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Exploring the role of boundary resources in platform to platform openness of digital healthcare platforms.

A case study of digital platforms in Dutch healthcare

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by

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Abstract

This research explores the role and challenges of openness between digital healthcare platforms through the use of boundary resources in the Dutch healthcare system, focusing on factors influencing openness decisions. Traditionally, boundary resources facilitate arm's-length relationships between platforms and their periphery. This study examines their specific contribution to platform-to-platform openness in digital healthcare. To properly define openness between platforms, a distinction was made between interoperability and platform-to-platform openness: interoperability focuses on the compatibility of platform resources, while openness emphasizes the provision or accessibility of these resources. Boundary resources are further divided into technical and social aspects, shaped by laws and regulations. A document analysis of key policy documents maps how these relevant boundary resources function. The importance of APIs is emphasized as a means to progress toward an interconnected digital healthcare system, however, the practical implications and impact of openness decisions leading to the formulation of API's, particularly between platforms, remain somewhat unclear. Interviews with the most relevant stakeholders in the field provide further insight into the drivers and barriers affecting boundary resources adoption. Most emphasis is placed data exchange and transactional based platforms by the stakeholders. The distinction between interoperability and platform-to-platform openness in healthcare can help avoid conflating compatibility requirements with broader governance and strategic considerations, enabling more focused discussions on factors essential for platform-to-platform openness. Boundary resources, while holding significant potential to facilitate openness, are not clearly distinguished by platform owners in their application for inter-platform openness compared to openness toward complementors, while these two forms of openness can serve a distinct purpose. Openness concerns are further composed of involved technical costs, security and data liability issues, as well as competitive pressures, with the potential loss of operating models and market position adding additional complexity to these openness decisions. Regulatory direction stimulates the development of boundary resources to promote inter-platform openness by embedding platform connections within the broader market ecosystem. Boundary resources could be further utilized further to enable platforms to extend their periphery and for addressing deeper infrastructural and collaborative challenges within the healthcare sector. Platform-to-platform openness is influenced not only by decisions of the platform owners themselves, but also by broader market dynamics, regulatory frameworks, and the platform environment. This research highlights the potential of boundary resources in tackling infrastructure, innovation, and data-sharing challenges in healthcare.

Contents

1 Introduction

In the Netherlands, the pressure on the health system is growing due to an increasingly ageing population and staff shortages, requiring the modernization of healthcare operations and resilient regional partnerships. Lack of interoperability has been identified as a key obstacle to the up-scaling and modernization of digital care, limiting the exchange of electronic health records (EHR's). Increased interoperability has the potential to alleviate the pressure on the system [1]. Without interoperability, healthcare systems create isolated information silos, characterized by the "lack of ability to exchange data with other similar systems."

Inadequate interoperability of EHR systems can result in substantial societal impact, ranging from an increased chance of prescription errors and patient data fragmentation to iatrogenic injury from unnecessary testing and overall higher healthcare costs [2]. This restricted ownership of medical data also leads to a decline in the quality of patient care and an inability to transfer patient data between healthcare systems [3, 4]. This while the role of EHR systems in healthcare is to digitize patient health information, to lead to improved patient outcomes and more effective healthcare delivery, enabled by efficient data exchange among various healthcare providers.[5]

For healthcare organiszations to optimize data exchange and availability, a well structured information technology (IT) infrastructure is essential. IT infrastructure encompasses the underlying technology, software and networks which enable the effective exchange of health information between (different) systems, devices and applications. Healthcare organizations and their information systems are referred to as 'interoperable' when these organisations are able to interpret and accurately record information,communicate digitally, and share it with one another.[3] Interoperability therefore, extends beyond IT and software, including organizational, technical and semantic aspects as well.

For these effective healthcare exchanges, platforms play a central role in optimizing data exchange and availability. Digital healthcare platforms, also considered a form of infrastructure, can be any digital solution bringing together multiple users, facilitating services and interactions between these users and other stakeholders. Platforms are complex constructs, composed of technical elements with associated organisational processes and standards, often in a multi-actor setting. In healthcare the range of available platforms and varying functionality is extensive, offering a diverse array of solutions tailored to various needs and use cases. Examples of platforms are for example digital solutions which fulfil infrastructural roles at a regional level for healthcare exchange, (RSO's), as well as telemedicine platforms allowing for digital consultations or Personal Health Environments (PHEs) which serve as patient portals. Digital platforms differ from stand-alone applications by facilitating interactions among *multiple* user groups.

The use of open and secure platforms in healthcare as digital resources are described by Deloitte [2024] as an important contribution for addressing challenges posed by an aging population, rising costs and maintainability concerns. For platforms, setting the right level of openness is said to be the most complex and critical decision, as an increase in openness is often seen as being more fragmented, but also being more innovative. Consequences of choosing the wrong level of openness, to much or to little, can determine the success or failure of a platform.[7], [8]. While platform openness refers to how platforms interact with their users and partners within the ecosystem, platform-to-platform openness focuses on the interaction between different platforms and their ecosystems, allowing for collaboration and data exchange across systems.

While Mosterd et al. [2021] lays the foundation on considerations for platform to platform openness based on platforms in the automotive and Internet of Things sectors, in healthcare platform-to-platform openness is often defined as the degree of interoperability. The relationship of platform to platform openness and interoperabiliy is not always clear and is thought to be same.[10], [11]. For the healthcare sector both openness and interoperability between platforms is complex due to the sector's highly regulatory, ethical and privacy challenges accompanying healthcare data, requiring well-thought-out approaches for balancing openness and innovation with compliance and patient safety. [12], [13]

One potential way for addressing these interoperability and openness challenges is through the use of boundary resources, which are originally described as tools that mediate access to the platform's core resources for complementors [14]. Since they mediate access to the platform core, this could also be conceptualised for the use of boundary resources for openness *between* platforms, still facilitating the access of resources as well as the inter platform relation, eventually enabling the exchange of data between diverse healthcare platforms.

Boundary resources can be dived into two aspect, technical and social boundary resources. Technically, these boundary resources may include software tools, APIs, and technical specifications that must be compatible,

open, and well-documented.[14] Social boundary resources are described as the platform-specific rules, guidelines and agreements that govern interactions and openness between platforms. [15] Both types of boundary resources are supported by laws, rules, and governance structures, that must foster, rather than impede, openness between platforms.[16]

And although the potential of boundary resources, especially APIs, as tools for improved interoperability is recognized as contributing to openness for platform innovation [17] , their impact on openness *between* platforms remains under-explored. Particularly the use of APIs is recognized by the Dutch government and relevant advising stakeholders for facilitating interoperability and in the eventual creation of a national healthcare IT infrastructure.[18],[19],[20],[21]. This national focus underlines that in practice interoperability and openness challenges in healthcare are transcending individual platform concerns and platform-to-platform relations are seen as part of the solution to these challenges. As van der Wielen et al. [2022] highlights, platform-to-platform openness in healthcare is shaped by the interplay of roles, regulations, and ICT infrastructure, emphasizing that these challenges extend beyond mere technological considerations.

1.1 Research questions

Because of the complexity of platforms, interoperability and openness in healthcare, where platforms serve multiple functions and the market is broad and composed of many actors, this calls for detailed conceptualizations of platform concepts before platform-to-platform openness can be properly explored. And although interoperability is increasingly prioritized due to healthcare needs and legal requirements, the concept of platform openness in healthcare is not well-defined, and interoperability in public governmental reports is often used as a proxy for openness. [16],[20] While there has been significant research on healthcare interoperability, [22] [23], as well as from organizations like Nictiz, the Dutch knowledge organisation for digital information provision in healthcare, [24] and on the healthcare market openness by governmental institutions,[16],[25] and platform openness in literature,[26], [27], [10], as well as the use of boundary resources around platforms in healthcare,[17], the specific focus on *platform-to-platform openness* is lacking in healthcare platform literature. In particular, the combination of this focus with the role of boundary resources in facilitating platform to platform openness has not been explored before.

This research aims to contribute to the ongoing discussions on interoperability and openness in healthcare by examining the role and challenges of openness between digital healthcare platforms through the use of boundary resources within the Dutch healthcare system.

This results in the following main research question:

Main Research Question

How do boundary resources contribute to platform to platform openness of digital healthcare platforms?

To employ boundary resources as tool for analysing platform to platform openness, they must first be defined within the context of healthcare platform ecosystems. This leads to the first sub-question of the study:

RQ1: What are the boundary resources for digital healthcare platforms?

This question aims to look into the technical as well as social boundary resources for digital platforms in healthcare. Because we adopt an platform ecosystem based view including the landscape in which digital platforms have to operate, the manner of how these resources are influenced by regulations is included, such as the "Electronic Data Exchange in Healthcare Act"or Wegiz in Dutch, transcending individual platform openness concerns. This is important because it highlights how regulatory frameworks affect the accessibility and interoperability of platforms within the healthcare ecosystem.

To further address the main research question, it is essential to investigate what motivates stakeholders in the platform environment to provide or engage in the realisation of boundary resources for openness towards platforms, recognizing the extensive landscape and potential differences between digital healthcare platforms.

This leads to the second sub-question:

RQ2: What are the drivers and barriers in openness decisions for the adoption of boundary resources for digital healthcare platforms?

These sub-questions together aim to explore how boundary resources facilitate the arm's-length relationships between platforms, and to understand how and to what extent the identified boundary resources are considered in promoting openness between platforms, contributing to clarifying the role of boundary resources in platform-to-platform openness within the Dutch healthcare system.

1.2 Method

The high level research design setup and methods used in this research are visualised in figure 1.

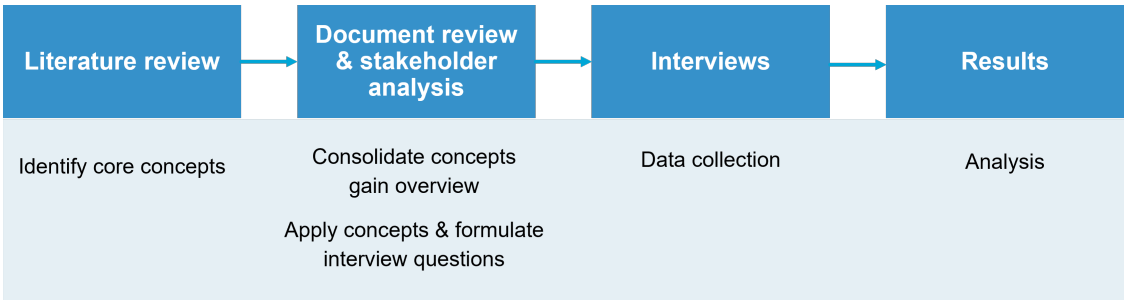


Figure 1: Adopted high level research design.

Because of the lack of research on platform to platform openness an exploratory approach is adopted. First, to address the gap regarding terminology of platform concepts, this research will focus on defining platform-to-platform openness by exploring the relation of interoperability, platform to platform openness and the role of boundary resources in both openness and interoperability in the literature review. After consolidating concepts, further analysis will be conducted through a case study of openness of digital platforms in Dutch healthcare, composed of a document review and interviews.

The document review will seek to answer the first research question in looking into what the boundary resources are for digital healthcare platforms and provide further insight into the detailed concepts of the literature review in practice, finally allowing for the the formulation of the questions used in the interviews. The interviews will then further dive into drivers and barriers for the use of boundary resources in relation to platform to platform openness, answering the second research question. The research method is further elaborated in detail in section 3.

2 Literature review

Before examining platform-to-platform openness, it is essential to clarify key concepts: what a digital platform is, what the types of openness revolving around platforms are and what are the differences between platform openness and platform interoperability. For this elaboration, we zoom in on what boundary resources are, how they work in literature in platform to application openness, [14] so that this understanding can be applied within the relation of platform-to-platform openness.

2.1 Digital platforms

First, an overview of literature surrounding digital platforms is provided. This is essential because platforms are widely adopted and play diverse roles, making it important to establish a clear understanding of what platforms are and their defining characteristics before delving into their interrelationships. Aiming to provide a deeper understanding of the structure, dynamics and the strategy of platforms and associated organisations for platforms as unique digital solutions. [28]

A digital platform is a broad term used to describe any platform leveraging digital technology to facilitate interactions, transactions, or services. Gawer [2014] desribes two main types of dominant theoretical perspectives in digital platform literature. The first perspective is inspired by economic theory, in which platforms are seen as markets, focusing on bringing together two or more distinct but interdependent groups of users, facilitating interactions and value exchange between them. The platform creates value by enabling direct interactions that would not be possible or as efficient without it. This (multi-sided) aspect of platforms follows network effects and enjoys strong interdependence- and creation of value through interaction between groups.[29].

The second perspective originates from engineering design, and views platforms more commonly as modular technological architectures upon which complementary add-on modules can provide further functionality. The engineering design literature can be separated further into innovation and information-system based perspectives of platforms,[9] in which there is focus on recombinant innovation, emphasizing the digitality of platforms and their complementary components. *Digitality* mainly being used in relation to third party development, as being the extensibility of software modules on which third parties can develop complementary offerings. This is next to *modularity* as a platform feature, being the modularization and distribution of functionality between the core platform and complementors. [17].

The divergence of these multiple platform perspectives has not helped improve understanding of how platform competition and platform innovation are intertwined, while understanding how these views converge in reality is necessary to gain more insight into the path that platforms will follow.[29] This further stresses the importance, in the context of de Reuver et al. [2017]'s research agenda on digital platforms, on defining and using proper scoping of digital platform concepts on different architectural levels in specific industry settings. Therefore, also for platforms in healthcare a clear distinction of the used digital platform concepts is necessary. Specifically, the distinction between technical and socio-technical concepts of digital platforms in healthcare needs to be made.

