A DIGITAL PLATFORM IN INFORMATION SYSTEM FOR DUTCH PRIMARY CARE

A study on key stakeholder requirements and architectural requirements on openness

MASTER THESIS
BY
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DELFT
MARCH, 2023

TU Delft PROMEDICO

A Digital Platform in Information System for Dutch primary care

A study on key stakeholder requirements and architectural requirements on openness

Master thesis submitted to Delft University of Technology

in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE

in **Complex System Engineering and Management**

Faculty of Technology, Policy and Management

by

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To be defended in public on March 30 2023

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Preface

Conducting scientific research is like swimming. At the beginning, you are excited and expect to swim to the destination with the fastest speed. But in the process, various random events happen that exhaust you. At this point, you feel like you are shrouded in a fog and have lost your way.

Take a deep breath.
When you quiet your mind, you will discover the unlimited potential of your creative thinking network. The knowledge and experience you have observed and gathered in your life and work will help you solve these challenges. Before you realize it, you have reached the destination.

Looking back to when I first stepped into the Netherlands in 2020, I was full of curiosity. And my life has been a mixture of mysteries and challenges. During my time at TU Delft, I have learned to adapt to complex situations and face unpredictable consequences rationally. As CoSEM says, life is often complex rather than complicated. Moreover, TU Delft's diverse background has provided me with many refreshing insights. I am like a dot, and the multiple layers of connections in the network help me to become a more flexible but structured individual.

I am grateful to the people who have criticized and instructed me along the way, providing me with direction to become better; and I am grateful to the people who have encouraged me and taught me the importance of being filled with positive beliefs and confidence. In addition, I would like to give additional appreciation to certain people.

I would like to appreciate my family for raising me to be a creative thinker and explorer of the world; I would like to appreciate Saba for opening the door to the world of healthcare and giving me a chance to start sprouting from the seeds I had hidden deep in my heart. And for helping me to build a strong foundation in the field of healthcare;

Thank you, Mark, for helping me to have a deeper understanding of the digital platform ecosystem. and for the support you provided me when I lost my direction; Thank you, Gijs, for providing me with the opportunity to put theory into practice. You have inspired me with your skillful combination of optimism and pragmatism.

The world at the intersection of primary care and digital platform in information system is full of opportunities and challenges. I am glad to have embarked on this journey and made my contribution. I hope you will enjoy the journey just as much as I have.

Ran Kong
Delft, March, 2023

Summary

Situation
In Dutch primary care, there is a complex dilemma that needs to be solved: the architecture of the digital platform in information system (DPIS) is not open sufficiently, which leaves the architecture without the necessary flexibility and portability. And this leads to difficulties in transferring the necessary medical information between caregivers using different DPISs. While there are sufficient innovations for DPIS, the lack of focus on primary care and understanding of the requirements of caregivers prevents these technologies from effectively providing solutions to existing problems.

DPIS serves as an emerging technology that assists in the decision making, coordination and control that occurs in the organizational environment to improve the efficiency of information exchange. If we can use its potential wisely, it will greatly reduce the pressure on healthcare in the Netherlands. Researchers have shown that if we can enhance the openness of DPIS based on an understanding of the requirements of stakeholders within the ecosystem. This not only provides a flexible digital component library for end-user operations and facilitates the delivery of healthcare information. It also lifts the constraints on innovation in the healthcare industry.

Complication
In order to use the openness of DPIS to solve the problem of difficult information exchange in the healthcare industry, we first need to understand the current situation. However, there is currently no research in the Netherlands that addresses the intersection of healthcare and DPIS. Adapting existing healthcare to take into account only the advantages of DPIS openness could lead to many unpredictable risks. Although openness can lead to innovative developments in the information domain of healthcare in the Netherlands, this is accompanied by many issues of power distribution and information security. In addition, we need to be extra careful when considering the use of openness in DPIS to improve primary care, which is the area where patients first interact with caregivers and has a strong influence on the patient experience of healthcare in the Netherlands.

Therefore, we need to adapt the existing architecture of DPIS after a thorough understanding of the Dutch DPIS for primary care landscape and a clear understanding of the interests and requirements of stakeholders at the intersection of healthcare and DPIS. By building a bridge between the social and technological domains, we can maximize the benefits of DPIS to address the challenges of difficult healthcare information delivery.

Question
This master thesis is concerned with answering the question:
What are architectural requirements that can enhance the openness of digital platform in information system in primary care in the Netherlands?

Approach
The design science approach is used to answer research questions. This study is based on the revised research sequence suggested by the IDEPF0 framework in design science. The first phase (explicit problem) discusses the current situation and problems in the Netherlands. A

progressive approach was used to discuss the Dutch DPIS, Dutch primary care, and DPIS for primary care separately. In the second phase (define requirements), a literature review was conducted. The aim was to use the literature to identify the factors that influence the openness of the architecture and the requirements of key stakeholders. The next two phases (design and develop, demonstrate requirements) focused on the design and use of artifacts. Firstly, using requirements analysis, connections between key stakeholders and the architecture were established. This was followed by the development of an interview protocol. In the final phase (valid requirements), the requirements were validated and the results analyzed using semi-structured interviews. The interviews not only helped to confirm the validity of the information gathered in the scientific literature, but also provided additional insights into the current situation in the Netherlands. This laid the foundation for an open design of the DPIS architecture.

Results

Regarding the current situation, we obtained the following results. The existing situation is characterized by a low degree of openness of DPIS. Due to the different interests of IS suppliers, this has led them to add regulations to the general information exchange standards that meet their own needs. This results in caregivers using different DPISs not having direct access to the medical information they need from other DPISs. In addition, IS suppliers are reluctant to collaborate with other IS suppliers in order to protect their position in the market. This has fragmented the market for information exchange into different regions. If the government could lead them to cooperate and participate in the development of open and standardized data exchange standards, it would greatly help to solve the difficulties of caregiver interaction.

From the literature review, I have summarized four factors that influence the openness of DPIS as: interoperability, stakeholders, organizational structure, and environmental dynamics. Among them, interoperability in the context of collaboration focuses on DPIS for healthcare in the context of organizational policy, care process, information, application and IT infrastructure, the laws and regulations under six layers. Stakeholders analyzed the impact of differences in interest interests and goals of caregivers, IS suppliers and software suppliers on the core functions of DPIS. Organizational structure is considered as the structure that can enhance the openness of DPIS . Environmental dynamics focused separately on the impact of technological trajectories and multihoming costs on DPIS and openness. Where technological trajectories take the perspective of complementary and replacement technologies, multihoming costs focus on the costs associated with developers and platforms.

After using semi-structured interviews to validate and revise the openness-related requirements of the key stakeholders (IS suppliers and software suppliers) in the DPIS that I defined, I concluded that their requirements focused on nine areas: actors' market position, government control, data exchange, caregivers' power, incentives, architectural requirements, allocation of responsibilities, business interest goals, and embedding of new technologies.

For openness-related architecture requirements, experts stated that the prerequisite for an architecture to be marketable is conformance to Dutch information exchange regulations. For development and security reasons, the architecture should have stable, dependable and adaptable user interfaces, and meet the complements of market demand. And the architecture should have the ability to adapt to changes in the environment. For the DPIS open,

experts explained from two perspectives. They stated that DPIS should be useable by anyone, but when sharing information, only authorized people should be able to share it. Finally, the experts stated that the architecture should give caregivers a domain space, and that the independence of the domain space meets the specific needs of caregivers, while the non-independence ensures that caregivers are closely connected to other domains.

Next steps

Future steps towards the analysis of the openness of caregivers and patients' requirements. In order to ensure that the DPIS architecture is truly functional after being put into primary care, we should construct a network of relationships between all actors in the intersection of DPIS and primary care. This study focuses on the needs of IS suppliers and software suppliers related to openness, but lacks the needs of caregivers and patients' perspectives. It would be useful to summarize the requirements of all actors and compare the differences. It would provide both scientific and practical perspective on the validity of the architecture design.

TABLE OF CONTENT

List of tables

List of figures

List of abbreviations

AIS: Apothekers informatiesysteem
AMR: Antimicrobial Resistance
DGPGs: Digital Global Public Goods
DHIS2: District Health Information Software 2
DPIS: Digital platform in information system
GDPR: General Data Protection Regulation
GGDs: Gemeentelijke Gezondheids Diensten
GPs: General practitioners
GZN: Goede Zorgnetwerken
HIS: Huisarts informatiesysteem
ICT: information, communication and technology
IS: Information system
ISO: International Organization for Standardization
ISO 11353-2: Maturity Model for Enterprise Interoperability
NGOs: Non-governmental organizations
Suppliers: IS suppliers and software suppliers
WGBO: Wet Geneeskundige Behandelovereenkomst

1

INTRODUCTION

1.1 Problem statement

The aging of the population and the increasing number of patients with chronic diseases are two of the most prominent challenges in Dutch health care today, and solutions are urgently needed. These pressures are further amplified by the advent of COVID-19. The emergence of emerging medical care technologies offers the possibility to address the complexity and multifaceted nature of these challenges. As a key component of emerging technologies, digital platforms in information systems (DPIS) shows unlimited potential from the perspective of information exchange and management. The World Health Organization has also shown that DPIS can enhance the strong interconnectedness of the world's population. Innovations in the digital domain will achieve much in terms of improving population health. In other words, DPIS assists in guiding decision-making, coordination, and control in organizational settings through the interconnected components of collecting, processing, storing, and disseminating information (Bourgeois, 2019).

At the same time, primary care in the Netherlands has demonstrated a desire to move towards digital health, particularly by using DPIS to address issues related to openness such as difficulties in exchanging medical data. In a study by Haarbrandt et al. (2018), DPIS demonstrated capabilities that could enhance healthcare data collection interactions. This capability can be used to ensure data effectiveness and avoid delays in data interactions. In other words, this capability of DPIS also addresses the avoidance of long information transfer times that prevent timely and effective communication between caregivers or between caregiver and patient. At the same time, it also validates the importance of DPIS to the development of primary health care. Such as assisting caregivers in processing medical information and facilitating behavioral interactions and communication between different caregivers. In addition to its impact on the internal environment of such healthcare behaviors, DPIS also builds a bridge between software suppliers, IS suppliers and caregivers. This not only ensures that IS suppliers and software suppliers have immediate access to caregivers' experiences and feedback on their needs, but also ensures that IS updates or designs are truly based on underlying needs and social issues.

1.2 why information system and why digital platform in information system?

From a component perspective, information systems (IS) consist of hardware, software, and data that assist people in implementing behavioral initiatives in processes, i.e., applying scientific knowledge in practice. Among them, the hardware, as the physical component, provides the physical class of contact perception; the software establishes a link between the

hardware and the user by setting guidelines. That is, it provides the basis for users to use such physical components; and data, due to its information gathering function, provides the basis for effective decision making and assists in improving organizational performance. In addition to this, the data assists those involved in IS in the integration of the technical components with the organization. The embedded combination of these three forms an IS that can strengthen ties with suppliers and customers and other relationship networks and improve process efficiency by influencing the organization internally and externally. This provides a significant competitive advantage to the organization.
From a network communication perspective, IS provides the possibility of applying software on different hardware and operating systems by defining rules and standards (IBM Docs, 2021). In other words, the data storage and information exchange functions of IS facilitate the exchange of information between organizations using the same software but with different physical operating systemswhich has a great impact on the smoothness of decision making and implementation. In addition, these functions of IS also indirectly enhance the communication between users and suppliers, and ensure that the system vulnerabilities are fixed and updated by IS in a timely manner.

And research on digital platforms would provide a more effective organizational structure for IS development goals and offer potential for innovation (van Hattum, 2020). So, what are digital and platforms, and how do digital platforms differ from non-digital platforms? In this study, digital is invoked as digital technology, which implies homogeneity, editability, reprogrammability, distribution, and self-referentiality of data (Yoo et al., 2010; Kallinikoset al., 2013). A platform, on the other hand, acts as a collection with a stable core and variable periphery, bringing together multiple user groups. Thus a digital platform can be defined as a socio-technical portfolio of software and hardware (Tilson et al., 2012) that contains various modules that extend the functionality of a product (Sanchezand Mahoney, 1996; Baldwin and Clark, 2000) and associated organizational processes and standards.

Thus, DPIS, as a focus on the digital partition of IS, has an emphasis on the convergence between innovative technologies, people, processes, and network communications at the digital level. The study of DPIS offers the potential for innovation in addition to providing a more effective organizational structure for the development goals of IS (van Hattum, 2020). At the same time, the ability of DPIS to scale without performance degradation can facilitate more efficient exchange of information, goods, and services between users (Watts, 2020). Overall, the capabilities of DPIS are well positioned to provide solutions to existing healthcare challenges in the Netherlands. For example, DPIS can serve as the basis for the consultation process (e.g., appointments, communication, referrals, etc.) provided by caregivers to patients, enhancing interactions between caregivers or between caregivers and patients.DPIS can also improve the efficiency of solving healthcare challenges, such as defining key factors that influence patient needs and rank priorities (Zaken, 2022).

However, this capability of DPIS is still at a more idealistic level. One reason is that the advantages of DPIS have inspired more and more suppliers to enter the market, resulting in healthcare organizations being faced with an overwhelming number of choices. This may lead them to partner with IS suppliers who are not able to solve the problem. In addition, due to different business development goals, some IS suppliers want to ensure the originality of their research and development. This means that they do not want to collaborate with other IS

suppliers to develop modules that enhance the openness of healthcare data exchange. Alternatively, some IS suppliers already have sufficient capacity to monopolize the market and are more focused on developing their business interests than on meeting the needs of the healthcare market, which makes it more difficult to open up DPIS. These issues have led researchers to focus on how to make DPIS more effectively embedded in the ecosystem (de Reuver et al., 2018; Parker et al., 2017; Wagner & Prester, 2019), and how to facilitate the development of this embedded system.

1.3 Scope of this thesis

Digital platforms in information systems are a challenging subject to study because of their distributed nature and intertwined nature with institutions, markets and technologies (de Reuver et al., 2018). The study of digital platforms in the Netherlands is even more complex, not only because of the four lines of the Dutch healthcare system, but also because researchers need to study not only the interests of the stakeholders involved in each line separately and the interaction behaviors but also the practical applicability and future development of the designs based on these behavioral initiatives. In addition, due to individual variability and adaptability, even when researchers are working on the same problem, there is a high degree of diversity in the research and solutions provided. Overall, research on DPIS needs to consider not only the network of stakeholders' requirements and four lines separately, but also the network of relationships that develops when both are embedded in the development and the researcher maintains consistency of purpose as much as possible.

In order to ensure the scientific and practical nature of the study, this study will be conducted in accordance with one of the three recommendations provided by de Reuver et al. (2018), namely (1) clearly listing the elements involved in the study and the meaning of these elements; (2) identifying the development context and scope of application of the study; and (3) using a mixture of research methods to enhance the rationality and rigor of the design to conduct the study. Therefore, in this section, the specific decisions made regarding the selection of the specific context for this study are shown below.

The first scoping decision of this study was the identification of the application area, i.e., the identification of the application area as primary care in the Netherlands, i.e., the act of patients receiving care without referral. The system as public goods shows the interaction between the organization and the individual. The second scoping decision focuses on the need for key stakeholders in the existing DPIS.

From the perspective of development and use, the main stakeholders involved in the existing Dutch healthcare DPIS are IS suppliers, software suppliers, and end-users. End-users refer to the healthcare professionals involved in primary care, including general practitioners (GPs), dieticians, psychologists, physiotherapists, pharmacists, etc. In the rest of this research, these professionals will be referred to as caregivers. In this study, IS suppliers and software suppliers are considered as key stakeholders. The reason for not considering caregivers as key stakeholders is that the purpose of this study is to improve the architecture to enhance the openness of the DPIS. Caregivers, as users of the DPIS, do not have a professional technical background and are therefore only able to provide feedback from a general level, which would increase the error in the design of the architecture.

In section 6.1 the requirements for key stakeholders are analyzed in detail. These requirements are then translated into architectural language in section 6.2. In addition, these requirements are defined in such a way that only the systems used by caregivers in primary care are considered as target DPIS. The reason for this is that caregivers in different lines do not have the same diagnostic responsibilities, which means that they have different and arguably unique usage requirements. This in turn leads to the fact that the DPIS they use has different functionality from the DPIS used by caregivers in other lines, i.e., diversity of functionality.

Governance policies, such as laws and regulations, that relate to official organizational structures are not a major consideration in this study. Although governance serves as a cog in the wheel that operates in conjunction with the DPIS architecture, i.e., the two develop and operate together in synergy. However, from a design perspective, too much consideration of governance instruments would limit the potential scope for possible development. At the same time, the existing literature suggests that governance policies do significantly influence the development of the DPIS ecosystem (section 1.5.2.3). Therefore, it was decided to ignore this aspect and focus the study on defining the requirements affecting the openness of primary care DPIS from the perspective of key stakeholders and on the transcription of architectural requirements.

1.4 Goal of this thesis

The Dutch primary care has shown a clear willingness to enhance the openness of the DPIS. Therefore, the goal of this thesis is to define and validate the requirements of the architecture. The requirements for openness are first defined from the perspective of key stakeholders (IS supplier and software supplier) and then translated into architectural requirements. The purpose of establishing a link between stakeholder requirements and architecture requirements is to facilitate the interaction of different industry perspectives on openness and to ensure that the design of the architecture is truly based on consumer needs and market demands.

The reason for considering the requirements of key stakeholders as the starting point is that these stakeholders have a clear interaction with the DPIS as developers and owners. Their needs and behavioral decisions greatly influence the openness of the DPIS. In addition, key stakeholders often have a deep understanding of the traditional old Dutch healthcare DPIS and a forward-looking vision of future DPIS development. The study shows that although the renewal of the Dutch healthcare DPIS is very challenging, the innovative design can bring sustainable benefits if it truly combines innovation and tradition effectively. Key stakeholders have the ability to provide the basis for this development.

The intended outcome is a validated and modified architectural requirement that can facilitate the opening of the Dutch primary care DPIS.

1.5 Research question

The following research question is considered to be the key question to be answered in this study:
What are architectural requirements that can enhance the openness of digital platform in information system in primary care in the Netherlands?

1.6 Sub research questions

The sub-research questions support the goal of answering the main research question. The sub-research questions were designed based on the IDEF0 framework (Appendix A, Figure 8), i.e., the following five aspects were considered: elucidating the problem, defining the requirements, designing and developing the artifacts, presenting the artifacts, and evaluating the artifacts. The following set of sub-research questions was constructed as follows.

Sub research question one:
What does the current digital platform in information system for the primary care in the Netherlands look like?
Sub research question two:
What are the factors that influence the openness of digital platform architecture?
Sub research question three:
What are the key stakeholder requirements regarding openness?

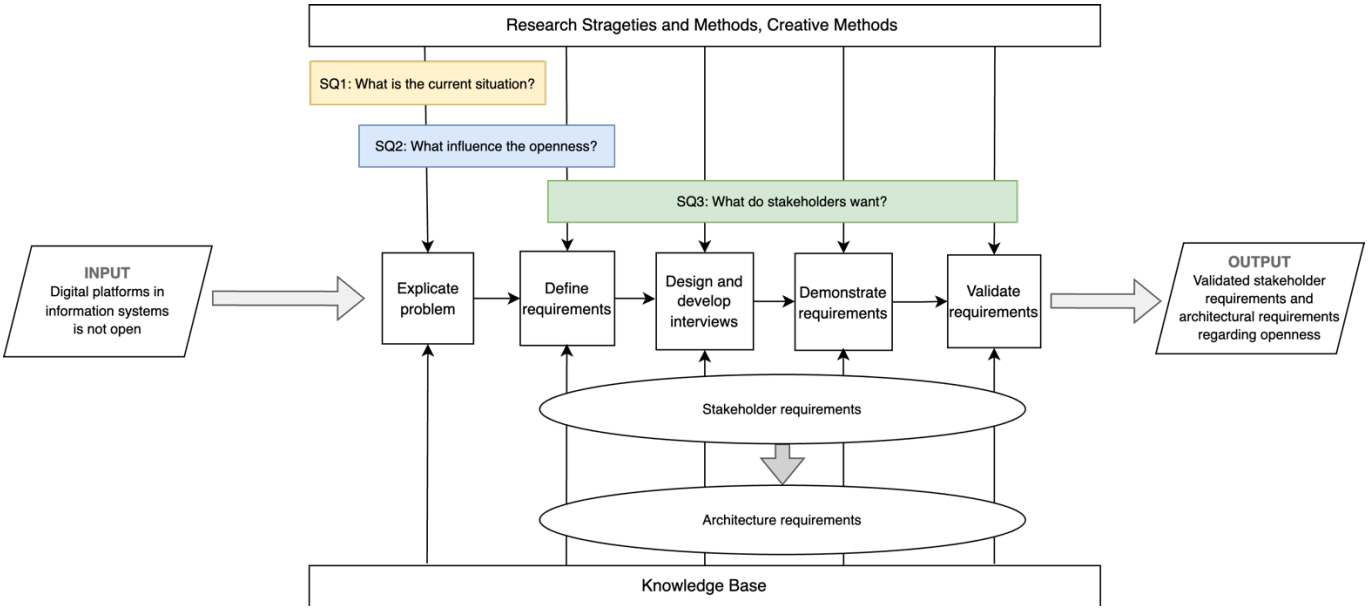

Figure 1 Research flow (author: own)

Figure 1 shows how these sub-research questions relate to the overall research approach. This research flow is an adaptation of IDEF0. The next section gives a short description of the approach applied to each sub question. A detailed explanation can be found in chapter 3.

1.6.1 Explanation for sub-question

Sub research question one: What does the current digital platform in information system for the primary care in the Netherlands look like?
The starting point of IDEF0 - explicate problem requires that a clear definition of the existing problem requires first an understanding of the current environment and the challenges involved. A review of all scientific articles on DPIS in Scopus revealed that there is no detailed research on the digital platform ecosystem in the Netherlands. Therefore, this study will first provide a background investigation of DPIS from a general perspective, followed by a study of the current state of the Dutch healthcare system. Finally, how DPIS are positioned within Dutch primary care domain is explored. The approach applied in these three parts is documentary analysis and literature review.

Sub research question two: What are the factors that influence the openness of digital platform architecture?
The second step of this study belongs to the starting point of IDEF0 - the combination of explicate problem and define requirements in the second step. This phase focuses on why the architecture of DPIS is so important and the factors that influence its openness. Therefore, this phase starts with an explanation of the importance and composition of the architecture, followed by a discussion of the functional and non-functional requirements of the architecture. And then establishes the link between openness and architecture and discusses the factors that influence the openness of the architecture. The method applied here is literature review.

Sub research question three: What are the key stakeholder requirements regarding openness?
This phase is a continuation of define requirements and the integration of design and develop artifact, demonstrate artifact, evaluate artifact. This phase begins with an analysis of the key stakeholders of primary care, discussing their requirements and interests related to openness. The key stakeholders' requirements are then transformed into an architectural formulation based on the architectural requirements in chapter 5. Finally, key stakeholders' requirements and architectural requirements were verified, revised and supplemented by interviews.

The reason for considering the requirements of stakeholders is that Morgan et al. (2021) have suggested the most successful platforms consider the interactive requirements of end-users, service providers and other stakeholders. Their requirements greatly influence the success of the DPIS architecture design. In this study, in order to give thought to the realization of openness, we analyzed the relationship between stakeholders such as IS suppliers and software suppliers. In addition, ownership and provisioning rights are considered when defining their requirements. Among others, and normative distinctions were analyzed from a private and public perspective (Dijck & Poell, 2016). The lack of clarity of boundary and relationship between stakeholders is a major cause of platform closeness (Furstenau & Auschra, 2016). In this context, stakeholders specifically refer to IS suppliers, software suppliers, and caregivers. The methods involved in these sections above are literature review, stakeholder analysis, requirements analysis, and semi-structured interviews.

1.7 Relevance to MSc CoSEM programme

This proposed research fits well with the criteria of the CoSEM master' s thesis because it is designed from three perspectives: social perspective, human perspective, and technical perspective. For society and human perspectives, the interaction between the stakeholders involved, such as IS suppliers, software suppliers, and caregivers, is analyzed. And their requirements are defined. For the technical perspective, the design of the interview is considered as an artifact design. This interview design was designed by considering the cross-domain gaps in the Dutch socio-technical system. In addition to this, this interview design identifies architectural requirements through functional and non-functional requirements analysis and stakeholder requirements analysis. The main reason for using these analyses was to ensure flexibility, adaptability and development of the design. Therefore, this proposed research is aligned with the development goals of the CoSEM program students.

1.8 Involvement of external parties

This thesis is conducted in the context of a research internship at Promedico ICT. Promedico ICT is a company who develops and maintains innovative applications such as information systems for Dutch primary care.

The external stakeholders i.e., the stakeholders involved in the semi-structured interviews in this study were from DPIS in the Netherlands. The participating stakeholders all had experience working at the intersection of the Dutch healthcare market and digital information systems. or has worked as a caregiver in primary care, who is well aware of past and present issues. In addition to this, the privacy of these stakeholders and the institutions involved is securely protected. They will only provide the necessary information for this study and will not interfere with the research process in any way.

1.9 Structure of this thesis

The remainder of this research is structured as follows: the findings from literature review on digital platforms, openness and healthcare. Next, key concepts of digital platform are defined, and elements of DPIS ecosystem are discussed. After presenting a discussion of different scholars' perspectives on DPIS, I describe the research methodology, including intended outcome, method, data usage and tools. This is followed by a discussion of the Dutch DPIS, the current state of the healthcare system and DPIS for primary care. Afterwards, the reasons why architecture and openness are important are discussed and the factors that influence the openness of the architecture are analyzed. Key stakeholders' requirements and architectural requirements are analyzed in detail in chapter 6. Lastly, the interview results are discussed and classified according to the background of interviewees. Before discussing the directions for future research and reflection from this research, the conclusion is presented in the last section.

2

THEORETICAL BACKGROUND

This section is concerned with providing a background knowledge on Dutch healthcare system and DPIS. Firstly, section 2.1 presents the classification of healthcare in the Netherlands and a detailed explanation of primary care. Section 2.2 defines the key concepts of DPIS. Section 2.3 then explains the elements and characteristics of the DPIS ecosystem and emphasizes the relevance of these elements to openness. Finally, section 2.4 summarizes the views of experts in different fields on DPIS and explains the place of this research in scientific research.

Search string for section 2.2 to section 2.4:
TITLE-ABS-KEY(("digital platform" OR "platform ecosystem" OR "platform architecture") AND ("open" OR "open platform*")) AND (LIMIT-TO (OA,"all"))*

2.1 Dutch healthcare system

2.1.1 Healthcare classification in the Netherlands

The traditional classification of health care takes into account the level of treatment, the physical characteristics of the target group, the need for care, and the location of treatment. The level of treatment depends on the nature of the patient's health problemwhich determines the level of treatment the patient needs to receive. In contrast, the target characteristics of the target group depend on such things as age, gender, and risk group. The need for care, on the other hand, divides the human life stages, i.e., birth stage of life, growth stage of life, and end of life. The classification of the place of treatment is not the place in the traditional physical sense, but refers to the mixed means of treatment that the patient needs to receive, i.e. internal treatment, external treatment or mixed treatment (Overview of Zorgdomeinen, 2018).

This study did not focus on these classifications from a traditional perspective, but rather considered a classification in terms of the level of treatment needed by the patient. This classification is also known as the level of treatment classification. This classification was chosen because it allows for a better construction of the association with IT and the ability to limit the target group, thus allowing the study to better analyze the problem.

The standard classification of treatment levels in the Netherlands consists of four lines, accompanied by the standard naming form: number-line. Zero-line care, also known as preventive care, refers to care that does not require a request for additional help. First-line care, also known as primary care, deals with conditions that cannot be dealt with in preventive care. Second-line care can be considered as a complementary act to primary care, i.e., primary care that cannot fully treat the patient and requires more specialized care, including but not limited to hospital care, mental health care, etc. The provision of this care may require a

referral from the primary caregivers. Third-line care is highly specialized care for physical or mental health. This care is the responsibility of the clinical practice.

2.1.2 Detailed explanation of Dutch primary care

Primary care, i.e. care that is available to anyone and where patients can be seen directly without the need to be certified for referral (Broeders, 2019). This includes acts of care provided by GPs, oral care providers, physical therapists, pharmacists, social workers, and psychologists in counseling offices (Eerstelijnszorg - Rijksoverheid.nl, 2009; Broeders, 2019). For the cost of care by oral care providers and physical therapists, patients need to have additional health insurance to be reimbursed in addition to their basic insurance.

General practitioners provide a consultative and guiding role for patient care support as the core of primary care, i.e., they provide potential solutions and care modalities for patients through their own experience. The dark blue dashed line in figure 2 shows the network relationship of GPs with other caregivers in primary care healthcare. The caregivers represented by the GPs will provide care support to the patient upon request. But if the care support provided does not address the patient's concerns, the GP will provide advice to the patient to assist in resolving the patient's concerns by leveraging their network of relationships with other practices. It is important to note that this referral behavior differs from the referral behavior of GPs in the second-line in that the purpose of the referral behavior in primary care is to provide advice to the patient, i.e., there is no apparent referral behavior. This referral behavior assists patients in understanding their problems and directs them to caregivers who can provide the exact service. The unnecessary waste of time and labor costs associated with using GPs as intermediaries is avoided (Broeders, 2019).

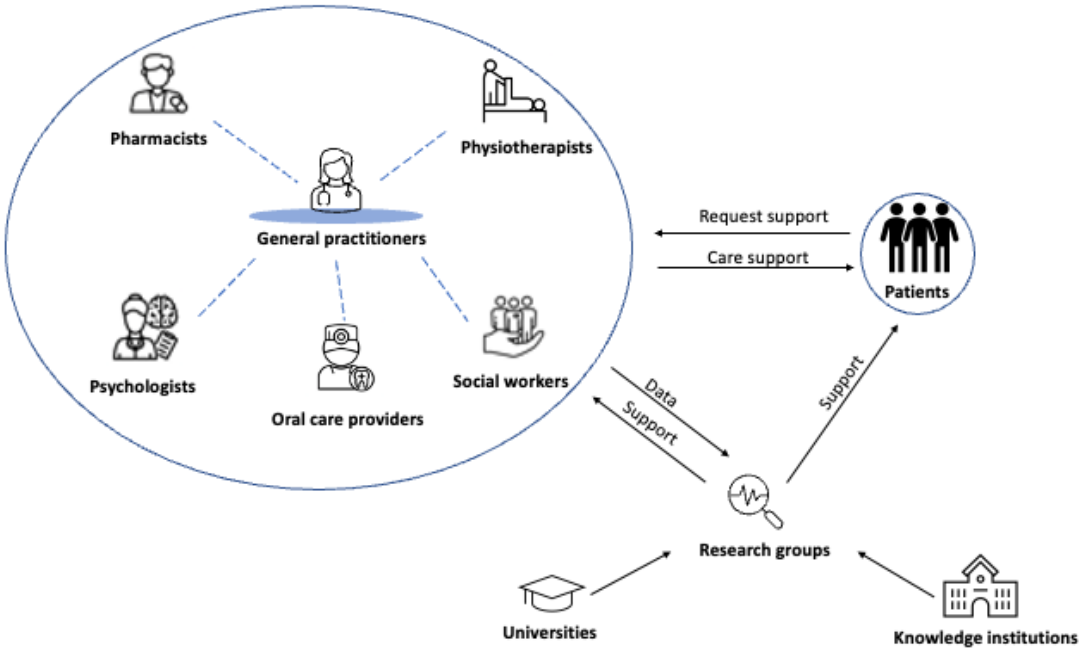

Figure 2 Visual representation of stakeholders' interactions in primary care (author: own)

In addition to caregivers and patients, there is another major component in primary care, namely healthcare research organizations. The aim of these institutions is to facilitate the research of researchers in order to improve the current state of health care and to enhance the patient experience. NIVEL (Dutch: Nederlands Instituut voor Onderzoek van de

Gezondheidszorg) is one of these national healthcare research institutes, which has a wide range of research interests, from Labor and Organizational Issues, Evaluation of Healthcare Legislation and Regulations, and Pharmaceutical Care, etc. The next section provides a summary of NIVEL's research in primary care. The purpose of providing this summary is to demonstrate the importance of such research institutions to the data base on the nature, scope, and quality of primary care in the Netherlands.

