'innovation-ownership' in healthcare

Private companies are particularly well-positioned to design and develop innovative digital platforms within the healthcare sector due to their access to advanced technologies, access to R&D funds, specialised expertise, and the ability to rapidly iterate on solutions. However, they face significant challenges when competing against in-house solutions developed by hospitals or electronic medical record (EMR) providers. These internal solutions are often more closely aligned with the specific needs and workflows of the healthcare institutions that create them, resulting in better integration and potentially higher

acceptance among healthcare professionals. They benefit from a deep understanding of the institutional context and the ability to tailor functionalities precisely to the needs of end-users.

Balancing these dynamics is crucial for the successful adoption and utilisation of digital platforms in healthcare. It necessitates a collaborative approach where private companies and healthcare providers work together to integrate the best aspects of both externally developed and in-house solutions. This collaboration can foster an environment where innovation is driven by both technological advancement and practical applicability, ultimately enhancing patient care and operational efficiency.

With the current design of the application, these users will have to be motivated through ease of use of the application. While all the care-teams from Hospitals B, C & D highlighted that they value quality of care above all else, this commitment can be surpassed due to the increase workload the platform may bring to the care-team.

4.4 Design Phase

4.4.1 Brainstorming & co-creation

The ideas generated from the rapid brainstorming session are discussed and re-clustering yields the following distinct themes:

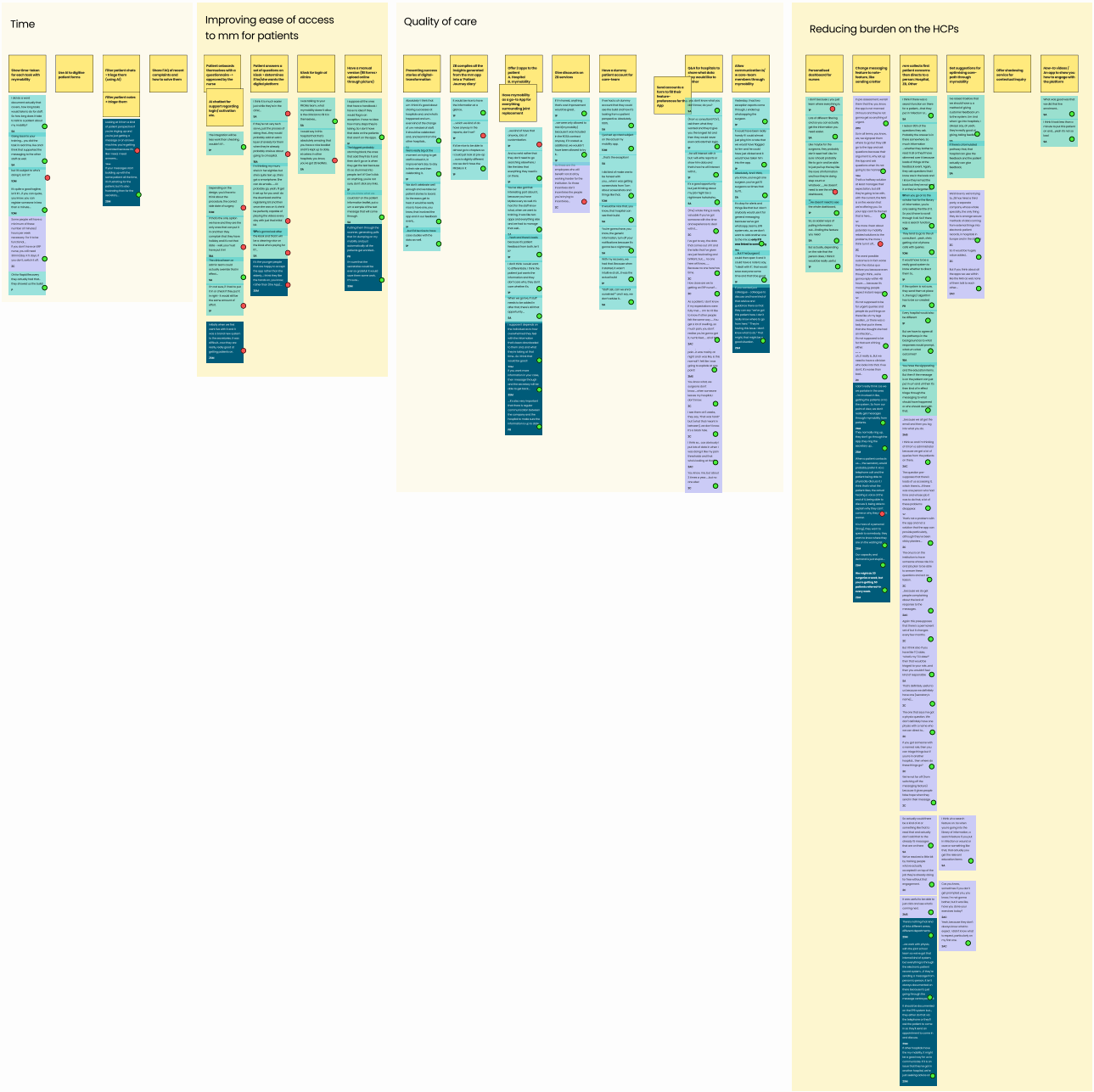


Figure #24: *Sentiment analysis of the quotes from the co-creation workshops*

- *How might we add more value to the care delivered through mymobility?*
- *How might we improve the time-efficiency of care delivered?*
- *How might we get more patients to engage with the platform?*
- *How might we use reduce the burden of the healthcare professionals?*

The open-format of the co-creation session gave the participants freedom to express their opinions openly. The ideas with more than 4 red quotes were discarded.

This activity served as a test for desirability for the users in focus- HCPs.

4.5 Design Roadmap

4.5.1 Horizon #1

In the first horizon, the focus should be on incentivising Zimmer Biomet for changing focus towards improving adoption of the mymobility platform along with retaining the existing customers by addressing the recurring complaints in the usage of the current platform. The value of focus in this horizon is reducing the burden on the care providers while retaining the existing users.