In this research, the main focus will be on platforms from a socio-technical based perspective. Platforms are conceptualised, based on the conceptualisation of Gawer [2014], as:

> *"An evolving socio-technical systems that provide a foundation for interaction and innovation among a diverse community of actors, creating value through economies of scope, while having a modular technological architecture."*

This conceptualisation allows for differentiation between platforms based on platform *function* being transaction, innovation or hybrid platforms. Transaction platforms facilitate exchange, creating value by enabling transactions between users and or suppliers of services or products. Innovation platforms make their technical infrastructure available for creating new products and services e.g. using apps. Hybrid platforms combine aspects of the previous two and are often initialised as one of the two and then later mixes in the second type of functionality. These platforms are known to gradually invert companies, shifting the company's internal value production to external value creation for and from the stakeholders in the networks they serve.[7] This means that value is created externally by facilitating the interactions and exchanges between platform users, with the platform acting as an enabler rather than a direct producer of value.

Building on this, data platforms, as a subset of digital platforms, place an stronger emphasis on the relevance of data and its context. These platforms create value centred on digital resources designed to store, buy, sell, and analyse data.[30] In the healthcare industry, this focus on data introduces challenges and opportunities related to data use and accompanying new ways of structuring data platforms.[31]

The role and function of these data platforms will change due to the coming establishment of international data spaces, which will require them to become more interoperable towards each other to enable data sharing across ecosystems. [32] Platforms have the potential to transform into these data spaces, essentially becoming an interconnected open data platform system of platform ecosystems, or system of systems. This further shows the relevance of openness between platforms.

This transformation however, requires research on the foundational elements necessary for trusted data sharing between platforms, as well as the structures and processes to develop the required infrastructure, governance, and interoperability models. Kari et al. [2023] emphasizes that this is enabled by *"interoperability fostering decentralized data ecosystems,"*and highlights how multiple actors can collaboratively develop and manage a decentralized architecture, distributing ownership and eventually fostering openness (between platforms). To contribute to opening up information silos in healthcare, it is said that interoperability must be enhanced. [34],[33]

Digital platforms in healthcare

Since the goals and value provided by individual platforms vary, this has led to a wide range of initiatives being labelled as platforms, contributing to the "platformisation" of healthcare [35], even though some do not align with the definition of digital platforms used in this research. Therefore the platform demography of self-proclaimed platforms should be a bit elaborated upon. Platforms are often labelled as such, even when in essence being single-purpose applications with a stand-alone functionality, not combining multiple users. Similarly, initiatives described as platforms can also tend to focus only on bringing together like-minded stakeholders around a specific theme in healthcare. These are often more like discussion groups or collaborative initiatives, lacking the true digital infrastructure typically associated with digital platforms. While these collaborations initiatives do succeed in connecting various actors, they fall short of embodying the full digital capabilities of a genuine *digital* platform,[31] not following the social-technical definition of platforms.

To provide further clarity regarding platforms in healthcare, it is essential to distinguish between Health Information Systems (HIS), particularly Electronic Health Record (EHR) systems, and health data platforms. HIS and EHR systems primarily focus on storing and managing digital medical data within individual healthcare organizations. In contrast, health data platforms are digital environments designed to aggregate, process, analyse, and share patient data from multiple sources. These health data platforms unify data and users to create insights and services without directly altering the original HIS databases. Instead, they typically connect to a separate data layer, ensuring data integrity through the use of uniform data models. This approach allows health data platforms to facilitate data sharing and analysis on a broader scale than traditional HIS, while maintaining the security and integrity of the original data sources. [22], [36], [13], [11]

Examples of digital platforms in healthcare that facilitate interactions among multiple user groups include "regionale samenwerkingsorganisaties" (RSOs), which are regional platforms owned and structured by healthcare providers. Suppliers of EHR systems also offer platforms, often as add-on functionalities for hospitals, practitioners, or other healthcare providers. Additionally, there are standalone platforms that facilitate interactions, such as those with Multidisciplinary Team Meeting (MTO) functionalities, telemedicine platforms enabling digital consultations, and patient portals like Personal Health Environments (PHEs) that cater to multiple user groups.

Platform ecosystems

To provide a more intricate perspective into platform dynamics, it is essential to consider the concept of platform ecosystems, compared to platforms as a standalone system, following the innovation and economics-based perspective, a platform ecosystem is typically seen as a complex network of interdependent actors, including a collection of firms and contributors, all revolving around a single digital platform and enabling the co-creation of value through the exchange of resources, knowledge, and data.[17],[28] Research on digital platform ecosystems (DPE) highlights the importance of understanding the role of a platform within its ecosystem.[37] This understanding helps determine the types of users and providers involved, as well as the appropriate level of openness required for different roles and at the different levels within the ecosystem. A typical DPE includes a platform owner who implements governance mechanisms to facilitate value-creating processes between the plat-

form and its ecosystem of complementors, such as app developers and a use base consisting of both consumers and suppliers.[38] [37] [39].

Before further elaborating on the platform ecosystem and openness *between* platforms, the roles and levels of openness surrounding a digital platform are further detailed in the following paragraphs.

Platform Openness

The specific meaning of platform openness in the healthcare sector remains somewhat ambiguous. In the existing literature on platforms, openness refers to the degree to which external parties can readily utilize, enhance, or monetize a platform.[40] But since platforms can exhibit varying levels of openness towards different stakeholders and in different contexts, these directions of openness should be specified further.[10] We discusses openness from a role based view from Eisenmann et al. [2008] and on a level based view from Ondrus et al. [2015], after which these levels are compared placed in the platform ecosystem based view.[41]

Role based view on platform openness

Eisenmann et al. [2008], adopting an economic based view of openness, emphasizes that it can lead to confusion when referring to a platform as open or closed, without clearly referencing to the role within the platform. Four key roles are defined in a digital platform ecosystem; two different user groups, demand side and supply side users; and the roles of platform providers and the platform sponsors. These roles are visualised in figure 2. The demand side users are the end users of the platform, while supply side users are the users providing complementary products or services, such as application developers. The platform provider is the primary point of contact for the users. Platform sponsors own the design and intellectual property rights of the platform. Platform providers serve as intermediaries, facilitating the transactions between users, supplying the platform components and enforcing its rules. Platform sponsors do not directly interact with users and instead possess the authority to alter the platform's technology, establish its rules, and determine the eligibility of platform providers and users.

Eisenmann et al. [2008] defines a platform as being "open" when it allows unrestricted participation in its development, commercialization, and applies any necessary restrictions, like compliance with technical standards or licensing fees in a fair, non-discriminatory manner to all prospective platform users. Elaborating on this, each role in figure 2 has their own form of openness. Openness towards demand-side users is defined by the platform's accessibility to consumers, ranging from offering free access to imposing more barriers and restrictions. For supply-side users, openness is the extend to which third-party providers can integrate their offerings with ease, the more open the platform is the easier the integration. Openness at the provider level refers to the extent to which a platform is provided by multiple stakeholders who jointly manage the overall platform experience, allowing distinct actors to participate in delivering the platform to end-users. Openness on the platform sponsor role refers to the extent of shared design of the platform and shared intellectual property rights.

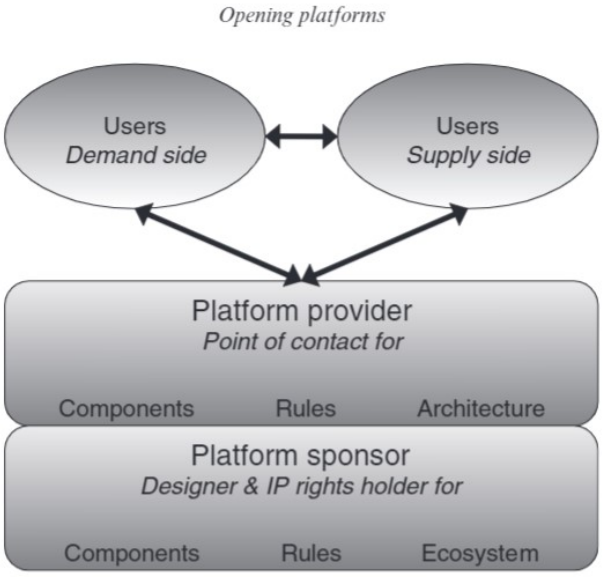


Figure 2: Elements within a platform-mediated network, adopted from Eisenmann et al. [2008].

Platform layer view on platform openness

Next to the user-based model, the model of Ondrus et al. [2015] , zooms in on multi-sided platforms while structuring platform openness further by building four layers of openness upon on the just described platform roles, as seen in figure 3.

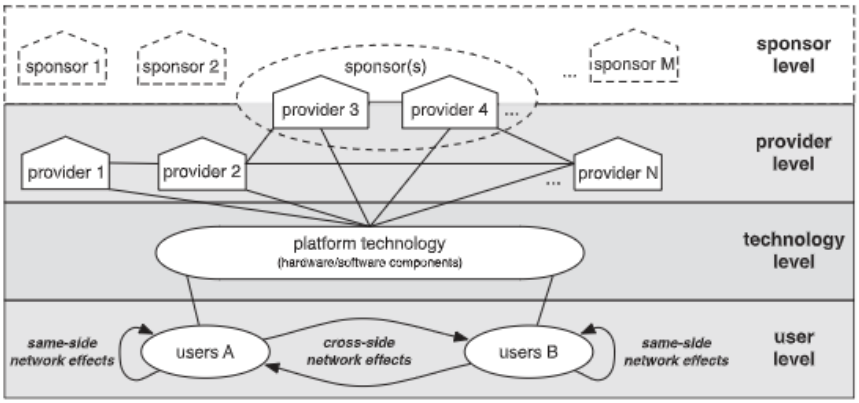


Figure 3: Platform level based openness, adopted from Ondrus et al. [2015].

These levels differ subtle from the role based openness of Eisenmann et al. [2008]. The user level openness, again in demand and supply users, focuses on how accessible the platform is to new users, but combines openness of the roles of demand and supply-side users into a single layer. The newly added technology layer focusses purely on the platform's technology and compatibility with other platforms, separating actors or platform roles from the platform technology. Openness at the technology level refers to how accessible the platform's code or architecture is to other platforms and how interoperable or compatible it is with related technologies.[27]

Openness at the provider-level, requires collaboration and interoperability, particularly when multiple providers use the same underlying platform technology. This form of openness is characterized by horizontal collaboration among firms offering an interindustry platform, where multiple actors utilize shared technology to deliver their services. The platform itself can be provided by either a single firm, which vertically integrates all different resources and capabilities, or by an array of horizontally collaborating firms with specific roles and responsibilities. The incumbent platform providers have the ability to decide what the initial degree of openness is at the provider level entails, in which the technology itself is seen as a key driver for this provider level openness.

The sponsor level focuses on the control and influence exerted by the platform's sponsors, who own the property rights and guide the development of the platform. Openness at this level refers to the platform's governance structure and the extent to which it allows for external participation and influence in decision-making.

Ondrus et al. [2015] acknowledges that the provider and sponsor role can be a combined role, influencing both the sponsor and provider level openness. This combined role is also acknowledged by van der Wielen et al. [2022] specifically for primary healthcare and builds upon the model of Mosterd et al. [2021] and Ondrus et al. [2015] for the conceptualisation of platform-to-platform openness, and incorporates the sponsor, platform, supply side and demand side user level openness. Platform-to-platform openness in healthcare is described as the extent to which a platform is interoperable with other platforms, as opposed to the strategic collaboration among sponsors, while still recognizing the intertwined relationship of the provider and sponsors of a platform.

Platform ecosystem

Having outlined the different platform roles and levels of openness, Ondrus et al. [2015] emphasizes that the extent of interoperability and the ability of multiple firms to provide a single platform are shaped by the interactions within the ecosystem. The ecosystem perspective is particularly relevant because it highlights how relations within the ecosystem influences platform configurations and possibly openness considerations. It allows for accommodating external influences and ecosystem-wide interactions, going beyond the dynamics of the individual platform.

To illustrate the roles placed within a platform ecosystem, an interpretation based on Drewel et al. [2021] is presented in figure 4

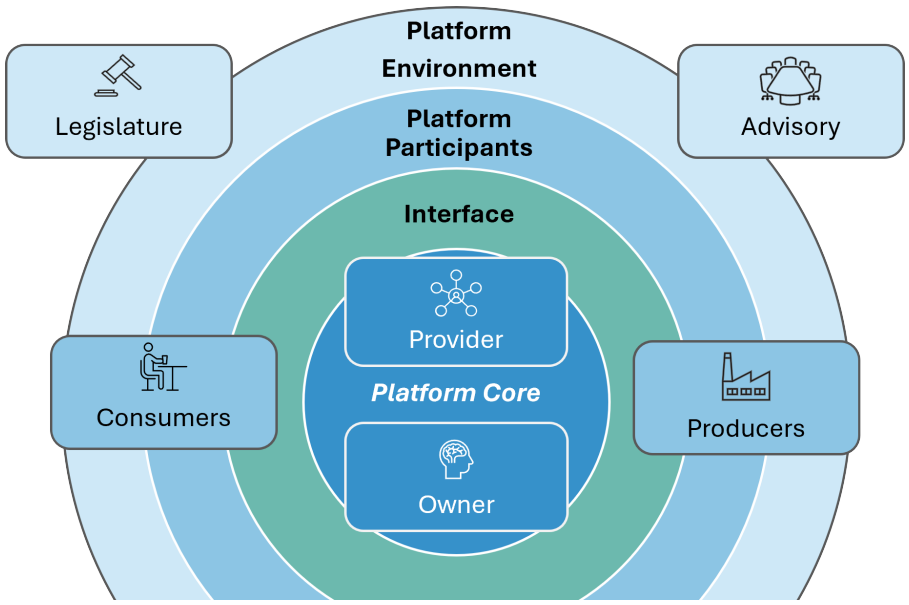


Figure 4: Roles in the platform ecosystem, adopted from Drewel et al. [2021], [41].