2.1.2.1 NIVEL Primary Care Registries (Dutch: Nivel Zorgregistraties Eerste Lijn)

NIVEL provides services related to panels, national databases and monitors from the perspective of patients, clients, residents, caregivers, and care organizations. NIVEL as a national representative has certain specificities, mainly in the following aspects: a. Data base covering entire primary care; b. Data dating back to 1970, providing the possibility of comparing current and past results; c. Weekly update of data, allowing for timely feedback on current events; d. Multiple research parties as partners, making it easy to link the data they have to internal and external research.

In general, NIVEL, in addition to being a database providing a large and diverse set of primary care data (Nivel Zorgregistraties Eerste Lijn | Nivel, n.d.), also serves as a platform to build possibilities for researchers to work with these data. This possibility is not limited to internal researchers of institutional organizations, but is more open to any scholar who needs this data resource. However, this openness does not mean that the privacy of patient data is not protected. NIVEL does not obtain metadata directly from caregivers but rather by encrypting the data information provided by caregivers through a trusted third party (ZorgTTP). These data include, but are not limited to, health and disease, care use, drug prescriptions, references to more specialist care. Details of the sources and distribution of these data can be found in appendix A, figure 12.

2.2 Key concepts

Digital platform in information system (DPIS) is a hot topic nowadays and is being enthusiastically and extensively researched by researchers from different industries. However, the distributed nature of DPIS is such that it intersects with organizations, markets, and technologies, making it more complex and challenging to study (de Reuver et al., 2018). In addition, the different areas of expertise make it possible for researchers from different fields to interpret the same concepts with minor errors. Therefore, it is particularly important to define the concepts related to the DPIS as a whole and to define them from the perspective of experts in different fields.

This act of exploring the same concepts in different fields can assist the researcher in gaining a more comprehensive and thorough understanding of key concepts. It also provides innovative and creative, but realistic ideas for the subsequent architectural design. Finally, non-information, communication and technology (ICT) workers or researchers attempting to understand concepts related to DPIS may have difficulty understanding the meaning of the terminology and why the evolution of DPIS will have a significant impact on their field due to a lack of expertise. field. Therefore, in addition to the classification of definitions mentioned above, it is important to consider how to summarize the definitions of these specialized terms

in easy-to-understand and simple language to facilitate the understanding of people with non-ICT backgrounds.

2.2.1 (Digital) platform

In this section, digital platform is conceptualized. Firstly, the core concepts on non-digital platform is introduced. Secondly, the difference between non-digital platform and digital platform are compared. This is followed by an introduction to the concept of digital platform architecture.The definition of these core concepts is explained and analyzed based on the research results on Scopus.

Non-digital platform

In general, platforms act as a stable core and a variable periphery (Baldwin et al., 2009; de Reuver et al., 2018) that can act as intermediaries for multiple actors (Furstenau & Auschra, 2016). And it assists these actors to compete in bilateral or multilateral markets (Jean Charles Rochet & Tirole, 2003). In other words, non-digital platforms can provide actors with access to knowledge integration and provide the basis for complementary services and products such as cost sharing (Gawer, 2009, p. 2). Put differently, non-digital platforms assist in building networks of relationships among actors. It provides a positive impact on the development of the platform by generating network externalities. This means that as the number of actors increases, the effectiveness of the platform increases. In addition, the behavior of actors drives the development of platforms such as modular development and innovative reorganization (Henderson & Clark, 1990; Baldwin et al., 2000; de Reuver et al., 2018). Dijck & Poell (2016) define non-digital platform defined as a technological, economic and social frameworkwhich facilitates economic interactions and social exchanges between actors. The non-digital platform, in other words, can provide a moderating service for actors' behavior. Therefore, in this study platform is considered as a tool that can help regulate the interaction and association between stakeholders in primary care such as IS suppliers, software suppliers, and end-users.

In a nutshell:
Non-digital platforms can help build bridges between individuals in society and facilitate communication and interaction between individuals. The establishment of this relationship does not require that the individuals involved have the same background or cultural knowledge.

Digital platform

What is digital platform？ Digital platform emphaizes socio-technical characteristics of the platform, including their layered modular architecture (Yoo et al. 2010; Wagner & Prester, 2019). In addition, digital platform also focus on the interactions between such as platform users, governance mechanisms, and the platform ecosystem (de Reuver et al. 2018; Wagner & Prester, 2019). In comparison to non-digital platforms, digital platforms contain components at different levels, such as devices, operating systems, and applications (de Reuver et al., 2018).

In simple terms, digital platform adds an innovative element to a stable core system and a variable periphery. This variable periphery increases the flexibility of functional changes by considering modularity as a principle (Tiwana, 2013). This flexibility needs to be underpinned by standardized interfaces for interaction. In other words, digital platforms ensure that

stakeholders' requirements are met by providing them with a reusable and flexible library of digital components that can be changed (Morgan et al., 2021). Such reusable and flexible digital components include, but are not limited to, reusable data, infrastructure, and business process components.

In addition, digital platforms represent the default capability of the supply side to assist in scaling and commercialization by providing a comfortable and reliable experience for users (Tilson et al., 2010; Furstenau & Auschra, 2016). In this context, the supply side mainly refers to software suppliers (van Alstyne et al., 2016). Since the behavior of software suppliers is also directly influenced by IS suppliers. Therefore, the supply side is considered here as a common subject resulting from the collaboration between the two. For this research, digital platform is defined as "an online software-based infrastructure consisting of scalable peripherals of a core software-based system. The purpose is to facilitate interactions and transactions between users".

In a nutshell:
Digital platform provides the possibility of digital needs on the basis of platform.

2.2.2 Platform architecture

The architecture of a platform implies a conceptual blueprint with interaction, describing how the ecosystem can be divided into a relatively stable platform (Tiwana et al., 2010) and a set of complementary modules with low diversity and low reproducibility (Baldwin and Woodard 2009). Tiwana et al. (2010) also indicate that the design rules will provide constraints on both of these. In this case, the complementary modules consist of other modular elements such as applications, microservices, etc., instead of the traditional monolithic approach (Tiwana & Konsynski, 2010; de Reuver et al., 2018). Besides, if the complementary modules combined with the physical product are integrated with the hierarchical structure of the software, the resulting architecture will create new possibilities for future product manufacturing (Yoo et al., 2010, p. 729). In short, the dependence of the technical architecture and the digital platform on different dimensions of the platform makes it an innovative driver for the development of digital platforms.

In a nutshell:
Platform architecture describes the phenomenon of dividing the functions and interactive behaviors of a digital platform.

2.2.3 Platform openness

Furstenau & Auschra (2016) define platform openness as unrestricted participation, i.e., the act of external parties who do not need to gain access to the platform in order to engage in conditional access to the three levels of code, content, and physical infrastructure (Lessig, 2001). At the code level, openness refers firstly to participation in the platform itself and secondly to restrictions on innovation on top of the platform (Eisenmann et al., 2009; Furstenau & Auschra, 2016). At the content level, openness is related to the right of access, addition and transfer of data. These two levels of openness mean that platform risk will be reduced by facilitating the potential use and ability of providers, healthcare providers, insurers, and patients to contribute as a way to achieve platform development (Furstenau & Auschra, 2016).

In a nutshell:
Platform openness allows for a network of external developers who produce innovative services based on actors' requirements to assist in unlocking data access and enhance the experience of using actors' access to information. It is thus clear that platform openness offers alternatives for establishing information interactions that will greatly assist in the development of primary care. For the reminder of this thesis, platform openness is defined as "a way of allowing caregivers to access, use, or exchange medical information."

2.2.4 Internal attributes of platform

The internal attributes of digital platform in information system consist of architecture, governance. These two elements discuss DPIS from the perspective of software engineering and governance respectively. The combination of architecture and governance not only ensures that the development of the technical architecture is reflected in the way the platform is managed, but also ensures that the DPIS is compatible with the environment in which it is located to ensure its continued development (Katz & Shapiro 1994). In addition, the expression of multiple authentic opinions contained in governance also provides a solid foundation for the development of DPIS. For example, the concern for turbulence analyzes the survival index of emerging digital technologies and also focuses on the difficult situation of adding new mods (e.g., those related to openness) to existing DPIS.

As mentioned in section 2.1.2.3, the "difficulty" or even "reluctance" of official organizations such as governmental organizations to deal with emerging technologies and the imbalance in the expression of opinions between them and NGOs are serious obstacles to the adoption of digital technologies in the healthcare industry. Therefore, it is particularly important to develop a reasonable governance to guide official organizations. When the pace of technological development is too fast to be embedded in the system of the day, a rational structure can balance this turbulence by allowing or discouraging new inputs (Tiwana et al., 2010). And this is one of the implications of this thesis.

2.2.5 Platforms and ecosystems

According to the explanation in section 2.2.1 of this thesis, a digital platform can be defined as a digitally oriented platform system which is an extensible code base for a software-based system. It provides the core functionality shared by the modules that can be interoperated with it and their interoperable interfaces (Tiwana et al., 2010). And ecosystem, as an innovative form of organizing independent actors around a stable product system at its core (Cennamo & Santaló, 2019; van Hattum, 2020), represents the collection of modules with which the platform interoperates. In this thesis, ecosystem is defined as the collection of the platform and the model specific to it (Tiwana et al., 2010).

2.3 Elements of DPIS ecosystem

This section discusses the elements of DPIS ecosystems and briefly discusses the relationships between the elements, which is visualized in figure 3.

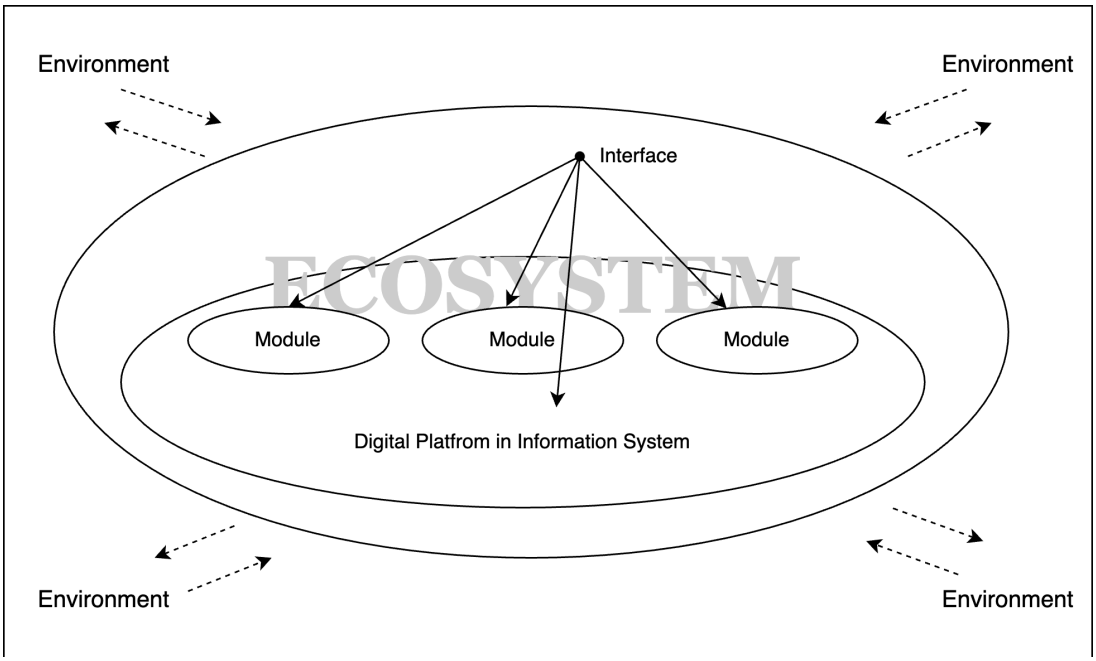

Figure 3 Elements of DPIS ecosystem (author: own, adjusted from figure 1 of Tiwana et al., (2010))

2.3.1 Elements

Modules

Modules act as additional software subsystems to the system, providing diverse functionality to the DPIS by building connections to the DPIS (Tiwana et al., 2010). Modules have strong connections between internal elements and do not have very direct or strong connections to elements of other components (Baldwin & Clark, 2000, p. 63; Baldwin & Woodard, 2009). Therefore, in this thesis modules are defined as functionalized software modules that can be added to the core system of a platform.

Module has two forms, one is called a core component, and the other is called a (flexible) component. A core component is a module that does not change at will according to social needs or rules. However, this does not mean that it will never change. Core components will evolve over time. The situation is reversed for (flexible) components. It tends to dynamically adapt to consumer needs, market demands, or design rules determined by suppliers.

Environment

This environment specifically refers to the environment of the ecosystem in which the DPIS is located. This environment contains external factors that can positively or negatively affect the DPIS.

Interfaces

The interface establishes the boundaries of the module and describes the rules of interaction between the digital platform and the module. Examples include specifications and design rules (Tiwana et al., 2010). Modular interfaces can reduce coordination costs and transaction costs across module boundaries (Baldwin & Clark, 2000; Baldwin, 2007; Baldwin & Woodard, 2009). At the same time, the coupling of interfaces and modules provides the platform with the ability to introduce new products and services (Yoo et al., 2010).

2.3.2 Relationships between elements

As shown in figure 3, the DPIS that exists within the ecosystem has multiple modules and an interface that provides specifications and interaction rules. Changes in the external factors that exist in the environment affect these elements and consequently their relationship to each other. This will eventually lead to changes in the ecosystem. This may be caused by the fact that the external environment provides information that is lacking in the existing ecosystem. In the case of this study, openness was considered as the missing information.

At the same time, the volatility and evolution of the ecosystem can also have an impact on the environment. This is caused by the uniqueness of the modules and the different settings and mechanisms of each DPIS. This provides each ecosystem with functions and features that are different from those of other ecosystems. Likewise, this leads to competition between different ecosystems. Also in this study, for example, the modifications (complements) that suppliers assigned to DPIS with its own characteristics to enhance openness caused competition within the environment. In general, the influence of the external environment and the DPIS ecosystem is mutual rather than singularly deterministic.

2.4 Perspectives on digital platforms

The digital platform as a foundation supports the diversity and evolvability of the system by limiting the connections between other components. Its definition also exists differently in different domains. However, all these different perspectives on digital platforms still have the same root, namely the structure of the platform (Baldwin et al., 2009). What follows is a discussion of the definition of digital platforms from the viewpoint of product development researchers, technology strategists, and industrial economists, as well as the collaterals that arise. A summary of these perspectives can be viewed in table 1.

2.4.1 Three perspectives on digital platforms

Product development researchers describe a platform as a project to create a new generation or set of products for a given company. In this definition, "product" is the focus, which leads to the subsequent derivative "platform product". Platform product refers to a new product with multiple design elements that meet the needs of a core customer base (Baldwin et al., 2009). Such new products have a very robust foundation and variable modules (i.e., design elements) that can be interacted with through standardized interfaces (Tiwana et al., 2010). Adding, replacing or removing these easily changeable modules results in new derivatives, i.e., new functionality added to the existing robust foundation. And this, in turn, is the essence of the platform.

Technology strategists show a different view. They see platforms as 'value points' that can be controlled by behavioral means such as extreme rent setting. This leads to the concepts of 'competition', 'evolving structure', 'market leadership ' and other related concepts. In this context, competition focuses on the competitive behavior of different firms in an industry and the subsequent survival strategies that arise. Individuals must evolve in response to the turbulence of the external environment in order to survive, to ensure robustness and resilience of individual structures and competitive business behavior. This evolving structure (Bresnahan & Greenstein, 1999) reflects the fact that even in some highly competitive market

segments, the dominance of controlling behaviors such as the direction of the industry is still concentrated in a few dominant individuals. The platform acts as an aggregator of information resources, which provides a strong base for these few dominant individuals. In addition, this competitive evolutionary behavior motivates other non-dominant individuals on the platform to find their own market leadership and cross-platform strategies to improve their chances of survival. Cross-platform strategy in this case means creating an internal platform that can interact with any operating system composed of other individuals (Cusumano & Yoffie, 1998). In other words, a cross-platform strategy represents openness, reducing information latency by blurring boundaries to enhance information interaction between different individuals to reduce risk. It follows that competitive behavior among individuals forces individuals to develop evolving structures that are adapted to social volatility, but cross-platform strategies can reduce the achievement of absolute dominance by a few individuals on a single platform through cooperation among individuals on different platforms.

Industrial economists view platforms as hubs that provide an intermediary role for transactions between more than two groups (including two groups) of agents (Rochet & Tirole, 2003). Transactional products include, but are not limited to, representational products and services. The platform acts as an intermediary, providing the possibility of interaction between multiple groups of individuals (i.e., agents) which greatly increases the complexity of the transaction. Parker and Van Alstyne (2005) suggest that platform owners must propose solutions to control the behavior of these individuals to reduce the competitive dynamics in order to control the platform in a stable state capable of providing services.

Table 1 Summary for different perspectives of digital platform

Industry	View	Derivative Product	Source
Product development researchers	Projects that can generate new products	· Platform product	(Baldwin et al., 2009)
Technology strategists	Value point	· Competition · Evolving structure · Market leadership	(Bresnahan & Greenstein, 1999)
		· Cross-platform strategy	(Cusumano & Yoffie, 1998) (Baldwin et al., 2009)
Industrial economists	Intermediaries	· Network externalities · Competitive dynamics	(Rochet & Tirole, 2003)
			(Parker & Van Alstyne, 2005)
			(Baldwin et al., 2009)

2.4.2 Positioning this thesis in scientific research

Understanding the openness requirements of the key stakeholders in DPIS is one of the main focuses of this study. In addition, the study identifies and validates their common requirements and the architectural representation of these requirements, and discusses the relationships and potential associations between the requirements of key stakeholders. This study was selected with the aim of designing a DPIS that would better promote openness, not only because of the research shortcomings identified in appendix A3.1, but also because of the importance of the DPIS study as mentioned in the perspectives of the three stakeholders in table 1.

Therefore, it can be seen that this study does not start from a single perspective, but first builds a network of relationships between key stakeholders. The requirements of key stakeholders for DPIS are then discussed. From the problem, the requirements are discussed, designed and validated. Finally, the developmental nature and limitations of this study are discussed.

3

RESEARCH METHODOLOGY

This chapter discusses the general approach used in this study and the methodologies used to answer each subquestion, as well as the tools used in the research process. In addition to this, this chapter describes the sources and use of data. Table 2 presents a summary of these.

3.1 General research approach- design science

The purpose of this study was to define the requirements of key stakeholders in primary care in the Netherlands regarding the openness of DPIS and to translate these requirements into architectural requirements that are consistent with the development goals. These requirements were then validated using a semi-structured interview. The architecture that meets the development goals here means that the defined architectural requirements on openness are based on the functional requirements and non-functional requirements of the architecture.

Design science focuses on how to design effective artifacts explicitly based on existing theoretical foundations. In this study design science supports the definition and verification of key stakeholders' requirements and architectural requirements, and ensures the validity and practicability of requirements definition and verification from both a technological and social perspective. The study also ensures the validity and practicability of requirements definition and verification from both scientific and social directions.

3.1.1 what is design Science?

Design science (Johannesson, Perjons, 2014) as a typical approach that can improve the functional and non-functional performance of artifacts are able to design practical designs through the pursuit of human performance (Wikipedia contributors, 2021). Based on the identified knowledge gaps and main research question, it is suitable to choose it as the research approach because there is an obvious study void in the construction of an open digital platform architecture for the primary care healthcare in the Netherlands that needs to be redesigned. Meanwhile, the design of this project will be designed from both social and technological perspectives. For social, how to define different requirements from stakeholders in order to construct a platform ecosystem that truly meets their wishes and interest. This ensures that they can provide timely feedback on requirements. For technical, how to standardize the existing DPIS in the Netherlands, and meet the functionalization and non-functionalization requirements. These properties meet the requirements of the design science approach. This project's sub-research questions are based on the method framework and visualized through the IDEF0 framework (appendix A, figure 8). The IDEF0 framework incorporates the influence of external variables, such as research strategy and methodology, and knowledge base, to achieve the desired and potential outputs of the system design through the resource input of the control system, in addition to clearly articulating the steps to be considered in the design process.

3.2 Approach for a given chapter

This section discusses the methods, data sources, and tools used in each chapter, and elaborates on the intended outcome. Table 2 provides a summary of these.

Table 2 Research methodology of this research

Chapter	Methods and Tools	Sub research questions	Potential outcomes
4	**Method**: Document analysis, literature review **Tool**: Mendeley, Scopus, draw.io, MS Words, MS Excel	SQ1: What is current situation?	· Conceptual representation of DPIS situation; · Conceptual representation of DPIS in primary care
5	**Method:** Literature review **Tool**: Mendeley, Scopus, draw.io, MS Words, MS Excel	SQ2: What influences the openness?	· Literature study of architecture; · Key factors that influence the openness of DPIS
6, 7	**Method**: Literature review, stakeholder analysis, requirement analysis, semi-structured interview **Tool**: Draw.io, MS Teams, MS Words, MS Power Point, MS Excel	SQ3: What do stakeholders want?	· Requirements of key stakeholders that are relevant to DPIS openness; · Architectural requirements that are relevant to DPIS openness; · Concept design of interview content; · Validation of key stakeholders' requirements; · Validation of architectural requirements; · Extra suggestion for enhancing DPIS openness

3.2.1 Methods to sub research question 1

Current research still does not have a clear understanding of the digital platform in information system for primary care in the Netherlands. Therefore, the first step in designing a digital architecture that can enhance openness and adaptability to the environment in primary care is to have a clear understanding of the existing situation. Van Hattum, M. (2020) provides some insights into the first phase of this study from the perspective of "soft environmental information". That is, such information contained in a DPIS often contains information about organizational structures that are difficult to objectify. This means that the design of the DPIS is more dependent on external changes and reactions rather than more focused on the needs of the demander. In addition, this "soft environment information" often determines the criteria chosen in design decisions (Kuechler & Vaishnavi, 2008).

3.2.1.1 Intended outcome for this stage

Therefore, the aim of this phase is to learn the current status of DPIS in primary care in the Netherlands from existing studies. In this research, platform openness is defined as the level that allows caregivers to access, use, or exchange medical information. Therefore, the current situation was first discussed from the perspective of information communication, followed by an analysis of the reasons why it is difficult to open the Dutch DPIS for primary care.

3.2.1.2 Method for this stage

Two data collection methods are used in this phase: documentary analysis and literature review. Documentary analysis, also known as desk research, is a cost-effective method for collecting and summarizing data published on public websites, which can be used to support

scientific research. In addition, documentary analysis has several clear advantages: (1) it is an analysis and filter of proven data; (2) it is not influenced by the researcher's subjectivity; (3) it provides a more broader understanding of the research topic; (4) it is faster and not plagued by time constraints of data collection (QuestionPro, 2021). Although documentary analysis has these clear advantages, the data obtained need to be evaluated. This is to ensure the authenticity and validity of the data obtained. Literature review, on the other hand, focuses on assessing the feasibility of data and solutions. In other words, literature review can assist decision makers to make better decisions or determine better courses of action by effectively evaluating the information obtained.

In addition to compensating for each other's shortcomings, the combination of the two can help researchers lay the groundwork for subsequent sub questions from a process and outcome perspective.

3.2.1.3 Data usage

The main sources of data for this stage are scientific studies from the official Dutch medical research institutes and scientific studies by van Hattum in 2020.

3.2.1.4 Tools

The scientific literature was collected using Scopus, the reference management tool was Mendeley, and the information collected was organized using Microsoft Office Words and Microsoft Office Excel. Draw.io was also used to visualize certain associations and processes in the information.

3.2.2 Approach to sub research question 2

This phase is a continuation of chapter 4. What is a digital architecture? What kind of digital architecture fits the current development of primary care in the Netherlands? What characteristics does an architecture need to have in order to enhance information exchange and achieve openness?

3.2.2.1 Intended outcome for this stage

Therefore, the purpose of this phase is to summarize the concepts of architecture and openness in the scientific literature in order to provide a more comprehensive and clear perspective. In addition to this, this phase focuses on the factors that influence the relationship between architecture and openness in DPIS. Thus, first, why architecture is so important is discussed, followed by the introduction of the composition of architecture. subsequently, the requirements of architecture are defined in terms of both functional and non-functional. After that, the concept of openness is introduced, the relationship between architecture and openness is defined and the factors influencing the openness of architecture are analyzed.

3.2.2.2 Method for this stage

The data collection method of literature review is used in this phase. Literature review provides ideas for solving theoretical or practical problems in terms of theoretical explanations or prerequisites. At the same time, literature review can also be used to assess the feasibility of a design solution. That is, it provides insights from the perspective of practical

knowledge (Knopf, 2006). In this study, to determine what influences the openness of DPIS, it is important not simply to summarize existing research but also to critically evaluate the current situation. Literature review, as a method of reviewing existing knowledge, can be of great help in this study.

In addition, Knopf (2006) shows that literature review has the advantages of (1) providing a larger context; (2) providing a direction for research to develop; and (3) exposing directions that have been well done in the research field and avoiding duplication of research and development.

3.2.2.3 Data usage

The data collection method for this step was scholarly publications, and to ensure the quality and dependability of the scholarly literature used, scientific articles were sourced from scopus database only. In addition to the scientific articles on architecture and openness collected in chapter 2, the following search string was used to increase the accuracy and credibility of this study.

TITLE-ABS-KEY (("digital platform architecture" OR "platform architecture") AND ("open" OR "open platform*")) AND (LIMIT-TO (OA , "all")) AND (LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019)) AND (LIMIT-TO (LANGUAGE , "English"))*

3.2.2.4 Tools

The tools used in this stage are the same as in section 3.2.1.4. Mendeley is also used as a means of managing scientific literature; Microsoft Office Words and Microsoft Office Excel as a means of organizing information; and Draw.io as a means of visualizing and exhibiting specific information.

3.2.3 Approach to sub research question 3

3.2.3.1 Intended outcome for this stage

One of the goals of this phase is to collect and aggregate the openness requirements of the key stakeholders in Van Hattum's (2020) study and to find common requirements among these stakeholders. The common stakeholders' requirements are then translated into an architectural representation by constructing associations between the stakeholders and the DPIS architecture. The purpose of this is to ensure that the requirements of the architecture are based on social and market needs. Thus, the architecture design in the future research will not be limited to the conceptual level, but can be put into use to achieve the purpose of enhancing openness. The analysis of the above mentioned elements is presented in chapter 6.

The second goal of this phase is to validate the key stakeholders' requirements and architectural requirements collected in chapter 6 through semi-structured interviews. The purpose was to ensure the reliability and authenticity of this scientific study. In addition to this, additional requirements related to openness were collected through interviews. The purpose is to reduce the subjective judgment of the researcher in defining the requirements in this study and to minimize the research error.

3.2.3.2 Method for this stage

The data collection and analysis methods used in Chapter 6 were literature review, stakeholder analysis, and requirements analysis. The method used in Chapter 7 was semi-structured interviews.

Literature review
As mentioned in section 3.2.2.2, a literature review can help identify gaps in existing research and provide a direction for research development. The identification of key stakeholders in this study regarding the need for openness was collected with the help of a literature review in the study by (van Hattum, 2020).

Stakeholder analysis & requirement analysis
Stakeholder analysis develops management strategies by analyzing the behaviors, intentions, interrelationships, and interests of relevant actors. Stakeholder analysis also focuses on the impact of the behavioral initiatives of these actors on the decision-making process of strategy formulation (Brugha & Varvasovszky, 2000). In this study, the interrelationship between the needs and interests of two key stakeholders: IS suppliers and software suppliers, was the main focus. Unlike stakeholder analysis, requirement analysis builds associations between the requirements of relevant actors and the design. As a structured and organized approach, it is used to identify the resources and requirements needed to satisfy the system needs (Grady, 2010). Therefore, requirement analysis is a good way to assist in defining architectural requirements from a system perspective when translating stakeholders' requirements into architectural representations. That is, it systematically decomposes the requirements of the relevant actors to describe the functions that a DPIS must have. This also relieves stakeholder analysis of the time constraints and difficulties of dynamic adaptation in an unstable and rapidly changing environment.

Semi-structured interview
This method is a set of interviews with a high degree of flexibility. This does not mean, however, that all questions it contains are completely random, but rather that it provides respondents with an open space for reflection through pre-defined questions (Johannesson & Perjons, 2021; van Hattum, 2020). The purpose of the semi-structured interview with experts in the field of DPIS was to validate the needs of key stakeholders in primary care DPIS regarding openness and the requirements for openness in platform architecture. The setup of the semi-structured interview is described in detail in Appendix B. This includes the informed consent form as well as interview content design and additional supplements.

3.2.3.3 Data usage

The data source for chapter 6: Concept design - stakeholder is Van Hattum's research in 2020: digital platform for Dutch first-line healthcare: A study on Trade-offs and openness of the platform architecture. Chapter 7: Evaluation Of concept design focuses on the validation and revision of the stakeholder requirements and architectural requirements collected and defined in chapter 6. Therefore, the data source for this chapter, i.e. the interviewees, came from DPIS companies serving healthcare in the Netherlands and from research institutions with background knowledge of healthcare in the Netherlands. The interviewees were coded

to ensure their privacy. Please refer to table 3. for the full list of interviewees' roles and the type of company or research institution they work for.

Table 3 Types of interviewees' roles and institutions

Code	Company or institution type	Role
SS1	Software supplier for hospital	Architect, business developer, sale
SS2	Software supplier for mental, disable, youth care	Sale
ISS1	IS supplier for informal care	Buisness developer
ISS2	IS supplier for informal care	ICT manager
HO	healthcare organization for GPs	Cargiver, program manager
DS	Dutch standard for health data exchange	ICT architect, advisor
IP	Information Provision Foundation for healthcare	ICT architect, software developer
RI	Research institution	Researcher

3.2.3.4 Tools

The tools used in this stage are Microsoft Office Teams (MS Teams) and Microsoft Office Power Point (MS Power Point), besides Draw.io, Microsoft Office Words and Microsoft Office Excel. MS Teams was used for the interview when the interviewee was unable to participate in the interview in person, and MS Power Point was used for the presentation of the interview content.

4

WHAT IS THE CURRENT SITUATION OF DUTCH DPIS FOR PRIMARY CARE? – WITH THE FOCUS ON OPENNESS

For the purposes of this study, platform openness is defined as the level that allows caregivers to access, use, or exchange medical information. Therefore, in this chapter, the focus is on the impact of existing information communication methods on caregivers.

4.1 Information communication methods and standard

There are two forms of information communication between caregivers, the traditional old Zorgmail or fax-based information exchange and the DPIS-based exchange. Both forms are based on caregivers sending a request to the data owner. Compared to the DPIS-based data request method, the traditional data request method lacks complete security measures and is time-consuming, making it very easy to harm patient privacy due to data loss. This means that it is difficult to securely and timely access the information needed. Meanwhile, the purpose of DPIS-based data exchange approach is to ensure that medical information is recorded, requested, shared, exchanged and transmitted in the correct quality. Although the current DPIS-based data exchange method is not perfect and has some operational complexity, it can avoid the above-mentioned risks to a greater extent.

To support behaviors such as data acquisition behavior, data exchange behaviors, communication behaviors between caregivers, and interactive behaviors between caregivers and patients, information exchange standards play an indispensable role. It ensures smooth and accurate data exchange by focusing on four main components: datasets, use cases, deployment scenarios, and technical design (Meijboom & Klein Wolterink, 2020). Among them, dataset is responsible for providing data sets containing terminology, while the other three components are responsible for providing process descriptions, as well as business role, system role and transaction specifications, and communication standards, respectively.