In this horizon we tackle the problem of

- Low motivation to independently market mm
- Lack of effective feedback loop
- Challenge of 'innovation ownership' in healthcare

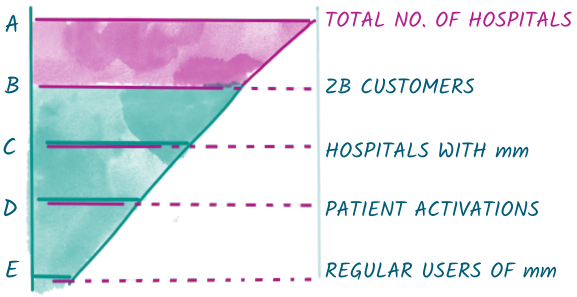


***Figure #25**: Consumer adoption funnel for mm- Horizon 1*

This will bring us to ***Figure #25***. From here, we try and increase the total number of hospitals with the mymobilityplatform. By increasing the value of mymobility within ZB, we push good promotion of mymobility through other channels and discover new cross-product value for mymobility within ZB with the value - creation workshop (Rossi et al., 2024). By addressing the low hanging fruit and fixing the burning issues with the usability of the application, we improve the adoption of the mymobility platform along with retaining the existing customers by addressing the recurring complaints.

4.5.2 Horizon #2

In the second horizon, the focus shifts to the care-providers. Redesigning the service to effectively improve their workflow and co-design a version of the Application that is best suited to their needs.

In this horizon we tackle the problem of

- Variability in customers serviced by ZB
- Lack of effective feedback loop

This will bring us to the second horizon and ***Figure #26***. From here, we try and increase the total number of hospitals with the mymobility platform, ie. 'C'.

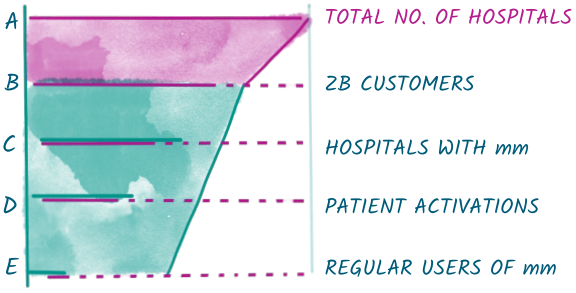


***Figure #26**: Consumer adoption funnel for mm- Horizon 2*

By improving the efficiency that the care-teams can achieve with mymobility through feature enhancements, we ensure a higher adoption rate of the application amongst care-providers.

4.5.3 Horizon #3

In the third horizon, the focus shifts back to the patient. Being a pioneer in the field of orthopaedics, mymobility should enhance the value of care given to and received by the patient. Expanding their reach beyond the average knee-replacement patient.

In this horizon we tackle the problem of

- Variability in customers serviced by ZB
- Challenge of 'innovation ownership' in healthcare