In the model of Drewel et al. [2021], the platform core contains the provided digital platform infrastructure and the roles of platform provider and owner, coupling the technology layer again to the roles of platform providers and platform owners.

The interface in the figure represents where interaction and access are facilitated for platform users, again consisting of both producers contributing capabilities to the platform and consumers utilizing its functions. To describe this variable periphery in terms of functionality as well as involved actors, the visualisation of the interface layer in figure 4 is seen further to include the flexible range in which collaboration and value creation can occur as well, next to the participation of actors.

Now introducing an extra layer to the platform ecosystem, *the platform environment*, which contains actors that are not directly involved with the interactions on platform itself, but do exert influence on the platform based business. The platform environment is composed of legislature and advisory bodies, influencing openness in the platform environment by establishing laws and regulations that mandate data sharing and fair access, while advisory bodies guide platforms on best practices and compliance, and help them implement standards for transparency and interoperability.

A well described effect which (mainly user-based) openness can facilitate is the creation of network externalities, or network effects, when platforms combine different user groups, increasing utility as the number of users grows. These externalities can be differentiated as direct, where value is determined by users within the same group, or indirect, where an increase in value is determined by users in a different group. [28] Network effects do tend to create a market where the platform with the largest number of users will eventually dominate and capture the entire market share, often locking in users and undermining the ability of rival platforms to gain traction. This outcome is reinforced by the lack of opportunities for competitor differentiation and the strength of market entry barriers. These network effects can be a driving forces for platforms, and is in essence what a platform aims for when trying to enable non-linear creation of value. Network effects can occur on the user and producer side of the platform, and this multi-sidedness of platforms makes it important to understand what an actor group contributes and what motivates them to use or contribute to the platform, which can be done by analysing their roles, resources and interactions, as well as environmental influences such as other platforms and rules and regulations.[17] [37].

2.2 Comparison of models

While Eisenmann et al. [2008] focuses on openness of the roles around a single platform, Ondrus et al. [2015] introduces a layered approach to openness. This layered perspective allows for a broader analysis, including how platforms interact with each other through interoperability and collaborative configurations involving multiple platform providers and owners. While Ondrus et al. [2015] makes a clear distinction between actors and technology by adding the technology layer and equates this with interoperability, this separated technology layer is not included in the conceptualisation of van der Wielen et al. [2022] for openness between platforms in

primary healthcare. While this technical perspective emphasizes how platform technology enable joint services via collaboration of multiple sponsors and providers, the focus of Ondrus et al. [2015] on interoperability is rooted in the telecom industry and does not fully address the multifaceted nature of interoperability in digital healthcare, which also spans organisational, semantic, and syntactic aspects, therefore interoperability in healthcare is further detailed in section 2.6.

The model of Drewel et al. [2021] is used as complementation to these openness frameworks by mapping the broader platform ecosystem, also including the platform environment allowing to incorporate its influence on platform-to-platform openness. By using this approach stakeholders and their interactions can be included, offering a more holistic view of openness across platforms by considering influences beyond individual ownership or sponsorship of a platform. Particularly, the platform owner and sponsor, as a potentially combined role, and advisory and regulatory roles outlined in figure 4 are used further in the stakeholder analysis to include their openness considerations involved in platform-to-platform openness for platforms in healthcare.

Forms of openness between the platforms and its periphery are further elaborated in the next section.

2.3 Acces and resource openness of platforms

To further explore openness within and across platforms, two additional forms of openness must be included alongside the established level- and role-based openness. Karhu et al. [2018] introduces these two forms of openness as *resource* openness and *access* openness, which focus on strategies that promote innovation and value generation by extending platform business beyond the platform's core functionality. These approaches to openness involve either the relinquishing of control and becoming an open-source platform or making "*boundary resources*" available to third parties, such as APIs (Application Programming Interfaces), which allow external developers to interact with and build upon the platform's functionality.[42]. Resource openness refers to the platform's core, where the host may forfeit intellectual property rights (IPR's) related to core resources. These forms of openness can be implemented together and at different levels, as they are not mutually exclusive. Access openness allows for platform control through the processes of resourcing and securing. Resourcing is the process of enhancing the scope and diversity of the platform, while securing is the process of ensuring that the platform maintains control over its operations and related services. These functions are essential in balancing external contributions with maintaining platform control [14].

The degree of resource and access openness in platforms, particularly in EHR systems, can refer to how openly documented, accessible, and interoperable the underlying technologies, protocols, and data formats are. This determines the platform's ability to exchange data and integrate with other systems or applications, with or without proprietary restrictions or vendor lock-in. The extent of access openness in general specifically depends on how effectively platforms offer access for information exchange, using standard formats, as well as their ability to process and integrate information from external systems through the provided boundary resources. Karhu et al. [2018] integrates the concept of competitiveness between platforms into the notion of boundary resources, emphasizing their multifaceted role in fostering collaboration while also defending against exploitative actions. This highlights how boundary resources can enable complementors and sustain competitive advantage when opening up platforms and that competition influences openness considerations.

The focus will be on the use of boundary resources to enable access openness, rather than resource openness, since boundary resources provide a clearer emphasis on controlled accessibility and mechanisms that facilitate inter-platform relations, as opposed to the sharing of platform IPR's and resources. Additionally, boundary resources, offer better insights into platform dynamics, focusing on the flexible periphery of the platform rather than its core.[14]

2.4 Boundary resources

Boundary resources, defined as the *software tools and regulations that enable arm's-length relations*, are composed of tools and rules that allow platforms to communicate with complementors in a business-like manner, while maintaining platform autonomy and balancing the stimulation of external contributions with platform control.

Boundary resources originate primarily focused on third-party development and user openness, such as platform-to-app openness, also in healthcare mainly desribed for supply-side user openness by van der Wielen et al. [2022]. They are used to open up platforms to external actors, allowing for controlled third-party innovation, and are

seen as cooperative governance mechanisms. Platforms that offer broader and more flexible access through boundary resources create more opportunities for external developers to innovate, driving the growth and diversification of the platform's ecosystem.[43] As the platform and its ecosystem evolve, the design and adaptation of boundary resources is an ongoing process, shaping the trajectory of the platform ecosystem itself.[17]. The utility of boundary resources in research lies in focusing the analysis on the flexible periphery of platforms, facilitating relationships and connections, despite challenges in comparing core functionalities across platforms. Boundary resources highlight the potential for accessing design capabilities that allow other actors to leverage their specialized knowledge and create modules to enhance the platform's core functionality. Because these resources underscore the extensibility of platforms, they should be designed with complementors in mind rather than focusing solely on the platform's core. [17], [43]

Boundary resources are described as being the key to properly exposing and expanding core functionalities and essential for the creation of "collaborative value" for peripheral actors [44] The use of these resources for the examination of the flexible periphery of platforms is particularly relevant in healthcare, where the variation in core platform interactions is extensive. This highlights the importance of boundary resources as a subject when we extend their use to platform-to-platform openness in this study.

Boundary resources are composed of technical and social elements [15],[45]. Technical boundary resources include software tools such as APIs, SDKs, and documentation. Social boundary resources encompass platform-specific rules, guidelines, intellectual property rights (IPRs), and agreements that govern interactions and openness between platforms. These resources are further shaped by legal and policy frameworks[17], especially social boundary resources, even more so for highly regulated sectors like healthcare. Their relation is visualised in figure 5.

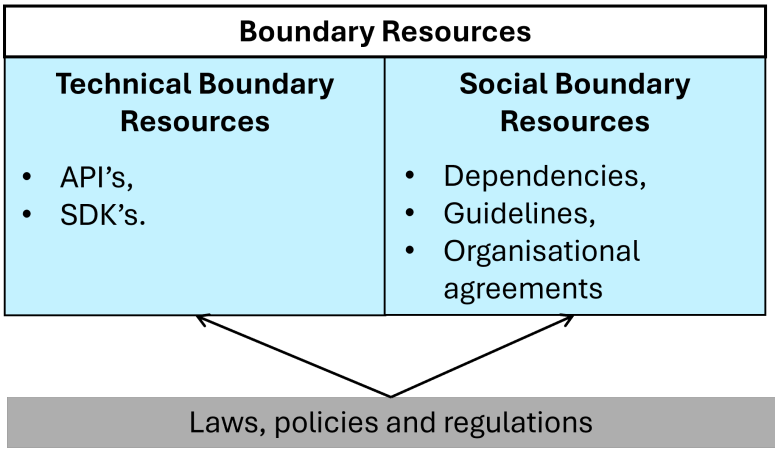


Figure 5: Boundary resources can be divided into technical and social aspects, driven by laws and regulation.

When referring to social boundary resources, it is important to distinguish them from a subset defined as knowledge boundary resources[46], which include technical documentation, information portals or training materials, which are typically limited in use for platform to application purposes. In contrast, social boundary resources composed of dependencies, guidelines, IPR's have a broader use and could be used in a wider applicable extending their relevance to platform to platform interactions. In figure 5 the IPR's are left out of the concept of social boundary resources on purpose in line with the definition of access openness by Karhu et al. [2018] and Mosterd et al. [2021] for platform to platform openness. Both state that the inclusion of IPR's would fall under the category of resource openness, as it involves an integration of platforms rather than merely enabling controlled accessibility.

The way boundary resources facilitate interactions between platforms and third party application complementers is expected to differs from how they manage platform-to-platform interactions, and may still vary depending on the platform in question, with potential reusability on the technical side, while the social boundary resources are expected to show the greatest variation.

This inter platform relation facilitated by boundary resources is visualized in figure 6 building on the model of Drewel et al. [2021].

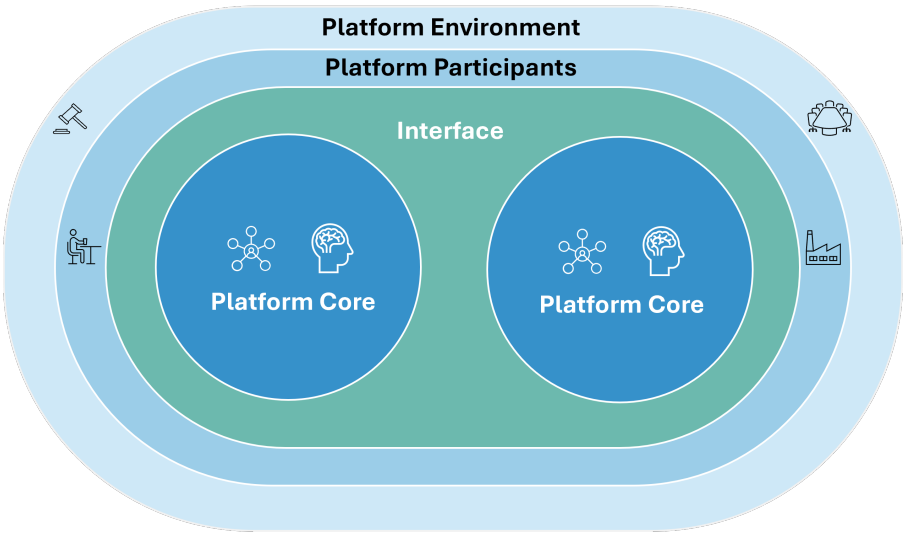


Figure 6: Platform to platform openness, maintaining core functionality.

2.5 Platform to platform openness

That platform-to-platform openness is an essential area of focus has been highlighted in the research agenda of de Reuver et al. [2022], which also raises the question of what platform-to-platform openness specifically entails. Mosterd et al. [2021] lays the foundation for studies about openness consideration between platforms, and explicitly builds upon the view of Ondrus et al. [2015] by the acknowledgment that platform to platform openness is not a mere technological issue, but seeing it as a socio-technical construct in which organisational arrangements have to be made to become interoperable. This approach implies that it ties the platform provider and sponsor roles back to the technology layer described by Ondrus et al. [2015].

The framework of factors influencing openness decisions proposed by Mosterd et al. [2021] offer several preliminary factors that platform owners consider when making decisions related to platform-to-platform openness, as illustrated in table 1. These considerations provide a basis for understanding the trade-offs and drivers that determine how platforms open or restrict access, shaping how boundary resources are structured within the platform ecosystem.

Preliminary framework of factors affecting platform openness decisions.

Factor	Examples
Direct benefits and costs	License fees paid by complementors Costs of maintaining interfaces
Indirect benefits and costs	Low-quality complements harm the reputation of the platform
Strategic-level factors	Barriers to entering markets
Market-level context factors	Competitiveness of the market
Organizational context	Maturity of the organization
Legal and legitimacy concerns	Antitrust law requiring platforms to open up

Table 1: Preliminary framework of factors involving openness decisions, adapted from Mosterd et al. [2021].

Direct benefits can include increased revenues from license fees and an increase in platform users. Indirect benefits can relate to increased motivation of other parties to contribute to the platform, leading to desired network effects and innovation potential through generativity. Direct costs involve the setting up of the open interfaces and the monitoring of potential extra users. Indirect costs include potential reduction of revenue when third parties create competing complements, e.g. platform forking, increased coordination costs, and risks to platform integrity due to low-quality contributions. Positive strategic level factors related to platform to platform openness is the strategic positioning of sponsors by aiding in entry of new markets or building legitimacy in existing ones. On the downside, strategic factors to keeping platforms closed is to prevent potential exploitation by competitors, and locking in customers, in combination of the setting of higher margins. Market

Level context factors can consist of the effectiveness of openness within a certain competitive landscape, with corresponding market maturity, availability of compatibility standards and entry to market. Organizational context factors influencing openness decisions include profitability (for-profit vs. non-profit), organizational maturity, and market position. For example, companies with less market power may be more inclined to open up compared to dominant competitors.