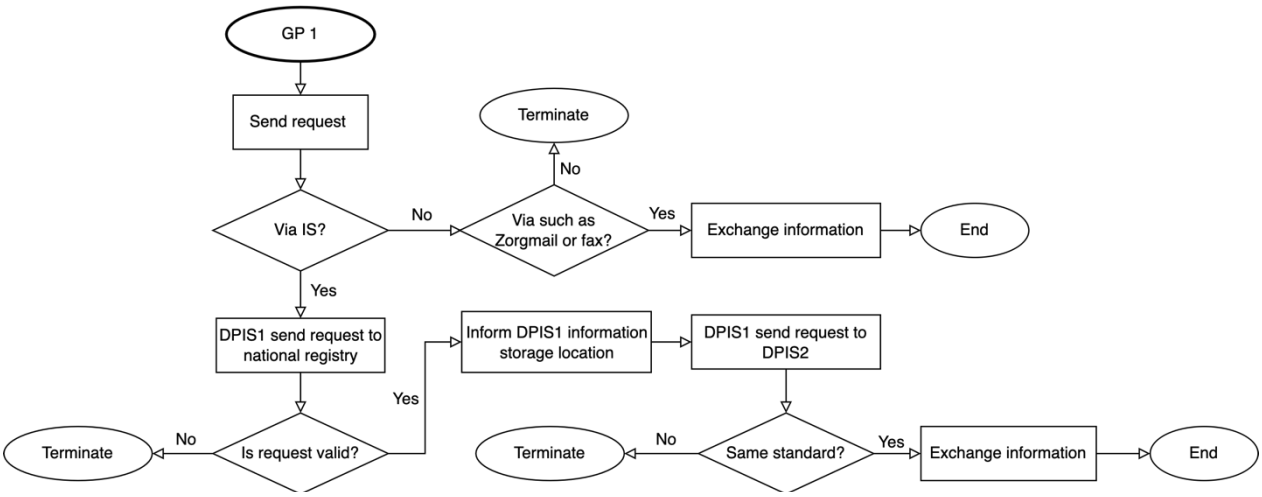

Figure 4 Case demonstration of the DPIS-based data exchange (author: own)

Figure 4 depicts the information communication method with GP as an example. After GP1 sends a data request through DPIS1, the national registry will first diagnose whether the request is valid, and if it is not, the process will be terminated; if the process is valid, the national registry will inform DPIS1 after confirming the location of the data storage. In this case, the national registry is responsible for tracing their tracking DPIS1 first sends a request to this storage location (DPIS2 in this example). DPIS2 then compares whether it uses the same information exchange standards as DPIS1 and confirms the differences in information standards between the two systems. If the standards are different or the differences are too great, there is a risk that the data request will be rejected. And this is one of the reasons why sometimes the data exchange is not completed in time, which has a significant impact on the diagnostic behavior of the GP.

4.2 Reasons for the difficulties of DPIS-based information exchange for primary care

As mentioned in chapter 1, one of the reasons for the high inefficiency of the existing DPIS market in the Netherlands and the difficulty of opening it up is the presence of too many IS suppliers in the market, which have a high probability of developing DPIS with similar functionality due to market demand constraints. The increased competition in the market makes it more difficult for these companies, especially startups, to survive. At the same time, the competitive nature of the market also increases the risk and complexity of consumer choice. In other words, when evaluating and comparing DPISs, consumers cannot fully predict the risks and future prospects of products from different companies with similar features. This can lead consumers to choose the most idealized DPIS that meets their needs and implementation criteria, but there is no guarantee that the DPIS will be able to survive in a rapidly changing technology industry. In extreme cases, this complexity can lead consumers to prefer companies with a long history of providing only basic functionality. This behavior only tends to make the DPIS industry a monopolized situation and more difficult to achieve openness.

On top of that, heterogeneity is also a reason for the difficulty of opening up the Dutch DPIS market. In the pharmacy data DPIS (Dutch: Apothekers informatiesysteem, AIS) industry, for example, there are nine IS suppliers working on AISs, although these IS suppliers share the common goal of providing convenient and fully functional DPISs to their customers. The differences in the architecture of data and information exchange make it difficult to transfer information between pharmacies and achieve complete openness.

But what factors lead to a DPIS architecture that is not open to IS suppliers? This is often determined by the strategic behavior of IS suppliers. To protect their own interests, IS suppliers will prevent their customers from switching to other IS suppliers by limiting access to the user-base. In addition, IS suppliers may also offer preferential services to healthcare organizations to facilitate long-term cooperation. In order to bundle the existing customer base with the target customer base to maintain the stability of the business development. This deadlock hinders the openness and innovation of DPIS and will continue to exacerbate the pressure on healthcare (NL TIMES, 2021). Currently, various industries in the Netherlands have shown a clear willingness to enhance the openness of DPIS. Therefore, it is worthwhile to investigate how to facilitate the interaction of different industry perspectives on openness and to ensure that the products put on the market truly meet the needs of consumers.

In general, the current situation of Dutch DPIS for primary care can be summarized as a phenomenon in which medical data is difficult or even impossible to exchange smoothly. This is mainly due to the presence of a large number of DPIS with unique features in the DPIS market and the interest protection behavior of IS suppliers.

5

SUGGESTION - LITERATURE ON PLATFORM ARCHITECTURE AND OPENNESS

This chapter provides a literature review of the DPIS architecture and the concept of openness and summarizes the factors that influence the openness of the architecture.

Section 5.1 reports on the importance of architecture and discusses the components and requirements of architecture. This is followed in section 5.2 by a description of the reasons why openness in architecture is important. Finally, in section 5.3, the factors that influence architectural openness are presented and discussed.

5.1 Platform architecture

5.1.1 why platform architecture is important

The researchers indicated that to truly enhance the openness of DPIS, it is important to start from the perspective of the architectural design of DPIS. The architecture of DPIS is designed to be very important because it can help manage the growing complexity by serving the functions of the ecosystem (Tiwana, 2013). And opennss is to increase the possibility of market input by acting on the access criteria of the platform. At the same time, an open platform in a collaborative premise meets the current state of social development by acting on patient needs and innovation needs. Thus, it facilitates the increase of the potential share of the market required by the stakeholders. Thus, considering how to achieve the openness of DPIS from the architectural design ensures a balance between the need for developer autonomy and access to potential stakeholders (Tiwana, 2013). Beyond this, the end product from the architectural design can integrate these stakeholders into a more cohesive ecosystem and diminish the negative impact from outsiders.

Platform architectures can also assist in the evolution of such systems when the underlying system is complex (Baldwin et al., 2009). This means that each component of this complex system, especially the core components, can be steadily enhanced when the interfaces are stable. In this system, it is not possible to develop a single system from a single stakeholder's point of view or to adapt the components by considering the development of a single function. In order to achieve successful operation of the system, it is necessary to consider how to combine components flexibly and to consider the impact that a single operation may have on the overall system. Otherwise such actions can lead to rigidity of the system. At the same time, unforeseen circumstances may occur during the evolution of the system. Digital platform

architectures can reduce the occurrence of such scenarios by reducing the probability of possible negative interactions (Tiwana et al., 2010).

5.1.2 Composition of the architecture

In a platform system, the architecture consists of three types of components: complements, core components, and interface (Baldwin et al., 2009). Core components can be considered as the infrastructure of the platform system architecture, which remains stable regardless of the changes in complements. complements remain stable regardless of changes. But stability here does not mean staying the same. It has the ability to evolve over time. Complements are a set of complementary components that allow for change, often with high variety and high rates of change over time, and whose diversity is often determined by the needs of society and the willingness of IS suppliers to grow. The interface is responsible for managing the interactions of components and the operation between the core components and complements.

These three components form the architecture through the modularity of the platform system. Figure 5 provides a visual representation. It is worth noting that the interior of the core components is not the basis of the platform system, but in contrast, the interfaces are essential as design rules. In addition to the necessity to ensure the stability of the interface, it is also necessary to ensure its flexibility (Tsadimas et al., 2009).

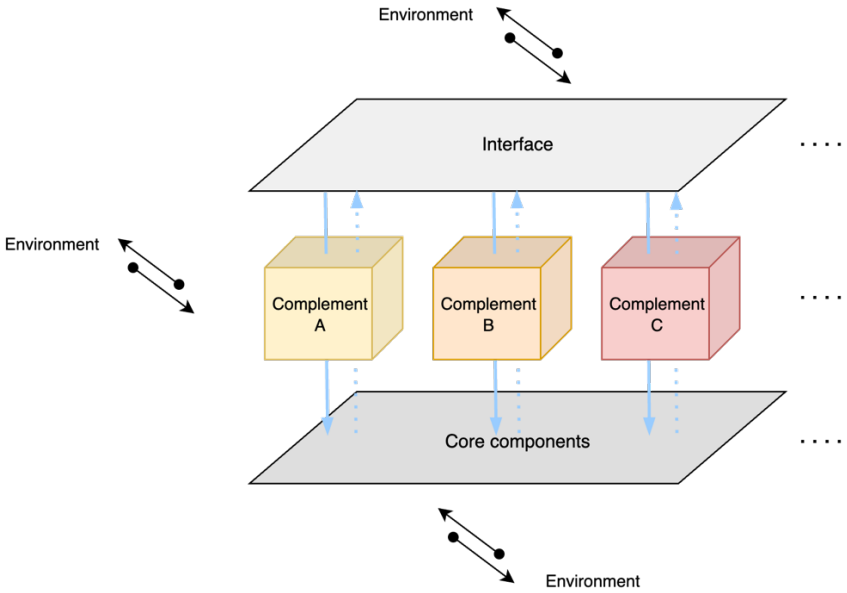

Figure 5 Architecture demonstration (author: own, design is based on Tiwana et al., (2010) and Tsadimas et al (2009)5.1.3 Requirements of architecture

In this section, the design requirements of the architecture are analyzed in terms of functional requirements (FRs) and non-functional requirements (NFRs). The reason for this is that FRs provide insight into the expected behavior of the system in terms of the services or tasks that the system needs to perform (Xu et al., 2005). In other words, FRs explain how the system must work. NFRs, on the other hand, impose constraints by imposing limitations on the behavior of the product being developed. I.e., NFRs explain how the system should perform.

5.1.3.1 functional requirements

Based on Tsadimas et al (2009) scientific research, functional requirements of IS architecture should be considered from response time and role behavior two aspects. Response time requirement implies the time interval in which a service should complete its execution. Based on the consideration of the platform system infrastructure, this implies the operational behavior between the core components and the complements, and the impact on the time when the interaction of the components takes place. The Role behavior requirement emphasizes the diverse behaviors of different users. In other words, the role behavior requirement describes the probability and frequency of a user initiating a service. In a platform system, the diversity and variability of the complements often have an impact on whether users choose to use the service, while the stability of the core components often determines whether users will continue to use the service over time.

5.1.3.2 non-functional requirements

Physical, availability, and performance comprise the non-functional requirements of the DPIS architecture. Physical requirements refer to the limitations of hardware resources that affect design decisions. The limitations here refer to the limits of hardware capacity in the network infrastructure and its impact on the system. Availability requirements refer to the ability to provide services that can be used and are also related to the hardware aspects of the network infrastructure.

Unlike physical requirements and availability requirements, Tsadimas et al (2009) split the performance requirements into behavior, utilization, and load. Behaviour requirements refer mainly to time-dependent service behavior, such as the loading time and response time of system services.Utilization requirements refer to the proportion of network infrastructure resources used by the application when operating under normal or extreme conditions. In contrast to the above mentioned, load requirements are often derived requirements, i.e., they refer to the load imposed on the components within the resource when the act of allocating the resource occurs.

5.2 Why architecture openness is important?

Digital platform openness can facilitate the development of digital platforms. In a platform-based context, openness implies the opening of three important layers: the code layer, the content layer, and the physical infrastructure layer (Lessig, 2001). At the code layer, openness improves the participation issues of the platform itself (Eisenmann et al., 2009) and the embeddedness in social systems by lifting the restrictions on innovation on the platform. At the content layer, openness takes into account the access rights of the platform. This implies control over who can access what content or add what content and to what extent data can be transferred to other environments.

Beyond that, Furstenau & Auschra, (2016) stated that openness facilitates the development of platforms by considering the needs of stakeholders such as IS suppliers, software suppliers, caregivers, and their potential contributions to the platform. This behavior enhances the potential for interoperability between stakeholders and the platform (Benedict et al., 2016). Conversely, if one chooses to neglect to enhance the openness of the platform will enhance the riskiness of the platform development. This is due to the lack of or uncertainty in

regulations or systems, or the personal choices of IS suppliers (e.g., risk aversion). IS suppliers may choose to disable some of the platform's features such as data exchange functions related to openness, or provide proprietary interfaces to mitigate losses. But in the long run, such choices limit the development of digital platforms.
In general, enhancing the openness of digital platforms means encouraging innovation on the platform and the degree of freedom to use it in different ways (Furstenau & Auschra, 2016). In the context of primary care, promoting openness also means encouraging the interaction of caregivers with IS suppliers or software suppliers to ensure that caregivers can realize their own needs related to openness in a more innovative way.

5.3 Factors influencing platform architecture openness

The researchers proposed four main factors that influence the openness of digital platforms as interoperability, stakeholders, organizational structure, and environmental dynamics. interoperability considers the consistency of healthcare DPIS protocols at six levels. Stakeholders are mainly the IS suppliers and software suppliers. Their decisions often determine the organizational structure of the DPIS (van Hattum, 2020). Environmental dynamics discusses the impact on the openness of the DPIS in terms of both technological trajectories and multihoming costs.

5.3.1 Interoperability

Benedict et al. (2016) show that the interoperability potential of the platforms greatly affects openness. According to Sprenger (2020), interoperability can be divided into six layers: organizational policy, care process, information, application and IT infrastructure, the laws and regulations. Each of these layers has unique actors, concepts, and standards, although they all focus on the protocols that need to be developed in different scenarios of health care DPIS in a collaborative context. Nictiz's (n.d.) layer model provides a good interpretation of the built-in properties of interoperability. Therefore, the following section introduces interoperability on the basis of their layer model and analyzes the special case of primary care using GP as an example.

Organization policy layer (layer 1)
This layer focuses on organizational agreements at the administrative level. The aim is to increase the interaction between health care institutions in three ways: cooperation, allocation of responsibilities and division of competences. In the context of primary care, this layer can be used to emphasize the rules of conduct for caregivers. For example, by regulating the communication between the GP and the patient before making the act of referring the patient, setting boundaries for information exchange between GPs and other caregivers.

Care process layer (layer 2)
The target group of this layer is the caregivers and the relevant managers of the healthcare organization. This layer focuses on the collaboration of caregivers in the provision of diagnosis and governance and care, the handover between caregivers and managers, and the transfer of interfaces between health care organizations. Typical examples are the development of the COPD standard of care and the drug data transfer chain (Nictiz, n.d.).

Information layer (layer 3)
This layer focuses on the documentation of information and the development of sharing protocols. These protocols are developed in collaboration with the caregivers and information service providers. In the primary care scenario, the protocols are developed by the representative staff of the GP's institution, the IS suppliers of the DPIS used by the GP, and the GP.

Application layer (layer 4)
This layer focuses on the process of sharing DPIS data between healthcare organizations and the applications that store, structure, process, analyze, or exchange information (Sprenger, 2020). For example, what data is shared, how this data is shared, what rules need to be followed in the sharing process, and how to secure the information that is shared. A typical agreement is the one developed jointly by IS suppliers and software suppliers for a standardized data domain model.

IT infrastructure layer (layer 5)
This layer focuses on the IT infrastructure needed to ensure the smooth implementation of the information layer, such as databases, servers and search engines. This layer does not only consider healthcare as the only service target, but also focuses on how to provide services for the information layer from a holistic perspective. Therefore, this layer does not provide components specifically designed for healthcare. The agreement for the IT infrastructure layer is also developed jointly by IS suppliers and software suppliers. This agreement includes, for example, guidelines for the exchange of data between different servers.

The laws and regulations layer (layer 6)
Unlike the first five layers, this layer emphasizes the national or international laws and regulations that the first five layers must comply with. For example, the General Data Protection Regulation (GDPR), which focuses on privacy and security protection, and the Wet Geneeskundige Behandelovereenkomst (WGBO) (Nictiz, n.d), which focuses on the protection of patients' rights and obligations.

Interoperability is facilitated when these layers of agreement are nested within each other in compliance with laws and regulations. In summary, within the context of healthcare, these six layers - management within the organization (layer 1), the care process (layer 2), the data base of the care process (layer 3), the applications required for data sharing (layer 4), the IT base (layer 5), and the laws and regulations (layer 6) provide the basis for interoperability. Similarly, when these layers are used to serve primary care, only the target groups are restricted to primary care caregivers and suppliers, and the content of the layers is modified according to their role characteristics.

5.3.2 Stakeholders

The main stakeholders involved in the construction of a DPIS for primary care are caregivers, IS suppliers and software suppliers, where the choice of DPIS features and modules is based on the interests of caregivers. IS suppliers determine the core development goals and required functions of the DPIS by combining the direction of industry development, interest and needs of the target group (caregivers). In this research context, openness was chosen as the core development goal of the Dutch DPIS for the purpose of information exchange and

communication among caregivers in primary care. In this process, software suppliers act as service providers. They develop and maintain the openness-related modules and functions on the DPIS. Chapter 6 and 7 summarize the views of the stakeholders on openness.

In a nutshell, caregivers provide the open development direction of DPIS for Dutch primary care, IS suppliers determine the development direction of DPIS, and software suppliers lay the foundation for the development of DPIS.

5.3.3 Organizational structure and the influence of stakeholders on organizational structure

Mohr's (1971) study showed that traditionally, organizational structure is seen as a structure that enhances effectiveness. This structure needs to be organized in a particular way. In the innovative conception, organizational structure is seen more as a variable that cannot be manipulated at will. Its nature is influenced by causal factors such as organizational context (Thompson, 1967; Lawrence & Lorsch, 1986), technology, and so forth. In the case of IDC - IT EXECUTIVE - DX Platform (Appendix A8, figure 14), the organizational structure is enhanced by adding an intelligent core to the traditional foundations of IT governance, architecture, development services, etc. Thus, we can see that the organizational structure plays an essential role in the successful development of the company's core values and goals.

Likewise, organizational structure can assist in laying the foundation for a business or organization when enhancing DPIS openness is considered a core development goal. It can be adapted to the combination of primary care and DPIS by considering the differences between the two environments. In addition, organizational structure can also help a company or organization to clarify its core development goals and identify the factors that are associated with or influence this core. In the context of this study, openness is considered as the core, while data exchange, data requests, customer relationships, etc. are considered as the associated factors.

In the process of designing an organizational structure, the decisions of software suppliers and IS suppliers often have an impact on the shape of the final organizational structure. Software suppliers are responsible for developing the DPIS and providing the services required by IS suppliers. IS suppliers are primarily responsible for the development of the DPIS. Inherent tensions between potentially divergent interests of software suppliers and IS suppliers determines the complexity of business processes and the degree of support (Tiwana et al., 2010). These two factors are key indicators of the quality of the organizational structure (Chen et al., 2021).

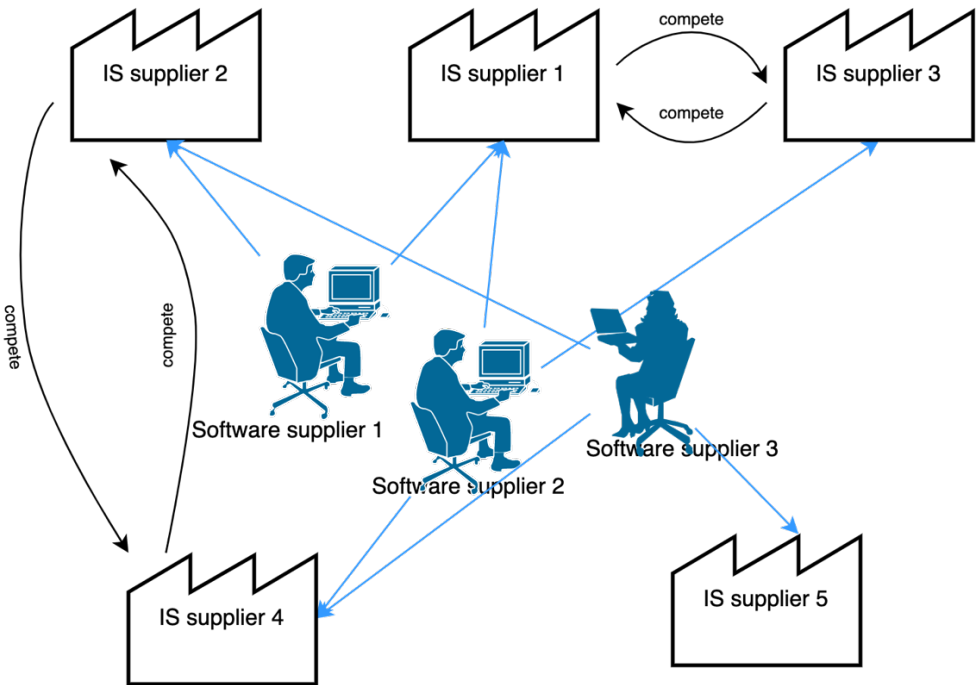

Figure 6 Relationship between software suppliers and IS suppliers (author: own)

On top of that, Tiwana et al. (2010) indicate that software suppliers do not only provide services to one platform. In other words, software suppliers may have partnerships with multiple IS suppliers. These IS suppliers may even have a competitive relationship, such as both focusing on the development of a digital platform for pharmacy. Conversely, IS suppliers may similarly employ multiple software suppliers to obtain the services they need. This behavior increases the complexity of the degree of networking. The increased complexity of networking makes it more difficult to control the nodes in order to move them in a given direction (increased openness) and more difficult to control the organizational structure. Figure 6 provides a simplified view of the network relationships between software suppliers and IS suppliers.

5.3.4 Environmental dynamics

Technological trajectories and multihoming costs as two major factors of environmental dynamics (Tiwana et al., 2010) discuss the impact on DPIS as well as openness in terms of complementary and alternative technologies, and the costs associated with developers and platforms, respectively.

Complementary technology means that it provides functions that existing technology does not have, but does not replace the entire technology. The impact of complementary technologies is also known as positive impact. It means that the available resources are used more efficiently or the results are improved if the technology is used as much as possible while maintaining a high level of the independent variables (Mehta et al., 2022). Replacement technology implies a comprehensive update of technology, such as a shift from written communication to digital communication. Replacement technologies may have a more negative impact than complementary technologies. This is due to the imbalance between the large number of information technologies that can improve outcomes and the low level of

independent variables. In this context, the independent variable can refer to the knowledge interagtion of IT use. This is why, in the current social context, technology tends to be slow to turnover. From the update of basic functions to the replacement of functional modules. Instead of replacing all existing technologies in an instant.

Mehta et al. (2022) show that complementary and alternative technologies are characterized by rapidity, unevenness, and unpredictability. Although these characteristics may seem negative, this provides an opportunity for the evolution of DPIS. This means that the characteristics of complementary and alternative technologies can help DPIS to extend to adjacent but unrelated domains with potential users (Eisenmann et al., 2006). This can help to build bridges between people in different domains to enhance the exchange and communication of data. In the context of primary care, this can better help caregivers to articulate their needs and perspectives related to openness, and lead to a clearer perception and understanding of the real situation and background knowledge of people with IT backgrounds. At the same time, this provides a clear development and design direction for people with IT backgrounds.

In general, when considering, for example, openness as the core of development, technological trajectories can facilitate communication, guide design direction and ensure design effectiveness. In addition to this, technological trajectories can ensure responsiveness and flexibility of DPIS (Khalil & Khalil, 2019), while increasing the interaction between takeholders on the platform. This means that the information processing and exchange capabilities of these takeholders are enhanced.

Second, multiple attribution costs (Armstrong & Wright, 2007), i.e., the costs incurred by software suppliers associated with more than one platform. Attribution costs include, for example, adoption, operation and opportunity costs. As mentioned in section 5.3.1, software suppliers often establish partnerships with multiple DPISs. This behavior doubles the cost that software suppliers have to pay. Therefore, in establishing a service relationship with multiple parties, software suppliers need to have a very clear understanding of their own interest needs and wishes. In other words, they need clear reasons to motivate themselves to provide services to multiple DPIS at the same time. Therefore, if IS suppliers can provide the development kits, adapters or compatible interfaces that software suppliers need, it will effectively reduce the cost of multiple addresses and conversions Tiwana et al. (2010). At the same time, it is more likely to attract more software suppliers to build partnerships. Similarly, this scenario applies to the development of DPIS openness. IS suppliers need to clearly demonstrate to software suppliers the benefits (reduced attribution costs) and development potential that they can obtain by establishing a partnership with multiple software suppliers or seeking support from software suppliers. In other words, IS suppliers need to clearly inform software suppliers of what they need and what they can offer.

6

STAKEHOLDERS

This section analyzes the requirements of two key stakeholders, IS suppliers and software suppliers, and discusses them in terms of decision rights, control mechanisms and proprietary vs. shared. Although caregivers are the end-users of the service, their requirements do not act directly on the design of the IS, but are relayed through the mediating role of IS suppliers. Therefore, in section 6.1, the behavior and influence of caregivers are discussed in a side-by-side manner but their needs are not analyzed in detail.

Compared to all the stakeholders in table 14 stakeholder overview, the analysis in this section omits researchers, and patients, whose behavior is not decisive for the design and development of the DPIS, although they are involved to some extent in the use of the DPIS at this stage.

6.1 Key stakeholder analysis

6.1.1 Role of key stakeholders

IS suppliers, as owners of information platforms, not only want their platforms to be fully functional, but also want them to have a certain uniqueness in order to gain some profit. In other words, IS suppliers expect the platform to induce consumers to use technology products autonomously and without additional complex operations. Here, caregivers can be considered as indirect consumers, whose access to the IS is provided by the purchase of their organization. In addition to this, caregivers' experience of using technology products as users of the DPIS platform has a significant impact on the speed at which patients receive rational consultation and treatment. This requires IS suppliers to take the experience of using the final product into consideration in the design concept of the IS in pursuit of the completeness of the IS functionality.

Software suppliers, as developers and providers of software and functional modules, ensure the complete architecture and functional requirements of the DPIS platform. The relationship between software suppliers and IS suppliers can be seen as complementary, with one providing the concept and the other the technology. While caregivers are only external to the group formed by the above two parties, they enjoy the end result. The diverse network of the three (Appendix A, figure 13.) also determines that the design of the openness of the platform for a single stakeholder will inevitably have a positive or negative impact on the other two.

But why do IS suppliers choose to work with software suppliers instead of designing independently? The main reason is that software suppliers can provide value when faced with multiple options for system development. When the development option is "the right but not the obligation to take a specific action", software suppliers can analyze and confirm the option

value to decide whether a particular complement should be selected to override another complement (Baldwin et al., 2009).

Option value, by definition,is the value that a private individual is willing to pay to maintain or preserve a public asset or service, even if there is little or no likelihood that the individual will actually use it (Wikipedia Contributors, 2019). In this context, option value refers to the willingness of potential consumers to pay for a DPIS with innovative or unique features. When the potential willingness of consumers is consistent or predictable, option value is low, and similarly, this leads to a decrease in market diversity, which in turn leads to competition within similar goods. However, when the potential demand of consumers is heterogeneous, the option value will increase. When unpredictable trends in technology act as external variables for consumers, the increase in uncertainty also has a positive impact on option value. At this point, software suppliers will be attracted to the platform by the existence of option value in the complement. IS suppliers can use this phenomenon to confirm whether there is a need for innovative development of supplements. However, this behavior must be based on the premise that the IS supplier does not expropriate all the value created by the software supplier.

6.1.2 key stakeholders' requirements

This section first focuses on the summary and analysis of the key stakeholders' requirements. These key stakeholders: IS suppliers and software suppliers have their requirements for openness from section 4.4 of the study (van Hattum, 2020): A digital platform for Dutch first-line healthcare: study on trade-offs and openness of the platform architecture. The study on trade-offs and openness of the platform architecture is presented in section 4.4.

The reason for choosing to extract the need for openness from these data is the scientific basis of the data. The data was collected by Mats van Hattum through expert interviews and desk research, and subsequently validated through conversations with experts in the field. As can be seen in table 4.1 of his study in appendix D, IS suppliers and software suppliers present the perspectives of business, IT architecture, product development, network development and healthcare development. Therefore, when I summarize the openness requirements of these two key stakeholders, I will also elaborate on each of these perspectives.

Table 4 Requirements of key stakeholders

Requirements from software supplier	
Business perspective	1) Interests and benefit objectives in line with business development 2) Effective financial subsidies 3) Non-extreme control 4) Flexible information infrastructure to support variable demands 5) Giving caregivers a certain status
Product development perspective	6) Giving general caregivers access to review patient records 7) Provide caregivers with effective incentives 8) Reduce insurance company control over incentives 9) Clear allocation of responsibilities
IT architecture perspective	10) Clear incentives 11) Dynamic market with clear potential demand 12) Weakened market position of insurance companies 13) Centralized national database
Network development perspective	14) Incorporation of new technologies beneficial to the development of primary healthcare 15) Clear accountability for data information
Requirements from IS supplier	
Product development perspective	a) Effective incentives for caregivers b) DPIS with full functionality c) Government proposes standardized information exchange standards d) Architecture to connect caregivers handling the same patient data
Network development perspective	e) Balance the market influence of software suppliers f) Provide adequate and effective incentives for caregivers and software suppliers g) Standardized regulations that encourage innovation
Healthcare development perspective	h) Trusted national central database i) Standard structure for government-provided information exchange j) A data repository where patients can manage their own medical information

Table 4 summarizes and discusses the common requirements of IS suppliers and software suppliers in terms of openness. The reason for summarizing the common requirements is to ensure that the subsequent translation of the architectural requirements is based on multiple perspectives. In other words, to avoid the influence of subjective requirements as much as possible.

6.1.2.1 Software suppliers' requirements

In table 4, the requirements of software suppliers are split into four perspectives: business, product development, IT architecture, and network development. Among them, the business perspective indicates that the main requirement of software suppliers is that the DPIS should be innovative in primary care to meet the business goals and interests. It is also required that the architecture of DPIS should be flexible enough to support the changing and dynamic needs. However, the lack of financial subsidies has stalled such innovations. Therefore, software suppliers recommend the design of a rational financial structure to facilitate the development of financial incentives. In addition, the ownership and control of the participants in the innovation market should be controlled. That is, software suppliers do not expect the existence of a single actor controlling the market to cause extreme monopoly. Finally, the business perspective also suggests that additional attention should be given to caregivers

during the design of the DPIS architecture. In other words, give caregivers a certain status so that they have access to the information they need when they need it.

The product development perspective on requirements also focuses on caregivers. This perspective suggests that in addition to granting access to designated caregivers to review patient records, consideration should be given to granting access to any general caregivers related to patient care to avoid delays in patient care due to overly complex information requests and timeliness of information. In addition, the product development perspective also raises a number of needs for incentives. This requirement suggests that in addition to reducing the insurer's control over incentives, additional incentives should be assigned to caregivers.

In contrast to the business perspective, the beneficiaries of this requirement are caregivers rather than companies, with the aim of obtaining more efficient and effective patient care for patients. In addition, the product development perspective also focuses on the allocation of responsibility. Who is responsible for solving problems with IS? Who is held accountable? Accountability refers to the principle of organizing the relationship between those who are managed and those who govern. In general, accountability refers to being responsible to others, how authority and resources are used, and what the results are. It follows that accountability in DPIS innovation development without sufficient clarity is highly prone to the phenomenon of organizational management chaos, resulting in wasted resources. This eventually leads to the failure of innovation iterations.

The IT architect perspective on the needs of software suppliers also focuses on clear incentives and the erosion of insurance company power. Unlike the other perspectives, the requirements of this perspective also focus additionally on the needs of data storage locations and markets. It requires that there should be a centralized national database for storing healthcare data.