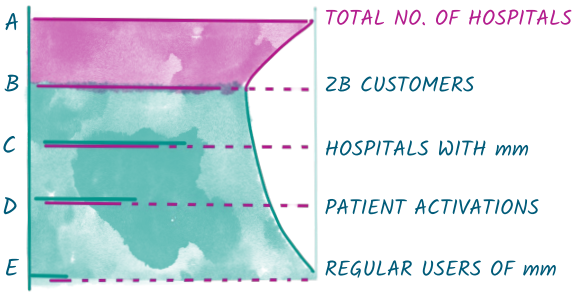


***Figure #27**: Consumer adoption funnel for mm- Horizon 3*

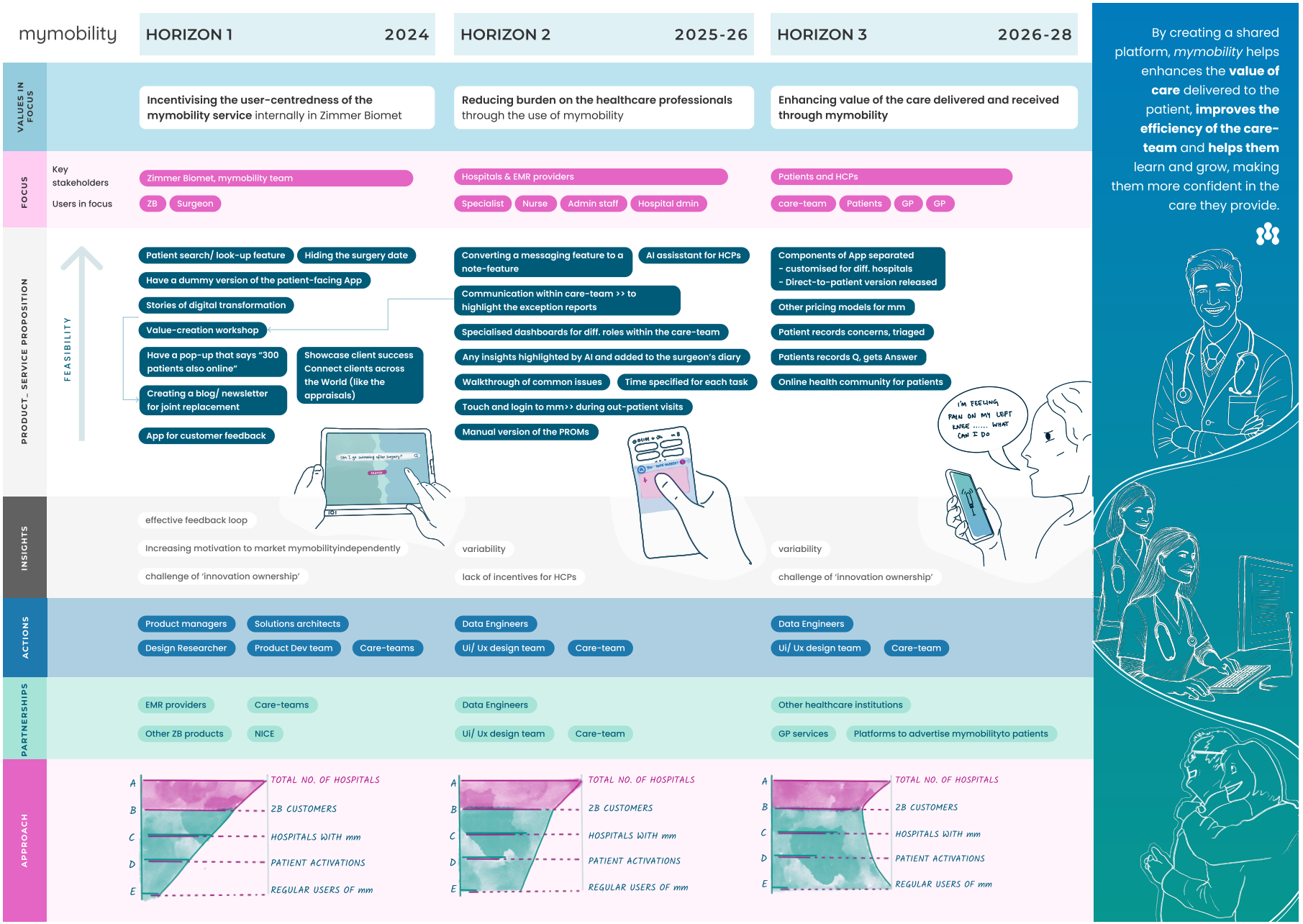


***Figure #28**: Consumer adoption funnel for mymobility- Horizon 3*

In the third horizon, the focus shifts to all the participants of the care-path and to enhancing the value of care delivered as a whole (Figure #28). Zimmer Biomet should utilise their decades of experience in joint replacement and orthopaedics to get direct access to the patients. By this I mean all patients, Providing a sustainable, long-term strategy for them to engage with the material, which gives ZB a large database to innovate with in the future. In this horizon, by opening parts/ modules of the application direct-to-patient, they can start marketing to the GPs directly.

This will boost their uptake. Getting access to high volume of patients across diverse geographies opens up a realm of opportunities for the product-service. Now we arrive at the last horizon and ***Figure* #28,** Here we try and remove the clinical team as a gate-keeper for the mymobility application and extend our reach to patients with multiple orthopaedic conditions. Increasing E by by-passing C. This also lends well to the digital transformation of ZB and makes them a leader in orthopaedic care-management for both, the care-receivers and providers.

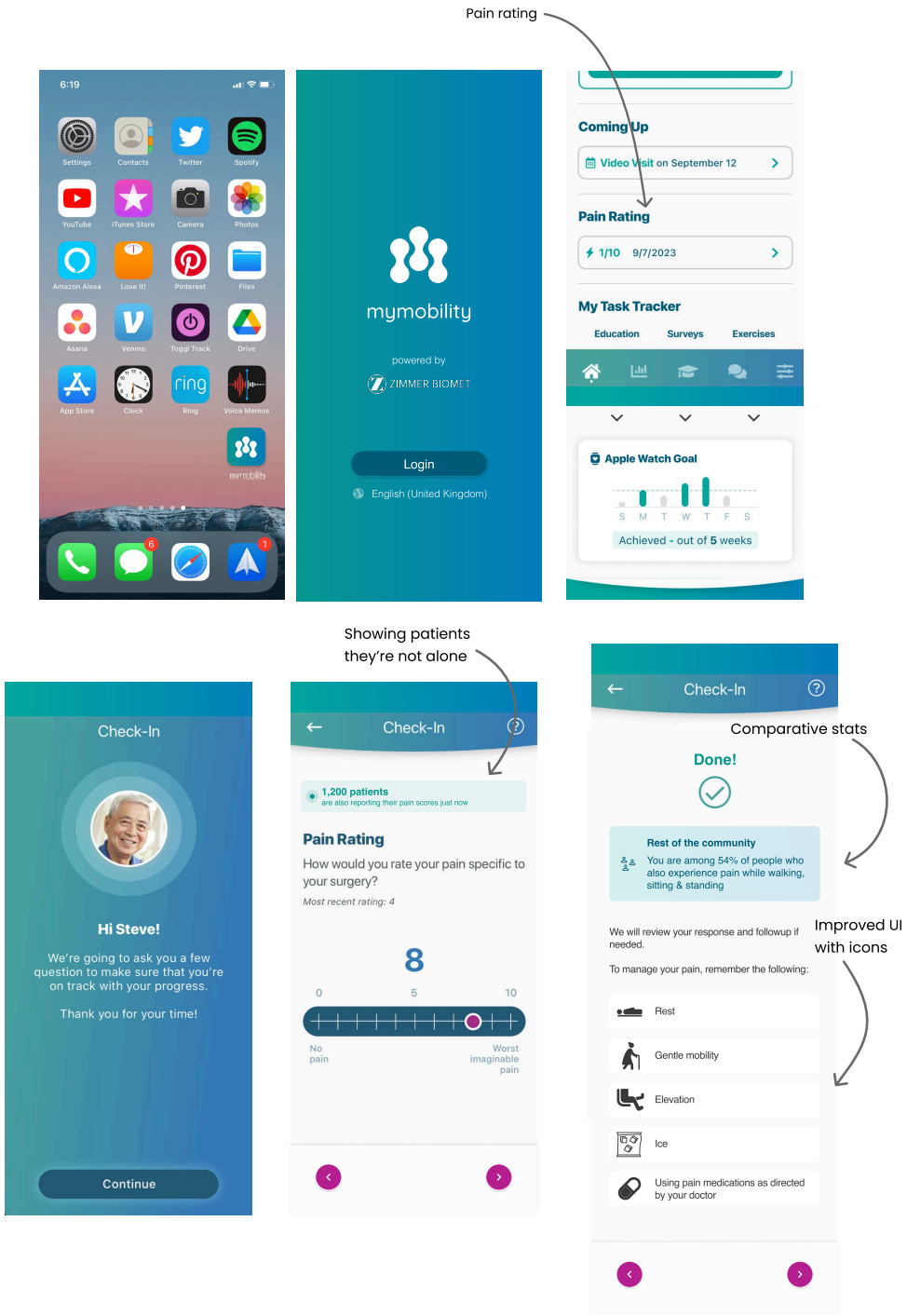


***Figure #29**: The idea about pain levels: "XXX patients also reporting their pain scores"*

4.6 Design Prototypes

The system is designed to enhance patient monitoring and streamline healthcare processes. Key functionalities include (Figure #30):

1. Patient search feature: Easy query feature that can direct the patient to any specific type of information so they don't have to go looking (or asking).
2. Exceptions: Review anomalies or outliers in patient data to ensure no critical issues are overlooked.
3. Data Review: AI generated insights and suggested actions based on analysed patient data trends over a period of time.
4. Customised actions: Customise actions for regular check-ins to ensure tailored care plans.