Legal and legitimacy concerns also drive platform openness decisions. Legal and legitimacy concerns, such as antitrust laws and privacy regulations (e.g., GDPR or Wegiz), can shape regulatory requirements that either compel or restrict platform openness. Platform owners may be hesitant to open up their platforms due to privacy laws, fearing liability in the event of data breaches.[9] Because of regulations such as GDPR, which include requirements for data portability and the right of individuals to access their data [47], openness can also be stimulated, however uncertainty about future regulations can also restrict decisions related to platform openness.[9]

Openness is a particular contentious issue in regards to data privacy and security. While there are compelling reasons for open platforms at various levels, such as increased innovation, enhancing interoperability, and improving user experience, there are valid concerns against it to safeguard data en ensure privacy. [30]. This can be perceived as a trade-off between openness and technological innovation on the one hand and safety and quality of data exchange on the other. Due to the sensitive nature of healthcare data, ensuring confidentiality and compliance with strict privacy regulations like GDPR is essential, as platforms become more open to facilitate interoperability, the risk of data breaches and unauthorized access can increase if not properly managed. [48] Currently, in healthcare, there is security through obscurity, because siloed data is somewhat protected simply because it is difficult to access. However, this is not a reliable or sustainable approach to security especially since openness of systems and breaking up of information silos in healthcare is widely desired. [49] Instead, the principle of "privacy by design" should be adopted for integration of robust platform security measures.[50].

The concepts of modularity, even generativity of the platform and factors incorporating resourcing and securing, as concepts based of platforms to app openness and boundary resources can be included as components contributing in their own fashion to these inter-platform relations, touching multiple factors defined by Mosterd et al. [2021].

Since platform to platform openness is described as the degree of interoperability between platforms, interoperability, specifically in healthcare, will be elaborated upon further.

2.6 Interoperability in Healthcare

Intoperability is used to describe the ability of healthcare organisations to digitally exchange information and use the information that has been exchanged. However, it is hard to develop a single, common interoperability format for data exchange of healthcare organisation because of variations in products available for use ranging in clinical terminologies, technical specifications, and functional capabilities.[51] Because interoperability is a broad topic with many common threads, there are many distinctive definitions, but is broadly accepted in literature as "the ability of two or more systems or components to exchange information and to use the information that has been exchanged ". The definition of interoperability originates from computer science and closely resembles the concept of compatibility.[52]. M. Lehne and Thun [2019] distinguishes between technical, syntactic, semantic and organizational interoperability for healthcare systems. Technical interoperability refers to the ability exchange data through communication channels and protocols for reliable data transmission, allowing different systems to communicate and exchange data through a common IT infrastructure, using standardized interfaces and protocols. Syntactic interoperability delves into the exchange format and structure of the data, while semantic interoperability refers to the ability of different systems to maintain, interpret and understand the meaning of the exchanged data, ensuring that the receiving system can correctly and accurately interpret data. Organisational interoperability refers to business processes and workflows, supported and possibly obliged by policies and regulations. Since different stakeholders have varying interests and may not always strive for optimal interoperability, the organizational layer provides the incentive for interoperable data exchange. M. Gaynor and Rawn [2014] specifies the interoperability classification on sharing of data further as either internal or external. Stated to be internal interoperability when data sharing is within the same institution or healthcare provider, and referring to external interoperability as the exchange of medical data between different institutions including hospitals, pharmacies, and for example outside labs. These different levels of interoperability build upon each other and are complementary in achieving comprehensive interoperable healthcare data exchange, underlining the essentiality of this aspect to is essential to take this into account in the creation of new healthcare systems and partnerships. [23]-[33]

Regarding external interoperability, Nictiz, the Dutch National IT Institute for Healthcare, developed a 5-layered model, separating interoperability into five layers, with every layer containing its distinct actors, concepts and standards. The openness of these standards is the degree to which the standards used for data exchange and interoperability in EHR systems are openly developed, maintained, and openly accessible, without proprietary restrictions or licensing fees. All tiers are overarched by two essentials columns consisting of laws & regulations and security, as seen in figure 7. When the agreements at each of these levels are compliant, interoperability is established and information can be exchanged successfully. The 5-layered model underscores the interconnected and interdependent nature of the different types of interoperability described by M. Lehne and Thun [2019].

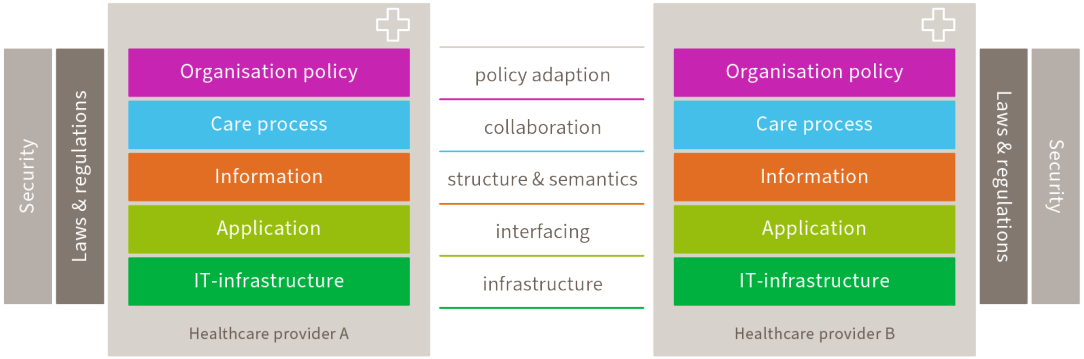


Figure 7: Interoperability Model, adopted from Nictiz, 2024.

Specifically at the care process, the technical application and infra-structure level, decisions are made about the way information can be exchanged between the involved parties and which communication infrastructure and information exchange mechanisms are chosen for this purpose.[24] This all has to be done while adhered to standardized terminology and information standards while being compliant with security rules and governmental regulations. These most frequent adopted standards facilitating interoperability at each level are described in appendix B. The structure of the 5-layered interoperability model of Nictiz is more detailed but comparable to the distinction made by others and can differentiate between lower level technical components, and higher level organizational components.

For clarity, the infrastructure layer of this model primarily refers to the shared hosting and monitoring of applications from the interfacing layer. This should not be confused with the infrastructure necessary for data exchange as regional or national initiatives, which extends beyond the apps and platforms of individual healthcare providers.

The lack of interoperability in healthcare include organisational and technical obstacles. Data is often seen as a commodity which might give a competitive advantage and therefore purposeful disruption of information flow across various EHR systems occur.[53] The cultural aspect of EHR interoperability is thought to be even more of an extensive challenge than the technical one, requiring close coordination and collaboration among stakeholders such as patients, providers, health IT professionals, and regulators.[54] Clear interoperability policies guidelines and governance at the forenamed levels is required to set up this "interoperability culture."[55].

2.7 Conclusions

In this section we explain the difference and relationship between interoperability and platform to platform openness. Next we relate these concepts to that of boundary resources, in this way we can analyse the way interoperability and openness correspond to the use of boundary resources in healthcare.

While platform-to-platform openness refers to and is measured by the degree of interoperability by Mosterd et al. [2021] and Ondrus et al. [2015] refers to interoperability as the technological level of platform to platform openness, both conceptualisations do not provide a specific definition of interoperability or further specify which levels or types of interoperability is referred to. This report argues that directly measuring platform-to-platform openness by the degree of interoperability can result in a simplified and muddled understanding of these two concepts.

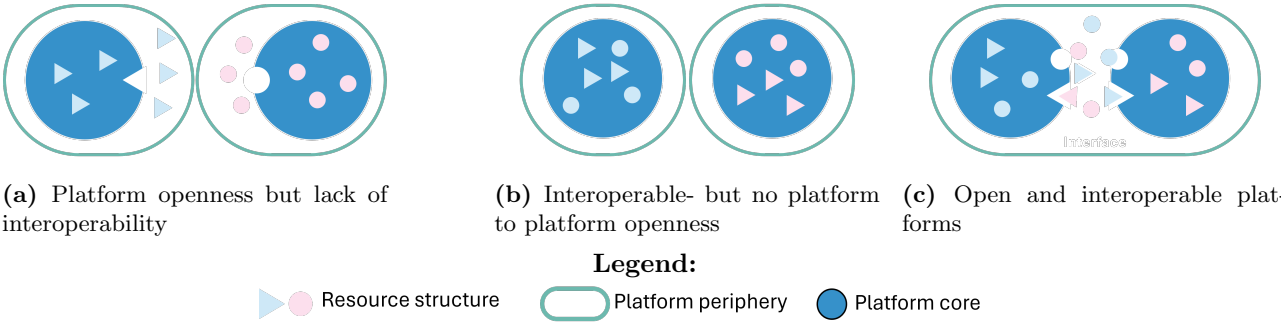
Interoperability refers to the ability of different platforms to exchange data and use the exchanged data effectively, supported by available standards. It is composed of multiple layers, facilitating communication and interpretation between platforms, ensuring that they can work together efficiently across the multiplicity of interoperability dimensions. In this, interoperability assumes that platforms are actively working together to enable exchange and interactions. Therefore we define, interoperability as the degree to which platforms are compatible. By changing this definition to compatibility we acknowledges that platforms may not actively collaborate but can still be aligned enough to be compatible without engaging in direct coordination or intentional partnership.

This definition makes it also easier to differentiate interoperability from platform to platform openness, which will be defined as the degree to which one platform provides and allows access to its resources by another platform. This builds upon the levels of openness defined by Ondrus et al. [2015], where each level focuses on the extent to which specific roles can engage with the platform and its resources. This availability of resources and the extent to which a platform provider enables accessibility is shaped by the surrounding platform environment. For instance, as highlighted in the preliminary model of Mosterd et al. [2021], openness is influenced by market-level factors such as market competitiveness and existing barriers to market entry, emphasizing that openness considerations are dependent on the ecosystem in which the platform operates

Simplified, platform-to-platform openness will be referred to as the degree of *accessibility* of resources, while interoperability will refer to the degree of *compatibility* of resources. Although closely related, these concepts are considered to be distinct, because it is thought to be possible for a platform to be interoperable with other platforms without being open. For example, platforms can be interoperable because both platforms have shared standards and processes, theoretically enabling data exchange or access, but the actual access to the desired platform resources might be restricted, indicating a lower degree of openness. Conversely, a platform might offer extensive access to its resources, displaying a high degree of openness towards other platforms, but if it lacks the necessary technical standards or organizational alignment it may not be considered interoperable.

By labelling interoperability as compatibility this also reflects on the intent of openness for enabling diverse and independent platforms to coexist and function together without directly requiring rigid, predefined interoperability frameworks. It also helps to separate intoperability from the definition of "access openness,"[42], focusing on the degree of accessibility and control over platform resources. We transfer the use of boundary resources for access openness from platform to application purposes towards the relation between platforms.

Technical as well as social boundary resources play a role in both the concepts of openness and interoperability. The extent to which boundary resources, such as API's, are provided for *access* to platform resources relates to platform-to-platform openness, while the *standardization* of these resources are classified under interoperability. The provided degree of access is not necessarily addressed by interoperability. While interoperability ensures that platforms can interact and exchange data, openness focuses on what resources are provided and the conditions under which these provisions can occur, including the accessibility and permissions granted to external entities. This distinction is presented in a simplified manner for a straightforward single platform to platform use-case in figure 8.



(a) Platform openness but lack of interoperability

(b) Interoperable- but no platform to platform openness

(c) Open and interoperable platforms

Figure 8: Illustrated platform to platform openness and interoperability as distinct concepts that should be considered separately.

The described openness associated with the users and levels accompanying a digital platform[27], shows that openness on one level does not necessitate openness on another, and that openness is a continuum. The same goes for interoperability between different platforms or organisations. While presented in a single platform-to-platform configuration in figure 8, it is important to recognize that both interoperability and openness are use-case specific. The degree of platform-to-platform openness and interoperability can vary mutually depending on the specific relationship, platform, and ecosystem context.

Both interoperability and openness are frequently discussed in relation to data exchange and the use of platform resources, though their goals differ. Interoperability primarily focuses on ensuring the ability to exchange and utilize data effectively, making data exchange a central aspect of its purpose. In contrast, openness is often viewed as a prerequisite for enabling such exchanges or achieving interoperability. Using the notion of compatibility in this context excludes the exchange itself, emphasizing alignment rather than the act of sharing data. While both concepts are associated with exchange, they do not inherently require it. Instead, the exchange can be seen as a consequence of openness and interoperability to some extent.

The challenge when focusing solely on interoperability for data exchange is that it might not account for the willingness or considerations for making resources accessible, in which openness becomes relevant. However when focusing solely on openness and providing extensive access to platform resources without ensuring compatibility, this can result in highly open but still isolated and disconnected platforms, effectively still maintaining current silos. In an scenario where the platform itself and platforms and users in their periphery would all adhere to the same standards adopted from interoperability models, this would not necessarily guarantee the actual openness of platforms. While uniform agreements and standards are necessary to make use of the resources of another platform, so are the strategic decisions about why and how resources are, or are not, considered to be shared and accessed.

By making the distinction between the defined platform to platform openness and interoperability, we adopt a new position in literature. The separation of these concepts allows for separating compatibility as being more focussed on the aliment of interoperability aspects such as standards, protocols data formats and infrastructure between organisations, to that of openness considerations, encompassing decisions related to governance, availability of resources and accessibility involving strategic, market, economics and legal factors.

In the context of platform ecosystems, particularly in sectors like healthcare, distinguishing between these concepts is crucial for research. Stakeholders often use the terms interoperability and openness interchangeably, leading to potential misunderstandings about the extent and meaning of both concepts.[16], [20], [21]. By clearly separating these two concepts, a more nuanced understanding of the role and intentions of a platform can be achieved. Using access openness facilitated by boundary resources as the measure of platform-to-platform openness is thought to be appropriate because it incorporates strategic accessibility and usability of platform resources, while maintaining platform autonomy and still acknowledging that interoperability is critical for ensuring compatibility, at each relevant layer of the interoperability model. Compatibility can even be viewed as an openness consideration when platforms or its environment mandate compliance with specific standards and these compatibility efforts entails costs or investments. Challenges in interoperability may have underlying struggles revolving around platform openness, influenced by factors such as financial constraints, market dynamics, and competitive pressures.