This requirement is based on the fact that it is difficult to access or exchange data. The main reason for this is the presence of too many DPIS in the primary care market, which leads to different data standards and diverse and complex data requests. The existence of a centralized national database would increase the access to data permissions by regulating data requests (van Hattum, 2020). In addition, software suppliers have shown that the services they provide need to be based on a latent demand in the market. This demand can be considered as an additional incentive in addition to financial incentives. However, it is worth noting that the dynamic nature of the market can lead to fluctuations in the latent demand in the marketwhich can have an impact on the service behavior of software suppliers. Therefore, software suppliers need to establish a stable relationship with IS suppliers to ensure that the services they provide are not only in line with their own subjective wishes but also with the demand instructions required by IS suppliers.

The network development perspective addresses the need for software suppliers in terms of technology development and information accountability, respectively. It suggests that new technology should not be added to healthcare blindly just because it has features that traditional technology does not have or because it will accelerate the development of healthcare. Rather, a rigorous risk assessment and weighing of the technology should be done to determine whether such new technology should be incorporated into the system and the benefits it may bring. In addition, there is a need to look at the capacity of the existing

healthcare system to take on such technology, the space required for such technology, the cost of time and resources required to train technicians, etc. Particularly for the first line as a relationship with the patient, additional attention needs to be paid to the impact that new technologies can have on primary care.

In addition, the network development perspective emphasizes the importance of assigning clear responsibility for data information. This means that when data information is misused, there is a designated person who is responsible for this action. Such person can be caregivers, software suppliers, or IS suppliers. Who is responsible depends on the nature of the harm. For example, if caregiver A wants to send a patient's medical information to caregiver B, but due to an operational error caregiver A sends the patient's information to another of her channels and misses the withdrawal time because it is not detected in time. In this case, we can consider caregiver A as the main person responsible for the action, but we also need to analyze what caused her to make the mistake. Is it because caregiver A did not pay attention, or is it because the partition of the interface is not clear enough? Or is it due to the lack of clear delineation of buttons in the interactive interface? Or is it because IS suppliers did not consider asking caregiver A to repeat the confirmation before sending the message?

In general, giving clear responsibility for data information can be more effective in correcting errors and updating the DPIS. If the responsibility lies with caregivers, consider retraining them or observing them. If the responsibility lies with the IS suppliers, consider how to update the DPIS interfaces.

6.1.2.2 IS suppliers' requirements

According to the background information in section 4.4 of van Hattum (2020), the requirements of IS suppliers are divided into three areas: product development, network development and healthcare development. The requirements of IS suppliers in the product development perspective are centered on caregivers. The requirements from this perspective not only indicate that caregivers should be given effective incentives, but also focus on building an effective DPIS architecture to assist caregivers to deliver healthcare data more smoothly. In addition, this perspective suggests the need to ensure the full functionality of the DPIS, so that it can be used over time and meet the diverse and complex needs of caregivers in primary care.

Furthermore, the requirements of IS suppliers under the product development perspective suggest that the government should provide clear standards for information exchange. This is also reflected in the healthcare development perspective. The main reason for this demand is that IS supplies tend to add to the existing general information exchange standards in their own interest or in accordance with their own preferences. This results in DPISs developed on the same information exchange standards not being able to exchange data because of these minor differences in regulations. Therefore, IS suppliers expect the government to provide standardized information exchange guidelines to facilitate the flow and exchange of data as much as possible.

The requirements of IS suppliers from a network development perspective suggest that governments should also provide standardized regulation to encourage innovation. Rather than just using financial incentives to stimulate innovation. At the same time, this perspective

also suggests that financial incentives should be given in consideration of IS suppliers, rather than just caregivers. In other words, incentives should be given not only to end-users, but also to those who have ideas and want to implement them.

In addition to this, the demand from this perspective suggests that the market impact of software suppliers should be balanced. This requirement is based on two main considerations: avoiding monopolistic behavior and encouraging innovative ideas to enter the market. If software suppliers have a high position in the market or a large market influence, their direction and behavior can have a great impact on the market. For example, software supplier A has monopolized the majority of the market by providing innovative services to the healthcare industry for the past two decades. As time progresses, A is not ready to explore new technologies but only to update its existing ones. Technology is advancing rapidly, and the technology held by A is no longer at the top of its game as it was twenty years ago, and can even be described as "too traditional". However, due to A's monopoly position, it is difficult for other software suppliers to enter the market. This has indirectly led to the stagnation of the market development. Therefore, it is particularly important to balance the market influence of software suppliers.

Healthcare development perspective on the requirements of IS suppliers takes into account the requirements of patients. It suggests that patients should be given the power to access, manage, and store their own medical data. To encourage these behaviors, there should be a data storage space for them. It might be possible to set both patients and caregivers as target groups for this national database.

Table 5 Common requirements for openness of key stakeholders

No.	Common requirements:
1	Not only one or a few actors controlling the market
2	Less control by insurance companies
3	The market influence of software suppliers should be balanced
4	Digital platforms should have a flexible but fully functional long-term architecture
5	Give caregivers enough/more power to interact (access) with others
6	Provide incentives for IS suppliers, software suppliers, and caregivers as a result of developing/using digital platforms
7	Digital platforms should have a clear mechanism for assigning responsibility
8	A centralized database where data can be stored
9	Standardized guidelines for information exchange
10	Digital platforms should be designed to ensure alignment with business benefit objectives
11	Digital platforms incorporate new technologies for primary care development

After analyzing all the requirements of the IS suppliers and software suppliers, I conclude that a number of common requirements are present, as shown in Table 5. In this table, digital platform refers to DPIS. the purpose of not using Digital platform in information system is to prepare for the subsequent interview design. Overly long names can make it difficult for interviewees to capture the focus of the interview questions.

Among common requirements in table 5,

Requirements 3) and e) are both on the topic of actor control of the market. Therefore, I take 1: there should be not only one or a few actors controlling the market as a common requirement. In this view, additional consideration is given to the market impact of software suppliers. The purpose of this is to separate the overall situation from the specific situation in order to see if the requirements of key stakeholders have changed and if their concerns have shifted. Therefore, I likewise take 3: the market influence of software suppliers should be balanced as a common requirement.

Requirement 8) and 12) are both on the topic of insurance company. Therefore, I take 2 as a common requirement: there should be less control by insurance companies.

Requirement 4) and b), d) are both on the topic of architecture requirements. Therefore, I take 4: digital platforms should have a flexible but fully functional long-term architecture; as a common requirement.

Requirement 5), 6) and d) are both about caregivers' access. Therefore, I take 5: we should give caregivers enough/more power to interact (access) with others as a common requirement. This common requirement contains two main pieces of information, which are to provide caregivers with access to patient medical information and to provide caregivers with the power to communicate with other caregivers or patients.

Requirement 2), 7), 10) and a), f) are both about the topic of incentives. Therefore, I take 6: we should provide incentives for IS suppliers, software suppliers, and caregivers as a result of developing/using digital platforms as a common requirement.

Requirements 9) and 15) are both about the topic of responsibility allocation. Therefore, I take 7: digital platforms should have a clear mechanism for assigning responsibility as a common requirement.

Requirements 13) and h) are both about the topic of data storage location. Therefore, I take 8: a centralized database where data can be stored as a common requirement.

Requirements c) and i) are both on the topic of information exchange guidelines. Therefore, I take 9: standardized guidelines for information exchange as a common requirement.

Requirement 1) and 14) are both about the topic DPIS development requirements. Requirement 1) addresses the need for DPIS development and survival from a business perspective, while requirement 14) focuses on the changes of DPIS that need to be made in terms of technological innovation to embed primary care. Although both requirements are about the development of DPIS, I decided to split them into two points due to their different perspectives. This has the advantage of clarifying the development needs of DPIS in different contexts. Therefore, I have included 10: digital platforms should be designed to ensure alignment with business benefit objectives and 11: Digital platforms incorporate new technologies for primary care development as common DPIS development requirements.

6.1.3 key stakeholders' requirements analysis

This section analyzes the common requirements summarized in section 6.1.2.

1. There should be not only one or a few actors controlling the market

IS suppliers and software suppliers expect that there is no extreme central control in the market. Central control, by definition, is a component designated as the central controller and is responsible for managing the behavioral activities of other components (Sommerville, 2008). In the context of market development conditions, this means that in a hypothetical situation there is no single actor or a few actors monopolizing the market and dominating the sovereignty in the market. To reduce the occurrence of central control, decentralized ownership of R&D designs (i.e., DPIS) is not a potential solution.

Decentralized ownership does not mean sharing the core resources of the design with other competitors, but rather with government ministries such as the Ministry of Health, Welfare and Sport (Dutch: Ministerie van Volksgezondheid, Welzijn en Sport; VWS), National Institute for Public Health and the Environment (Dutch: Rijksinstituut voor Volksgezondheid en Milieu; RIVM), and other government ministries. In this context, the role of the relevant government ministries is not only to decentralize ownership and enhance openness, but also to regulate processes, provide advice and guide the direction of research and development (Ministerie van Volksgezondheid, Welzijn en Sport, 2011; RIVM, 2021). In order to ensure a successful decentralization of ownership, it is recommended that the relevant ministries should guide or even force the relevant stakeholders to cooperate with them.

In addition, full access to DPIS is a potential solution. In other words, the actor can obtain access to DPIS and review the required information without additional requests. This could be seen as another form of decentralized ownership, but the benefits would not be limited to government ministries. For access and use of DPIS, this can be any group of people who have the ability, curiosity, and desire to use DPIS. However, when it comes to reviewing information on DPIS that involves personal privacy, this requires limiting access to only certain specific groups within the population.

This full openness, while ensuring that a few actors cannot maintain absolute control of the market, increases the risk of attacks on DPIS leading to information theft. It may also increase potential consumer suspicion of innovative technological solutions. Therefore, while enhancing the openness of DPIS as a development concern, we also need to consider the challenges of securing the system and keeping potential consumers.

2. There should be less control by insurance companies

In today's market, insurance companies are connected to a wide range of industries, which ensures a stable and extensive network of relationships. This network allows insurers to have a certain influence on the innovation or direction of technology, and even the ability to determine the direction of the customers in their network.

The Capability map (appendix A, figure 13) describes the nine basic capabilities of an insurance company: business management, product management, marketing, sales and distribution,

customer care, asset management, money management, claim management, and business support (Angeli, 2019). Among them, product management guides the development of the client's products to a certain extent by defining and engineering them, i.e., by assessing the current market situation and the potential and defects of the products; marketing analyzes the development of the products in the market through data acquisition and other actions to determine whether it is necessary to invest in such products. In other words, whether it is necessary to increase or decrease contact with such customers; the two main functions of customer care, customer relationship management and data-driven insurance, also diagnose to a certain extent the dynamics and complexity of the relationship between the insurer and the customer company, as well as the relationship network. Among them, data-driven insurance improves the customer-agent experience by operating diagnostic control mechanisms for problems to ensure the growth of the customer's business (Brothers et al., 2018).

Thus, it can be learned that although the actions of insurance companies in the existing market are held in check by government actions and laws and regulations, there is still a clear control over the market. To reduce such control, the same methods of decentralizing control can be considered. For example, by intervening in an insurer's network of relationships to diffuse its control over product direction or by considering the diffusion of its control through enhanced external regulation deployed by the government. Such actions would require that external regulatory deployments have the ability to look at the insurer's operational processes and challenge its unusual behavioral practices that are difficult to understand in futures, and suggest corrections or make them directly, subject to consultation and communication.

3. The market influence of software suppliers should be balanced

The market impact of software suppliers is often determined by the innovativeness, rationality, uniqueness, stability, and sustainability of the software features they provide. Innovativeness and uniqueness imply that the software or complements have new features or enhancements to traditional features; rationality implies that the software or complements are designed in accordance with market wishes or developed for the target group; stability implies that the suppliers release error-free programs (T, 2022). Even if the design goes wrong in the future, it can still be fixed rather than just destroyed. In other words, the design is able to participate in the life cycle; sustainability means that the software or complements will not be replaced by other similar designs in the short term and can continue to evolve.

But why is it that when multiple software/complements with similar functions compete, there is always a winner and not all software suppliers grow together in harmony? And why do these winners always maintain a stable position and expand their market position? Similar to the control of insurance companies, part of the reason is determined by the network of the suppliers (Borgatti & Halgin, 2011) and whether their behavior is in line with the market rules. In addition, like competition in other industries, software suppliers also establish certain ties with relevant government agencies in order to ensure the smooth development of their businesses. For example, they establish partnerships with such organizations/deployments or promote their products to such organizations/departments in order to integrate them into their development networks. Since this study does not focus on network development and market complexity, it does not elaborate much on this.

However, the consequence of this action is the monopoly of a few companies in the market industry. This means that these few companies hold absolute control over the innovation and development of technology, which makes it more difficult for different DPIS to interact with each other and more difficult to achieve openness. The government is the main reason for this situation. Why? Because the government determines the suppliers that can be brought in (M&I/Partners, 2021). In other words, the government controls the direction of technology development. If there is not a good connection between government management staff and technology staff, or if there is an older age group within the government, this can make them lack a certain level of technological sensitivity. This has a certain impact on the openness and innovation direction of science and technology.

Taking the market shape of hospitals as an example, the two software suppliers Chipsoft and Epic split the vast majority of the market in 2021 with 70% and 13% respectively (M&I/Partners, 2021). Both companies are privately owned, which results in full ownership of their own software supply development and are not influenced by the actions and decisions of their shareholders (Bukman, 2018). In other words, Chipsoft and Epic determine the fluidity and feasibility of data exchange and the possibility of DPIS openness. Likewise, if this phenomenon of market control by a few players occurs in primary care, it will also limit the exchange of information and the interaction of caregivers, thus making it difficult to open the DPIS.

In summary, in order to reduce the market influence of certain software suppliers that try or have monopolized the industry, a decentralized control approach can also be considered. For software suppliers, national government agencies/deployments no longer view software suppliers or knowledge organizations only as the director of National Exchange Point (Dutch: Landelijk Schakelpunt, LSP). They are also seen as a target group that needs to be better regulated in lieu of transferring full regulatory authority. For the government itself, it is more important to weigh their position in the market and their relationship with these suppliers. It is important to note here that the distribution of control affects whether innovative products can be brought to market and whether they can persist in the marketplace. It is worth considering how to maintain the balance of decentralized control.

4. Information systems should have a flexible but fully functional long-term architecture

In a summary analysis of the requirements of IS suppliers and software suppliers in Van Hattum's (2020) study, both agree that for DPIS to be open, the architecture needs to have three important attributes: long-term, fully functional, and flexible. Long-term means that the architecture needs to be long-lived. This requires designers to design architectures that not only meet the current needs of society and the public in the context of the present, but also to consider the changing needs in the next five years or longer. Strategies to address these changes in demand and their impact on the architecture should also be discussed. Due to the volatile changes in demand this may require the architecture to remove some of its own properties or add some new ones. However, since these requirements are determined by changes in the market and society, this requires a certain sensitivity and flexibility on the part of the architecture designer. Sensitivity requires the architect to be able to capture these dynamic requirements and propose a response in a timely manner, while flexibility requires the architect to be able to dynamically adapt the existing architecture.

Meanwhile, the assurance of the long-term nature of the architecture is also motivated by the characteristics of the DPIS industry and the current state of healthcare for three main reasons: (1) the time required to fully embed the DPIS, i.e., the time required to complete the replacement or update of the existing DPIS; (2) the time required for the users (e.g., caregivers) need to become familiar with the use or master the replacement DPIS; (3) the change in effectiveness and efficiency.

Fully functional ensures that the architecture has complete basic functionality as well as potential functionality that may be required in the future. This design based on potential future requirements also determines the implementation of the long-term properties of the DPIS. Flexible is more a consideration of functional diversity and changing requirements. Functional diversity refers to the fact that a feature of DPIS has multiple features or attributes and can support more than one type of service. Requirements change means that DPIS can not only support the current requirements, but also can be dynamically adjusted to serve different or even special requirements.

In summary, the three inseparable attributes of flexible, fully functional and long-term are the foundation for building a DPIS with development and openness.

5. Give caregivers enough/more power to interact (access) with others

The ultimate goal of a DPIS for primary care is to increase openness so that caregivers can better serve their patients, improve the efficiency of diagnosis and treatment, and avoid detours in the patient consultation process. This better patient service exists in two main ways:

(a) Increased online interactivity among caregivers

The increase in interactivity can facilitate better discussion of the patient's condition and underlying circumstances by caregivers. For example, by considering the opening of a designated online common space.

This situation is mainly time wasting (e.g., travel time) by considering reducing physical offline interactions. However, it is important to note that this behavior does not really happen face-to-face and may cause some bias due to the different situations of the participants. In addition, whether patients should be included in this common space is also a matter of discussion. Patients have the right to be informed about their situation and to raise concerns. At the same time, the transparency of the process can increase the patient's trust in the treatment plan. However, because of the different roles of patients and caregivers, they are in different contexts. Involving the patient in the caregivers' discussion may increase patient anxiety, which may trigger additional effects that could have been avoided. Also, generally speaking the patient does not have a relevant medical background. This means that they do not understand certain medical terms correctly and may even misunderstand them. If the patient tries to raise questions with the caregivers, it may not only delay the process of identifying the cause of the illness, but may also cause the caregivers to be distracted and lead to an incorrect diagnosis.

Therefore, the ideal situation is to maintain the transparency and openness of caregivers' communication in the common space, so that patients can view the discussion process and

the medical documents related to them at any time and any place. However, the patient's rights are limited to the right to view and not to participate. The right to participate is opened after the diagnosis is confirmed. Patients can ask questions about the diagnosis and the implementation plan.

(b) Open access to enhance the smoothness and possibility for caregivers to access medical documents

The process of diagnosing and treating a patient may involve more than one caregiver; for example, in primary care, if the GP1 does not have sufficient knowledge to assess the patient's condition or is unable to specify a detailed etiology, the GP1 will organize a discussion with other GPs or other caregivers. In other words, the most accurate diagnosis and treatment of the patient is provided by aggregating the answers of multiple perspectives on an unknown etiology. However, since these caregivers may come from different medical institutions, there is a certain possibility that they do not have direct access to the patient's medical documentation. Additional access to valid patient medical information is required through additional requests or additional referrals from GP1.

At the same time, there is a certain possibility that this request for access to medical documentation will be denied; or simply because caregivers do not have a suitable schedule to participate in the consultation organized by GP1. This additional behavior with additional waiting time indirectly delays the patient's treatment. Therefore, the smoothness of the consultation can be improved by enhancing the open access to DPIS. In other words, the waste of time costs can be minimized.

6. Provide incentives for IS suppliers, software suppliers, and caregivers as a result of developing/using digital platform

The purpose of providing incentives to IS suppliers and software suppliers is to motivate them to develop DPIS and functional modules that meet the needs of social and technological development. Although the two stakeholders' own intentions are similar, additional incentives from the government or related agencies will increase their motivation even more. Motivation mainly acts to increase the overall profitability of the organization by increasing the productivity of employees and improving industrial and interpersonal relationships (Carbon Collective, 2021). In the context of primary care in the Netherlands, IS suppliers will shift their productivity mainly to deeper research, so that they can achieve a more effective integration of their development intentions with the existing social framework or laws and regulations. At the same time, software suppliers are guided to establish the right development goals. This has a strong influence on strengthening the openness of DPIS.

The purpose of providing incentives to caregivers is different from the purpose of providing incentives to IS suppliers and software suppliers, focusing more on guiding and promoting the use of DPIS by caregivers and making caregivers aware of the impact on their efficiency when DPIS is enhanced. Emphasis is placed on the shift in willingness, i.e., from coercion to autonomy, and the impact of the shift in willingness on behavior. It is also important to make caregivers aware that DPIS updates or replacements in terms of openness are not only for business purposes, but also to serve the needs and experience of caregivers. Therefore, the incentives provided to caregivers should be considered on the basis of individual requirements.

Such as considering the impact of DPIS switching on personal operating habits and adaptation cycle, the impact of DPIS replacement or update on personal emotions, the impact of technological innovation on traditional development thinking, etc.

Incentives include both financial incentives and non-financial incentives. Financial incentives include bonuses, perquisites, co-partnership, productivity linked wage incentives, profit-sharing, retirement benefits, commission (Carbon Collective, 2021). For suppliers, the government or related organizations focus on incentives in terms of both bonuses and co-partnerships. By providing additional financial support, for example, as an incentive to develop DPIS that meet the needs of the government or other agencies. Or by establishing partnerships to provide partial ownership, or by providing certain benefits at a discount from the market price to incentivize suppliers. For caregivers, the incentives are more from bonuses, retirement benefits and commission.

Non-financial incentives are considered in terms of status, organizational climate, career advancement opportunity, job enrichment, job security, employee recognition programs and employee participation and empowerment perspectives are considered. These perspectives take into account more human emotions and involvement. In the case of employee participation and empowerment, employee engagement can be increased by considering the creation of events that focus on the impact of technology innovation on healthcare. This initiative that induces a sense of belonging by guiding employees to participate in matters that concern them. And by giving them more autonomy, they understand the importance of their own value and the importance of serving the organization. And the combination of targeted topics (healthcare and technology) helps them better understand the dynamics of change and the need for openness in the industry.

7. Digital platforms should have a clear mechanism for assigning responsibility

A clear mechanism for assigning responsibility should require not only that when there is an error in a DPIS function or module, the developer is responsible for the corresponding error. It should also require a re-examination of the relationship between DPIS and users. In other words, when users, such as caregivers, make operational errors, the responsibility should not only be attributed to the caregivers, but also to what caused the caregivers to make operational errors. Especially when the focus is on enhancing the openness of DPIS, the possibility of these errors will increase. Developers need to pay more attention to finding mechanisms to cope with chaos and to find ways to simplify the presentation of complex functionality.

At the same time, the following questions should be asked when the error occurs:

(a) Can this operational error be withdrawn after it has occurred? What are the consequences if it cannot be withdrawn?
(b) Did the error occur due to a lack of clarity in the classification of the operator interface?
(c) Did the error occur because the guidance notes provided for caregivers were not clear enough?
(d) Did the error occur as a result of inadequate training of caregivers?

8. A centralized database where data can be stored

Enhancing the openness of DPIS means that stakeholders such as caregivers can access the information they need without having to request additional permissions to access the files they need. Establishing a centralized database and requiring individual providers to store medical data in this database could be considered an option. This centralized database should be standardized and owned by the state. This not only reduces the difficulties or even the inability to exchange information due to the different rules of different DPIS systems. It also ensures that the data is consistent, uniform and up-to-date.

Although centralized database has the benefits mentioned above, there is a great risk of monopoly, especially if it is fully owned and regulated by the state. If the overall goals of the state in the medical direction are not aligned with the goals of the medical technology industry, it is very easy to limit the potential for innovation. This can lead to a situation where the industry has the intention to develop in this direction, but the state does not have the ability to provide support or does not set this innovation as a priority at this stage, thus inhibiting this development from occurring. In addition, because this medical data is stored in a centralized space, it can be easily targeted by hackers which can lead to malicious data leakage. This means that the country needs to develop extremely secure defense systems to protect the data and to perform regular and periodic maintenance of the security system.
While a centralized database has significant advantages in enhancing openness, it also has significant disadvantages. Experts need to make a trade-off after confirming the country's current situation and capabilities to ensure the best solution is achieved.

9. Standardized guidelines for information exchange

One of the major reasons for the difficulty in achieving openness in DPIS from the interview data of van Hattum (2020) is the lack of uniform standardized guidelines for information exchange. The reason why standardized guidelines for information exchange are important is that the openness of DPIS requires Smoothness and accessibility of access to information data. If information cannot be exchanged, how can openness be achieved?

Most medical technology companies modify or add their own guidelines to the common guidelines, often related to the company's research focus or interests. The end result is that even though these guidelines are initially standardized and based on certain guidelines, eventually the modifications and additions lead to differentiation. This makes it impossible to exchange information even from the same patient. It might require communication and collaboration between IS suppliers to create a guideline that is suitable for multi-platform development and suits the interests of each company. A more common information exchange standard today is the electronic health records (EHRs) provided by the EU to facilitate cross-border interoperability (*Electronic Health Records | Shaping Europe's Digital Future*, 2022) and Fast Healthcare Interoperability Resources (FHIR).

10. Digital platforms should be designed to ensure alignment with business benefit objectives

Business development objectives consist of four components: profit earning, market share, innovation & utilization of resources and increasing productivity. Profit and market share, as

the basic conditions for sustaining a business, show the stability, efficiency and the scale of progress. Market share further defines the demand from the customer's point of view in order to create quality goods that satisfy the purpose.

Innovation and resource utilization then considers how to improve efficiency and create more valuable products in a changing and dynamic social environment. In the context of the intersection of technology and healthcare, resources are even more limited. Companies need to think about how to make the most efficient use of labor, raw materials, capital, and technology (Objectives of Business: Economic and Social, Concepts and Examples, 2018). Especially in an era of creativity and innovation, it is important to think outside the box. Productivity, on the other hand, serves as a measure of the effectiveness of the use of resources. It is also a measure of the ability of a company to survive and grow from an output perspective.

The reason for ensuring that the design of DPIS should be consistent with business development goals is that open development needs to be built with these goals as the infrastructure. The ability to achieve further goals can only be achieved once the foundation has been built and stabilized.

11. Digital platforms incorporate new technologies for primary care development

In order to achieve full openness, developers should not limit their gaze to existing technologies only, but should take a long-term view, i.e., consider the possibilities of future technology direction. Considering how to embed these innovations into the existing DPIS before they occur. By incorporating technological changes into the development process in a timely manner, the DPIS can not only adapt itself effectively in a dynamic environment, but also make the DPIS design more responsive to the requirements of users. It also keeps the users and the healthcare organization sharp and open to innovative technology. It avoids stagnation due to fear of rapid technological advancement.

However, it is important to note that there are effective trade-offs when considering the integration of new technologies into the primary care development process. The need to update or replace the DPIS is determined by considering the existing situation, development goals, and the strengths and weaknesses of the technology. If the need for replacement is identified, the difficulty of implementation and training of users also need to be considered.

6.2 Translating key stakeholders' requirements into architectural representations with open considerations

This section focuses on translating the common requirements of stakeholders defined in section 6.1 into architectural representation requirements. The definition of architectural requirements is based on section 5.1.3 from the perspective of functional requirements and non-functional requirements. From the paraphrased architectural requirements, it is clear that IS suppliers and software suppliers have expectations of the architecture mainly in terms of role behavior requirements, availability, and capabilities.

In table 5, No.1, No.2 and No.3 all focus on the impact of a small number of actors on market control. To reduce this negative impact, consider adopting a fully open architecture and granting the same authority to all actors with similar capabilities. This authority should not be determined by actors' influence or position in the market, or their partnership with the government. Therefore, when translating this key stakeholders' common requirement into architectural requirements, the attributes of privilege allocation and full openness of the architecture are particularly emphasized. At the same time, it is not necessary to reflect the role attributes of actors when defining architectural requirements. Therefore, the architectural requirements are stated from a holistic perspective. This corresponds to No.(1) and No.(2) in table 6, respectively.

In table 5, No.4 emphasizes that DPIS should have a flexible, functionally diverse and long-term architecture. To ensure that this requirement is fulfilled, additional attention should be paid to the interface, which is the core component of the architecture. Therefore, when translating this requirement into architectural requirements, the focus is on the core functions of the architecture itself and the interfaces. In other words, in order to ensure that the above three properties of architecture are achieved, it is necessary to ensure the stability and dependency of the interface, while also ensuring that the architecture has the ability to adapt itself to the environment. This corresponds to No.(3) and No.(8) in table 6.

In table 5, No.5 is concerned with the power that caregivers should have when using DPIS. Therefore, when translating this requirement into architectural requirements, it is considered that a dedicated space should be set in the architecture to achieve this goal. This corresponds to No.(4) in table 6.

No.6 of table 5 cannot be implemented in the language of the architecture and is therefore disregarded.

In table 5, No.7 emphasizes the allocation of responsibilities. In the case of a DPIS problem, the architecture should have the capability to respond to the scenario. Therefore, the architecture should have a clear function or module to perform this operation. This corresponds to No.(5) in table 6.

In table 5, No.8 focuses on the location of data storage. Since the DPIS-based data storage space is located online, the DPIS architecture needs to have the ability to provide this data storage path in order to ensure that this requirement is met. This corresponds to No.(6) of table 6.

In table 5, No. 9 emphasizes the need for a standard information exchange guidelines to ensure smooth data exchange, and therefore this requirement should also be taken into account when designing the architecture. This means that the mechanism of the architecture needs to be fully complied with the national information exchange regulations, which corresponds to No.(7) in table 6.

In table 5, No.10 and No.11 focus on the basic requirements for DPIS to be able to survive in the market. In other words, DPIS needs to not only keep up with the demands of primary care development, but also ensure that it obtains stable commercial benefits. To ensure that these requirements are met, the complements in the architecture need to have the ability to be flexible and adaptable to market and societal demands. This corresponds to No.(9) in table 6.

Table 6 Architectural requirements for openness

No.	Architectural requirements
(1)	The architecture should be able to provide access with the same capabilities to actors who have ownership or control
(2)	The architecture should be completely open, i.e., fully open access to all interested external parties
(3)	The architecture should have the ability to adapt itself to changes in the environment
(4)	The architecture should provide a dedicated space for caregivers to interact
(5)	The architecture should have clear modules for assigning responsibilities
(6)	The architecture should provide a clear path to remote data storage
(7)	The architecture should have a mechanism to comply with national information exchange regulations
(8)	The architecture should have stable, dependable interfaces that can be used even under extreme conditions
(9)	The architecture should have complements that can be used and meet the dynamic needs of the market

The reasons for transcribing the requirements of the stakeholders into architectural requirements are as follows: (a) The search of the scientific literature on Scopus did not reveal any architectural studies of DPIS for the Dutch situation. To define architecture requirements based on this collected literature would lead to behavioral invalidity. In other words, even if I collected a large number of valid architectural requirements from this literature, they would not fit the existing development needs in the Netherlands because they are not defined for the Dutch context, much less for primary care. Therefore, in order to ensure the validity of this study, the openness-related requirements of the takeholder were first collected from the validated van Hattum (2020) study on the openness of DPIS for primary care in the Netherlands. Subsequently, the stakeholders' requirements were translated into an architectural formulation by considering them from an architectural perspective. (b) This act of translating requirements builds a bridge between humans and design. It ensures that the architectural requirements of DPIS are not defined solely on the basis of driving the development of primary care. Rather, the requirements and wishes of the human community are analyzed and their ideas are translated into design. In other words, the design serves humans rather than just development. This also subsequently provides a solid foundation for architects. It provides a path for their architectural designs to be more realistic and to be truly put to use.

6.3 Other insights

The Dutch government's desire to facilitate the smooth exchange of medical information among caregivers and the desire to regulate the development of DPIS in the healthcare market led the Dutch government to develop a national infrastructure, such as AORTA, in line with technological developments.

Although the purpose of this infrastructure is the electronic exchange of patient data, it was still rejected by the Senate in March 2011. The main reason for this rejection is that the

connection between health care institutions and citizens is mandatory and automatic (Van Der Vliet, 2012; Nationale Infrastructuur, 2022). In other words, AORTA was put into operation without really asking for attention to the needs of the citizens and without respecting their decision rights, so that its management was replaced after its failure that would have changed the purpose for which AORTA was originally created. This made it more difficult for medical data to be exchanged or reviewed by caregivers. In addition, this also increased the reliance on the old system OZIS, making it more difficult to open up DPIS.

7

INTERVIEW

This chapter validates the stakeholder requirements and architectural requirements defined in chapter 6 through semi-structured interviews. The results of the interviews are also analyzed and discussed.