Lastly, the system supports (Figure #31 and 32):

6. Clear overview: A cleaner dashboard helps reduce the time taken to complete various tasks to improve efficiency.
7. Restricted access: Unique access for each member of the care-team. Reducing clutter and cognitive load on each user (Clinician, nurse or Admin).
8. Chat is now notes: More precise and short engagement reduces pressure on the care-teams to be responsive constantly.
9. AI assisted triaging of notes: AI assisted categorisation based on importance, low temperature LLM.
10. Customer support: Provide real-time assistance to staff members encountering difficulties (Figure #33).

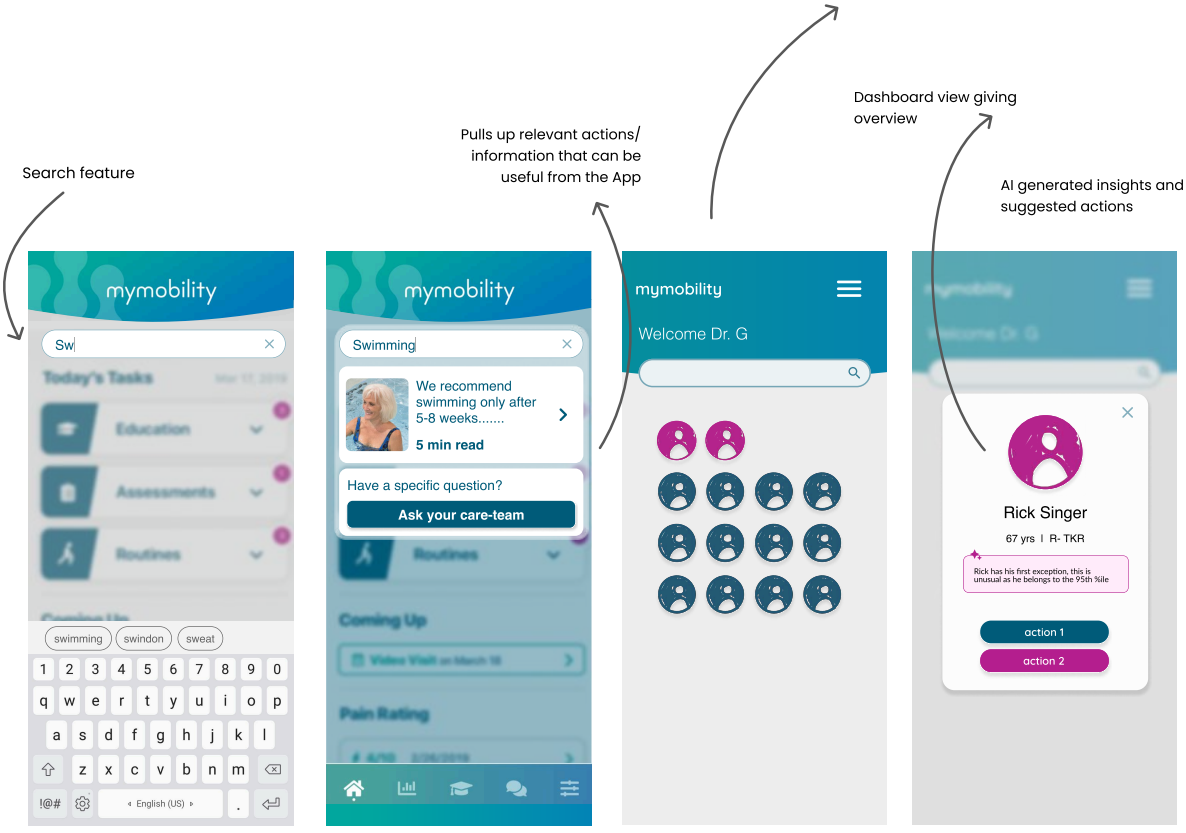


***Figure #30**: Patient-search feature & mobile dashboard overview with AI generated insights*

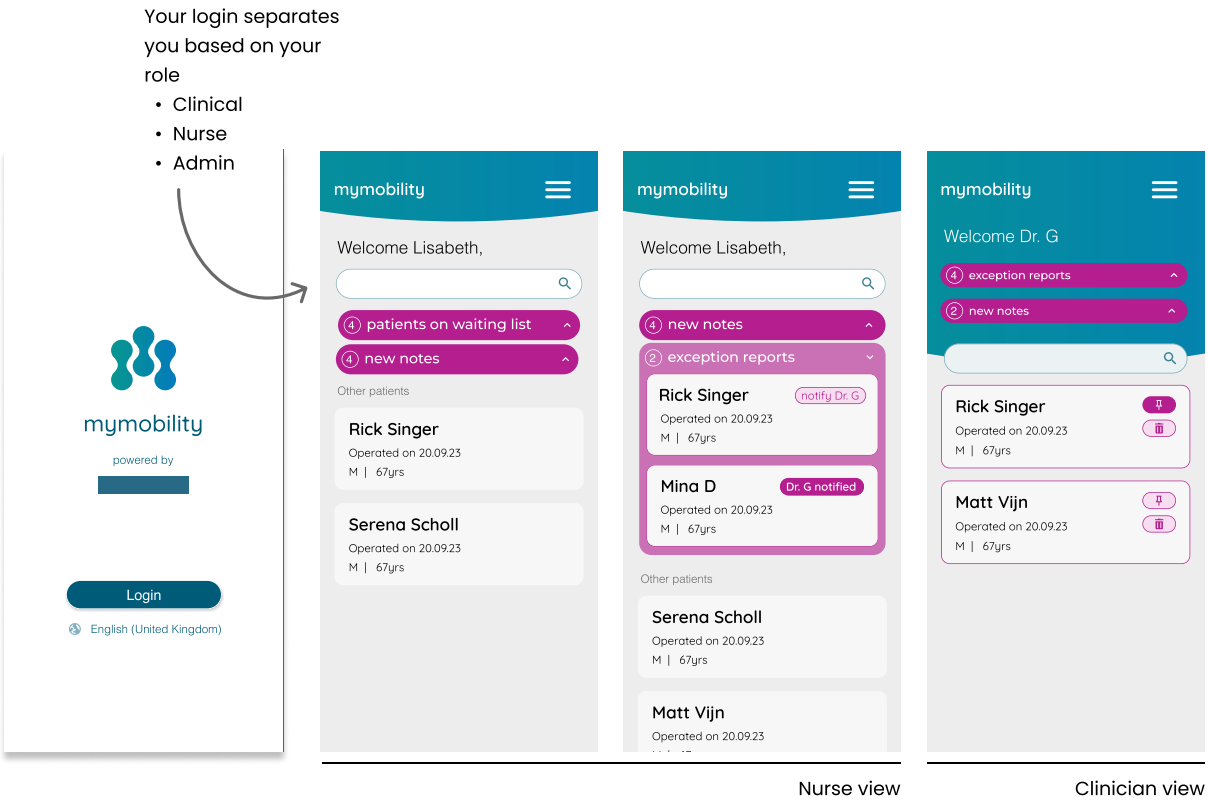
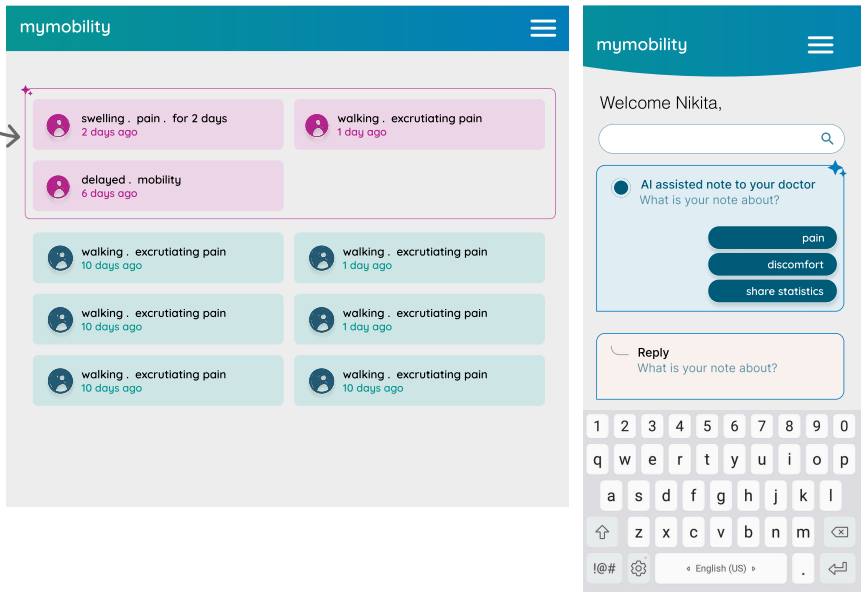