Having established this distinction, the method used in this research is described in the next section.

3 Methodology

3.1 Research Design

Approach

This study employs an exploratory embedded case study approach, focusing on platform to platform openness as unit of analysis facilitated by boundary resources as a group or function. By doing so, it increases comparability between platforms and provides a deeper understanding of platform-to-platform relations within the healthcare ecosystem, without delving into specific individual boundary resources by focusing more on the roles these resources play between platforms. This aligns with the research agenda of de Reuver et al. [2017], which highlights that small-scale methods fail to provide a holistic understanding and recommends incorporating the structure and dynamics of digital ecosystems. This consideration is integrated into this study's design for examining platform-to-platform openness, building on the literature review through the use of a document review and interviews as research methods.

The case study strategy will first be justified, followed by an explanation of the context of the case study. After that the data collection methods for the document analysis and interviews will be detailed, followed by an explanation of the further performed analysis.

Justification for Case study strategy

A case study approach is chosen for its flexibility to accommodate various perspectives, allowing the study to be designed and tailored to the complexity of the research problem. By focusing on the perspectives of the three stakeholder groups identified in the literature review; platform owners, regulators and advisory bodies, this approach enables an in-depth analysis of platform-to-platform openness within the platform ecosystem.

This case study approach is particularly useful in real-life situations and contemporary events allowing for the exploration of these phenomena in their natural settings [56]. This is a fitting strategy to examine the ongoing challenges faced in achieving the desired "platform openness" in healthcare. [20], [21] Addressing these issues requires an understanding of the interplay between technology, regulation, and stakeholder dynamics, which a case study can explore. However, unlike experimental designs, case studies do not allow for the manipulation of variables or control of confounding factors, which can make it difficult to establish causal relationships [57]. Additionally, case studies rely heavily on the researcher's interpretation, which may introduce subjectivity [58] To address this, the rigidity of the case study method is important.[59], further elaborated in the following sections.

The focus of this study is on the Dutch healthcare platform landscape, specifically investigating digital healthcare platforms as a **single embedded case study design**, using the documents for further consolidation of concepts and interviews to gather data. The single case in this study is the Dutch healthcare ecosystem for platforms. This should not to be confused with a platform ecosystem, solely focused and revolving around a single platform. As a representative case involving a multitude of stakeholders, this study focuses on a single topic using multiple embedded units and incorporates the diverse stakeholder perspectives to provide further contextual understanding. It is considered an embedded case study because there are multiple embedded unit(s) of analysis, when considering drivers and barriers for openness between platforms facilitated by boundary resources.

3.2 Data collection methods

Document Analysis

In the document analysis, theoretical concepts from the literature review are further solidified unto the Dutch healthcare market, providing insight into the present dynamics and current openness of the healthcare ecosystem and the platforms placed within. This analysis will also help to refine and prepare more targeted questions for the interviews that follow. The five documents used in the analysis are introduced below, in which we examine current openness considerations, platform(-to-platform) openness in Dutch healthcare, and the current role of boundary resources in enabling this openness. The used documents are verified for authenticity and credibility assessed by considering the author's expertise and potential biases, as well as keeping the representativeness for general case and the specific case study in mind. Since these documents are all formulated by regulators and advisory bodies for the government and are publicly available, they are considered reliable sources, consistent with Yin [2018], which emphasizes the reliability of regulations and guidelines in outlining standardized practices. The document review outlines the environment of the platform ecosystem in healthcare, focusing on identifying key regulations and reports that shape the use of boundary resources. It also serves to consolidate core concepts,

formulate questions, and enable data triangulation by analysing policies, regulations, societal trends, public opinion, and current use cases of boundary resources.

List of main documents analysed

The main included documents used in the analysis are regarded as relevant across multiple levels of the healthcare platform data exchange landscape in the Netherlands and are as follows:

1. Nictiz API Strategy:
This national strategy focuses on the standardization of APIs and their role in promoting openness at the application and infrastructure interoperability layer, described as an essential element for data availability, standardisation of information, for consistency of information standards and technology-driven innovation.

2. Integral care agreement (IZA):
This national *agreement* in the Netherlands unites the government, healthcare providers, insurers, municipalities and patient organizations for enhancing healthcare quality and affordability, again emphasizing data availability and standardized IT solutions as crucial components for innovation and international competitiveness.

3. National Vision for Healthcare (Nationale visie en strategie voor het gezondheidsinformatiestelsel, or NVS):
The NVS is a strategic policy document including the outline of long-term goals for digitizing healthcare in the Netherlands, with a focus on data availability, citizen control, and hybrid digital care planned to be realized by 2035. Currently, only the initial vision of this document is included, the strategy part is planned to be published by Nictiz publicly by the end of 2024.

4. The law for mandatory exchange of healthcare information (Wegiz):
This legal framework mandates the digital data exchange of certain prioritized healthcare data and promotes interoperability standards and platform openness in healthcare.

5. Research by D&A Conclusion into nationwide healthcare infrastructure:
The Ministry of Health, Welfare and Sport commissioned a study to explore potential scenarios for establishing a nationwide network of healthcare data exchange infrastructures and provides an analysis of the possible scenarios for creating a national infrastructure network for data exchange in healthcare, involving in certain scenario's platform-to-platform relations.

Interviews

Participant Selection

Interviews are conducted with key stakeholders in the Dutch healthcare platform ecosystem based on the model adopted from Drewel et al. [2021], further elaborated in the stakeholder analysis in section 4.1. By employing purposive sampling, stakeholders are deliberately targeted aiming for specialized knowledge and experience with platform openness and the use of boundary resources. By involving multiple stakeholders within each category the use of **replication logic** is enabled, thereby enhancing the reliability of our findings through the identification of consistent themes and patterns. By capturing a range of perspectives from each stakeholder group this provides for a more holistic understanding.

The first group of participants consist of platform owners, operating healthcare platforms and are central to implementing and managing openness strategies, therefore forming a core group of participants. The platform environment is represented by advisory bodies that emphasize interoperability and advocate for the use of open APIs and standards, as well as regulatory stakeholders from the government who contribute to the development of guiding policies and regulations. Consulting parties in the platform environment, involved in advising the government and leading digitalization initiatives while using platforms, are also included.

To gain more value from the method, deliberate efforts were made to involve key persons within the case study, as suggested by Yin [2018]. The participants were approached and identified through direct individual outreach and by leveraging the network of the company ChipSoft, acting as an independent research sponsor. ChipSoft is a Dutch software company specializing in innovative healthcare IT solutions, providing integrated EHR systems as incumbent in the Dutch market, aimed at enhancing patient care and operational efficiency for various healthcare institutions. The participants were approached with a clear emphasis that, while gratefully utilizing the network of ChipSoft, this is an independent research project conducted by a student of the TU Delft. The platform landscape is explored within the Netherlands for scoping purposes. Although the European Health

Data Space is a pressing topic touching these concepts crossing borders, there is a lack of concrete public information on existing international cooperation on platform-to-platform openness in healthcare, therefore keeping the national level as focus of this research.

An overview of the involved participants can be found below in table 2.

The interviews 1 to 4 were conducted with representatives from four different healthcare platforms. Interview 5 and 6 are conducted with professionals aligned with the Dutch ministry of healthcare. The following three interviews in table 2 are conducted with healthcare foundations managing healthcare policies, interoperability standards and the national vision and strategy in the Netherlands, being interview 7 and 8 and 9. Participants 10 and 11 are representatives from healthcare consultancy companies that contribute to advisory reports for the government and support implementation processes for healthcare providers. To conclude and confirm results, a prominent consultancy participant was included in interview 12.

Interview	**Role**	**Concerned Actor**
1	Senior Relation Manager – Oversees key relationships and strategic platform partnerships.	Platform owner
2	Platform Director – Leads and manages healthcare platform operations.	Platform owner
3	Expert Innovation Consultant – Advising and managing innovation strategies as a seasoned healthcare digitalization veteran.	Platform owner
4	Platform Regulatory Lead – Ensures regulatory compliance and guides governance of a platform.	Platform owner
5	Expert & Management Consultant – Advises government and healthcare sectors on policy and management.	Government, healthcare ministry
6	Senior Policy Officer – Engages in policy development and implementation for government healthcare.	Government, healthcare ministry
7	Expert in Legislation and Policy – Specializes in healthcare regulation and policy, contributes to defining the national course for the health information system.	Healthcare Advisory body (non-profit)
8	Expert in Legislation and Policy – Specializes in healthcare regulation and policy, contributes to defining the national course for the health information system.	Healthcare Advisory body (non-profit)
9	Expert in Legislation and Policy – Specializes in healthcare regulation and policy, contributes to defining the national course for the health information system.	Healthcare Advisory body (non-profit)
10	Senior Consultant – Provides strategic consulting services to healthcare organizations and government bodies, also contributing to advisory reports for governmental projects.	Consultancy organisation
11	Director, Healthcare Consultancy – Senior leader in healthcare consultancy, providing advisory services.	(International) Consultancy organisation
12	Partner, Head of Healthcare Consultancy – Executive-level consultant leading a healthcare advisory practice, also contributing to advisory reports for governmental projects.	(International) Consultancy organisation

Table 2: Interview candidates and their roles in the platform ecosystem

Interview Process

Interviews are a valid and essential data collection method within case studies, providing rich, detailed insights into stakeholder perceptions and opinions. The use of semi-structured interviews allows for flexibility and adaptability, enabling the option to probe for more information, clarify responses, and explore new directions as they emerge during the conversation. Face-to-face interviews are preferred to observe non-verbal cues, which can provide additional insights and help guide the conversation. However, it is crucial to remain aware of potential biases, both from the interviewees and the interviewer, and to take steps to mitigate these further during the data collection and analysis processes.

Preliminary interviews and throughout the document analysis, it is shown that the concepts of openness and interoperability are often used interchangeably. Initially the notion of interoperability compared to platform openness was only mentioned if directly asked for to minimize bias, only then allowing for a focused discussion on the extent and differences between the two concepts. However, after ambiguity around concepts emerged, to ensure better alignment with the theoretical part after the first two interviews a more extensive explanation of the concepts of interoperability and openness is provided.

Before the start of the interview, this necessary required framing of the interview was provided per email to the interviewee, outlining the assumptions, landscape and layers of platform relations within which the questions are asked. This outline was then checked together for understanding at the beginning of the interview. The provided figures and elaboration send by mail is included in appendix A. Depending on the type of stakeholder the focus of the interview, as well as the provided context in terms of focus on technical, social or laws and regulations can vary slightly. The interview protocol includes questions designed to gather information on drivers and barriers in the use of resources for platform-to-platform openness.

The interviews are semi-structured which allows for exploring the desired topics while maintaining the possibility to converge into emergent relevant topics. The formulated questions are divided into three main categories. First, general questions about platform-to-platform openness, focusing on the challenges of openness between platforms and the policies and regulations that support it. Next, technical boundary resources, with a particular emphasis on the API strategy of Nictiz and lastly social boundary resources, concentrating on the challenges surrounding their formulation and implementation.

3.3 Analysis approach

Analytical framework

This study adopts grounded theory as an inductive methodology, following the structured process proposed by Yin, which employs systematic procedures to analyze data and generate theories grounded in the data itself. This is performed in this research mainly high level, by consolidating the meaning of each alinea, not unlike latent content analysis, but using grounded theory principles, particularly constant comparison and iterative interpretation, to synthesize insights across multiple interviews as well as the policy documents. This approach is ideal for this case study to maintain flexibility while providing insights and allowing triangulation. By performing the analysis at a higher level and consolidating meaning of each section, similar to latent content analysis, but incorporated grounded theory principles such as constant comparison and iterative interpretation, this allowed for synthesizing insights across multiple interviews and documents.

Data analysis

The analysis process began with an initial round of open coding, followed by axial coding to identify and refine key themes and relationships. Open coding was conducted using Atlas TI, shortly after the completion of the interview. This resulted in approximately 500 unique codes, with groundedness ranging from 1-5. The codes were descriptive, interpreting the words of interviewees rather than ad-verbatim. The memo's written during the interviews were also processed afterwards.

The initial high-level categories were derived from the literature, being social technical and corresponding laws and regulations. For the axial coding which followed, within these categories, considerations for openness were identified. This process involved combining the 500 unique codes into a separate document and categorizing them. If codes were mentioned only once, they were removed from the scope, unless there were very solid arguments. Additional themes emerged during the interviews, which will be detailed and presented in the results section.

To provide an example, the following excerpt is taken from an interview with a platform owner, discussing the use of APIs in the context of the API strategy:

> *"...this essentially means that it pertains more to interoperability than to openness. An open API refers to providing technical functionality under certain conditions, ensuring interoperability with our system. However, this does not necessarily mean that every application or all data from the system can be accessed via that API."*

Which can be translated into the following code:

> *Open API's in the API strategy, relate to the notion of interoperability providing restricted access*

These examples of codes illustrate how specific insights from the interviews were categorized. During axial coding, multiple codes were grouped into themes, such as openness considerations. Additional themes, particularly those related to openness decisions for the role of platform owners, draw on Mosterd et al. [2021]'s preliminary framework. Although not explicitly differentiating between interoperability and platform-to-platform openness, the framework provides a useful starting point, offering insights that can be adapted to healthcare platforms.