7.1 Interview descriptive

A total of eight interviewees participated in the semi-structured interview, which took place between October 2022 and November 2022, with seven interviewees interviewed in October and only one interviewee interviewed in November. It was initially intended to limit all interviews to October, but this was delayed for personal reasons for one of the interviewees. The average length of the interviews was 50 minutes. The shortest interview was 43 minutes and the longest was 65 minutes.

Interviewees have background knowledge related to this study, and they work in the areas of software development, business development, caregiver, research, and ICT development, respectively. Therefore, their background areas can be summarized as business, caregiver, research, and ICT architect. During the interviews, the interviewees showed a high level of interest and engagement. However, one of the interviewees did not actively provide her own subjective opinion, but almost completely complied with the interviewer's logic. Therefore, this interview data was chosen to be treated as ineligible and not included in the analysis of the interview results. As a result, research was removed from the four domains summarized above. When analyzing the interview results, only the three perspectives of business, caregiver, and ICT architect will be analyzed and compared. For the design and content of the interviews, please refer to appendix B.

7.2 Interview results

This section presents the results of the validation and analysis of key stakeholders requirements and architectural requirements by using semi-structured interviews.

Table 7 Overview of interviewees

Code	Organization type	Perspective
SS1	Software supplier for hospital	ICT architect, business
SS2	Software supplier for mental, disable, youth care	Buisness
ISS1	IS supplier for informal care	Buisness
ISS2	IS supplier for informal care	Buisness
HO	healthcare organization for GPs	Cargiver
DS	Dutch standard for health data exchange	ICT architect
IP	Information Provision Foundation for healthcare	ICT architect

Table 7 presents a summary of the types of organizations where the interviewees are located. In addition, this table also classifies them according to their professional and educational background. In order to keep the interviewees' personal information confidential, they are assigned codes, which are used when citing their feedback in the interviews.

7.2.1 Interview results analysis of key stakeholders' requirements

No.	Requirement	Final answer
1	There should be not only one or a few actors controlling the market	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement.

Business perspective
This perspective suggests that there should never be only one or a few actors controlling the market. If only one or a few actors existed in the market, these actors would have an unassailable position. In other words, the monopolistic behavior of these actors can lead to changes in the behavior of the market. For example, the guidelines for entering the market, the rules binding within the market, the direction of the market, etc. They can make any behavior in full accordance with their own interest goals and under the conditions of compliance with laws and regulations. In the current hospitalindustry in the Netherlands, this monopoly phenomenon has already taken place. The software supplier, led by Chipsoft, occupies 70% of the market. This has led to a certain closeness in the hospital industry.

Respondents in this perspective indicated that ideally four to six actors should be maintained in the small market, such as the market for youth care and mental care. This avoids the emergence of absolute sovereignty, in addition to ensuring the decentralization of actors' power. This ensures the flexibility and freedom of the market. It also provides these actors with the opportunity to divide the market into zones. This allows them to continue to focus on their own areas of research.

Caregiver perspective
A small number of actors can lead to a noncompetitive market, which can result in actors being satisfied with the status quo and having less incentive to continuously update their technology holdings. Therefore, a reasonable control of the number of actors in the market is an important factor to maintain the market dynamics and the development of technological innovation. In addition, if only a small number of actors exist in the market, it is necessary to be regulated by the government or relevant departments. For example, adjusting laws and regulations or issuing new policies to promote changes in the behavior of actors.

This perspective also suggests that the presence of one or a small number of market leaders in a market is manageable. Unlike monopolies, the role of market leaders is to regulate market behavior and promote innovation.

ICT architect perspective
This perspective also provides insights from a competitive point of view, as Interviewees shows that it is difficult to compete with only a small number of actors in the market. In other words, these actors do not need to put in extra effort to keep making market strategies for

developing new products or updating the functions of current products. Although the government would incentivize these actors by engaging in regulation, such as designating suppliers such as DigID, this would shift the market to another situation where government-led actors control the direction of the market. Therefore, while considering increasing market dynamics in this way, additional consideration needs to be given to the relationship between the government and the government-selected actors and the remaining actors in the market.

No.	Requirement	Final answer
2	There should be less control by insurance companies	No

Interviewees in business, healthcare, and ICT contexts have all expressed negative views of this requirement.

Business perspective
Although it may seem that insurance companies have a very obvious relationship with health care, in reality they have no such relationship. In the case of youth care (>= 18 years old), for example, the financial subsidy that youth receives is actually provided by the government. In this scenario, the insurance company only acts as an insurance provider. This is because in order for youth to receive the financial subsidy, they must be insured. In general, the insurance company does not have the ability to control the direction of the market.

Caregiver perspective
The responsibility of the insurance company is to ensure that the users are in a stable health care transaction. They only control the direction of spending healthcare money. The way insurance companies operate is determined by the market and government regulations. For example, if an insurance company informs an insured person that it will reduce reimbursement in Area A. This does not mean that the insurance company is trying to control health care. This does not mean that the insurer is doing this to control the development of medical technology, etc. in area A. This is often a result of government mandates.

ICT architect perspective
This perspective suggests that insurance companies do not have the ability to control the direction of the market and suppliers, and their interest lies in reducing the cost of efficiency, in addition to the interest mentioned in the two points above. On top of that, the government has clearly placed limits on the ability of insurance companies to do so. But this does not mean that we should be less wary of insurance companies. On the contrary, we should be concerned about the way they are protecting the privacy and security of their customers' personal medical information.

Due to confidential reasons, providers are not allowed to provide patient information to insurance companies. However, insurance companies may obtain private medical information about their clients through other channels such as health organizations or through the actions of the client in order to obtain reimbursement from the insurance company. Assuming that the insurer has not entered into any agreement with the government, this means that the insurer is in some way violating the confidential regulations by obtaining sensitive data about individuals. Which may violate the patient's privacy due to where the insurer's interest shifts. However, in reality, compared with other markets, the health insurance market is heavily

regulated by laws and regulations (Netherlands Authority for Consumers and Markets: Monitor Financial Sector, 2016). While such regulatory actions can limit the behavior of insurers (including competitive behavior), this does not mean that the government has complete control over the data held by insurers. In other words, the government cannot fully predict the direction of insurers' behavior. And this could very easily pose a risk to patient data.

No.	Requirement	Final answer
3	There should be a centralized database where data can be stored	No

Interviewees in business, healthcare, and ICT contexts have all expressed negative views of this requirement.

Business perspective
The advantage of creating a centralized database is that caregivers from any health care organization would have access to the same and complete medical information about the patient. But such a database would have significant challenges for privacy and safety, and the consequences and risks associated with a single breach of medical data would be incalculable. Moreover, the ability to fully protect the database is currently not available. Therefore, the idea of a centralized database is not realistic.

The transfer and exchange of data should be facilitated by establishing centralized standards or by promoting existing centralized standards such as the open EHR and FHIR standards. These centralized standards have standard interfaces and formats and do not impose any constraints on where the data is stored. As long as the data owner and the data recipient follow the centralized standards and both parties have the desire to share or receive the data, the transfer and exchange of data can be established.

Caregiver perspective
This perspective also argues against the idea of a centralized database from the perspective of privacy. Interviewees suggests that in addition to being vulnerable to hacking, a centralized database may also be subject to government misuse of patient medical data. Why does the government have this "capability" and not other institutions? This is because the ownership and control of such databases is often owned or claimed by the government.

ICT architect perspective
This perspective suggests that it is not possible to create a centralized database. In other words, the data is in its own unique, specific format. But if this centralized database is successfully implemented, data transfer and exchange will be very easy. In addition, in 2016, the Dutch government rejected the proposal to create a centralized database.Lead, they decided to develop a trust framework that can access database (with different formats) with different information systems. The Dutch government rejected this proposal because they felt that a centralized database would only amount to a collection of data extracted from different databases and would not be necessary. The Dutch government also mentioned that they would gradually lose ownership and control of the data once the centralized database was implemented.

No.	Requirement	Final answer
4	There should be standardized guidelines for information exchange	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement.

Business perspective
Different companies and organizations have their own guidelines, which are based on standardized guidelines such as the FHIR standards, and modified according to the characteristics of the company or organization. The subtle differences between these guidelines lead to challenges in data exchange or online communication. If actors in the market can work together to produce standardized and open guidelines that meet industry standards, customer data can be smoothly recorded, extracted, reviewed or downloaded, and exchanged with other platforms, regardless of which platform the customer is using in the industry. However, it is important to note that actors in the market do not have the autonomy to design such open standardized guidelines. They are afraid that the risks they may suffer if they use open standardized guidelines will increase significantly. Such as their position and power in the market, and their influence on the customer base.

The government has a very important role to play in facilitating the establishment of open standardized guidelines. The government can use its regulatory power to guide actors to focus on the design of standardized guidelines for information exchange. They can also issue preferential policies or regulations to dispel actors' concerns.

Caregiver perspective
Ideally, each DPIS would be associated with other DPISs in the network. In other words, these DPISs have the ability to build a common environment for their users, thus ensuring the ability to use data and information from other DPISs or to communicate with users on other DPISs. The establishment of standardized guidelines can facilitate this proactive openness to occur. This is something that is currently lacking in the healthcare industry. In addition, current DPIS designed for healthcare do not prioritize how data permissions are shared and how information is processed. Standardized guidelines can contribute to the improvement of the current situation by including content related to these issues.

ICT architect perspective
Standardized guidelines for information exchange are necessary, but it is difficult to achieve a general standardized guidelines due to the unique needs of users. Therefore, the focus should be on standardizing smaller parts of information exchange, such as a complete data collection method, a complete service, standardized component sizes, etc.

This perspective also suggests that additional attention needs to be paid to the definition of interfaces and the definition of complete exchange services when standardizing the guidelines or small parts of the information exchange mentioned above.

No.	Requirement	Final answer
5	We should give caregivers enough/more power to interact (access) with others	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement.

Business perspective
The main purpose of DPIS is to enable caregivers to provide better services to patients. This requires us to pay special attention to the needs of caregivers when designing the DPIS. For example, by analyzing their information and communication requirements or consulting their perceptions of the DPIS, we can update the functionality of the DPIS in a timely manner.

Take youth care as an example, in the process of providing treatment and guidance, caregivers not only need to communicate with the patient, but also need to communicate with the patient's parents. In this case, if caregivers are not given enough authority to communicate with the patient's parents and are restricted to communicate with youth patients only, there is a high possibility that caregivers may have difficulty in making accurate diagnosis due to lack of basic information about the patient. At the same time, parents of youth patients can give caregivers additional access as supervisors. Youth's parents can give this caregiver the power to interact with other caregivers by requesting the DPIS access head, such as passing medical information or seeking assistance. This access focuses on the viewing and sharing of private medical information rather than the ability to use the DPIS.

Caregiver perspective
This perspective suggests that in addition to the need for greater interaction between caregivers, there is an equal need for greater openness between caregivers. This can be thought of as openness of access for both or more parties. The reason for this is that in most cases, caregivers want to harvest more inputs than other caregivers and do not want to share too much of the information they have with other caregivers, i.e., as outputs. In other words, caregivers are often curious about the information that other caregivers have and want to have information that they do not possess. But they do not want to actively share the information they have.

In the case of GPs and pharmacists, for example, if a patient goes directly to the pharmacy and asks for the medication they need, the pharmacist will provide the medication from a more general perspective due to a lack of knowledge of the patient's condition. This medication may not be effective because of the patient's particular medical condition. However, this can be effectively avoided if the GP shares the patient's medical information with the pharmacists or if the pharmacists have access to the patient's medical information.

ICT architect perspective
Giving caregivers enough power to interact with others or giving them enough access to data can ensure that caregivers provide better care. Therefore, there is no need for more power or access to caregivers.

In addition to giving caregivers enough power, we also need to set limits on this power. In the ideal situation of total freedom, individual autonomy desires and needs (intrinsic motivation)

are often influenced by the intrinsic psychological needs of competence, autonomy, and relatedness (Deci & Ryan, 2000) and are often based on dynamic group goals. In this context, dynamic group goals imply goals that are negotiated by the group to meet the interests and development of the group or goals that are established directly by the group leader. Dynamism implies that goals may change to some extent depending on changes in external demands.

In the context of healthcare, giving caregivers complete freedom means giving them complete autonomy in their choices. This can lead caregivers to develop their own practices for the same problem or get data standardized which can only be used for one problem based on their own volition. To some extent, this granting of complete freedom can motivate caregivers intrinsically, i.e., out of a desire to accomplish autonomy without external rewards (Singh et al., 2010; Di Domenico & Ryan, 2017). On the other hand, however, this amounts to a liberal development of administrative issues. This can lead to a confusion of overall interest goals. In the hospital industry, for example, there are sixty hospitals in the Netherlands using Chipsoft's DPIS. However most of them cannot exchange information with each other because hospitals are given too much room for their own decisions (add some specific modifications in DPIS according to their situation).

Although this phenomenon can be coordinated with the overall goal through multiple consultations or by government regulation. However, the first one takes time and effort that the healthcare industry does not have. This process may even result in a complete shift from intrinsic to extrinsic motivation of caregivers, i.e., from autonomous expectations of satisfying self-wishes to forced coercion to avoid punishment.

The strict guidelines set up by the government have limited the sense of autonomy of caregivers to a certain extent from the beginning. In other words, they set boundaries for their freedom of expression. Such boundaries not only prevent the addition of overly personalized or customized functions to the DPIS, but also limit to a certain extent the negative evaluation of such innovations by potential users (e.g., caregivers), and maintain as much neutrality as possible in the trade-off between intrinsic motivation and intrinsic motivation. In short, it encourages the input and use of technology but avoids the occurrence of overly liberalized non-standard use behaviors.

No.	Requirement	Final answer
6	We should provide incentives for IS suppliers, software suppliers, and caregivers as a result of developing/using information system	/

Interviewees in the business, healthcare, and ICT contexts held different views on whether incentives should be given to IS suppliers and software suppliers. However, they all agree that caregivers should be given incentives, but not more incentives.

Business perspective

As to whether incentives should be offered to IS suppliers and software suppliers, respondents ISS2 indicated that incentives only last for them for a short period of time and are not effective in the long term. Internal motivation is what drives suppliers to continue to innovate. Therefore, there is no need to provide additional incentives to suppliers. The remaining two

respondents with business backgrounds, SS2 and ISS1, agreed and added that the government should invest incentives in the development of guidelines. Standardized open guidelines can lay the foundation for openness in DPIS and ensure that users of different platforms can communicate without barriers.

They also show that the government is being narrow-minded. They focus only on the current development of the healthcare market and do not have a vision for the future. As a result, their primary focus is on large companies while selectively ignoring smaller ones. This leads them to measure a lot of potential expansion space.
For caregivers or health care institutions using DPIS, respondents in this perspective indicated that the government has invested a significant amount of money in the health care market (€ 10 billion/year) and that this amount of money continues to grow. However, the government does not focus this funding on the development of DPIS. Therefore, respondents suggested that the government should consider focusing on the current use of funds such as supporting the development of online treatment programs rather than providing more financial incentives.

Caregiver perspective
Respondent HO indicated that there is already enough competition in the market that there is no need to provide additional incentives to IS suppliers and software suppliers to encourage innovation. For caregivers, there is also no need to provide additional incentives to them. The government has already established enough subsidy programs, such as the program of acceleration of information exchange between patients and professionals. In other words, at the financial level, caregivers already have enough incentive to use DPIS for interaction.

ICT architect perspective
This perspective suggests that the government should give extra attention to suppliers that are entrepreneurial or have good ideas. In the current Dutch market, suppliers only earn €7.5 per active user, which means that only popular products can survive. Even if the products are well-designed and make a significant change to technological innovation, if they do not attract enough active users, bankruptcy is the only way they will survive.

Furthermore, the interviewees show that the use of financial subsidies by the Dutch government is currently not oriented correctly. In the current situation, even if the final product is not in the expected or desired form, or does not produce effective results, the suppliers are still able to receive the benefit.

In short, a lot of financial subsidies in the Netherlands is not relevant to results which will cause problems in the healthcare market. Therefore, it is suggested that the government should decide whether subsidies should be given at all based on the final output of the product. If suppliers produce effective results, the government will not take any additional initiatives or give additional incentives; if the suppliers do not produce effective results, the government will withdraw some of the benefits or reduce the investment in future projects of the suppliers.

In general, the government should add penalty regulations to the existing financial subsidy policy, in addition to giving additional incentives to companies with innovative ideas.

No.	Requirement	Final answer
7	The market influence of software suppliers should be balanced	No

Interviewees in business, healthcare, and ICT contexts have all expressed negative views of this requirement.

Business perspective
Markets are flexible, volatile and cannot be fully regulated. It has unique mechanisms that provide an environment for actors to cooperate, compete, and so on. Even if we forcibly balance the influence of actors in the market. There is no guarantee that the market will reach the goals we set. Therefore, it is not necessary to force this environment to balance, but it is necessary to set certain limits on it. In the hospital market, for example, there is a shift to open data DPIS, and Epic and chipsoft, the two major players in the hospital market, are not in a very good position. The reason is that their systems are too traditional and old and may be eliminated from the market in the future. From this example we can see that monopolistic market actors also have a very high risk of losing their power and position. Therefore, when the influence of certain actors in the market is very strong, it is sufficient to have proper regulation by the government.

For example, laws and regulations are enacted or policies are issued to influence the behavioral initiatives of actors. However, it is important to note that the current Dutch government still holds the attitude of wanting to completely control the market, rather than being completely open to innovative technologies. This not only leads to the government issuing regulations or new policies that often lag behind the existing market, but also makes it difficult or even impossible for innovative technologies to enter the market. Therefore, in addition to the need to require the government to be more open and sensitive to innovative technologies, it is also necessary to consider how to decentralize the government's power.

Caregiver perspective
This perspective means that we should not focus on balancing the influence of software suppliers in the marketplace. Rather, the focus should be on how to allow or encourage caregivers to ask questions or make requests to software suppliers. Instead of having software suppliers unilaterally promote to caregivers' institutions. In short, caregivers ask software suppliers for their needs and decide which software suppliers to use. Instead of software suppliers using marketing strategies to influence the choice of caregivers or the institutions where caregivers are located.

ICT architect perspective
Software suppliers have some influence in the market because their skills are a natural process, so there is no need to force them to balance their influence. But in order to avoid the extreme direction of the market, the government needs to provide some guidelines. But this does not mean that the government should be given too much power to limit the development of software and DPIS space.

No.	Requirement	Final answer
8	Digital platforms should have a flexible but fully functional long-term architecture	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement.

Business perspective
Digital platform in information system (DPIS) must have the ability to be sustainable for the long run. This requires that the architecture of the DPIS needs to be able to be adapted and updated in response to changing needs and environments. It is difficult for a DPIS to exist in the market for a long time if its architecture does not have this capability, especially given the rapidly evolving technology. Chipsoft and Epic in the hospital market are suffering from transition difficulties due to the lack of flexibility of their legacy and old architectures.

While keeping the architecture flexible and continuously updated can be extremely stressful for developers and suppliers, it provides them with more opportunities to implement changes faster and adapt to new trends in the market. Older architectures do not have the ability to add new features consistently and over time. If this is done over time, the architecture will be quickly destroyed. But if suppliers still decide to ignore the flexibility of the architecture and focus only on the current development. This is more of a trade-off between making a high profit in the short term and holding on to it for the long term.

Caregiver perspective
This perspective also emphasizes that the architecture of DPIS should be designed for long-term considerations. It is also suggested that providers should ensure that software architecture is more flexible than technology infrastructure.

In the case of DPIS, technology infrastructure refers to the foundation of the architecture, i.e., the core components, while software refers to the complements, which are diverse and can change according to market needs. This means that for flexibility reasons, suppliers pay extra attention to the development of complements.

ICT architect perspective
Unlike the first two perspectives, this perspective emphasizes that it is not necessary to ensure that the architecture is fully functional. The dynamic nature of market and mass demand will lead to new cases and therefore cannot achieve complete satisfaction of their needs. Therefore, it is sufficient to ensure the flexibility of the architecture and the stability of the core functions, and to require software suppliers to continuously develop new functions.

In addition, this perspective suggests that architectures need to have the attributes of agile and cooperation, based on the consideration that "needs are based on certain standards". This is very important for the long-term development of the architecture in the market.

No.	Requirement	Final answer
9	Digital platforms should have a clear mechanism for assigning responsibility	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement.

Business perspective

This responsibility assigning mechanism is mainly applied to two situations: system failure and data security issues. When a DPIS system failure occurs, the IS suppliers should be responsible for the failure; if it is due to an operational error by the caregivers, the responsible person should be assigned after analyzing the specified scenario. For example, if the failure is due to a lack of clarity in the system interface design, the IS suppliers are primarily responsible and the caregivers are marginally responsible (because they did not remain sensitive). If the error is caused by caregivers ignoring the system warnings or using the system as they wish rather than following the operating instructions, then caregivers should be solely responsible. In short, a clear mechanism for assigning responsibility can increase the efficiency of troubleshooting by improving the speed of locating the person responsible for the failure.

If there is a data security issue with the DPIS system, the company storing the data cannot be directly assigned full responsibility for it. It depends on the use of the data. Consider whether the problem is related to several topics such as data storage, data protection, and data processing. Especially when dealing with sensitive data such as medical data, automate operations as much as possible. The data should be as completely protected as possible. Therefore, when entering into an agreement between caregivers or the caregivers' institution and IS suppliers, the regulations for assigning responsibility for data security are explicitly discussed.

Caregiver perspective

Respondent HO indicated that DPIS should have a hierarchy of authorization. It was also proposed that in addition to a clear responsibility allocation mechanism should be established, the focus should be on raising awareness of DPIS users and developers about the responsibility allocation for DPIS system failures. Such as promoting international normative regulations that are suitable for all and special regulations for specific groups. For example, data privacy regulations for target groups including caregivers and developers of data protection functions.

ICT architect perspective

This perspective complements the case of whether caregivers should be responsible for their behavior mentioned in the business perspective. The interviewees used Chipsoft's user interface as an example to illustrate in particular the excessive liberalization of caregivers' behavior. In Chipsoft's interface for caregivers with clear categories and sequences of actions, caregivers are required to fill in specified information on specified content screens. However, caregivers find these requirements too demanding, so they choose to fill in all the content in the free text box. However, this behavior causes the information to become unstructured data, which cannot be successfully recognized by the system. In other words, even if caregivers enter valid information but this information will still be recognized by the system as invalid. As a result, the information cannot be transferred to the DPIS of other caregivers. Therefore, it is important to regulate the use of DPIS by caregivers.

In addition, this perspective suggests that while caregivers are responsible for all communication or exchange of healthcare data, we need to consider whether they have sufficient capacity to assume the associated risks. Also, IS suppliers need to clearly understand the risks associated with the types of services they provide.

No.	Requirement	Final answer
10	Digital platforms should be designed to ensure alignment with business benefit objectives	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement.

Business perspective
The Dutch laws, regulations and policies determine some of the business benefit objectives of suppliers, i.e., if a company does not fulfill these requirements, it will not gain access to the market. Respondents also indicated that DPIS should be designed in such a way that it effectively integrates the two objectives of obtaining business benefits and serving the target group, and should focus more on the development of the second objective. For example, attention should be paid to the design of products in the direction of privacy and safety.

In the extreme case, if suppliers set the company's development goals only on the government incentive rules, they are not self-defining the development direction. In other words, the suppliers are not forced to pay their own bills, and the majority of their revenues originate from the government. This excessive dependence on government subsidies and the lack of self-defined development goals only ends up making suppliers unmotivated, i.e., not motivated to develop any new products or features. Therefore, in order to avoid this extreme situation, the government should clearly define the types of incentives to be given and establish rules.

We can also see this situation as an attempt by the government to control the direction of the market. But the government's focus on their demands and lack of openness to technology makes it difficult for them to capture the real needs of the market. This behavior not only wastes money but also creates meaningless and backward R&D.

This perspective also suggests that the government should focus on making standard structured data (data sent between caregivers) exchange guidelin. For more discussion on this, please refer to No. 4 There should be standardized guidelines for information exchange.

Caregiver perspective
This perspective also emphasizes that suppliers should not focus exclusively on the realization of benefits, but rather on the service and design concepts of the product.

"Your product helps you to realize your business objectives." *-- HO*

ICT architect perspective
This perspective only adds one additional point: different situations have different considerations. And IS suppliers need to decide on business objectives based on uses cases.

No.	Requirement	Final answer
11	Digital platforms should incorporate new technologies for primary care development	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement.

Business perspective
Respondents indicated that as long as the new technology is tested and positive feedback is received from testing with client groups, the technology can be incorporated into DPIS. At the same time, we should also enhance the education of caregivers who hold traditional views

"We should be educating them about new technologies as much as passing on the push for new technologies." – SS2

Caregiver perspective
This perspective adds to the relationship between new technology and caregivers. Respondent IP suggested that we should pay attention to the corporation between demands of caregivers and development agenda of DPIS. And consider how technology such as DPIS can be used to reduce the work pressure of caregivers.

ICT architect perspective
This perspective indicates that new technologies can help DPIS enable new functionality or improve process efficiency. It also highlights the need to validate new technologies before incorporating them with DPIS. This is particularly the case for the healthcare sector, which is a highly sensitive industry.

7.2.2 Interview results analysis of architectural requirements

No.	Requirement	Final answer
1	The architecture should be able to provide access with the same capabilities to actors who have ownership or control	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement.

Business perspective
In this case, actors should not be limited to IS suppliers, software suppliers, caregivers, etc. In order for DPIS to be truly fair and open, actors should refer to everyone. However, when it comes to sensitive medical information, actors should not include roles such as government. To protect patient privacy and security, actors with data access should be strictly limited to healthcare institutions.

This perspective highlights that we should give patients the same rights as caregivers. For reasons of data openness and transparency, patients need to have full control over their own medical data, in addition to the right to see the same medical information as caregivers. In a nutshell, patients have the power to gain insight into their own situation, the power to see

what caregivers communicate with each other, and the power to decide what happens to their own medical data.

"We should give patients ultimate control over their data." –SS1

Caregiver perspective
Respondents' IP suggested that giving the same access to actors with ownership or control can gain information from different perspectives, such as the medical perspective, the technical perspective, the public perspective, etc. A multidisciplinary viewpoint can help us to have a more comprehensive understanding of an issue.

ICT architect perspective
The architect has modified this requirement. Interviewee SS1 stated that architecture is about authorization and consent, not about ownership. Ownership is described by law and it is not about the person who generates the information. Medical information is private and the subject of the information is always the owner (patient). It is up to the owner (patient) to decide whether to share his or her medical data. The government has no right to interfere with this action.

Therefore, when a caregiver shares or transfers medical data, it should obtain the patient's consent for sharing the data in advance. If the patient chooses to refuse to share, the healthcare provider has no right to privately exchange their data against the patient's wishes.

No.	Requirement	Final answer
2	The architecture should be completely open, i.e., fully open access to all interested external parties	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement.

Business perspective
For this requirement, respondents highlighted consent as a prerequisite for architecting be completely open. They indicated that patients should have complete control over their medical data. In other words, patients decide what happens to their medical data, such as whether to allow caregivers to share their medical data with other caregivers or to allow caregivers to assist them in sharing their data with designated actors. Therefore, when external parties want to use a patient's medical data, they must first obtain the patient's consent, and then we need to ensure that the architecture has the ability to provide the possibility to open these information up to everybody.

Caregiver perspective
This perspective endorses the idea that the architecture should be fully open. A fully open architecture can help people understand the mechanisms of how the architecture works and give more trust to DPIS. This can help people move away from traditional thinking and make them more open to new technologies. In addition, this perspective also suggests that we should pay extra attention to security since personal information is involved.

ICT architect perspective

Interviewees emphasized that there should be a clear definition of open. Should there be complete openness to the use of DPIS or complete openness to the review and use of data? In the context of healthcare, everyone should have the right to use DPIS but not everyone should have the right to see and share medical data that is personal. In general, fully open for usage but limited access to personal information. In addition, this perspective emphasizes the bundle of information sharing and information control. It is suggested that having control over the information allows the owner to better protect his or her information. This is because the owners can maintain the security of their information by identifying which external parties have access to the information and where the information is going.

"A completely open architecture would be ideal for information exchange." – IP

No.	Requirement	Final answer
3	The architecture should have the ability to adapt to changes in the environment	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement.

Business perspective

At the same time, interviewees also indicated that suppliers should take the lead and guide their customers to comply with the changes. This is mainly to enable suppliers to adapt their architectures in advance and avoid forcing customers to accept these changes (e.g., changes in architecture functionality, changes in operating methods, implementation of new rules, etc.). This requires suppliers to have the ability to capture innovation on their own and to anticipate where technology is going. At the same time, they need to be constantly sensitive to new regulations and legal adjustments.

Caregiver perspective

This perspective suggests that the architecture needs to have the ability to evolve continuously. That is, the ability to add complements that conform to change or adapt existing complements to adapt to change while maintaining the stability of the core components of the architecture. Take the example of the interaction between caregivers and patients. Currently, patients are still required to send their own measurements at home to caregivers or to fill out questionnaires prior to their visit. If it is possible to effectively combine sensor technology and DPIS. This means that after obtaining the patient's consent, the data can be automatically transmitted to the caregiver and will greatly reduce the extra effort required by the patient and the caregiver. This requires an architecture that has the ability to facilitate this functionality.

ICT architect perspective

This perspective suggests that the architecture needs to not only adapt to changes in the environment but must always be able to optimize to meet the challenges.

No.	Requirement	Final answer
4	The architecture should provide a dedicated space for caregivers to interact	No

Interviewees in business, healthcare, and ICT contexts have all expressed negative views of this requirement.

The business perspective suggests that it is not necessary to give caregivers a dedicated space, but rather a domain space is sufficient. The purpose of this is to ensure transparent and open communication between caregivers. It also ensures that the client can independently manage and control their medical data. Even if the client agrees to give the caregivers a dedicated space, this does not mean an increase in efficiency. In other words, dedicated space for caregivers does not force caregivers to interact. They will still interact according to their own schedule and flexibility.

The ICT architect perspective affirms these views, and adds that the domain space allows caregivers to fill their specific requirements and ensures transparency. But the domain space of caregivers needs to be connected to other departmental domains. We can think of these domain spaces as dots in a network, which are connected to each other to ensure communication and the ability to pass information. But each dots has independence. They have spaces that are created specifically for their specific properties or needs.

No.	Requirement	Final answer
5	The architecture should have clear modules for assigning responsibilities	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement.

Interviewees from business backgrounds indicated that we should not limit the responsibility to IS suppliers and software suppliers, but should also We should also involve the customer. The reason for this is that before a customer signs an agreement with an IS supplier or before a system failure occurs, the customer needs to be clear about their role and what responsibilities they have before deciding whether to use the DPIS.

ICT architect perspective adds that for the division of responsibilities, one party must always be responsible for quality, with one party controlling the situation and the other monitoring the controls.

No.	Requirement	Final answer
6	The architecture should provide a clear path to remote/online data storage	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement.

Business perspective

This perspective suggests that all data information should be stored online rather than on local facilities. And caregivers should store their medical data in electronic health records and should be strictly prohibited from storing medical data on their private computers. The reason for giving extra attention to caregivers is that they are given too much freedom. Even when boundaries are clearly drawn, caregivers may prefer to cross them in a way that is convenient for them. Therefore, regulation and supervision of caregivers' behavior should be mandatory when it comes to private data and medical data.

Caregiver perspective
Respondent with a caregiver background, HO, indicated that while it is now possible to store most medical data remotely, a small amount of medical information is still stored on local facilities. This data is vulnerable to computer failure or theft. Therefore, we should strengthen the implementation of remote storage and cloud storage for all medical data. At the same time, we should strengthen the education of caregivers and gradually shift from mandatory to guiding them to use remote storage on their own.

ICT architect perspective
This perspective highlights the importance of storing data online from the perspective of data exchange. The sharing of medical information is an important part of providing diagnosis and treatment to patients. If medical information is stored locally, caregivers can only transfer information data through physical exchange. This is extremely risky. If the DPIS does not have online or remote storage capabilities, it becomes a storage and browsing space for caregivers to provide specified specific information. This is equivalent to dividing caregivers into separate individuals and cutting them off from each other or from others, which is not well suited to the current healthcare situation.