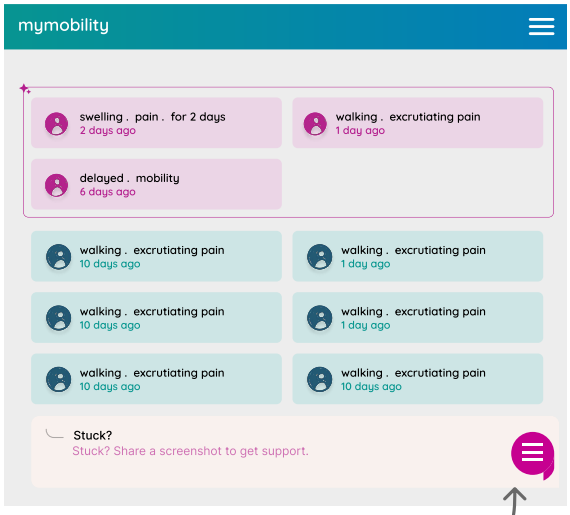
***Figure #31**: Patient-search feature & mobile dashboard overview with AI generated insights*

AI assisted triaging
of notes + keywords



Chat feature is converted to notes, less demanding of the HCPs **(Patient view)**

***Figure #32**: Patient-search feature & mobile dashboard overview with AI generated insights*



Share customer feedback directly whenever you're stuck, or get steps to find your way

***Figure #33**: Customer feedback feature*

4.7 Design Validation

The design validation of the 3 horizons (Figure #34,35,36) yielded a mixture of results. Some ideas were well received, with future potential to develop into solutions like the feature to allow communication between different members of the care team.

This is something that they had also identified in their VOC reviews and had logged in their customer feedback excel as a 'nice-to-have' feature. My research has shown the urgent need to provide this tailored view per-role within the care-team and hopefully mymobility can start the development of this feature soon.