3.4 Ethical considerations

Since the obtained interview data can contain Personal Identifiable Information (PII), such as names, job titles, or references to specific organizational details, measures were taken to ensure confidentiality. To maintain anonymity the specific platforms are not mentioned, since we focus on the use of boundary resources for platform to platform openness, and not on the core functionality of the platform. Since it is a highly specific landscape, the interviewee titles and organisations are also generalised to limit potential PII. Further mitigation measures were also are taken: before each interview, participants sign an informed consent form that explains how their data will be handled. Data was securely stored in a limited-access OneDrive folder, and transcripts anonymized. Each transcript is sent to participants for review before analysis, and any records containing PII is destroyed once transcription was complete. Observations from the interviews are aggregated during analysis to maintain confidentiality. A template informed consent form can be found in appendix A. In some interviews verbal agreement were provided in the recording, because of time constraints for the participant, the form could not be signed.[11] &[12]. This research followed procedures as part of a reviewed data management plan of the TU Delft, approved by the Human Research Ethics Committee (HREC).

3.5 Case recap

This case study, focused on the Dutch healthcare platform landscape, aims to explore in depth how boundary resources are used to achieve platform-to-platform openness, considering the complex stakeholder interactions within this multi-actor healthcare ecosystem. To accomplish this, a combination of document review and interviews will be employed, drawing on existing (grey) literature and insights from key stakeholders. The data will be analysed using latent content analysis, guided by grounded theory principles.

4 Document Review

In the healthcare sector, both public and private stakeholders collectively define how platforms are organised and the openness of platforms. To understand how boundary resources currently influence platform-to-platform openness within the digital healthcare context, it is essential to examine the existing research and documents on openness and current platform and actor dynamics in the Dutch healthcare market. The document analysis focuses on five key public documents that are highly relevant to the interoperability and the direction of platform openness in the Netherlands: this primarily concerns the API strategy, the Wegiz, the NVS, the IZA, and the D&A report regarding a national healthcare infrastructure. All relevant players from the included stakeholder analysis are involved or affected by these documents.

There are many other ongoing governmental initiatives, but for scoping reasons, these are consciously excluded from this research, openly acknowledging that several initiatives may overlap with the topics addressed here. Overall, the combination of legislation and regulation through the Wegiz, the national vision as an end goal for the Dutch healthcare IT market, the API strategy on a technical level and the documents on a nationwide network, and the IZA as a cross-sector vision from healthcare providers have been selected for inclusion in this study. These initiatives are considered the most influential and widely supported, representing a major contribution to how boundary resources are structured and developed by platform owners, aligning with the vision shared by stakeholders within the platform ecosystem.

Relevant stakeholder groups will first be identified, followed by an analysis of the selected documents regarding their perspectives on openness. Given the breadth of these documents, which address various aspects of healthcare, the analysis focuses on their relation to platforms and their impact on interoperability and openness, naturally placing strong emphasis on their take on improving overall data exchange in healthcare.

4.1 Stakeholder analysis

Before delving into the outlined documents, relevant groups of stakeholders and their relation to platform openness are described below. Each stakeholder, including platforms and other actors in the platform environment, holds their own preferences regarding the extent of openness. Developing a clear, one-dimensional view of these preferences is challenging, as desired levels of openness vary across a spectrum and depend on stakeholder types. Adding to this complexity, power dynamics can vary for and between each stakeholder, and stakeholders often hold multiple roles within a single platform ecosystem, even further adding to the challenge when it concerns platform-to-platform openness. These power dynamics are heavily influenced by control over data access, regulatory mandates, and the strategic goals of each stakeholder group. [26], [9] Therefore, the interrelation of relevant players is elaborated based on the roles of Drewel et al. [2021] in the platform ecosystem, incorporating the differing views on platform openness and their use of boundary resources. Since we are interested in platform to platform openness, beside platform owners, delegates of legislature and advisory companies are included which shape the platform environment to allow for platform to platform interactions. The specific addition of advisory bodies in the conceptualisation made in this research, highlights their role in providing guidance and expertise on interoperability initiatives and offering consulting support during (technical transformations &) implementations, while not having the enforcement power regulators do.

To make further statements about openness between platforms at an ecosystem level, it is important to incorporate a high-level view of the current state of openness in the digital healthcare market, since the broader platform environment shapes and influences platforms and their openness. In healthcare both public and private stakeholders collectively define the way platforms are organized, in which interoperability, data availability and openness are coupled to market forces.[21]. The market dynamics of the digital Dutch healthcare system are described in a report commissioned by VWS, providing a clear overview of the current state.[16] This report by Deloitte from 2022, differentiates between stakeholders in the healthcare ICT market, identifying them as citizens, new entrants, industry incumbents, and healthcare providers. Healthcare providers (such as hospitals and clinics), as users of these platforms, are not further included in this research. Similarly, patients, who should be the ultimate beneficiaries of openness, data sharing, interoperability, and data availability, will also not be included as stakeholders in this study, as openness considerations are made primarily at the platform owner and sponsor/provider level. The findings regarding the interrelation of these stakeholders form the basis for understanding their beliefs and considerations in this report. These insights are elaborated below to describe power dynamics, conflicts, and alliances, highlighting mutual interests and tensions surrounding openness and interoperability for the platform-based roles in Dutch healthcare.

4.2 Stakeholder types and interests

The Deloitte for VWS details the IT landscape and market dynamics in the Dutch healthcare sector. [16] Building on the stakeholders identified in that report. The three stakeholder types in the platform ecosystem, platform owners and sponsors (combined as one role), regulators, and advisory bodies, based on Drewel et al. [2021] framework. these roles are described below.[41].

- **Platform Owners/Providers:** These stakeholders are the creators and maintainers of the digital platform, having a focus on the development, governance, and monetization of the platform. Their goals typically revolve around maximizing profit, user retention, and ensuring control over the platform's direction, placing them at the core of the platform-based ecosystem. Platform owners are primarily interested in retaining control over the platform, often concerned that increased openness could dilute their market position, result in a loss of proprietary control, or allow competitors to gain leverage. However, partial openness could be strategically beneficial, encouraging third-party development and potentially expanding the platform's ecosystem to drive innovation. This aligns with Aanestad [2020]'s observation on the use of boundary resources at the platform ecosystem level, balancing accommodation with resistance. Due to the focus on boundary resources, specific platforms and their core functionality are not identified, as the interest lies in their periphery and openness towards other platforms rather than their core functionality. This approach is particularly relevant given the wide variation in core functionalities across platforms and the growing demand for openness from the platform environment when handling healthcare data.
- **Government and Regulatory Bodies:** Compromised of policymakers and regulators who oversee compliance with laws, standards, and data protection, ensuring fair and secure platform operation with a focus on the competition of the market, the protection of platform users as well as privacy. This role is primarily shaped by the Ministry of Health, Welfare, and Sport (VWS), which steers toward greater control, direction, and alignment. Driving standards and mandating openness to encourage data sharing, to increase transparency. By promoting platform-to-platform openness, regulators aim to enhance competition, prevent monopolistic behaviour, and ensure data portability and availability.
- **Advisory Bodies:** In this research, a division is made in these advisory bodies into two main types: non-profit organizations, such as Nictiz, which function as system enablers and steerers by managing standards and transitional initiatives, and larger consulting firms, which focus on transformation projects, regulatory compliance, and market research. Non-profit advisory organizations primarily contribute to maintaining standards and facilitating interoperability, indirectly influencing the platform ecosystem. Meanwhile, larger consulting firms can provide strategic counsel and audit services, helping platforms balance security, compliance, and risk with opportunities for growth and innovation. Both types of advisory bodies guide in platform development and openness and mainly provide insight and support for complex regulatory and operational challenges.

4.3 Key conflicts and alliances

In the healthcare market there is a 'competitive vicinity' of platform ecosystems [27], where firms provides a platform and competes against other platforms in the ecosystem.[11] As this competitive platform approach of Ondrus et al. [2015] focusses on openness decisions in the early ignition stage of a platform for market potential, and the current research is looking into platform openness in an already saturated market, this follows a more nuanced competitive market strategy at the provider level. This is relevant for the Dutch healthcare-IT market, since a vendor lock-in is experienced, being more pronounced in hospital-based EHR systems due to dependency on certain key players.[25] Most studies and developed guidelines, therefore, have a similar focus towards these platform owners, due to their central and significant role in digital healthcare due to their central position in healthcare, functioning as nodes in the health information system.

Platform owners in relation to VWS, will focus on alignment with regulatory demands and drivers for long-term sustainability for the platform, [6] in which government bodies and regulators, including VWS, will push for more open and interoperable systems to improve healthcare outcomes and ensure compliance with European standards. [24] However, IT suppliers (platform owners) are hesitant due to the investment required and concerns over maintaining competitive advantage. Resistance can occur when there is believe that fully open systems could reduce client retention by making it easier to change providers, and involves risk regarding proprietary control.[60] Full compliance and transitioning to more open systems can also require considerable investments for platform owners as well.[16]

Nictiz, as a knowledge organization dedicated to achieving "better healthcare through better information," plays a central role in aligning Dutch healthcare systems with European and global standards. Although not

directly involved in managing (national) infrastructure, Nictiz contributes to data exchange by development of critical resources, including the five-layered interoperability model, [24] the API strategy [18], and the National Healthcare Vision and Strategy [21], and is deeply involved in various aspects of interoperability and healthcare data exchange in the Netherlands. These (non-profit) organizations like Nictiz, focused on standardization, aim to create a consistent, unified approach to interoperability. However, interoperability can conflict with the business model of IT suppliers, especially if interoperability reduces control over their product or if data is deeply integrated within their systems, potentially impeding business sustainability. [16]

Advisory bodies may advocate for restructured subsidy models that prioritize regional collaboration over individual providers, but the government's ability to implement such changes is constrained by existing subsidy frameworks and political considerations. This creates tension between the government's goals and the advisory bodies' recommendations for alternative funding approaches, which in turn affect the interests of platform owners

The increase in pressure for rapid adoption of standards across the healthcare IT sector can cause conflict as well. Governmental bodies aim for expedited timelines to support system-wide (national) interoperability. (by the end of 2026 according to the NVS). However, IT suppliers and healthcare providers, who are closer to the market itself, recognize the operational complexities that can hinder rapid, uniform implementation. This results in a friction between the urgent government's push for standardization and the technical and organizational readiness of platform owners and users, to support such timelines effectively.

4.4 API's as Technical Boundary resources

Within the Netherlands, especially the use of APIs as boundary resources to facilitate access openness is gaining traction, especially in the context of interpreting openness and enhancing interoperability. [20], [18], [21]. The API strategy aims to increase integration and interaction between different systems, promoting interoperability and facilitating the development of robust and scalable applications[18].

APIs as boundary resources, offer flexibility in the way they are structured and implemented. For example one platform might use 10 well-defined APIs to provide a specific function, while another platform could require 50 smaller more specialized API's to accomplish the same task. While differing in quantity and structure, both approaches facilitate a comparable level of arm's length interaction between platforms and third-parties, or other platforms. This research will therefore views API's as a function, or type of boundary resource, mainly considering them in the term of functional role they play, rather than the specific number, or configuration of the API's involved. The degree of openness provided is therefore more influenced by the provision- themselves and the usage of APIs collectively, by platform owners and the provided range of applications/functionality, and less about how well-designed and comprehensive each API is in itself is.

While there is a lot of emphasis on using APIs, restricting the concept of boundary resources solely to APIs is acknowledged to be overly narrow, [10] as it only addresses a small part of mainly the technical aspect of the arm's length relationship between platforms. Any technical solution that facilitates these relationships could be considered a technical boundary resource. These kind of oversimplifications in technology often leads to the mistaken belief that open APIs or a single, all-encompassing integrative platform are the sole solutions for achieving platform openness and interoperability in healthcare.[10].

The API strategy in the Netherlands follows a three-step growth path, in which (REST) APIs gradually increase in interoperability and implementability, moving from open standards to technically standardized and eventually content-standardized APIs. This strategy is reinforced by the Wegiz, which mandates that interfaces be made available for data exchange, aiming for APIs that meet the first "Open API" (OA) standardization level [61][62].

In the strategy, open APIs are defined as those that facilitate access to services without access restrictions, closely resembling complete access openness, typically for open data use cases. In contrast, closed APIs facilitate connections with access restrictions. This distinction will be further referred to as unrestricted-use APIs and restricted-use APIs [18]. Internationally, open APIs are generally defined as restricted-use APIs, which include requirements for authorization and authentication. The degree to which these APIs are publicly documented, accessible, and usable by third-party developers determines their level of openness, and is mainly addressed in API deployment.

While Nictiz emphasizes the importance of open APIs, practical policies are driven by governmental frameworks like the Wegiz. How stakeholders in the platform ecosystem, view the role of open APIs in achieving national objectives for interoperability and possibly desired inter-platform openness is to be determined.

4.5 Research into Nationwide Network of Healthcare Data Exchange Infrastructures, D&A

Zooming in specifically on the data infrastructure of healthcare, the 2023 report by D&A medical group, issued by VWS, delved into possibilities for a national infrastructure for health data exchange, in which in essence two design methods were proposed for opening up healthcare systems: vendor-neutral storage of healthcare information and the use of standardized APIs for decentralised access of information.[20] The latter underlining a decentralized infrastructure approach when using API's to facilitate platform-platform connections, actually presenting platform to platform connections as an intermediate solution before enabling nationwide centralised data availability. The D&A rapport state openness to be "'the extent to which information captured by one system, is accessible within other systems and processes". Data availability is mentioned as a desired goal in healthcare mainly in the NVS, as the accessibility of resources by third party healthcare organisations and vendors, for primary or secondary usage of data.

The report is stated to be somewhat outdated, as confirmed in interview 9, but it has contributed to the direction VWS has taken. Note that the report is written with a focus on patients and healthcare suppliers and acknowledges that needs evolve over time as 'new and different forms of collaboration continue to emerge.' It provides a clear division in the solutions pursued in the network of platforms, distinguishing solutions based on whether they are application- or data-centric, and whether they are centralized or distributed (in terms of networks as well as data storage) in structure. Multiple scenario's from A to F are suggested, but the proposed suggestions as seen in the D&A report, for the nationwide coverage of the healthcare information system, most aligned with platform-to-platform openness and P-PO connections include:

- Scenario B: Connect existing infrastructure, application-centric and focused on alignment with an agreement system.
- Scenario C: Separate data and functionality via "data" (meta) platforms.
- Scenario D: Recommends uniform data models for healthcare providers to further separate data from functionality ("at the source").