Therefore, in order to ensure the interactivity between caregivers and to improve the security and efficiency of data exchange, the architecture of DPIS must have the ability to provide online or remote storage.

No.	Requirement	Final answer
7	The architecture should have a mechanism to comply with national information exchange regulations	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement. However, different opinions were expressed on whether national regulations or EU regulations should be used.

Business perspective
Respondents in this perspective indicated that this need is a prerequisite for DPIS to be able to be placed on the market.

The Netherlands has strict regulations about healthcare, and if a supplier does not comply with these rules, it will not be allowed to enter the market, regardless of whether its product solves a medical problem or promotes health care. Respondents also indicated that in the current situation, it is sufficient for the architecture to be able to comply with national regulations. Compared to EU regulations, national regulations are based on the Dutch context and the specific needs of healthcare and are more in line with the Dutch market and the needs of the public.

Interviewee SS1 also indicated that such mechanisms already exist in the Dutch market, such as those for Microsoft Azure. However, this mechanism is not perfect. There is a need for additional certifications such as the International Organization for Standardization (ISO), which should be dynamically adapted to the needs of the Dutch healthcare market.

Caregiver perspective
The development of medical care in the Netherlands is moving in a more international direction, especially in terms of policy issuance and influence. The Netherlands wants its regulations to have the same international impact as the GDPR. In addition, as a member of the European Union, the Netherlands is subject to EU laws and regulations. Therefore, the best solution is to add regulations or adapt EU regulations to meet the needs of Dutch healthcare development, while complying with EU regulations.

ICT architect perspective
Respondents indicated that the use of national regulations or EU regulations should first be observed in all cases. Subsequently, these regulations are adapted to national characteristics and needs. A typical example is the BSN, which is used in the Netherlands to limit the use of social networks to identify individuals for the security of citizens' private data.

No.	Requirement	Final answer
8	The architecture should have stable, dependable user interfaces that can be used under dynamics situations	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement.

Respondents indicated that stable and dependable as the core of interfaces provides the possibility of openness and interoperability of the architecture. Interviewee SS2 added that adaptable, an important property of interfaces, has also had a significant impact on the development of the architecture.

The architecture can only be updated for DPIS if it has stable interfaces. This is because software suppliers need to adapt softwares to interfaces when the interfaces are updated. If the interfaces are unstable, this behavior is not possible. This means that DPIS loses the ability to update or even evolve features or modules. In addition, stable interfaces facilitate the efficiency of DPIS to deliver information. Especially in the current Dutch situation, the government defines information services and requires DPIS to deliver information that far exceeds the capacity of the system. Although this behavior required by the government cannot be achieved, it still means that the information delivery of DPIS is always at its peak, which is guaranteed by the stability of the Interface.

No.	Requirement	Final answer
9	The architecture should have complements that can be used and meet the dynamic needs of the market	Yes

Interviewees in business, healthcare, and ICT contexts have all expressed positive views of this requirement.

Complements designed for market needs create a win-win situation for serving users and creating competition in the market. This means that suppliers use their expertise to design complements specifically for users to not only meet consumer needs, but also to stimulate innovation among actors in the marketplace. In the context of healthcare, this ability of suppliers not only creates a safe environment for caregivers to use DPIS, but also directly reduces the stress of caregivers. Suppliers reduce caregivers' stress mainly through actions that meet caregivers' needs such as optimizing the interface design and reducing the

operational complexity of DPIS. In other words, caregivers do not need to be involved in any complex development aspects and do not need to have any background knowledge related to DPIS. They only need to clearly state their needs and participate in a small number of simple tests to obtain complements that meet their needs.

However, it is important to note that the development of complements must be carried out under the premise of comply to laws and regulations and market policies. Also, it is important to limit its development to reasonable boundaries. If complements have too many complicated functions, the interface may eventually break down. So the design of complements should be as small as possible, starting from simple.

7.2.3 Interview results overview

7.2.3.1 For key stakeholders' requirements

Table 8 Overview of validated key stakeholder requirements

Stakeholder requirements		
No.	**Requirement**	**Final answer**
1	There should be not only one or a few actors controlling the market	Yes
2	There should be less control by insurance companies	No
3	There should be a centralized database where data can be stored	No
4	There should be standardized guidelines for information exchange	Yes
5	We should give caregivers enough/more power to interact (access) with others	Yes
6	We should provide incentives for IS suppliers, software suppliers, and caregivers as a result of developing/using digital platform	/
7	The market influence of software suppliers should be balanced	No
8	Digital platforms should have a flexible but fully functional long-term architecture	Yes
9	Digital platforms should have a clear mechanism for assigning responsibility	Yes
10	Digital platforms should be designed to ensure alignment with business benefit objectives	Yes
11	Digital platforms should incorporate new technologies for primary care development	Yes

For No. 2, insurance companies are only responsible for controlling cash flow and do not have a strong influence on IS suppliers and software suppliers. Nor do they have the ability to influence the direction of the market. The government is the actor that has these important influences.

For No.3, there is currently no capability to build a centralized database, and even if such a centralized database is successfully built, there is an excessive risk of hacking. Therefore, centralized open standards such as FHIR and EHR should be used instead.

For No.5, caregivers currently have enough ability to interact with other people. So there is no need to give them more power.

For No.6, currently the Dutch government already provides enough incentives to caregivers to encourage them to use DPIS, so there is no need to provide more incentives. For IS suppliers and software suppliers, additional incentives are only offered to startups or providers with good proposals.

For No.7, the market has the ability to balance itself.

For No.8, fully functional architecture is not likely to be achieved as user needs and market demands change daily. Agile and cooperative are also two important attributes of DPIS architecture.

For No. 9, extra attention should be given to the way caregivers handle data. And provide them with training to regulate their behavior.

For No.10, supplies should not only focus on commercial interests as the primary goal, but also on the development of products or features for the target users.

For No. 11, new technologies incorporated with DPIS must be tested.

Additions:
For No. 2, attention should be paid to what insurance companies deal with personal medical information.

For No. 3, the Dutch government rejected the proposal to setup a centralized database in 2016.

For No. 6, incentive refers to financial incentives. The government should put more incentives into the development of open standardized guidelines.

For No. 7, governments should be open to innovation rather than controlling it.

7.2.3.2 For architectural requirements

Table 9 Overview of validated architectural requirements

Architectural requirements		
No.	**Requirement**	**Final answer**
1	The architecture should be able to provide access with the same capabilities to actors who have ownership or control	Yes
2	The architecture should be completely open, i.e., fully open access to all interested external parties	Yes
3	The architecture should have the ability to adapt to changes in the environment	Yes
4	The architecture should provide a dedicated space for caregivers to interact	No
5	The architecture should have clear modules for assigning responsibilities	Yes
6	The architecture should provide a clear path to remote/online data storage	Yes
7	The architecture should have a mechanism to comply with national information exchange regulations	Yes
8	The architecture should have stable, dependable user interfaces that can be used under dynamics situations	Yes
9	The architecture should have complements that can be used and meet the dynamic needs of the market	Yes

For No. 1, we should give patients the same access as caregivers. In other words, patients have the right to view, share and control their own medical data. Respondents also indicated that the architecture is about consent and authorizations, not ownership.

For No.2, The architecture should be completely open for use, but for sharing, we should first get the owner's consent to access medical information.

For No.4, it is sufficient to create a domain space for caregivers. Not only does this create a separate space for their specific needs, but it also ensures that this domain space has a dependency on other domains, allowing caregivers to use this connection to get help directly when they need support from other departments.

For No.5, while validating this requirement, respondent SS1 suggested the use of technical terms for this requirement. Correct "module" to "control unit".

For No. 7, this mechanism should be adapted to the Dutch situation on the basis of the use of EU regulations.

Additions:
For No. 1, medical data should not be shared with the government. We should keep control of medical data in the hands of the patient, not the government.

For No.3, IS suppliers and software suppliers should always be sensitive to the development of technology and the adjustment of laws and regulations.

For No.6, an efficient path to remote or online storage is the basis for data exchange.

For No.8, interface should also be adaptable.

For No.9, complements should not have too many functions or the interface will crash.

7.3 Additional information from the interview

This section summarizes additional information related to healthcare that was mentioned in the interviews. And draws on this information for future recommendations.

Government should increase regulation and control of insurance companies
Currently, 50 % of the financial subsidies invested in healthcare come from insurance companies and 50 % from the government. Although insurance companies comply with government regulations, they still have a great deal of freedom of movement. For example, a precondition for patients to receive their healthcare reimbursement is to share their medical information with the insurance company. But the patient is not aware of what happens to the medical information. Therefore, the government should issue regulations to regulate the behavior of insurance companies more, especially regarding the storage and handling of medical data.

Long-term contract vs long-term architecture
The contract is developed by the sales department and the architecture is designed by the technical department. It is up to the consumer to weigh in on the expiration date before they decide to enter into a contract with a supplier. By choosing a long-term contract, they may take a higher risk due to incomplete DPIS functionality or failure to update in a timely manner. By choosing a short-term contract, consumers need to accept the ongoing dynamic changes and readily adapt their behavior to the features of the DPIS.

Creating a trust framework for patients

Patients may refuse to accept treatment options proposed by caregivers due to lack of understanding of medical technology or out of fear of innovative technology. Therefore, based on the efforts of caregivers and IS suppliers, the government should educate the public about the development and role of technology, and also alleviate patients' anxiety by creating a trust framework for patients.

Summary for business objectives

For maximizing consumer satisfaction:

1. Providing a DPIS for customers (healthcare providers) to work online/offline
2. Helping healthcare organizations reduce (internal) costs
3. Providing personal health environment for users
4. Automatic process for generating medication profiles (there will be 60,000 reports per year if caregivers are required to make reports)

For company development:

1. Recycling their own customers (patients)
2. Making a profit (but not the highest goal)
3. Enriching the value of the product

8

CONCLUSION

The aim of this study is to define the requirements that could enhance the architectural openness of DPIS for primary care in the Netherlands. This study is motivated by the fact that the current DPIS for primary care in the Netherlands is not open enough. This makes it difficult for different DPIS to interact with each other. In other words, this means that caregivers have difficulties to deliver or view necessary medical information. If the requirements of key stakeholders are understood and the architecture is designed according to their needs, this challenge will be addressed. At the same time, the desire for innovation in the Netherlands could facilitate this.

In this chapter, three sub research questions and the main research question are answered. The three sub research questions focus on the current situation, the factors affecting the openness of the architecture and the openness requirements of the key stakeholders. The main research question focused on the requirements to enhance the openness of the Dutch DPIS for primary care.

8.1 Answer to sub research question1

What does the current digital platform in information system for the primary care in the Netherlands look like?

The current situation of the primary care system in the Netherlands can be summarized as the coexistence of multiple DPISs. When these DPISs comply with different standards for information exchange, it is difficult or even impossible for caregivers using different DPISs to exchange information smoothly. This is due to the fact that, although IS suppliers of different DPISs comply with the information exchange standards mandated by the Dutch government as a whole, they adapt these standards to their own interests and needs and to the characteristics of the DPIS. These adaptations exacerbate the challenges of information exchange between different DPISs. Therefore, the Dutch government should use its regulatory power to guide the actors in the market to create standardized and open guidelines. This will allow data to be recorded, extracted, reviewed or downloaded, and exchanged with other DPIS, regardless of which DPIS is used.

However, it is worth noting that currently, primary care in the Netherlands does not focus on how data permissions are shared and how information is processed. When this is combined with the lack of autonomous research and development by IS suppliers, it makes it even more difficult to create standardized and open guidelines. Therefore, it is important to increase primary care's focus on data exchange and to guide actors in the primary care market to participate in the revision of guidelines on their own.

Example：
When caregiver A using DPIS A wishes to view medical information held by caregiver B using DPIS B, caregiver A will first send a request to DPIS B by filling out a valid and compliant data request on DPIS A. In the process of sending the request, the national registry will first diagnose the validity of the request. During the process of sending the request, the national registry will first diagnose the validity of the request. If valid, the national registry then informs DPIS A where the data is stored in DPIS B. DPIS A then sends a data request to DPIS B and simultaneously compares the differences in the information exchange standards between DPIS A and DPIS B. If there is a difference, there is a high probability that the request will be rejected and Caregiver A will not be able to access the medical information stored in DPIS B.

8.2 Answer to sub research question2

What are the factors that influence the openness of digital platform architecture?

The researchers identified four factors that influence the openness of digital platforms as interoperability, stakeholders, organizational structure and environmental dynamics.

Interoperability considers the protocols that need to be developed in different scenarios of DPIS for healthcare in a collaborative context from the perspective of organizational policy, care process, information, application and IT infrastructure, the laws and regulations. Stakeholders considered the impact of differing interests and goals of caregivers, IS suppliers, and software suppliers on the core functions of DPIS. Overall, IS suppliers determine the direction of the DPIS based on what they learn about the requirements of caregivers and market trends. Software suppliers are responsible for supporting the development of the DPIS.

Organizational structure is seen as a structure that enhances effectiveness. In considering the strengthening of DPIS openness as a core development goal, the organizational structure adjusts to the combination of both primary care and DPIS by considering the differences between the two environments. In addition, organizational structure can help companies or organizations to clarify their core development goals and identify the factors that are related to or affect this core. In this research context, development is considered as the core, while data exchange, data request, customer relationship, etc. are considered as the associated factors. In the process of designing the organizational structure, the decisions of software suppliers and IS suppliers have an impact on the shape of the final organizational structure. Therefore, extra attention should be paid to the inherent tensions between potentially divergent interests of software suppliers and IS suppliers when designing the organizational structure.

The two main factors influencing the dynamics of the environment are technological trajectories and multihoming costs, where technological trajectories focus on the impact of complementary and alternative technologies on DPIS and openness, and multihoming costs are concerned with the impact of developer and platform association costs on DPIS and openness. In cases where openness is considered central to development, technological trajectories can facilitate communication, guide design direction, and ensure design effectiveness. Meanwhile, technological trajectories can also ensure responsiveness and flexibility of DPIS (Khalil & Khalil, 2019), while increasing the interaction between stakeholders

on the platform. In the context of primary care, this means that caregivers' ability to process and exchange information is enhanced. However, it is costly to implement these features of DPIS, and multihoming costs can contribute by helping to reduce the costs that software suppliers have associated with more than one platform. For example, providing software suppliers with the tools they need to develop DPIS functionality.

8.3 Answer to sub research question3

What are the key stakeholder requirements regarding openness?
Chapter 6 uses the methods of stakeholder analysis and requirement analysis to analyze the common requirements of IS suppliers and software suppliers regarding DPIS openness collected in section 4.4 of (van Hattum, 2020). Chapter 7 validated and modified these requirements using semi-structured.

The analysis of the interview results resulted in the removal of two requirements that were rejected by all interviewees: a centralized database where data can be stored and the market influence of software suppliers should be balanced. For original No. 2, original No. 5, original No. 6, original No. 8 were revised. For original No. 2, insurance company was revised to government; for original No. 5, the word For original No. 2, insurance company was amended to government; for original No. 5, "more" was deleted. Respondents indicated that caregivers are currently given enough power and there is no need to give more power; for original No. 6, the beneficiaries of the incentive were reclassified. Respondents indicated that incentives should not be given to all IS suppliers and software suppliers, but only to those who have good proposals or entrepreneurial suppliers; for original No.8, based on feedback from respondents, deleted "fully- functional" and added "agile" and "cooperative."

Table 10 Validated and modified key stakeholder requirements

Stakeholder requirements		
No.	**Requirement**	**Original No.**
1	There should be not only one or a few actors controlling the market	1
2	There should be less control by Dutch government	2
3	There should be standardized guidelines for information exchange	4
4	We should give caregivers enough power to interact (access) with others	5
5	We should provide financial incentives caregivers as a result of using digital platfomr; We should provide financial incentives to IS suppliers and software suppliers who have good proposals or startups	6
6	Digital platforms should have a flexible, agile, cooperative and long-term architecture	8
7	Digital platforms should have a clear mechanism for assigning responsibility	9
8	Digital platforms should be designed to ensure alignment with business benefit objectives	10
9	Digital platforms should incorporate new tested technologies for primary care development	11

Note:
Original No. is the serial number of these requirements when they were originally defined, i.e. in table 8.

Table 10 summarizes nine common requirements related to openness for IS suppliers and software suppliers in the context of DPIS for primary care in the Netherlands. These nine requirements focus on control, data exchange, power of caregivers, incentives, architectural requirements, allocation of responsibilities, commercial interest goals and embedding of new

technologies. In this case, control refers to these two aspects, namely the power of actors in the market and the power of government.

8.4 Answer to main research question

What are architectural requirements that can enhance the openness of digital platform in information system in primary care in the Netherlands?

The definition of architectural requirements in this study was not collected from the scientific literature. Rather, they are defined after collecting openness-related requirements from IS suppliers and software suppliers and analyzing the functional and non-functional requirements of the architecture. In other words, this study builds a bridge between key stakeholders and architecture and expresses the requirements of key stakeholders in the language of architecture. This is done for two reasons: 1) to collect requirements that are consistent with the current state of primary care in the Netherlands; and 2) to provide a basis for the design of the architecture for the next phase. So that the design of the architecture does not focus heavily on the implementation of innovative features and lose sight of the real demands in the market.

Table 11 Architectural requirements that can enhance the openness of DPIS

Architectural requirements	
(original) No.	**Requirement**
1	The architecture should be able to provide access with the same capabilities to actors who have authorization
2	The architecture should be completely open for anyone to use; The architecture should be completely open for authorized people to share information
3	The architecture should have the ability to adapt to changes in the environment
4	The architecture should provide a domain space for caregivers to interact
5	The architecture should have clear control units for assigning responsibilities
6	The architecture should provide a clear path to remote/online data storage
7	The architecture should have a mechanism to comply with national information exchange regulations
8	The architecture should have stable, dependable and adaptable user interfaces that can be used under dynamics situations
9	The architecture should have complements that can be used and meet the dynamic needs of the market

After analyzing the interview data, the architectural requirements defined in chapter 6 were revised. for No. 1, "ownership or control" was revised to "authorization". Respondents indicated that the architecture was not related to ownership or control, but rather to who has permission to view the information; for No. 2, given the respondents' feedback, this requirement explained in more detail the openness of healthcare information. For No.2, given the respondents' feedback, this requirement explains in more detail the openness of medical information, dividing open into open to use and open to share; for No.4, the dedicated space was changed to a domain space. The independent nature of the domain space ensures that the specific needs of caregivers are met, and the dependent nature ensures that caregivers are connected to other domains or departments; for No.5, "module" is corrected to "control unit"; for No.8, the attribute "adaptable" is added to interface. Table 11 summarizes the validated and modified mentioned architectural requirements that can enhance the openness of DPIS in primary care in the Netherlands.

9

DISCUSSION

The final chapter focuses on reflections on the process and results of the study and the limitations present in this study. The purpose of this reflection is to identify the contribution of this research to social practice and scientific research, and subsequently to provide guidance for future research directions by clarifying limitations.

This section begins with a reflection on the application of design science in this study and the impact of this approach on the findings in section 9.1. This is followed in section 9.2 by an explanation of the limitations of this study. Subsequently, the notable contributions of this study are discussed in section 9.3. Finally, section 9.4 concludes this chapter by presenting recommendations for future research as summarized during the research process and analysis.

9.1 Reflection

Design science was used as the basic framework for this research, providing guidance on the design of artifacts and the answers to the main research question. Reflection on this research therefore includes reflections on the design science approach, its performance in solving real-world problems (Hevner et al., 2004), and the theories used in the research process.

9.1.1 Reflections on design science approach

Design science provides a solid foundation for contextualizing this research by offering clear insights into the initial problem. Design science also creates a network between different domains by building connections between scientific research and design. This advantage ensures the agility of the researcher's thinking. Beyond this, design science is concerned with how to explicitly design effective artifacts based on existing theories. It does so by pursuing human performance to improve the functional and non-functional properties of artifacts (Johannesson, Perjons, 2014; Wikipedia contributors, 2021). In this study, design science supported the definition of key stakeholder requirements and architectural requirements, and also ensured validity and utility when validating these requirements. Therefore, it can be known that design science is successful in this regard.

However, iteration, an important attribute of design science (Vaishnavi et al., 2004), was not implemented truly in this study. Due to the time constraints of the study, only one iteration was chosen to be performed in this study. As an example, after completing the definition of the requirements for the architecture regarding openness, it was validated using semi-structured interview. Subsequently, the requirements language of the architecture was specialized under expert guidance. If a second validation, i.e. a second iteration, could be performed on these specialized architectural requirements, this would be able to greatly increase the credibility of these requirements and reduce the government's skepticism in

practice. However, it is worth noting that we need to limit the background of the respondents involved in the secondary validation to architects only. The qualification is made at both the background knowledge and experience levels.

9.1.2 Reflection on design outcomes

This section reflects on the outcome of the use of architectural language.

The difference between the language of goal and requirement is ignored in the translation of key stakeholder common requirements into architectural requirements. The main reason for this is to ensure that the interviewees have the same understanding of the issues and to collect valid feedback during the interview process. Therefore, the architectural requirements were expressed in simple, plain language for the background of the interviewees. However, this makes some of the architectural requirements lack specialization and specificity. Therefore, even if these partial architecture requirements are validated, architects are prone to capture the wrong information due to misunderstanding of the text.

Table 12 Adjusted architectural requirements

	Architectural requirements
1	The architecture should be able to provide access with the same capabilities to actors who have authorization
2	The architecture should be portable and secure
3	The architecture should be maintainable
4	The architecture should have the systematic ability to interoperate with complex joins
5	The architecture should have clear control units for assigning responsibilities
6	The architecture should provide a clear path to remote/online data storage
7	The architecture should conformity to national information exchange regulations
8	The architecture should have stable, dependable and adaptable user interfaces that can be used under dynamics situations
9	The architecture should be usable and scalable

Therefore, after consulting with researchers who focus on the DPIS field, I have revised the proven architectural requirements in table 11.

No.1, No.2, and No.4 focus on the performance of the architecture. No.1 and No.2 jointly focus on the permissions and security of the architecture. No.4 focuses on the system ability to interactive operations of complex joins. In addition to this, No. 2 also pays additional attention to the portability of the architecture, i.e., the portability of browsers and the portability of data between different systems (*Software Architecture Notes - Architecture Requirements*, n.d.). Therefore, No.2 is modified to that the architecture should be portable and secure. Adaptation to environmental change of No.3 was modified to maintainable (Hulgan, 2012). "Comply with" in No. 7 was revised to "conformity to". The reason is that compliance emphasizes on "what is required" and conformity emphasizes on "what commits itself to", which focuses more on autonomy. The architecture in No.9 should have complements that can be used and meet the dynamic needs of the market is revised to the architecture should be usable and scalable (Hulgan, 2012). The full revised architecture requirements can be viewed in table 12.

9.1.3 Reflections on the usage of theories

Scientific theories provide guidance for design directions. However, no clear theoretical approach combining the findings from the intersection of primary care and DPIS was found

in the course of this study. This is due to the different areas of expertise, target groups, and focus of the researchers. Therefore, in order to mitigate the negative effects of this complexity, this study took a mixed research approach to the research as suggested by de Reuver et al. (2018). And after limiting the use of the study, the elements involved in this study were clearly listed. The meaning of these elements collected during the literature review process was then interpreted and adapted to the research context.

The same insights were provided by the respondents during the interviews. In particular, the definition of openness was addressed to DPIS. It was emphasized that when it comes to sensitive medical information, we should not define openness from a generic perspective. Rather, openness should be divided into use and sharing. That is, anyone has the right to use DPIS, but only those with authority can view and share medical information.

9.2 Limitations to this research

9.2.1 Data analysis methods

The review of the interview results did not use specialized software to identify the number of recurring codes and the association between these key codes. Instead, the researcher's subjective analysis was used. This was done because while there was some correlation between these requirements, this study placed more emphasis on treating these requirements as independent objects. Rather than a machine-based approach, the researcher was able to construct an emotional connection with the interviewees as the interviews progressed in order to identify the concerns they wanted to emphasize.

In other words, the researcher treats each requirement as object and explores its possible network connections. However, this has several disadvantages: inefficiency, the absence of key codes, the relations with other codes are missing. It is recommended to use Atlas.ti to confirm the groundedness (number of code mentions) and density (number of code associations with other codes) of the data collected in the interviews and to show the associations of the data through visualization. Subsequently, compare the results obtained in Atlas.ti with the results of this study. I.e., it is recommended that the researcher should draw final conclusions on the combination of subjective judgment and the results of data analysis by specialized software.

9.2.2 Information gathered during the interviews

1. The limitations of the data base led to a bias in the direction of the interviewees' work (i.e., not all focus on primary care). This could be due to the respondents' work background, focus/research direction, and lack of understanding of primary care.

Therefore, if we want to only target primary care, sufficient data resources have to be ensured. Subsequently, the interviewees should be screened for their background in the selection and identification. They should be classified into primary care areas of concern and other areas of concern. The reason this study did not make this division is because in excluding a non-standard sample data, three of the remaining seven sample data had the service area of primary care. In other words, the interview results from three samples can provide a very clear insight into the current situation in primary care and the requirements of caregivers.

The remaining four samples focus on the business and technology sectors at the intersection of the ICT industry and healthcare. Although the data from these four samples do not focus solely on primary care, they all have some understanding of primary care. Their insights into the intersection of the ICT industry and healthcare can also contribute to the requirements validation of this study. Also, their comments and insights were compared with the first three samples serving primary care in the review of the interview results to verify the validity of their comments.

2. Although caregivers were not considered as a target interview group, as they are not key stakeholders. However, one of the interviewees has a professional background in caregivers, and although this interviewee has understanding of medical technology, this interviewee still lacks a technical background compared to other interviewees, i.e., the lack of a deep understanding of DPIS. This resulted in the inability to validate the architectural requirements.

This is due to the fact that as students do not have the power to select their interviewees' backgrounds, which would lead to research bias. In the extreme case, if the interviewees do not have the right background for the research question, their interviews will only yield general recommendations from a popular perspective and will not allow for a deeper dive into solutions to existing problems. It is therefore recommended to define the required network of potential stakeholders after the research questions are identified and to send as many invitations as possible. If necessary, seek the assistance of supervisors or other regulators to increase the probability of a valid interviewee.

3. Although the target group for this study was IS suppliers and software suppliers, the reason for keeping the interview data from the caregivers is that we can compare the feedback from the caregivers on the requirements of IS suppliers and software suppliers with the feedback from the suppliers on their own requirements so that we can see the difference in their perceptions.

For example, caregivers may not understand why A is a very important requirement, but suppliers do. These differences in perceptions can provide research direction for subsequent studies, and can help architects design architectures that meet multiple requirements.

4. This stakeholder requirement analysis is defined based on (van Hattum, 2020). The lack of focus on caregivers can lead to a lack of caregiver level requirements in translating stakeholder requirements into architectural requirements, i.e., a lack of mass society level requirements. This leads to a disconnect between the technical level and the practical use level. Although feedback from caregivers on the existing DPIS was unexpectedly obtained in this study, it is recommended that the needs of caregivers and their behavioral feedback be taken into account at the initial stage of the study in order to build a link between the conceptual level design and the operational level.

5. The interview data for this study denies part of the data collected in section 4.4 of (van Hattum, 2020) from conversations with experts. This may be due to four reasons: 1) differences in the background and direction of concern of the researchers; 2) the influence of

the subjective judgment of the researchers; 3) the influence of the background information of the interviewees; 4) the limitation of the number of interviewees.

6. Only those with ICT architect background suggested modifications to No.1 of architectural requirements. Therefore, it can be seen that people without background expertise can only provide a general level view, which can have a significant impact on the validation of the requirements. That is, it can lead to significant variability or even invalidity of the data. Although these views are truly expressed by the respondents, they may produce conclusions that are too subjective due to their lack of background expertise. Therefore, it is recommended that when validating architecture requirements, the target population should be limited to those who are engaged in the industry and have background knowledge in architecture. Otherwise, even if such requirements are validated, there is no guarantee of the effectiveness and accuracy.

9.3 Contributions of this research

My research has five contributions. First, I analyze the current state of the digital platform for information systems (DPIS) for primary care in the Netherlands. In this study, platform openness is defined as the level that allows caregivers to access, use, or exchange medical information. Therefore, in the analysis of the current situation, the focus is on the status of information communication. This provides the reader with a foundation for understanding the research content and the answer to the main research question. In addition, this contribution fills a research gap in this area. No relevant studies were found in the literature review in Scopus.

Second, I define the factors that influence the openness of the Dutch DPIS architecture. For suppliers, this study can help suppliers to update their technology holdings and reflect on their situation from the perspective of interoperability, stakeholders, organizational structure and environmental dynamics. For consumers aiming to enhance openness, this can help them to make the most effective tradeoff when deciding which DPIS to use. Likewise, this contribution adds to the focus on DPIS openness in the Netherlands and fills a gap in the study.

Third, I identified the key stakeholders' requirements for openness and translated them into an architectural representation. This establishes a link between the real market needs and the technical characteristics of the architecture. This reduces the risk of designing architectures that follow the convenience of technology to the exclusion of the needs of the masses in the market. In addition, the requirements of IS suppliers and software suppliers defined in this study, as well as the architectural requirements regarding openness, are specific to Dutch primary care. Furthermore, these requirements were validated through interviews to ensure the accuracy and reliability of the results. Overall, this targeted research provides unique insights into the development of primary care in the Netherlands. Both researchers, developers, and government staff can consider these requirements as a basis for their openness-related project proposals.

Finally, by analyzing and summarizing the existing literature and interview results, I propose guiding questions for future research. Providing recommendations for future research is essential, firstly because there is not enough research in the Netherlands to address the intersection of DPIS and healthcare. Secondly the Dutch healthcare market is not international.

This makes it difficult for non-Dutch researchers to access valid information. Gaining a multidisciplinary and multicontextual perspective would not only provide diverse and innovative solutions to the problem, but also advance the development of DPIS in the Netherlands. Therefore, this study has social impact and relevance for future research.

9.4 Recommendations

This section summarizes the directions found in the different developmental stages of this study that are worthy of future research. It is also discussed in terms of relevance to science and practice. For a summary of recommendations please see table 15.

9.4.1 Recommendations to scientific research agenda

The recommendations in this section are discussed in two directions, i.e. future research directions collected in the literature review and future research directions derived from the research analysis process.

9.4.1.1 From literature review

When using the search string: TITLE-ABS-KEY (("digital platform" OR "platform ecosystem" OR "platform architecture") AND ("open*" OR "platform open*") AND (" health" OR "healthcare")) in a review of the current state of openness at the intersection of healthcare and DPIS, it was found that this intersection lacks attention to the influence of DPIS stakeholders, to the distance from official authorities, and to the business level. Table 13 provides a detailed summary of the key outcomes and future considerations of these studies.

For studies in the direction of stakeholders, researchers should discuss the differences in the needs and goals of healthcare stakeholders within the network (Haarbrandt et al., 2018). Vedam et al. (2022) suggest that researchers should also focus on the link between patient autonomy and healthcare design, the requirements of DPIS users (e.g. caregiver) and the trade-off between their requirements and personal power. In addition to this, if the DPIS has a regulatory function, attention should be paid to the riskiness of the development of the regulatory platform extension (Carr et al., 2017). And discuss the link between the regulatory nature of DPIS and patient safety, and the potential impact on patients.