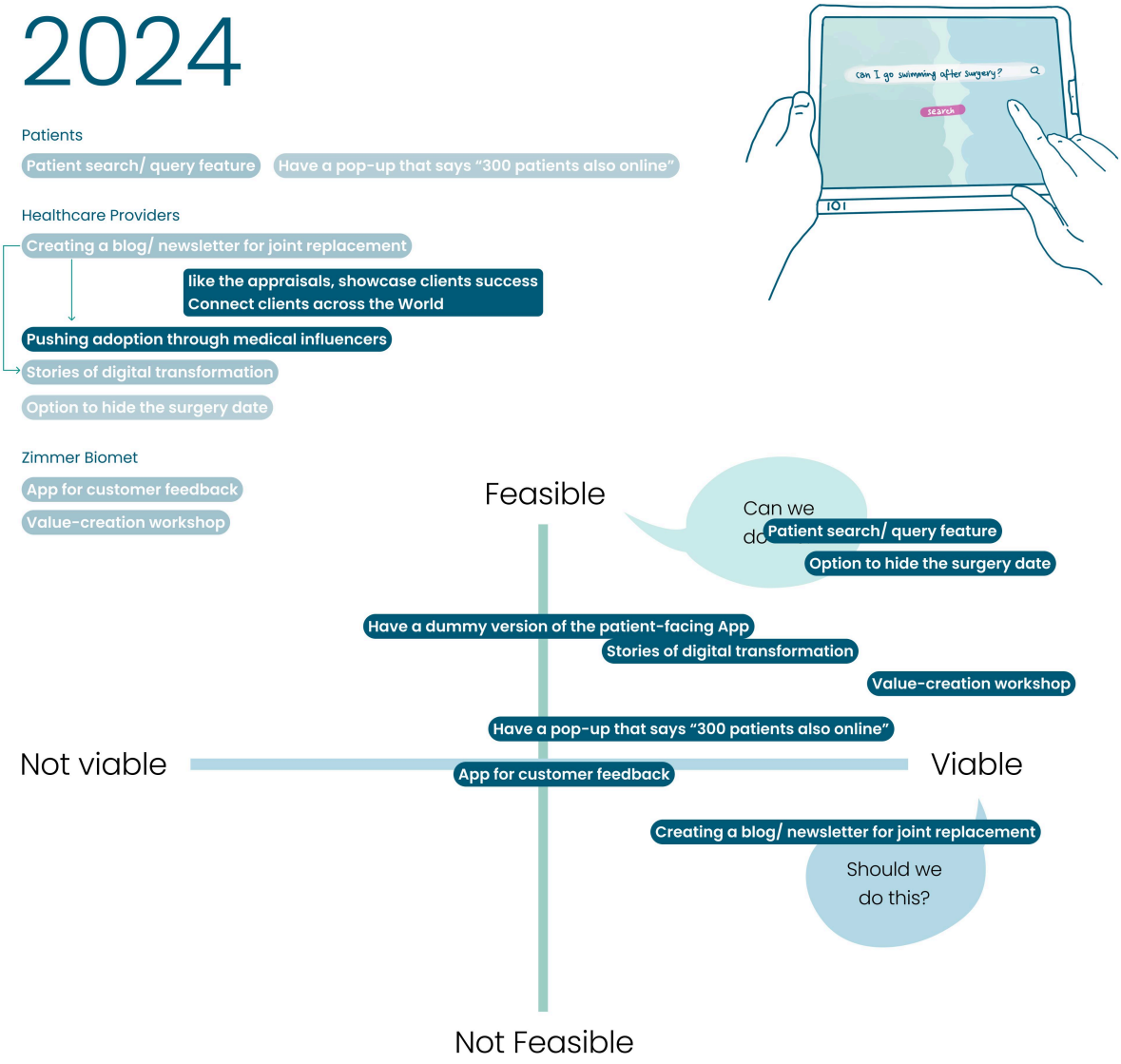


Figure #34: Assessing the feasibility & viability of the ideas from Horizon #1

Some of the ideas were deemed very feasible and viable and their development is already in the pipeline. An example of this is the patient-search/ query feature in Horizon #1. However, the revisions that ZB had planned to launch were never tried.

Then there were a few ideas that didn't seem too feasible or viable. An example of this was the customer feedback App. While this can be very desirable for the customers, it won't yield much to Zimmer Biomet to invest these many resources on it full-time in the near future.