In Scenarios B and D, data storage remains at the source, while in Scenario C, it is centralized. Data availability in the platform context here primarily refers to healthcare providers' access to each other's data, rather than access by patients themselves or other stakeholders from the ecosystem. All suggested models require a system-wide agreement framework and a uniform API strategy, with each proposed solution claiming to contribute to improved system access. A quick elaboration of the three suggestions is made below.

B: Connect existing infrastructure, application-centric and focused on alignment with an agreement system

In Scenario B, the primary focus is on connecting existing infrastructures using a data-centric approach where data remains at the source. This approach implies a higher degree of openness between platforms, enabling the sharing of data and resources by linking various regional and local systems without requiring centralized data storage, while maintaining the healthcare providers' systems as they are. Data remains at the source, with a focus on 'application-based' interoperability, allowing only limited use of standardized data.

C: Separate data and functionality via "data" (meta) platforms

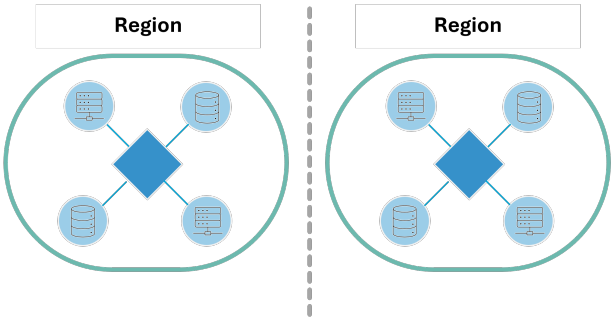
This scenario goes a step further by duplicating data from different source systems to a regional data platform, where it is stored in a standardized format and remains independent of specific applications. This creates a central source of truth, improving data availability for both healthcare providers and secondary data usage. Scenario C separates data from functionality, providing a solid foundation for broader interoperability within a regional network. (In structure, it somewhat resembles the proposed national EHR system). Because this scenario relies on central data storage and is data-centric, it enhances interoperability but limits flexibility for local systems. Here, "data platform" refers specifically to centralized storage, where data from multiple source systems is standardized for broader access.

D: Utilize uniform data models for healthcare providers to further separate data from functionality ("at the source")

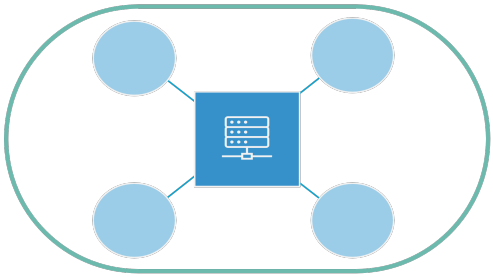
In Scenario D, a standardized data model is implemented across all healthcare providers, creating a foundation for interoperability by consistency in data formats and structures for each healthcare provider. Unlike scenario

C, which focuses on regional data platforms, this scenario aims for a distributed network model in which each provider maintains its own system with this unified data structure, enabling direct data access and queries across platforms. This reduces redundancy by decentralized data storage, because there is no need for duplicating data, and allows easy data integration across the network, though it demands significant adaptation from all involved systems to align with the standardized model.

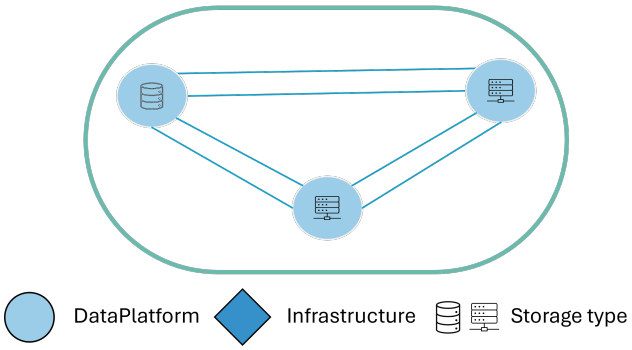
These suggestions are further visualised in figure 9



(a) Scenario B; Data remains stored at its source within local systems, connected regionally through application-based interoperability, with limited standardized data use and no centralized storage.



(b) Scenario C; Data from source systems is duplicated and stored centrally on a regional data platform in a standardized format, enhancing interoperability but limiting flexibility for local systems.



(c) Scenario D; Data is stored at the source but structured using a standardized data model across all healthcare providers, enabling direct queries and integration without duplication.

Figure 9: Three outlined (partial) solutions involving digital platforms in healthcare in the D&A report for a nationwide covering infrastructure in Dutch healthcare.[20]

To conclude and comment on these options, what stands out is that the type of interconnections or infrastructure, (how systems communicate) and the of data storage (where data is stored) in combination with the data model of the platform itself, seem to be coupled in this report, being peer-to-peer, (regionally) centralized or

federated. Both application and data centric models use API's network protocols or middleware to facilitate interoperability. The data itself can be stored centralized, distributed or in hybrid setups, but does not necessarily related to being data- or application centric. However, in application-centric systems, APIs are said to serve mainly the application's needs, with data shaped around the application's context while in data-centric systems or models, APIs are in general designed to provide more broad, standardized access to data, (e.g. using FHIR). Which encourages interoperability and allows for reusable data across different platforms or applications without requiring a lot of customization.

Notable is the use of platform's described at different levels, national, regional, and intermediary. A regional platform can serve as a central hub for data exchange within a specific region, collecting and potentially storing data from multiple healthcare providers to support regional interoperability. A national platform is seen as an overarching infrastructure enabling national data exchange, with or without data storage. Additionally, local systems and databases managed by individual healthcare providers are sometimes also considered platforms, functioning above the primary data or EHR database layer and facilitating interoperability from the provider's platform. This broad application of 'platform' illustrates its versatile occupied roles, whether as a data storage solution, an infrastructure, or an intermediary. Despite the fact that the D&A report is written with a focus on healthcare providers, platforms frequently appear as regional or national (public) solutions, mainly so with a focus for data exchange. Platforms fill different roles at distinct layers of infrastructure, data storage and stakeholders involvement.

Aside from the conclusions made in the D&A report itself, the document properly highlights the ongoing discussion around preferred approaches and the pros and cons of possible data storage and data models, which can vary in preference for each stakeholder, not only among healthcare providers but also for IT suppliers and the government. Platforms here, are mainly seen as nodes within a larger interconnected system.

4.6 Policies, laws and regulations

National Vision on the healthcare information System

Regarding policies in the Netherlands, a strategic policy document, the National Vision on the healthcare information System(NVS), is developed as well by order ofthe Dutch ministry of health. The NVS recognizes the importance of digitization in guaranteeing sustainable and people-centred healthcare and aims to increase the availability and exchange of medical data, control for citizens and the secondary use of data and envisions appropriate hybrid digital care with fitting data availability by 2035. Data availability refers to the ability to ensure that the right data is accessible in the correct form, at the right time and place, for both internal use within organizations and for external stakeholders, improving insights and easing the healthcare system. data availability is said to be a state of being of a single system, referring to the ease of data retrieval, while exchange and interoperability is said to be between healthcare providers. For developers and providers this means the ability to innovate in an application-oriented manner with the use of standardized and readily available data.

An open ecosystem, as envisioned by the NVS, is a healthcare system where various parties, including suppliers, healthcare providers, and patients, collaborate transparently with clear and binding agreements. The concept of an 'open' ecosystem aims to reduce dependency on a limited number of dominant suppliers in the healthcare IT landscape. This structure promotes innovation by making it easier for healthcare providers to switch to alternative solutions and for new suppliers to enter the market. Ultimately, this then should leads to a more flexible and future-proof healthcare system.

This requires the use of digital platforms for its realization, and integrated networks are described as essential, where data availability is mandated. Data availability is viewed as a prerequisite for innovation. The required data availability will opens the market for developers of new functionalities within the agreements established in the healthcare information system. The "Interoperability of applications is required and will be periodically tested to ensure seamless integration and communication between different systems." Data availability ensures that healthcare data is consistently available, accessible, and usable to meet information demands, regardless of specific use cases. 'Usable' refers to the format, which encompasses e.g. syntactic and semantic interoperability. 'Accessible' involves the agreements required for data exchange. The reduced dependency of specific use-cases, although not directly phrased, is interpreted as being enabled by the outspoken desired separation of data and functionality.[21] A nationally covering network of connected infrastructures or a meta-platform for data exchange is also mentioned as required for openness and exchange, in line with the D&A report.

The national vision and strategy also highlight a lack of clarity in roles, tasks, and responsibilities, recommending that governance structures, roles, and responsibilities be defined for each level. In which agreement is the

request to establish a focus at the strategic, tactical, or operational level. Regarding this division of roles and governance in the NVS, the Ministry of Health, Welfare, and Sport (VWS) is tasked with central oversight ("regie") aligning with existing healthcare structures. This includes adapting internal governance frameworks to ensure the NVS's goals, like interoperability, can be realized effectively. These adjustments in governance are recommended to incorporate input from both public and private stakeholders for furthering trust and collaboration across these groups. As this public-private cooperation will have to be realized, and trust between parties has to grow.

The NVS does refer to the D&A rapport in terms of the separation of data and functionality. This research will not include the IZA "gremia's or the specific consultation structures further in detail. Of course, all these suggested governance frameworks must be safe, legally compliant, and capable of managing data-sharing permissions while preventing misuse.

Wegiz

The NVS is complemented by a legal framework, the Wegiz (Wet elektronische gegevensuitwisseling in de zorg) which functions as a foundational legal framework within the Dutch healthcare system, mandating specificly what data should be electronically exchanged across healthcare platforms, and eventually standardized. The Wegiz is intended to serve as a catalyst; it doesn't mandate all healthcare data exchanges but aims to stimulate them within the market, but the Wegiz is going to mandate exchange through the use of "proper APIs". The Wegiz supports the realisation of data availability for the mandatory exchange of healthcare data via open API 's.

This framework is enforced through general administrative orders (AMvBs) that outline the exact data requirements and standards necessary for these exchanges. AMvBs are issued by the government to designate which data must be exchanged electronically and to establish quality and technical standards for this process.[63] These coupled interconnected standards which are mandated for adherence under de Wegiz are :

1. Quality Standards
   Quality standards define the data types needed for the provision of high-quality care, detailing what information must be exchanged to facilitate this. For each mandatory exchange, the quality standard specifies the "what" of data exchange, outlining which specific data points (e.g., patient history, medication lists) are essential.[62] This "what", is in agreement between patients, healthcare insurers and healthcare providers, tested by healthcare insurers Netherlands (ZN).

2. NEN Norms
   The Wegiz references NEN norms (from the Netherlands Standardization Institute) to specify the technical and linguistic requirements for data exchange systems. These norms set functional and technical criteria, ensuring that the systems involved in data exchange can communicate consistently. Systems used for data exchange under Wegiz must be certified to meet these NEN standards, which confirm they align with both technical compatibility and information security requirements, and allows for European and international alignment.

3. Information Standards
   NEN norms refer to Information standards (Nictiz) which serve as a bridge between healthcare processes and the ICT systems which supports them. These standards ensure that data exchanged is consistent, coherent, and retains its meaning across systems. They describe how data should be structured and formatted, enabling healthcare providers to share information accurately across different platforms.

4. Technical Agreements (TA/NTA)
   For interoperability at the technical level, the Wegiz incorporates technical agreements (TA) or Netherlands Technical Agreements (NTA), which provide guidelines on the mechanics of data transfer between systems. These agreements ensure that information systems use compatible exchange mechanisms, specifying standards for data formats, messaging protocols, and terminologies, such as SNOMED and LOINC.

The Wegiz mandates certification to ICT suppliers/platform owners, By setting clear standards and allowing general administrative orders to specify requirements, the Wegiz is said to encourage innovation within the healthcare IT sector, because ICT providers are incentivized to develop systems that meet these standards,

potentially giving them a competitive advantage in the Dutch healthcare market. This standardization can also reduce market fragmentation, as providers and developers focus on creating interoperable solutions that meet nationally recognized criteria. The Wegiz places significant emphasis on stakeholder involvement, requiring that healthcare providers, ICT suppliers, and administrators work together to meet compliance standards. Regular compliance monitoring is also a part of the implementation strategy of the Wegiz's, with healthcare institutions and IT providers required to undergo assessments and updates to make sure that their systems align with the latest NEN and technical standards. Non-compliance could even result in penalties or mandatory adjustments to ensure further alignment.

The Wegiz takes a phased approach to implement electronic data exchange. This phased rollout is designed to gradually incorporate more healthcare sectors and data types, starting with essential exchanges in urgent care scenarios and progressing toward broader applications. This incremental approach is said to ensure that stakeholders have time to adapt to the new standards and technical requirements without the disruption of existing healthcare workflows. This incremental approach is also adopted by the AMvBs, allowing the government to specify precisely what data exchanges are required electronically and to define standards as needed, but still allow for modification over time to reflect what is required and incorporate possible technical advancements.

IZA

Next to the Wegiz, a broad national agreement called the Integrated Care Agreement (Integraal zorg akkoord or IZA) is a national agreement made in 2022 between the Dutch government, healthcare providers, health insurers, and patient organizations, focussing on an above-sectoral, narrowed cooperation and agreement in search of healthcare improvement. The main focus is the ambition to keep healthcare affordable and maintain high quality; In this, data availability is mentioned as a prerequisite. The IZA builds upon and refers to both the NVS vision and the Wegiz law as part of the overall policy landscape it operates within. Together, it aims to enable IT suppliers to develop applications faster, based on standardised data and developed standards. The IZA and NVS underline the creation of an open market to stimulate innovation and create an open (healthcare) ecosystem.