For research in the direction of assistance from official authorities, researchers should view the government as the target group. Discuss the association of interest subjects within the government with other actors present in the ecosystem at the intersection of healthcare and DPIS (Morgan et al., 2021; Dijck & Poell, 2016). For example, discussing the regulatory nature of open-source platforms by analyzing the differences in goals and needs between government and providers (Dijck & Poell, 2016). Or by assisting official authorities in making trade-offs and assessing expected risks and limitations before technology and economics (Carr et al., 2017). In addition to this, researchers can also discuss the impact of policy assistance on the development and regulatory effectiveness of healthcare system security from a policy perspective. Radonjic-Simic et al. (2021) suggest that researchers should also consider the impact of Dutch response policies on the openness of the DPIS ecosystem in special contexts such as COVID.

For research on the direction of business-level influence, researchers can discuss its impact on competition in the healthcare industry from an inner source perspective (Morgan et al., 2021). And analyze how to maximize the adaptation and use of existing research to promote the Netherlands at the intersection of business, healthcare and DPIS.

9.4.1.2 From analysis process

In this section, I focus on the recommendations collected during the analysis of the interview results. The interviewees focused on the stakeholders in the ecosystem of Dutch DPIS for healthcare and suggested the following recommended target groups for research:

1. Insurance companies
   In order for a patient to obtain reimbursement for their healthcare, they often need to pass on their medical information to their insurance company. Although insurance companies state that they do not privately use patients' private medical data, we still need to pay a lot of attention to the way insurance companies protect and handle medical data. In addition to this, in future research, researchers need to pay special attention to the interaction between insurers and government, especially the direction of corporate governance.
2. Government
   Consider government control and influence over the market. Interviewees indicated that researchers should pay close attention to the distribution of government power. It is important for the government to give every DPIS supplier with innovative ideas or practical applications the same opportunities.
3. Caregivers
   Caregivers has a close relationship with patient medical data. Can caregivers afford to assume the risks associated with the security of such data if medical data is compromised or corrupted as a result of caregivers' misconduct? And what is caregivers' experience and effectiveness with DPIS?
4. All stakeholders within the ecosystem
   To ensure the success of the ultimate DPIS, it is important to listen to a wide range of opinions when making trade-offs that are not related to patient privacy. Therefore, it is important to facilitate the interaction and communication among the stakeholders involved in the ecosystem.

9.4.2 Recommendations to practice

The recommendations are discussed for different interest groups.

For caregivers:
It is important to regulate the behavior of caregivers when using DPIS. Due to convenience, some caregivers fill in medical information in non-specified text boxes. This results in inaccurate identification of medical information, which can lead to avoidable delays. Another obvious benefit of regulating the use of caregivers is that it indirectly gains the trust of patients. Whether or not a framework of trust should be established that is open and transparent to patients and gives them clear control over the direction of their medical data is an area of research worth discussing.

For IS suppliers:
The results of the interviews clearly indicate that IS suppliers should explicitly consider the boundary limits of data exchange when defining the openness of DPIS, i.e., the limits between "use" and "sharing". In addition, interviewees asked that IS suppliers should consider whether to apply sharing controls to open standards for data. The implementation of sharing controls for open standards can facilitate the autonomy of actors in the market to provide recommendations for open standards and avoid limitations. However, this act also divides the power of IS suppliers to a certain extent.

For official authorities:
The results of the study suggest that it is beneficial to focus on the construction of relationship with different groups. Especially with the premise that medical technology is advancing rapidly, if the government organizations can establish a good collaborative relationship with non-government organizations, this will lead to a shift in government mindset and reduce unnecessary concerns of government organizations (Dam et al., 2017). In other words, these relational bridges alleviate the situation of government's fear of innovative concepts or technologies by feeding new insights to government agencies (Dijck & Poell, 2016). At the same time, this can reduce the probability of failure of the government to build a national DPIS architecture. It is worth noting that if the government wants to build a DPIS that meets the social needs, it is important to pay attention from analyzing the reasons for the failure of AORTA, in addition to focusing on the relationship with caregivers and residents.

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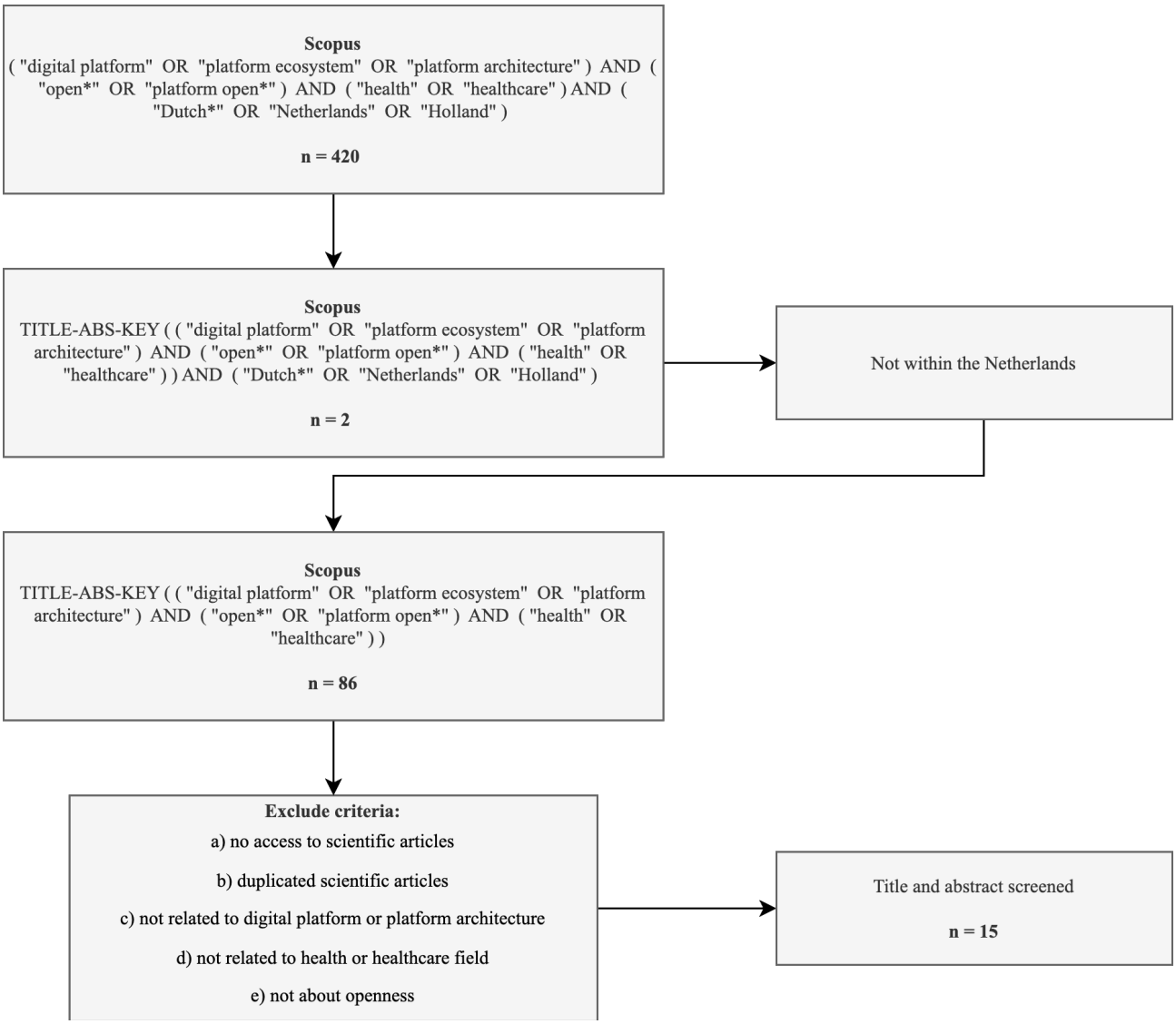
APPENDIX

A INFORMATION PACKAGE

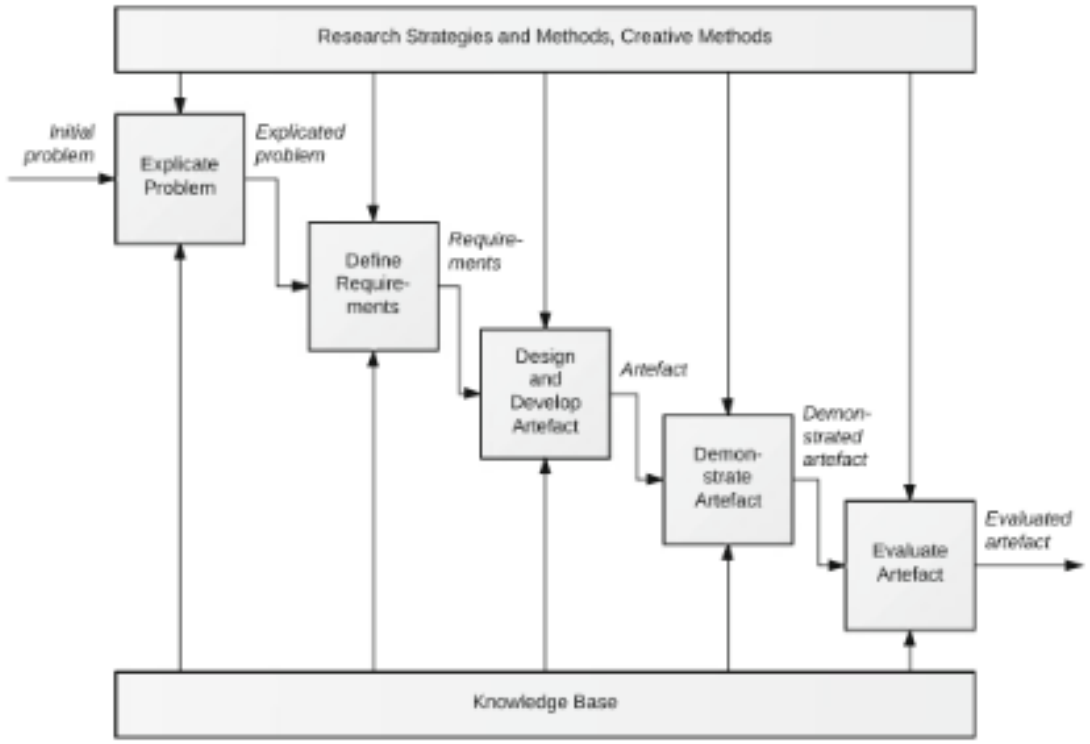
A1: Research flow chart

Figure 7 Research flow chart (author: own)



A2: IDEF0 framework

Figure 8 The method framework for design science research with research strategies and knowledge base – IDEF0



Cite from: (Johannesson, Perjons, 2014)

A3: Overview of literature research

This section provides an overview of the research process in literature research and discusses the scientific issues identified and potential research directions.

Search string for section A3:
TITLE-ABS-KEY (("digital platform" OR "platform ecosystem" OR "platform architecture") AND ("open" OR "platform open*") AND ("health" OR "healthcare"))*

A3.1 Findings from literature research

The purpose of this section is to provide the reader with a background knowledge of DPIS in the healthcare field. This section first describes how the scientific literature on scopus is searched and the focus of the collected scientific literature. In addition to this, a summary of future research directions in this scientific literature is presented. Subsequently, in section A.1.2, three studies related to this research are selected: stakeholder requirements and behavioral decision making, platform effectiveness, and governance and assistance. The issues in the collected scientific literature are summarized and analyzed.

A3.1.1 Overview of literature research

A search of the scientific literature was performed by using the screening process in appendix A.1 Research flow chart. The acquired literature was reviewed using keywords related to the Netherlands, digital platforms, healthcare, and openness. Two literatures were finally obtained. However, since the content of these two literatures was not related to the Netherlands, the literatures were reviewed globally by lifting the geographical restrictions. And a total of 15 scientific articles were left by considering the following five conditions: a) whether they had reading access, b) whether they duplicated other scientific articles, c) whether they were related to digital platforms or platform architectures, d) whether they were related to the healthcare field, and e) whether they involved openness.

These scientific articles conceptualize digital platforms from an ecosystem, security protection, and social and technological perspectives (de Reuver et al., 2018; Wagner & Prester, 2019). The ecosystem perspective focuses on the modularity and scalability of the platform (de Reuver et al., 2018). The security protection perspective focuses on the level of security and risk control measures for the potential beneficiary groups of DPIS under cost constraints. The social and technological perspective, on the other hand, typically focuses on the multifaceted nature of digital platforms in the marketplace and their variation in different economic conditions and market arrangement situations (de Reuver et al., 2018).

Half of the articles covered discuss the development and strengths and weaknesses of existing DPIS from an overall perspective such as national or global. Some of these scientific articles discuss how to address the existing shortcomings. In other words, i.e., how to develop new digital platforms that can be adapted. As an example of digital global public goods (DGPGs) represented by District Health Information Software (DHIS2), it has been recognized by several organizations, including the European Union (EU), and governments around the world for its free and open source features. DHIS2's open source features not only accelerate health data access for health agencies and government organizations (Open Health News, 2018), but also

enable the creation of analytics from real-time data in seconds, providing solutions with high probability. Thus, these features have led DHIS2 to become the de facto standard for the development of health DPIS (HIS) today (Sahay et al., 2017). Sahay et al. in 2020 also draw from three action research cycles: regional level, health facility level, and building global networks to enable scale examined how to enhance the extension of the Antimicrobial Resistance (AMR) monitoring platform based on the use of DHIS2 open source features. This extension enables free and unhindered access to countries, thus ensuring international patient data exchange across borders for more efficient diagnosis and treatment.

Carr et al. (2017) investigated the low-cost open-source digital platform MediPi from the perspective of cost and patient safety protection. MediPi as a digital platform for telemedicine, the security of personalized interaction, accuracy and dependability of data transmission are the most important factors. Therefore, the researchers identified risk control elements in terms of potential risk barriers. This not only helps to identify the value of such digital platforms for telemedicine, but also assists in assessing the risk elements that need to be taken into account for the expansion of such digital platforms. In addition to this, Carr et al. (2017) established the link between MediPi and patient safety regulation from a care setting perspective. The reliability of the non-regulatory nature of this digital platform is discussed and the overall safety effectiveness of this digital platform is analyzed in a modular structure.

For policy assistance and local sensitivity, Furstenau & Auschra (2016) suggest that DPIS are best designed and developed according to the customary and regionalized institutional characteristics of each region. Furthermore, Dijck & Poell (2016) add that governments have some responsibility to provide a clear conceptual transcription of medical and health research in order to coordinate the development of medical DPIS with local policies. However, in the real world, even though the government's expected goals for DPIS are similar to those of IS suppliers, the government still has difficulty in confirming whether DPIS actually have the capabilities presented by IS suppliers. This is due to the excessive and inconsistent number of evaluation models. Benedict et al. (2016) describe a quantitative evaluation model for eHealth platforms. This quantitative evaluation model discusses how the Maturity Model for Enterprise Interoperability (ISO 11353-2) can be instantiated in the healthcare domain and how the evaluation process can be operationalized and simplified in order to improve the transparency and reliability of the evaluation process. In addition, this quantitative evaluation model reduces the dependence on external capabilities. This can help the government to measure the value of the eHealth platform more effectively without additional external help. However, this scientific article discusses the various types of eHealth platforms from a holistic perspective, not just the Dutch situation.

Therefore, the following directions for research can be summarized as:

(1) Discusses the link between regulatory platforms and patient safety, focusing on the risks of regulatory platform expansion development.
(2) Analyze the difference between the needs and goals of government or municipality and suppliers, and discuss the regulatory nature of open source platforms.
(3) Discuss the impact of policy on the safe development and regulatory effects of healthcare systems, starting with policy assistance.
(4) Discuss how existing research can be used to adapt to the Dutch situation.

In the remaining scientific article, Radonjic-Simic et al. (2021) set the epidemic COVID in recent years as the object of study. The impact on vaccination rates is analyzed in terms of the variability of governmental decisions in different countries and focuses on the impact of policies represented by Germany. A platform blueprint is then developed based on these differences and the advantages of decentralization and openness for the DPIS ecosystem are discussed. This platform blueprint will not only help subsequent researchers to clarify the linkages between different actors, but also guide the government to assist social groups to participate in the vaccination process on their own. In addition to this, this article also discusses how the openness and decentralized model of the platform can assist international interconnection based on the GDPR. Morgan et al. (2021) focus their research on the intrinsic sources of DPIS. The researchers use three large digital platforms: Zalando, Philips Healthcare, and Paypal as case studies to illustrate the importance of inner source to the internal and external development of business. Furthermore, the researchers elicited the benefits of openness in digital platforms by explaining the association between intrinsic source and openness. Vedam et al. (2022), Aielloet al. (2019) and De Morais et al. (2020) consider the construction of openness in digital platforms from the perspective of human rights, diagnostic imaging and specific diseases (syphilis), respectively. For example, how to rationalize the use and securely store population-sensitive data; how to weigh differentiated perspectives in the design of development programs and minimize the impact of personal bias.

These remaining scientific articles can be considered as general-level scientific articles extended at the actor level. The study by Radonjic-Simic et al. (2021) focused on the behavioral associations among actors. The rest of the scientific articles focus on the different elements that influence the behavioral associations.

Therefore, the following directions to be studied are summarized.

(1) The impact of the Dutch COVID policy on the openness of the DPIS ecosystem.
(2) Association of Dutch government interest subjects with other actors.
(3) Discuss the impact of inner source on competition in the healthcare industry at the business level.
(4) Analyze the demands perspective of DPIS users.
(5) Analyze the openness requirements of DPIS users and the trade-offs with personal power.

A detailed analysis of the scientific articles involved in the literature study can be found in Table 13 below in the literature review of the current status.

Table 13 Literature review of current situation

Author, year	Key outcomes	Future considerations
Masuda et al., (2019)	- An adaptive integrated enterprise architecture (EA) framework is promoted; - Use cases of "IDC's Worldwide Digital Transfor- mation Use Case Taxonomy, 2017: Healthcare," should be applied in new IoT projects in the healthcare community.	Social issues: - Implementation of a collaborative platform for IoT services; - Design of IoT reference model capability indicators; - International standardization of digital healthcare IoT platforms
Radonjic-Simic et al., (2021)	- The blueprint of the COVID-19-Vacc Platform is developed which outlines the platform's ecosystem structure, its interactions process model, and the service stack; - This digital platform also connects various actors and enables them to involve, conduct, and track the vaccination process. - Facilitating Decentralization and Openness, ensuring Information Security and Data Protection, easy to Set Up, Robust, Scalable, and Modifiable	- Design and implementation of an underlying infrastructure suitable to realize services in an open and decentralized manner; - Compare to the actual pandemic situation and the accompanying requirements.
Haarbrandt et al., (2018)	- By establishing a shared information governance framework, data integration centers and an open plat-form architecture in cooperation with inde-pendent healthcare providers, the meaningful reuse of data will be facilitated.	- Consider specific needs of the development and networking phase, such as roll-out, care related aspects and curricula development in Medical Informatics of governance structures and policies. - Investigate the associated medical documentation and free-text documentation advanced methods to better combine to equally address the needs of caregivers and researchers; - Legal and ethical challenges such as the definition of a national patient consent model should be addressed.
Russpatrick, (2020)	- A new theoretical perspective to illuminate the motivators for contributors to digital innovation platforms for development is offered, which draws practical implications for public-sector and Digital Global Public Goods (DGPG) platform owners seeking to develop application economies. - The perspective of complementors to a Global Digitcal Public Goods (GDPG)platform is presented which offers especially low and middle income, out-of-the-box solutions to monitoring and containing outbreaks.	- Motivators and influences in the decisions by other complementors.
Vedam et al., (2022)	- The Quality Perinatal Services Hub (QPS-Hub) an open access digital platform is introduced, to disseminate evidence based guidance, enhance health systems accountability, It also provides a two-way flow of information between communities and health systems on rights-based perinatal services.	- To expand perinatal health care services that prioritize cultural safety and unconditional regard for all service users, support patient autonomy, and uphold freedom from mistreatment, prejudice and discrimination, as a human right.
Senbekov et al., (2020)	- Recent pandemics, including COVID-19, have greatly elevated the attention and demand for digital health technologies, such as locating, managing and treating this viral infection. The use of e-health technologies may help reduce the strain on healthcare systems.	- Lacking official regulations and recommendations, stakeholders (e.g, private and government organizations) are facing problems with adequate validation and approval of new digital health technologies.
Aiello et al., (2019)	- The role of diagnostic imaging in the digital platform and application of diagnostic images is identified. Open challenges in leveraging this intensive data generation for big data analytic decision making are highlighted.	- The need of empower data sharing from single sources of data.
De Morais et al., (2020)	- Information systems and available data are discussed, as well as strategies for a recommended system for syphilis prevalence, integrating health surveillance, formative demand, georeferencing for health teams and professionals, and epidemiological data.	- To produce a methodology in recommendation systems that allows integrating the universe that involves health surveillance with educational aspects that connect the territory and aggravating diseases. - This model should aggregate the various health data in the field of syphilisand correlate them with social, demographic and economic data.
Sanner & Nielsen, (2019)	- To promote inclusive innovation at scale should identify how to foster a network of innovation intermediaries around global public good software platforms (e.g. DHIS2)	\
Morgan et al., (2021)	- Identifies a four-stage model to explain how Inner Source helped to develop internal and external platforms;	- Create a common space to get the ball rolling; - Get familiar with groups already develop-ing reusable components; - Mobilize and empower people to lead the new vision; - Adopt a collaboration tool that connects silos; - Establish a governance process that fosters shared norms; - Avoid re-inventing the wheel.
Dam et al., (2017)	- The integration of an open source platform for mobile data collection commonly used in developing countries with an open source standard platform for electronic data collection in clinical trials was successfully applied in a pharmacokinetic study involving healthy human volunteers.	- How to implement innovative technologies and infrastructure to promote healthcare development in Africa.
Dijck & Poell, (2016)	- Focuses on the analysis of datafication (use and reuse of data) and commoditization (governance of platforms and deployment of business models). And concludes that governments have a responsibility to provide conceptual clarity in transforming the grand narrative of health care and health research.	- Lacking interactive behavior between the corporate, private, governmental and non-governmental sectors in the institutional governance system.
Furstenau & Auschra, (2016)	- The significance of a platform design approach that is sensitive to the preferences of different user groups and that builds on deep knowledge about the institutionalized laws, regulations, and habits of the field.	- the challenge of integrating data across multiple sources like care providers and patients stays unsolved, though initiatives that aim for more open platforms are coming up both in the U.S. and in Germany.
Benedict et al., (2016)	- A quantitative evaluation model operationalizes the evaluation process of eHealth platforms is described, which can reduces the dependence on an evaluation team and facilitate the implementation of assessments thus achieving the purpose of openness.	- The developed indicators of the case example need to be re-evaluated from non-expert perspective. - A rule set for defining indicators needs to be determined to inhibit abstraction issues.
Carr et al., (2017)	- A safety case for MediPi; a research prototype for a low-cost open-source digital platform is discussed; - Identify potential hazardous failures associated with the use of MediPi and examine current risk controls; - Explore the modular structure of the overall safety case of the platform.	- Envision an evolved version for active monitoring and to assist clinical staffs in making decisions; - Enhancement of users as a credit for risk control; - Trade-off between technical risk, clinical risk, and economic constraints must be clearly considered and justified, especially for cases of clinical notification.

A3.1.2 Scientific problem from literature research

This section delineates the potential issues and future perspectives in the reviewed literature, namely, stakeholder requirements and behavioral decision making, platform effectiveness, and governance and assistance. The table 14 defines the roles of primary care stakeholders. This table was revised based on Tiwana's (2013) analysis of the value proposition of stakeholders. The unresolved issues identified in the scientific literature are then analyzed in detail and potential solutions are proposed based on these stakeholders' role characteristics. In the platform effectiveness and policy section, the lack of practicality of the existing DPIS is first discussed, followed by the potential reasons for the non-openness of the DPIS ecosystem and the provision of feasible solutions validated by existing theories. Finally, the feasibility of the risk control solution is discussed by establishing a link between end-users and the DPIS ecosystem. The governance and assistance section discusses the reasons why healthcare DPIS are difficult to update and develop by defining the awareness behavior of official organizations. It also discusses how to reduce transaction costs by increasing the trust of stakeholders within the network and analyzes the suggestions made by the researchers.

A3.1.2.1 stakeholder requirements and behavioral decision making

Masuda et al. (2019) showed that there is a lack of interaction and cooperation among the stakeholders involved in the construction of the healthcare industry and platform systems. Since each stakeholder has different interests and goals, the lack of understanding between individuals even if they are forced to interact with each other makes it difficult to achieve the desired results. The Dutch healthcare industry can be divided into four lines, namely zero-line till third lines. Zero-line refers to preventive care measures and research. The main purpose is to avoid unnecessary involvement of external labor and to reduce the cost of labor. The main purpose of the zero-line is to avoid unnecessary outside labor and to reduce the cost of labor. The first-line (in most cases called primary care) refers to the treatment that the patient needs before being referred to the hospital, i.e., the patient is still within the scope of professional care and does not need to be referred to the hospital by general practitioners (GPs) to assist in his or her treatment. Second-line focuses on the act of referring a patient to a facility such as a hospital after caregivers are unable to diagnose the cause of the patient's illness or are unable to treat the patient due to technical equipment, making the patient's treatment occur primarily in such a facility. The third-line focuses on specific or special treatment, i.e., a patient's spontaneous visit to a special facility. The reason this occurs at a special facility is that they are often able to provide more specialized and specific care. At this point, the patient has already established a deeper connection with this type of facility.

The above four lines constitute a complex healthcare network, which means that if one stakeholder within the network makes a mistake, it will directly or indirectly affect the behavioral decisions of other stakeholders, or even create a cycle of mistakes. This is not only a waste of manpower, i.e., performing repetitive behaviors that could have been avoided, but also a great waste of health care resources that are already in short supply. Based on the analysis of the differences in the requirements and goals of the suppliers as defined in section 1.5.1 overview of literature research, this study focused on the needs and interaction behaviors of key stakeholders in primary care. Table 14 provides an overview of the stakeholder's character. The detailed analysis of the requirements of key stakeholders can be viewed in table 4.

Table 14 Stakeholder overview

Stakeholder	Character
IS suppliers	· Deliver the fully functional and complete DPISs that the market demands · As suppliers of DPIS
Software suppliers	· Deliver different functionalizated control units for DPIS · As module-suppliers of DPIS
Caregivers	· Deliver diagnostic and treatment services for patients · As end-users of DPIS
Patients	· As service-receivers of IS

From the above table, it is clear that stakeholders do not have the same characters and this leads to different development intentions as well as with different needs. The study by Haarbrandt et al., (2018) verifies this. This study claims that there are conflicting needs between suppliers and other stakeholders in the DPIS development process, making it difficult for the development and design to proceed smoothly. This means that even if the final product is developed in a way that satisfies the coordinated wishes of both parties, there is still the possibility that this design based on existing problems in society cannot really be put into practice. Most of these contradictions are related to generic and open (Russpatrick, 2020) and are influenced by motivations and choices of decision-making behavior as well as complex network relationships. While the overall broad goal of these stakeholders is relatively similar, namely that a DPIS put on the market can reduce the pressure on primary care and effectively address the openness needs of caregivers. Thus, the goal of serving patients is ultimately achieved. To address this issue, Morgan et al., (2021) suggest that attempts could be made to enhance collaboration within the network by stimulating the autonomous vision of these stakeholders.

In addition to this, since the patient is the ultimate service recipient, it is suggested that suppliers should also prioritize patient autonomy in the development process, such as cultural safety, choice, etc. Haarbrandt et al., (2018) also suggest that patients' autonomy of choice should be considered from both legal and ethical perspectives and a consent model should be developed to measure it. And even consider re-measuring the effectiveness of the design by introducing the patient's perspective (Benedict et al., 2016).

Therefore, the following directions to be studied are summarized:

(1) Differences in the needs and goals of healthcare stakeholders within the network
(2) The link between healthcare design and patient autonomy.
(3) Discussion of interactive perspectives on the openness of healthcare DPIS from different industry perspectives

A3.1.2.2 Platform effectiveness

This is well argued by the design of Russpatrick (2020), where the theoretical concept of a healthcare platform system is largely developed but not really put into practice. This lack of operational behavior may be due to the fact that these designs are designed for a specific situation, such as pandemic, and if forced into other contexts it is likely to be difficult to achieve the desired results due to the problem, the different stakeholders involved, and the different policies involved. Benedict et al., (2016) suggest that in order to avoid ineffective

design behavior, the development criteria and the definition of the design concept should be clarified first, keeping the whole concept single and neat, and avoiding overly abstraction of the design. At the same time, it is important to build a bridge between the data information of this specific domain and the data information of demographic, social, economic and other global influences in order to prevent the circulation and operability of the data (De Morais et al., 2020).

Another potential reason why theoretical ideas cannot be put into practice is the limitation of regional limitations (Masuda et al., 2019). Furstenau & Auschra (2016) showed that the United States and Germany had proposed to integrate data sources to break the borderline effect and ensure internationalization and openness of data flows. However, this proposal ended in failure. This difficulty in achieving commonality between different data sources can be referred to as "non-openness" (Aiello et al., 2019), which means a lack of access or permission boundaries in providing the possibility to interact with information. This non-openness significantly affects the experience of end-users, setting "invisible" operational limitations for them. This invisibility is difficult to detect until complex subsystem interactions are involved. The main reason for this is that if end-users only need to perform a single action on the target group and do not need to be embedded in other systems, they do not need to wait for actions or feedback from other subsystems users. In other words, end-users can directly perform whatever action is needed and do not directly touch the system's boundaries. However, this is often not the case in real life, where the act of diagnosing and treating a patient, even if only a single subject performs the diagnosis, still inevitably involves collaboration with other subsystems. In the case of the DPIS of the Dutch hospital, for example, the physician has to use thirteen subsystems at the same time to realize the patient's diagnosis and treatment. The complex and diverse platform systems form a network-like architecture, where a change in the behavior of any one of them will affect the behavior or choices of other sectors.

To break this capability boundary (Masuda et al., 2019) and limitations, Benedict et al. (2016) propose that attempts can be made to introduce non-specialist perspectives to enhance the effectiveness factor of platform openness. For example, to enhance the experience of end-users' usage and service-receiver's service experience, the effectiveness coefficient can be enhanced by considering quoting their perspectives from a non-specialized perspective and transforming them into a specialized construction. This approach of treating end-users and service-receivers as credits to help control risks also satisfies the willingness of IS suppliers to transfer risks and achieves a win-win situation for multiple stakeholders. In addition, the creation of a common space to promote interactive behavior of architecture design can be considered to facilitate the breaking of capability boundaries (Morgan et al., 2021). This act of changing the technical architecture also determines the economic features of sector. As mentioned in the previous paragraph, any small change will have an immeasurable impact on the final outcome.

Therefore, the following directions to be studied are summarized:

(1) The analysis of user experience and requirements of end-users
(2) The analysis of the demands and requirements of service-receivers
(3) The boundary between specialist and non-specialist
(4) The boundary restriction of data exchange

(5) Design of interactive communications space for stakeholders to make trade-offs recommendations

A3.1.2.3 Governance and assistance

Senbekov et al., (2020) showed that one of the reasons for the difficulty of updating healthcare systems is the lack of official regulation and advice. This makes it possible that even though DPIS continues to grow and there are many researchers working to promote and improve the healthcare system. However, the lack of conscious behavior of official governments to proactively embrace new technologies (Dijck & Poell, 2016) makes it difficult to validate existing technologies or novel designs. In other words, the traditional old thinking of official organizations hinders the development of healthcare systems (Dijck & Poell, 2016), and their decisions often determine the future action situation of healthcare development. It is therefore important to produce a methodology in the recommendation system to assist in the renewal of digital technologies in the healthcare system and to lead to a shift in thinking among those working in official organizations (De Morais et al., 2020). Official organizations in this context include both non-governmental and governmental organizations. The differences in goals of interest and potential needs between the two make it difficult to identify common goals to facilitate interaction. Even if NGOs take the initiative to innovate and expect some input from government organizations, the tendency of government organizations to be status quo and their difficulty in coping with technological changes prevents NGOs from promoting their products. Also, due to the iterative development of technology, such development companies will soon be obsolete if they do not enter the market in a timely manner, which will also have a significant impact on their motivation to develop.