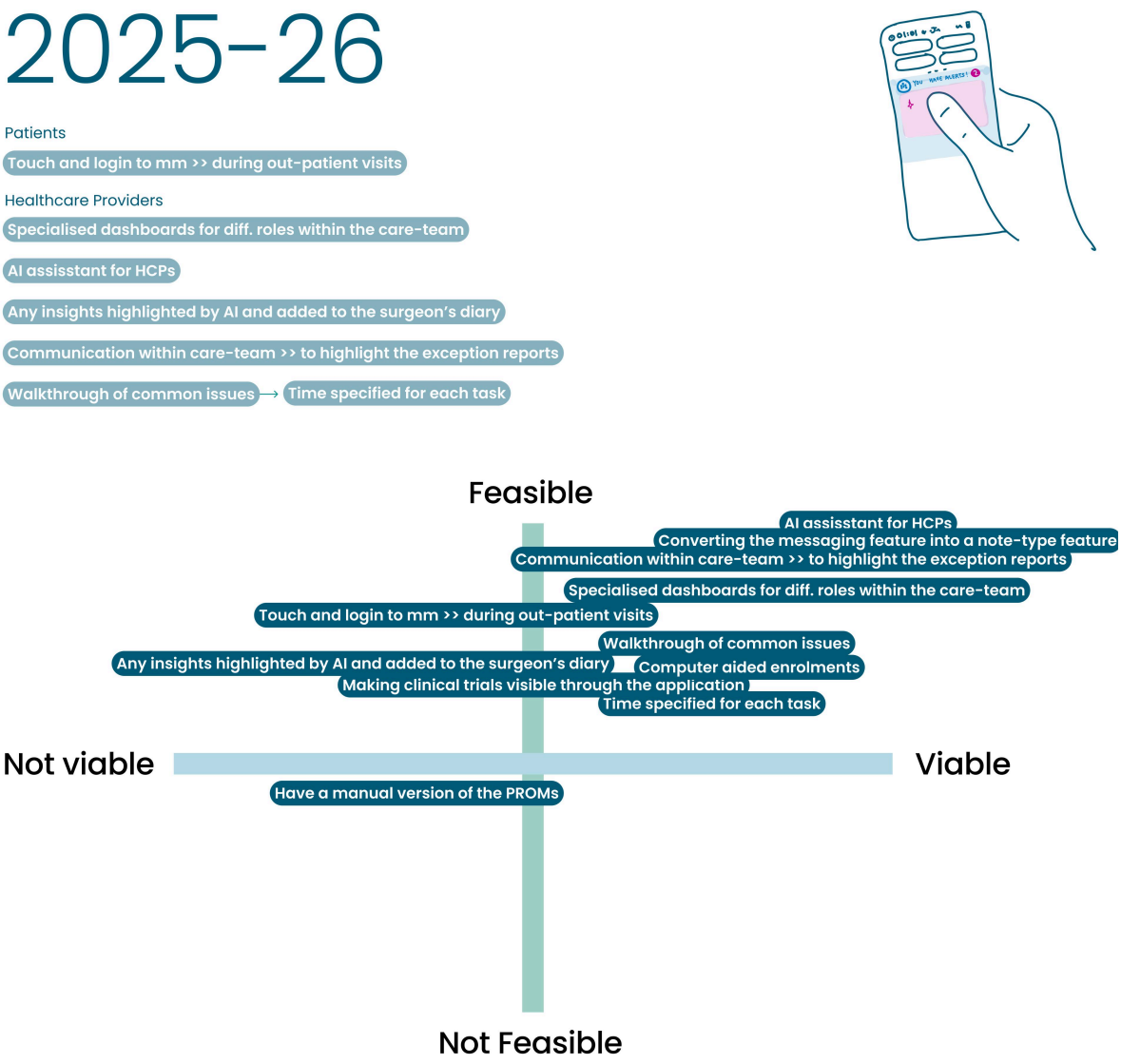


Figure #35: Assessing the feasibility & viability of the ideas from Horizon #2

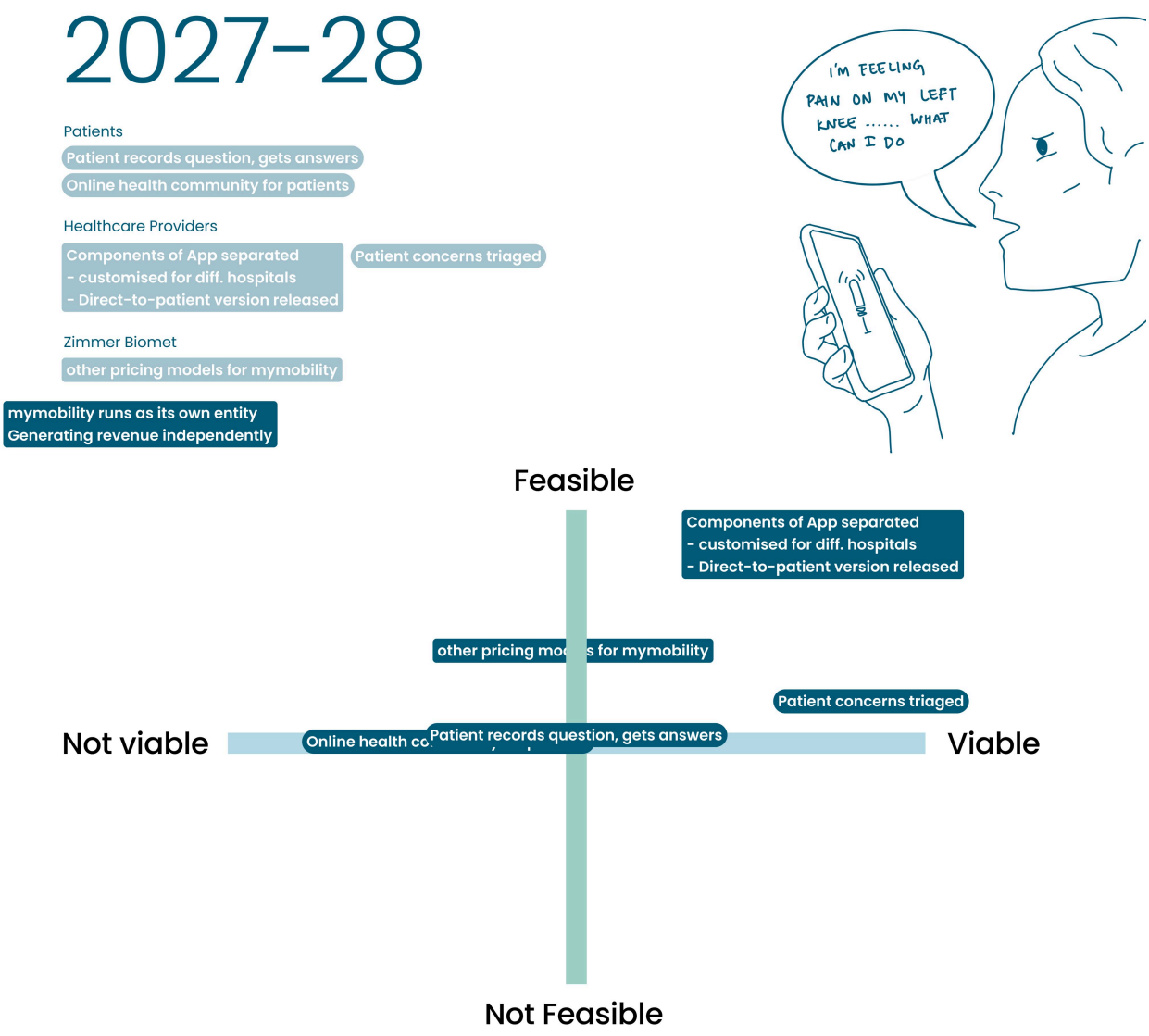


Figure #36: Assessing the feasibility & viability of the ideas from Horizon #3

5. Discussion

In this chapter I relook at the research questions and the sub-questions to see how it has been addressed. I also reflect on the method followed, discuss limitations and the future scope of this research.

The primary research question aimed to uncover the reasons behind the low adoption rate, which was addressed through the investigation of several sub-research questions.

5.1 Addressing Research Question

5.1.1 Using a data-enabled approach to design and deploy service solutions at Zimmer Biomet

Through a participatory approach, I was able to make sense of the data collected. Highlight parts of the roadmap that increase incentives for the HCPs:

- Also the customer feedback App/ feature.
- The split of the 3 horizons was informed by the choice of this approach
- Dummy version of the patient-facing application: This can be easily introduced in the first horizon.

5.1.2 Reducing the hesitation to adopt the mymobility platform

- Better integration with the EMR systems
- Value-mapping workshop within ZB >> connections with other products to stregthen the ZB Edge offering will make mymobility more lucrative to the Hospitals to adopt.
- Show success stories of digital transformation

5.1.3 Addressing the values of HCPs during the joint replacement care-path

Highlight solutions from the roadmap that address the need for time-efficiency of care-delivered.

- Time specified for each task
- Specialised roles within the care-team (diff. functions
- Communicating within the care-team
- AI assistant
- Patient search/ look-up feature
- Blog/ newsletter for joint replacement
- '300 patients also online'
- Diary feature

5.1.4 Reducing the burden on the HCPs with the use of mymobility

Highlight solutions from the roadmap that help reduce the burden on the HCPs. Also highlight how this addresses the key findings. Draw reference to 'Lack of incentives', 'lack of effective feedback loop' and 'challenge in innovation ownership'

- Converting the messaging feature to a note feature
- Hiding the surgery date
- Patient records concerns, triaged
- AI assistant for HCPs

5.2 Reflection on the process

Although this assignment was an investigation into the usability and deployment of the mymobility platform, it made me reflect on the challenges any private company while designing an App for use in the healthcare institutions would always face the problem of interoperability. As a designer, the ideal solution would be one that is the most seamless, therefore designed at the healthcare institute, tailored to their specific workflow. However, the argument against it would be the lack of an engineering design team and the shortage of funds to channel towards Research and Development (R&D).

There is surely benefit in tapping on the capabilities of private companies that have specialised expertise and ample funding for R&D to design such solutions. However, then we are faced with the challenge of scaling such a platform and then the problem of customisation is brought back. Leading me to ask some more fundamental questions; how should design iterations take place? How often? How should the interests of a diverse, multicultural set of stakeholders be taken into account through the design of 1 solution?

Furthermore, as a student and future practitioner of strategic design, I often asked myself if I am the best person to be working on this project. I am an external entity, with fragmented access to the resources of the company, working alone (as is the format of all graduation projects) and a very naive perspective towards improving the World. Perhaps a person from the company would be more well-equipped and motivated to solve this problem, also with other researchers or designers to challenge me along the way. Or to have a multi-disciplinary team work on it together. Therefore, keeping the process unbiased and trying to capture different opinions to get a robust overview of the problem has been a big challenge in this project.

5.2.1 Use of AI

Like Artificial Intelligence, a designer also tries to eliminate bias in the work that they do. Similarly, a designer always strives to understand the user from a very unbiased empathic perspective. As a design engineer, I try to capture the richness of the feedback from the user while making it very clear the bias they might be introducing themselves in the process. Design process is iterative in nature, just like AI, it learns from the past and evolves for the future.

In this thesis ChatGPT and its plug-ins were utilised extensively to improve my writing and also used to enrich the design methods I used through conversation. In addition, Dovetail was used for transcription, although only after removing any PII.

The use of AI in a designer's workflow is inevitable. It should not be feared but embraced. Although there might be a learning curve to adapting to the use of AI, the absence of this effort would be a huge set-back. I consider myself lucky to be at university during the rise of ChatGPT and witness this transition to an AI-enabled university education. Reflectivity and rich **description** is at the centre of a data-driven approach.

Working as a data-driven designer made me very conscious of how I was treating every stage of the design process. Making sure there was transparency in every stage.

5.3 Limitations

- This research is focused only to the UK and Dutch healthcare contexts, a similar study would have to be conducted for other countries to evaluate the situation.
- Data analysis only done by one researcher. More follow-up studies should be performed .
- The Discover phase was conducted in NL while the Design phase was conducted with users in the UK. While this took place due to the time and linguistic constraints, this is a limitation of this study and further studies in the two contexts should be done to enrich the findings.
- The small sample sizes for the study should also be kept in mind as it limits the validity of the results.

5.4 Future scope

As this study delves into a systems level understanding of the healthcare journey and explores the multi-faceted barriers to its adoption, this can serve as a starting point for further exploration such as:

- Usability studies of the patient-facing & clinician facing application: My study identified a big opportunity area in improving the service experience for the HCPs therefore that remained my focus however there is still a lot of value in doing a dedicated usability study of the onboarding, activation and log-in on both the patient and the clinician-facing the applications.
- Further to this effect, it would be valuable to test the concepts generated for each horizon in a hospital with the care-providers.
- A value mapping workshop should be conducted as a starting point to see how the value of the different offerings of Zimmer Biomet can be leveraged to improve adoption of mymobility.
- There is also great scope to explore in more depth the participatory approach in an organisation with such diverse set of customers across the globe.
- Another potential direction could be conducting A/B testing with mymobility and a competitor platform
- Expanding on one of the direction in the research, a research project could be focused on exploring the problem on interoperability in the context of external digital platforms deployed in hospitals/ healthcare organisations.

All in all, mymobility is a platform that has already demonstrated clinical efficiency and has seen some success stories over the years, however there is still a lot of potential for it to improve many more lives.

6. Conclusion

In this chapter I provide a conclusion of the research conducted.

This master's thesis investigated the application and impact of a data-centered participatory design approach in the development of healthcare technology. The primary objective was to evaluate how involving users and stakeholders in the design process, supported by data-driven insights, can enhance the effectiveness and user acceptance of healthcare solutions.

The research employed a mixed-methods approach, integrating quantitative data from surveys with qualitative insights from expert interviews and co-creation sessions. Utilizing the DIKW (Data, Information, Knowledge, Wisdom) framework provided a comprehensive understanding of the multifaceted impacts of digital health solutions. The participatory design framework ensured active user involvement throughout the design and development phases, resulting in more tailored and effective solutions.

The findings indicate that user participation contributed valuable insights, which directly informed design iterations and led to solutions that better meet user needs and expectations. This iterative feedback loop was crucial for identifying and addressing specific pain points, resulting in more user-friendly interfaces and functionality.

Moreover, the research highlighted the significance of interdisciplinary collaboration. Integrating perspectives from healthcare professionals, patients, designers, and project managers fostered a holistic understanding of the challenges and opportunities within the healthcare system. This collaborative environment was essential for developing innovative solutions that are desirable, viable, and feasible.

In conclusion, this thesis demonstrates that a data-centered participatory design approach can significantly enhance the development of healthcare technologies. By actively involving users and leveraging data-driven insights, this approach produces more relevant, effective, and user-friendly solutions. The findings provide a solid foundation for future research and practice, advocating for broader adoption of participatory design methodologies in healthcare technology development. This approach promises to drive innovation and improve outcomes, ultimately contributing to a more effective and patient-centric healthcare system.

7. Acknowledgements

My two year MSc journey in Strategic Product Design has not been easy, if I were to reflect objectively on the process, if I were in an organisation - I would never suggest a strategic designer to work in isolation. However, sharing joy, sadness, laughter and stress with some wonderful friends and family has helped me conclude this journey with a feeling of pride and contentment.

Firstly, I express my immense gratitude to my supervisory team. To Thomas, who is one of the kindest and sharpest people I have met. I loved how I would always have a list of questions for our meeting (on Notion) and you would very often ask me why after each question and then give out a smirk. I knew then that I was probably headed in the right direction but you didn't want to lead me there. That excitement was what pushed me farther and farther in the project. Needless to say, I wouldn't have nearly learnt this much if it wasn't for your support, encouraging me to ask more questions and connecting me with all the right people! You have greatly helped me hone my skills in what I may now call 'strategic thinking'.

To Jacky, I would like to thank you for your consistent support and encouragement along the course of the project. To give me the freedom to explore within the domain of Data Enabled design and pushing me to take chances with my approach.

In January 2022, I received my rejection from TU Delft. In March, I challenged the decision and in April I received my admit. To Richard, I thank you firstly for the part you played in accepting my appeal and overturning my decision. I have been inspired by your lectures (HEPS to Convergence) from the day I arrived and was always eager to have a chat with you. Thank you for providing me with essential information to steer the course of this project and to provide me a lot of positive energy along the way!

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This would be incomplete without thanking the knowledge i have gained through meetings with Mieke, Mathhijs, Naomi, Perla, Fredrik and Hosana! Also all the faculty members who have helped me grow as a designer and human being.

Last but most importantly, I'd like to thank my sister, my parents and grandmothers for the curiosity they instilled in me and for their support and unconditional love.

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