At the same time, the lack of trust between NGOs and government organizations also has a negative impact on their interactions with each other. If they, and even the stakeholders within the network, could increase their trust in each other by reducing transaction costs, the renewal and development of the healthcare system would at least not be stagnant. Such transactions include, but are not limited to, research and information costs, negotiation costs, and monitoring and sanction costs. As a result, official organizations limit their choices to existing products as much as possible. That is, as long as they can use existing products, they will never invest in alternatives. This cost saving is automatically passed on to potential developers, which has a strong negative impact on their R&D motivation. If this incomplete development and networking is iterated, the additional impact on the development of healthcare will only continue and be significantly higher. Therefore, researchers should consider dispelling the pending issues mentioned above by assisting the organizations involved in the trade-off between technology and economics and assisting in the assessment of expected risks and limitations (Carr et al., 2017). In addition to this, the concerns of governmental organizations can also be dispelled by implementing the involved programs in designated regions (Dam et al., 2017).

Therefore, it is particularly important to develop appropriate governance to guide the behavior of official institutions to facilitate the development of the DPIS ecosystem. Governance, as a cog in the evolutionary motor of the platform ecosystem, is directly driven by the behavior of architecture, but only sound platform governance can create innovation

and thus guide evolution and Prediction through interplay of architecture and governance behavior (Tiwana, 2013).

Therefore, the following directions to be studied are summarized:

(1) A methodology in recommendation system for healthcare digital technologies.
(2) How to lead a change in the mindset of governmental organizations.
(3) Bridge between governmental organizations and non-governmental organizations.

A3.2 Summary of recommendations for future research

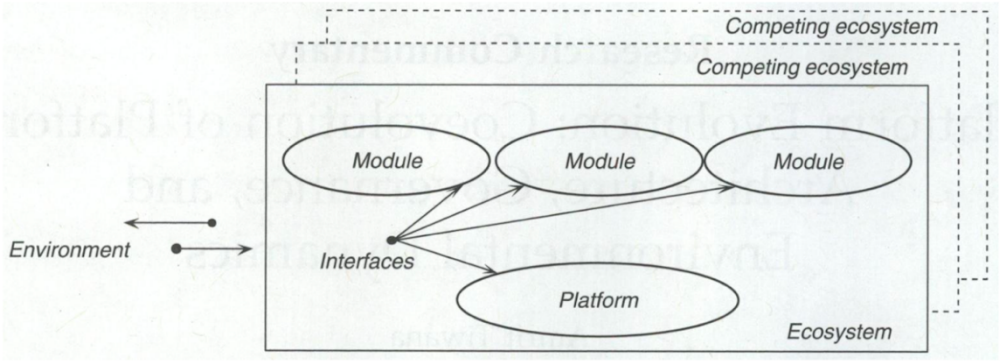
Table 15 Summary of recommendations

No.	Section
	section A3.1 overview of literature
search string: TITLE-ABS-KEY (("digital platform" OR "platform ecosystem" OR "platform architecture") AND ("open*" OR "platform open*") AND ("health" OR "healthcare"))	
From literature overview	
1	Discusses the link between regulatory platforms and patient safety, focusing on the risks of regulatory platform expansion development.
2	Analyze the difference between the needs and goals of government or municipality and suppliers, and discuss the regulatory nature of open source platforms.
3	Starting with policy assistance, we discuss the impact of policy on the development and regulatory effects of safety in healthcare systems.
4	Discuss how existing research can be used to adapt to the Dutch situation.
5	The impact of the Dutch COVID policy on the openness of the DPIS ecosystem.
6	The association of Dutch government interest subjects with other actors.
7	Discuss the impact of inner source on competition in the healthcare industry at the business level.
8	Analyze the demand of DPIS users.
9	Analyze the openness requirements of DPIS users and the trade-offs with personal power.
For stakeholder requirements and behavioral decisions	
1	Differences in the needs and goals of healthcare stakeholders within the network.
2	The link between healthcare design and patient autonomy.
3	An interactive discussion of different industry perspectives on the openness of healthcare DPIS
For platform effectiveness	
1	The analysis of user experience and requirements of end-users
2	The analysis of the demands and requirements of service-receivers
3	The boundary between specialist and non-specialist
4	The boundary restriction of data exchange
5	Design of interactive communications space for stakeholders to make trade-offs recommendations
For assistance from official authorities	
1	A methodology in recommendation system for healthcare digital technologies.
2	How to lead a change in the mindset of governmental organizations.
3	Bridge between governmental organizations and non-governmental organizations.
	Section 6.3 Dutch AORTA National Infrastructure Failure
1	How does AORTA differ from other DPIS and why did it fail, focusing on the relationship between caregivers, citizens and Dutch government.
	Section 7 interview
1	Locating and analyzing the relationship between insurance companies and the government, with special attention to the direction of corporate governance.
2	how to decentralize government power and reduce its control over the market.
3	Can caregivers afford to take on the risks associated with data security?
4	How insurers protect and process medical data
5	The difference between openness in the definition of using medical information and sharing medical information
6	should there be shared control about the open standards of the data
7	How to build a trust framework for patients
8	Regulating caregivers' use of medical data
	Section 9 limitation
1	Differences in concerns and needs between IS suppliers, software suppliers and caregivers
2	Analysis of the requirements of caregivers and patients on openness

A4: Elements of DPIS ecosystems

Figure 9 Elements of DPIS ecosystem

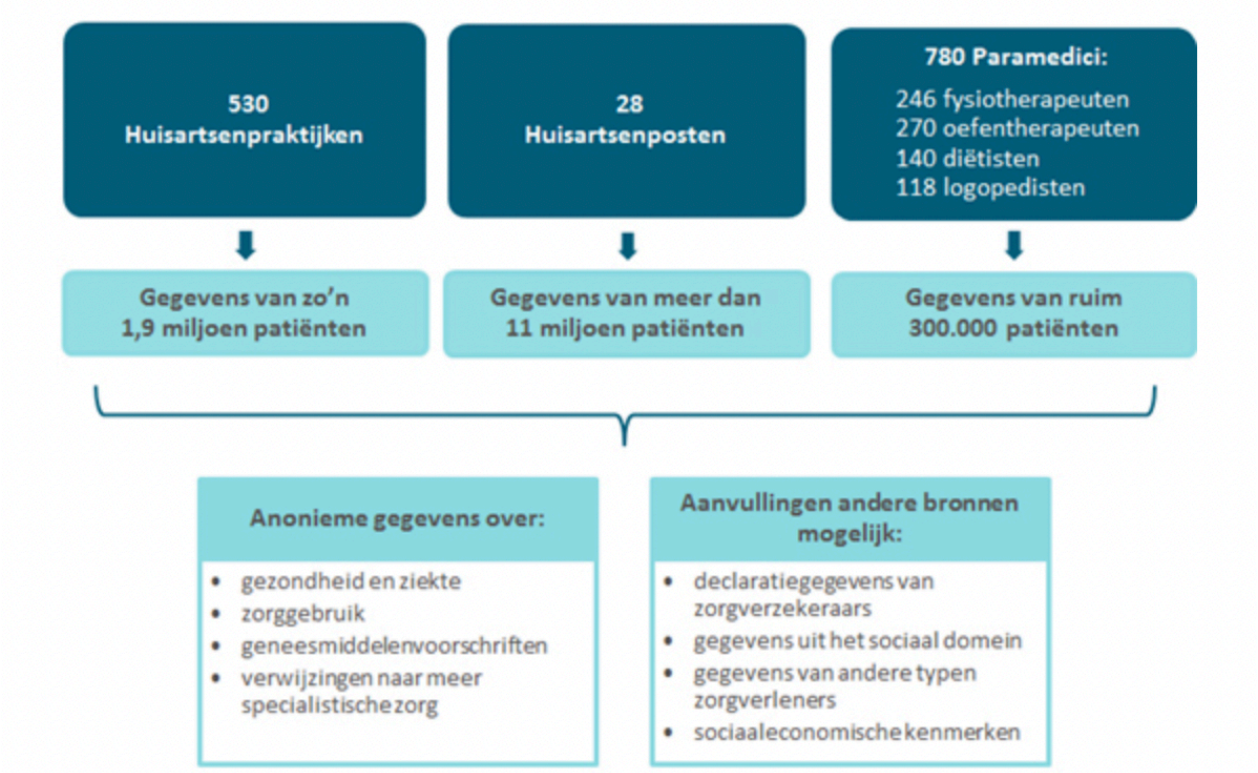
Figure 1 Elements of Platform-Centric Ecosystems



Cite from: (Tiwana et al., 2010)

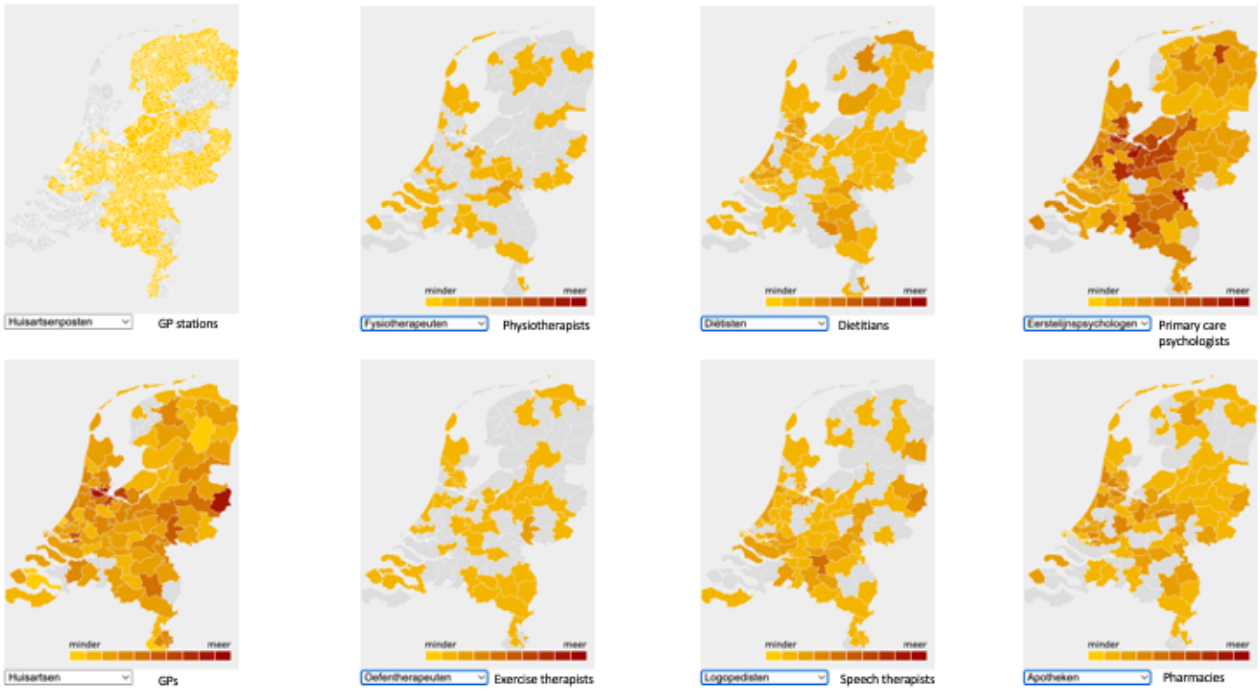
A5: Data source and Coverage Distribution of NIVEl

Figure 10 Data source of NIVEL



Cite from: Data source of NIVEl (*Het Unieke Aan Nivel Zorgregistraties Eerste Lijn | Nivel*, n.d.)

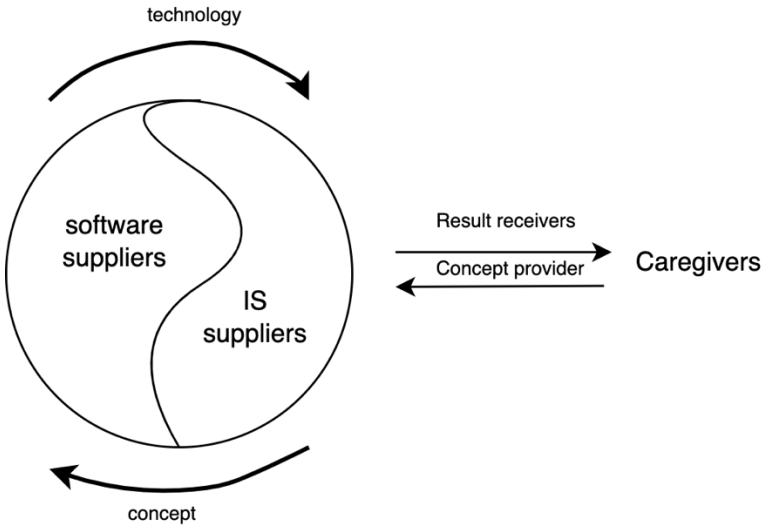
Figure 11 Coverage distribution of NIVEL



Cite from: Coverage Distribution (*Het Unieke Aan Nivel Zorgregistraties Eerste Lijn | Nivel*, n.d.)

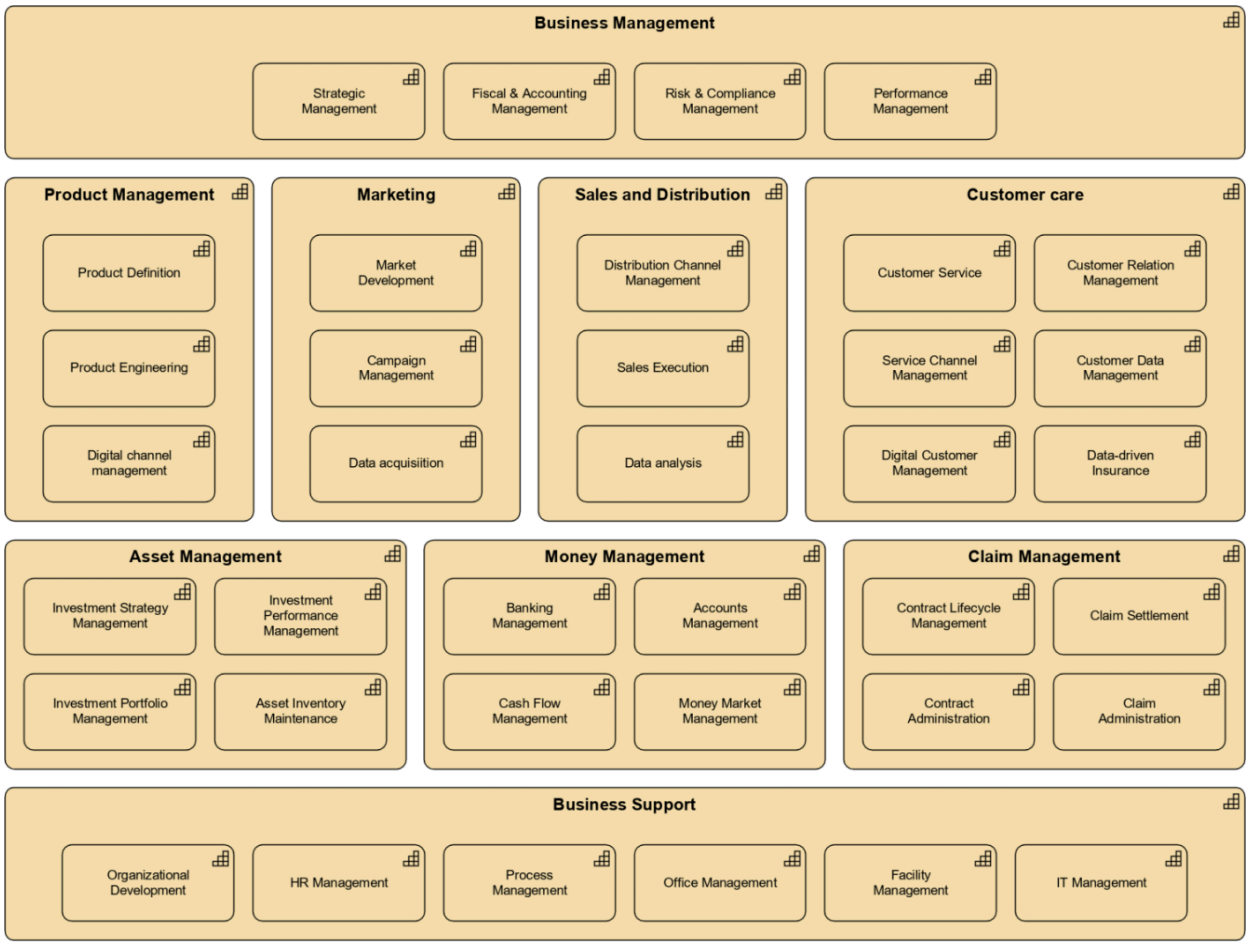
A6: Relationship between three stakeholders

Figure 12 Relationships between three stakeholders (author: own)



A7: Capability map

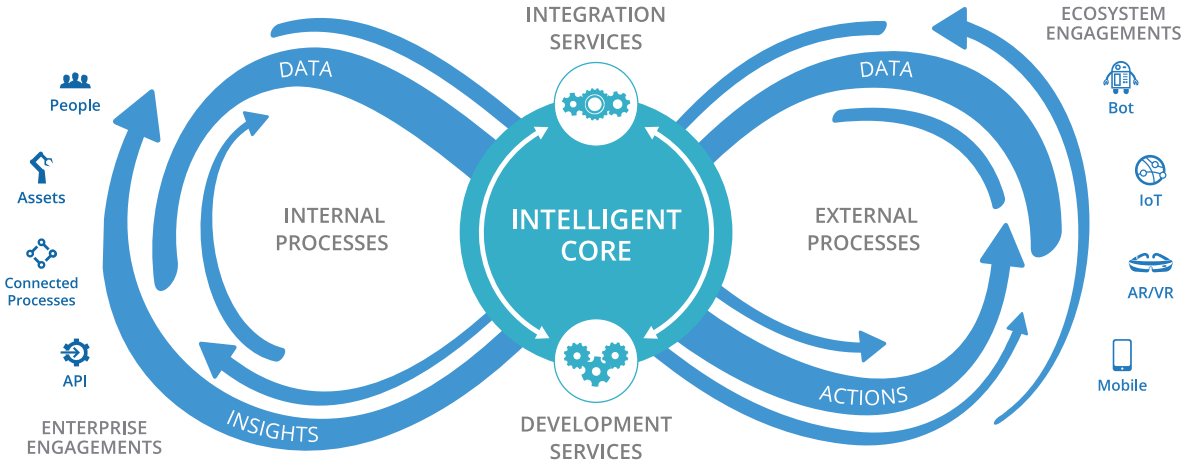
Figure 13 Capability Map



Cite from: (Angeli, 2019)

A8: Organizational structure of IDC- IT EXECUTIVE- DX Platform

Figure 14 IDC - IT EXECUTIVE - DX Platform



Cite from: (IDC - IT EXECUTIVE - DX Platform, n.d.)

B INTERVIEW

B1: Interview content design

The interview questions and presentation were designed on the basis of two scientific studies, Ullrich & Diefenbach (2010) and Baldwin et al. (2009), in order to enable interviewees to answer the open-ended questions of this study autonomously and smoothly. Ullrich & Diefenbach's (2010) scientific study suggested five elements that could facilitate participant interaction, namely effortlessness, attention, verbalizability, In the case of interviews, the first three elements were taken into account. Effortlessness means that the interview questions are presented in the most intuitive and concise way. This means that the interviewer does not need to explain the whole interview question or a word, and the interviewees can understand and answer it on their own. In order to ensure the validity of the interview data, the interviewer kept the interviewees' attention by using color stimulation, visual presentation, and interactive language. Verbalizability means that interviewees are able to express their views openly without overthinking. Ensuring that interview questions are concise can help achieve verbalizability. Please refer to appendix B2 for the revision process of the interview questions (requirements).

The scientific study of Baldwin et al. (2009) presents design structure matrics, which emphasizes the importance of visual design for architectural presentation. His study shows that layer diagrams as a type of visual presentation can easily show the flow changes of the architecture. Therefore, the visual design of the components of the architecture follows the three points proposed in this study: identifying the components, verticalizing the components, and determining the nature of the components. For the specific design, please refer to P5 of B4: interview slides.

B2: Requirements adjustment

Table 16 Initial Requirements

No.	Common requirements:
1	Non-extreme central control in the market
2	Reduce control of insurance companies
3	Balance the market influence of software suppliers
4	Flexible but fully functional and long-term information architecture
5	Give sufficient authority to caregivers
6	Provide incentives
7	Clear accountability mechanisms
8	Centralized national database
9	Standardized guidelines for information exchange
10	Designed to ensure alignment with business development benefit goals
11	Incorporate new technologies that facilitate primary care development

These requirements are the original version of the open requirements for IS suppliers and software suppliers collected in section 4.4 of the research from (van Hattum, 2020).

Table 17 Adjusted common requirements version 1

No.	Common requirements:
1	Non-extreme central control in the market
2	Less control by insurance companies
3	The market influence of software suppliers should be balanced
4	Digital platforms should have a flexible but fully functional long-term architecture
5	Give caregivers enough power
6	Provide incentives for IS suppliers, software suppliers, and caregivers
7	Digital platforms should have clear accountability mechanisms
8	A centralized database where data can be stored
9	Standardized guidelines for information exchange
10	Digital platforms should be designed to ensure alignment with business benefit objectives
11	Digital platforms incorporate new technologies for primary care development

The common requirements in this table were revised based on the feedback collected from discussions with the researchers. It can be seen that in No. 2, "reduce" was corrected to "less". The focus is shifted from the verb reduce to control; in No. 5, the use of authority is limited. The initial common requirements do not specify the beneficiaries of the incentive. Provide to whom? No. 8 added an explanation of centralized database. The information is presented in a clearer way.

Table 18 Adjusted common requirements version 2 (final version)

No.	Common requirements:
1	Not only one or a few actors controlling the market
2	Less control by insurance companies
3	The market influence of software suppliers should be balanced
4	Digital platforms should have a flexible but fully functional long-term architecture
5	Give caregivers enough/more power to interact (access) with others
6	Provide incentives for IS suppliers, software suppliers, and caregivers as a result of developing/using digital platforms
7	Digital platforms should have a clear mechanism for assigning responsibility
8	A centralized database where data can be stored
9	Standardized guidelines for information exchange
10	Digital platforms should be designed to ensure alignment with business benefit objectives
11	Digital platforms incorporate new technologies for primary care development

This table was amended based on the feedback collected in the first two interviews. After the modification, no further objections were raised by the other interviewees. The first two interviews used the common requirements version 1 and the subsequent interviews used version 2. The difference in version did not affect the final results, as the same responses were given to the interviewees when they raised questions.

To No.1 during the interview, interviewees often ask "what does non-extreme mean?", "what do you mean by central control ". Therefore, to avoid errors in information transfer, No.1 was described in the simplest possible language. It is worth noting that in the common requirement version 1, No.1, the researcher can understand the meaning of central control. But most interviewees don't understand it very well.

Similarly, interviewees in No. 7 asked "what is accountability mechanisms?", especially for respondents working in the area of medical care. Therefore, the term "accountability mechanisms" was paraphrased as "mechanisms for assigning responsibility". Therefore, it is recommended that the design of the interview questions should take into account the educational background and work orientation of the potential interviewees.

B3: Interview slides

A digital platform architecture to improve primary care ecosystem within the Netherlands

[date]

[interviewee]
Ran Kong

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1

1

Content

INTRODUCTION CORE CONCEPTS REQUIREMENTS

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2

2

Introduction - goal of this thesis

- Why?
  - **Reduce** stress in the healthcare
  - **Enhance** interaction between caregivers
  - **Improve** openness of digital platforms in information systems
- Goal:
  Define key stakeholders' requirements to assist in architectural design, to improve the openness of the healthcare ecosystem.

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3

3

Introduction - goal of interview

- To validate key stakeholder requirements
- To validate architectural requirements

Stakeholders' requirements → Architectural requirements

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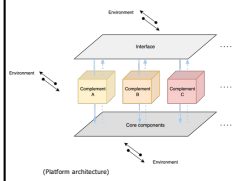
4

4

Core concepts



- Digital platform
  a software-based online infrastructure that facilitates interactions between users
- Platform architecture
  A conceptual blueprint that describes how the technology solution components work and how they interact
- Platform openness
  Who (external parties) can use, develope on or commercialize a platform

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5

5

Requirements

In this section,

please provide your opinions with these requirements, and explain the reasons.

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6

6

Key stakeholders' requirements (1/2)

What's your opinions about…

There should be… and why?
- Not only one or a few actors controlling the market
- Less control by insurance companies
- A centralized database where data can be stored
- Standardized guidelines for information exchange

We should … and why?
- Give caregivers enough/more power to interact (access) with others
- Provide incentives for IS suppliers, software suppliers, and caregivers as a result of developing/using digital platforms

7

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7

Key stakeholders' requirements (2/2)

What's your opinions about… and why?

- The market influence of software suppliers should be balanced
- Digital platforms should have a flexible but fully functional long-term architecture
- Digital platforms should have a clear mechanism for assigning responsibility
- Digital platforms should be designed to ensure alignment with business benefit objectives
- Digital platforms incorporate new technologies for primary care development

8

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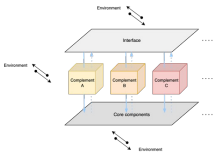
8

Review of platform architecture

A conceptual blueprint that describes how the technology solution components work and how they interact



9

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9

Architectural requirements (1/2)

What's your opinions about… and why?

- The architecture should be able to provide access with the same capabilities to actors who have ownership or control
- The architecture should be completely open, i.e., fully open access to all interested external parties
- The architecture should have the ability to adapt to changes in the environment
- The architecture should provide a dedicated space for caregivers to interact
- The architecture should have clear control units for assigning responsibilities

10

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10

Architectural requirements (2/2)

What's your opinions about… and why?

- The architecture should provide a clear path to remote data storage
- The architecture should have a mechanism to comply with national information exchange regulations
- The architecture should have stable, dependable user interfaces that can be used under dynamic situations
- The architecture should have complements that can be used and meet the dynamic needs of the market

11

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11

Thanks for your participation!
Any comments?

TU Delft PROMEDICO

12

B4: Consent form for semi-structured interviews

Participant Information

You are being invited to participate in a research study titled "*A digital platform architecture to improve first-line healthcare ecosystem*". This study is being done by Ran Kong from the TU Delft and Promedico.

The purpose of this research study is to learn stakeholder requirements to promote openness in the first-line Healthcare digital platform architecture, and will take you approximately 40 minutes to complete. We will be asking you to determine if the requirements provided in this research are correct and if there are any omissions.
The interview will be recorded and transcripts of data will be used as a basis for Master's graduation thesis report and scientific publications. The thesis which will be public available in order to solve problems of digital platform openness, but your personal information will not be included in the thesis. The thesis will only report aggregated information based on all interviews done as part of this study.

As with any online activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by keeping the thesis fully anonymous. The information involving individuals such as name, address, e-mail address will be used for administrative purposes only and will not be made public. All research data will be stored via dedicated project storage drive via TU Delft, only accessible to the research team (the PI and two supervisors: Mark de Reuver and Saba Hinrichs-Krapels).

At the end of this study, recordings will be destroyed. Moreover, all cleaned-up transcripts will be kept by Delft University of Technology for five years and will only be used for research on the same topic. Only research team have access during the research, and the supervisors will be responsible for data access for the following 5 years.

To avoid the risk of transmission of Covid, the interview will follow the instructions of the RIVM. Requesting an online meeting is feasible.

Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to omit any questions. If the data is reused, you may be contacted again.

Ran Kong; E-mail: R.KONG-1@student.tudelft.nl;
Mark de Reuver;

Explicit Consent points

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information above, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves: an audio-recorded interview. At the end of this research, all recordings will be destroyed. A pseudo-anonymous transcript will be created based on the recording, which will be preserved with this consent form for 5 years after the project end.	☐	☐
4. I understand that the study will end the end of this graduation research.		
Please add the anticipated timing or how the date will be determined		
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
5. I understand that taking part in the study also involves collecting specific personally identifiable information (PII) such as name, e-mail address and associated personally identifiable research data (PIRD) such as job title and company name with the potential risk of my identity being revealed. This information will be stored within on a secure TUD storage, only accessible to the research team.	☐	☐
7. I understand that personal information collected about me that can identify me, such as my name, my e-mail address, where I work, will not be shared beyond the study team.	☐	☐
8. I understand that the (identifiable) personal data I provide will be retained by Delft University of Technology for five years after the end of this study for the only purpose of conducting research on the same subject.	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
9. I understand that after the research study the information I provide will be used in an aggregated form in the graduation thesis report and scientific publications, which will be public available.	☐	☐
10. I agree that my responses, views or other input can be quoted anonymously in research outputs	☐	☐

Signatures

_____	_____	_____
Name of participant [printed]	Signature	Date

I, as researcher, have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____Ran Kong_____	_____	_____
Researcher name [printed]	Signature	Date

Study contact details for further information:

Ran Kong, R.KONG-1@student.tudelft.nl

Mark de Reuver

C SUMMARY OF TALKS WITH FIELD EXPERTS

Cite from (van Hattum, 2020)

Table 4.1: Summary of talks with field experts

Role	Focus of attention
Manager Business Development at software supplier	• The lack of innovation in information systems in the primary care domain can for a large part be attributed to (1) the wide diversity of involved actors, each acting towards their own best interest, and (2) to insufficient financial incentives to act in an innovative way. • In a future situation, it should be clear whether the solution entails a *centralized* or *decentralized* control and that there is no single actor that can control the market. • Important requirements for a future situation is that there is flexibility in the information infrastructure to react to changing demands, there is a financial structure in place that is targeted at realizing effective and efficient healthcare support and there should be measurements to ensure continuity. • There are interest groups for care providers that have a large power position in transforming the information infrastructure. • The software suppliers and their information systems are incapable of adapting to changing demands.
Product Owner at Healthcare Information Systems supplier	• There are little incentives for caregivers to require innovations from the information systems they use. Also, there are barriers to transferring to other software suppliers because the systems have different functionalities and user interfaces and they often involve long-term contracts.
Product Owner at AIS supplier	• The government does not impose standards on information exchange between different suppliers of information systems. Currently, these standards are defined by the market parties and whatever parties comply to those standards. • Current systems have a hard time connecting different users on the care provider side.
Head of Products at software supplier	• One has to account for the fact that not every random caregiver has access to attributes of patient records that they do not need for performing their role as a care provider to the patient. • Incentives for more effective and efficient patient care is lacking among care givers or they are hindered by insurance companies. • There is the difficult concept of 'responsibility', what if there is a mistake that can be (partly) attributed to the failure of an information system? That is difficult to explain to involved parties.
IT Architect at software supplier	• There is little incentive for innovating. Also, the market entry barriers are high due to high investment costs and low market entry possibilities as contracts usually involve long term arrangements. • Insurance companies have a large power-position over what innovations or medicine can be reimbursed. They indirectly have a large impact on the role of information systems in primary healthcare • There is no single server that may store all patient data. Therefore, there is not a national database with patient data but rather there are registries that log where patient data is stored.
Director at software supplier	• The current information systems fail to adopt novel technological developments that can benefit the primary healthcare domain. • It is difficult to allocate responsibility over patient's digital health related data; should the caregiver, the patient or the IS supplier be responsible?
Director at Healthcare IT network provider	• Software suppliers have a large power-position because if a large supplier fails to go along in attempts to innovate the domain, the market is unlikely to adopt the innovation. • There are little incentives for software suppliers and care providers to innovate. • Laws and regulations and public opinion may hinder attempts to innovate.
Two IT healthcare consultants	• There is a question in the field of information systems in this domain as to how alignment between actors and systems should be achieved. It may be best if the government would impose standards, currently, there is no party that determines the standards. Standards are organized by the market, therefor there is a myriad of different communication standards. • Patients have to give consent to every care provider they interact with. There is no central place where a patient can organize who has access to his/her information.