De IZA stresses next to data availability, that interoperability and openness are essential for this modernization of the healthcare sector. Regarding data availability, it stresses mainly the structuring and reusability of data & streamlined access, as well as simplified administrative tasks for providers, with an overall general focus on network-based care. It also establishes that interoperability is a non-negotiable requirement for seamless, secure data exchange between multitude of healthcare sectors. With a focus on international standards which is met through the alignment with the Wegiz currently.

Regarding data availability, the IZA emphasizes both primary and secondary care, as well as the need for citizen access. Healthcare providers should register data uniformly to enable reuse, stressing that electronic exchange should be the standard (though this is not yet fully practised) via regional and national networks with a standardized approach. Again, under the Wegiz mandate, NEN norms are referenced as standards for data consistency, along with the legally required use of "good" standardized APIs.

Openness within healthcare systems is structured around fostering competition and innovation. Through the Wegiz law, the IZA mandates that all health data exchanges between providers must be electronic and accessible. This legislative framework enables open access across different systems, where standards for APIs support fair competition and drive market innovation. VWS holds the authority to ensure these principles of openness are upheld,.

Besides the agreement from the field, the IZA is also supported by VWS in the form of IZA funding, covering an investment of around €3 billion, which is a significant amount for the Dutch GDP considered in combination with other financing resources such as VIPP5 schemes and subsidies such as the WBSO. Aimed at the digitalisation of healthcare and thus also at stimulating innovation, implementation and scaling up of digital healthcare solutions, including the formation and support of digital platforms, in which the IZA states that Nictiz's standardised API strategy is leading in the way of opening up systems. However, an elaboration of the principle of 'openness' or 'opening up' is not provided.

The guidelines provided for IZA applications for healthcare providers provide a clear overview of the necessity of interoperability, the applicable agreement systems, and the direction for healthcare providers toward appropriate 'common facilities' (gemeenschappelijke voorzieningen) that can be implemented within an agreement framework. Currently, healthcare institutions can select these facilities themselves. The topic of these generic

facilities is not explored further here, but since they are mentioned in the interviews briefly elaborated, and can be seen as tools needed to exchange healthcare data when a fully decentralized approach is inefficient or unfeasible, being complementary the agreement frameworks.[64]

Mandating Participation in National Healthcare Exchange Networks

Regarding openness and healthcare data exchange to achieve goals in the IZA, there is a complementary report by KPMG, which did examine the mandatory participation in a nationally covering network for data exchange infrastructure. [65] Interestingly, the study did not investigate *what* should be mandated exactly, only to what extent and how obligation for exchange could be imposed. The findings suggest solutions or that a combination of instruments is necessary to mandate participation, and mandating by law is seen mainly as a final push to bring remaining parties on board for data exchange. The options and combinations of options that were identified are primarily:

- Joint (public and private) development and management of standards;
- Enforcing mandatory participation through healthcare contracting, although this is complex in terms of feasibility since healthcare is purchased through procurement contracts;
- Deploying regulators, which is legally unfeasible due to the lack of a legal obligation towards suppliers to use enforceable standards;
- Implementing legislation, either through entirely new regulations or by aligning with existing laws.

As a foundation for effective data exchange, the report outlines that sufficient legal and economic incentives are necessary for the creation and use of standards for technical and system requirements, ultimately supporting interoperable systems in line with information and quality standards. Legal incentives alone (whether new legislation or adaptations to existing laws) will not achieve the intended results and is seen as a last resort. Effective data exchange mandates require strong collaboration between healthcare providers, IT suppliers, and the government. The government's role is to ensure sufficient legal and economic incentives to support the creation and maintenance of national infrastructures. Using specifically instrument 2 and 3 does provide insufficient leverage to change the current situation.

4.7 Conclusions Document review

An analysis of various documents was conducted to centralize and verify core concepts and look into the role boundary resources currently play in shaping platform-to-platform openness in the Dutch healthcare ecosystem, shaped by laws and regulations.

The National Vision on the Healthcare Information System (NVS) provides the national strategic framework, emphasizing the separation of data and functionality to foster innovation and interoperability while outlining a long-term vision for an more "open ecosystem" with reduced supplier dependency. The Wegiz serves as the legal foundation, mandating electronic data exchange through open APIs and adherence to quality and technical standards to ensure consistent implementation of openness at the technical and operational levels. Complementing this, the Integrated Care Agreement (IZA) facilitates cross-sector collaboration by promoting interoperability and structured data sharing, aligning stakeholders around the need for data exchange to improve care delivery and reduce existing fragmentation. The platform environment is steering towards a the use of national based infrastructure, where more openness in the platform-to-platform connections plays a central role, while not clearly deciding between being decentralised or federated. Through the Wegiz, subsets of data are mandatorily exchanged, where in all analysed documents, lack of interoperability is seen as to be the main obstacle for data availability and exchange of data.

The API Strategy focuses on technical guidelines for implementing standardized and open APIs, enhancing interoperability and scalability. According to the analysed documents, there is a strong focus on primarily APIs, which is shaped and directed in practice by the API strategy, as referenced in the Wegiz, NVS, IZA, and D&A reports. Specific stimulation for openness agreements between platforms and data exchange, aside from the mandatory set outlined in the Wegiz, are not discussed in detail in other documents, making the Wegiz the leading driver for mandatory openness. Beside this, the IZA is seen as important financial incentive for the development of regional digital platforms.

Lastly, the D&A Report explores infrastructural options for nationwide healthcare data exchange, emphasizing scenarios that enhance platform-to-platform openness through standardized data models and agreement systems. The D&A report shows the importance of openness between platforms in digital healthcare for the provision of a nationwide infrastructure, in which agreement systems are mentioned for enabling this openness, explicitly named mainly in scenario B, while still acknowledging its usefulness in the other suggested platform-to-platform solutions. These agreement systems resemble social boundary resources related to openness, although they are more of a trusted centralized technical framework for healthcare and IT providers, and based on this research, do not yet specify the extent of data exchange or resources presented. Considerations for committing to an agreement system focused on exchange could be viewed as a factor influencing platform-to-platform openness. It remains to be seen, particularly with regard to regulators, how the design of boundary resources and facilitated platform-to-platform openness is stimulated in the market beyond standardization and legal obligations mandated by the Wegiz.

Based on this document analysis in combination with the literature review, the questions in appendix A are formulated as an outlined framework for the design of the semi-structured interviews, further applied to each type of stakeholder. This will serve as a foundation to look into research question 2.

5 Interview results

While the focus of the interviews was on the technical and social boundary resources, as well as the most current laws, policies, and regulations surrounding the platform ecosystem, additional themes emerged during the discussions. These included stakeholders' experiences with the challenges in forming boundary resources in relation to platform openness and identifying the key obstacles they face in this process. As will be described in the results below, the difference between private and public platforms is often mentioned, along with a different interpretation and consequences seen around the concepts of interoperability, data availability and openness. After going into the responses received regarding technical- and social boundary resources and supporting laws and regulations, we will briefly zoom in emergent themes on how financial and security issues are perceived and addressed. In the interviews, governance was often mentioned as a limiting factor in decisions about openness as well.

The structure of the results section is designed to provide a clear overview of the key findings from the interviews. These themes are presented below in table 3:

Section	**Subsection**
5.1 Introduction to Results	Interoperability and Data Availability Openness in Healthcare Platforms Roles and Dynamics in the Dutch Healthcare Ecosystem Ambiguity in Data Ownership Separation of Data and Functionality Private vs Publicly Owned Platforms
5.2 Technical Boundary Resources	API Development and Standardization Requirements National API Library as a Tool for Openness
5.3 Social Boundary Resources	The Role of Agreement Systems
5.4 Policies, Laws, and Regulations	Key Policy and Legal Considerations
5.5 Security Considerations	Addressing Security in Data Exchange
5.6 Change Management and Governance	Challenges in Change Management API Strategy as a Governance Tool
5.7 Financial Considerations	Financial Structure of the Healthcare IT Market Challenges in Financial Allocation

Table 3: Overview of Results Sections and Subsections

The enumeration of sources in the result section is based on the interview candidates from table 5

5.1 Introduction to results

This first section will present interviews results revolving around key topics related to interoperability, data availability, openness, the separation of data and functionality and platform roles in the healthcare ecosystem to further understand the perspectives of the stakeholders on these topics.

Interoperability and Data availability

Platform owners view interoperability as a prerequisite for data availability and esssntial for continuous data availability [1]. Interoperability is seen as a precedent for data availability by platform regulators as well. [6] Data availability shares organizational aspects with interoperability [2], aligning with the National Vision for Healthcare (NVS) by Nictiz. In which organizational barriers are considered to be the main hindrance to interoperability, data availability, and platform-to-platform openness, whereas technical barriers are viewed as manageable [2], [10]

In regard to healthcare platforms and providers, data availability is seen by some as the continuous availability of data using pull-based methods, whereas interoperability is more on a push basis in terms of healthcare processes. [2]. In this, the discrepancies between healthcare providers' data needs and suppliers' capabilities hinder data availability [2].

Secondary uses of data underline the importance of interoperability further [10]. Incumbent platforms are noted to lead in determining supported interoperability standards, and the extent of connections with other platforms depends on the platform owner's ability to maintain assurance of their own product(s).[3] The government based interviews on the other hand, states that technical, juridical, and organizational layers of data exchange are all

intertwined and that harmonization of each is crucial to enable interoperability and openness.[5]

Each stakeholder speaks their own language when talking about data exchange and data availability in healthcare in which the complexity of interoperability alone lies in the ''Babylonian confusion of tongues" always being close at hand. [10] Referring to the possibility that conversations regarding interoperability are subject to broad interpretation.

Openness of Healthcare Platforms

Openness is perceived by platform owners as the degree to which third-party software or applications are connected to their platforms [3]. 'Opening up" of data, in terms of acces, is seen as the solution for the development of applications tailored to individual needs. [6] Ideally, open systems as envisioned by VWS would facilitate data exchange by making (at least) primary health data available through standardized APIs, enabling other parties to retrieve and potentially write back data, without exposing proprietary company-specific integrations.[6] The NVS contains a discrepancy in its definition of "openness," with an unclear distinction between market openness and interoperability. While the published vision part of the NVS emphasises the importance of making agreements to stimulate innovation and improve general healthcare, it does not provide concrete steps for achieving market openness.[7] This might be included in the strategy part of the NVS, which as stated in the document analysis, will be published at the end of 2024.

Roles and Dynamics in the Dutch Healthcare Ecosystem

Alignment in collaboration is challenging due to the large number of stakeholders. [9]Collaboration becomes easier with fewer stakeholders, as predictability in interactions would simplify information exchange. Currently, platform collaboration relies on consensus due to the lack of formal mandates, and while governance could theoretically follow NEN guidelines, defining and implementing these roles remains challenging. The large number of stakeholders and poorly defined roles within the Dutch healthcare IT system complicates collaboration, resulting in unclarity and ambiguity of the roles and power structures within the healthcare ecosystem. Clearly defining these roles is required for effective data sharing and ensuring accountability.[4],[10]. These challenges have led to calls for stricter governance and clearer accountability to facilitate successful information exchange. [2],[10].

There is a discussion about what should be left to the market in digital healthcare and what should fall under governmental control or provision as public service[10]. This raises questions about the government's ultimate goals and the limits of its influence in exerting control over digital healthcare systems[9]. IT suppliers and platform owners emphasize the need for greater clarity from te government besides standardized guidelines to reduce customization efforts[7]. Agreements on healthcare digitization and data exchange, such as the IZA, were initially established without fully involving the suppliers responsible for implementing these systems, leading to delays and hindering progress [6]. Insights on governance and change management are discussed in further detail in section 5.6.

Ambiguity in Data Ownership

Next to ambiguity around roles, there is also some ambiguity around data ownership. While most stakeholders agreed that data is owned by the healthcare providers themselves, this clarity is said to diminish when data is shared across different healthcare providers, potentially leading to reduced willingness to exchange information.[6] Only one interviewee stated that data ownership ultimately lies with the patients or healthcare users instead of healthcare providers.[9] In this, the government based interview states that healthcare providers play a central role in keeping additional value for their end users in mind, but ownership of data is often disputed between healthcare providers themselves and there is some struggle between each other regarding this ownership of data.[5] The way data ownership is handled in America is referenced to in the interviews, where data ownership clearly rests with the IT provider, offering more freedom to exert more control-over and monetize data, being contrasted by the extend of the GDPR in Europe. Ultimately, this brings the discussion back to the degree of control each player can exercise over data usage. While platform owners do have major influence on the respective platform based openness, there is complexity due to healthcare providers using their own self-hosted (EHR) software and owning their own data.[4] Consultancy bodies also state there is a reluctance to share data due to the power associated with this data ownership. This can even involve intentional reluctance to share data or achieve interoperability, often justified by citing security concerns but driven by strategic considerations.[10]

Separation of data and functionality

The NVS does refer to the separation of data and functionality, "distinguishing between the content and the transport of the data creates flexibility." and providing the notion that "a patchwork of applications should be avoided". Openness of this ecosystem is thought to be directly linked to competition based on data rather than functionality. This competition based on data is not considered currently feasible as a result of data being locked within legacy systems of healthcare platforms.[6][7] Separating data from functionality remains challenging due to the varying relevance of data for different stakeholders.[2].It remains unclear to government stakeholders [5], [6] what the separation of data and functionality fully entails. However, the API strategy is expected to contribute to achieving this separation [5]. The API strategy aims to establish a national catalogue of APIs to standardize and enhance interoperability.[8] An interviewee from an non-profit advisory body noted that the presence or absence of APIs, or even the number of APIs, does not inherently guarantee interoperability or openness between platforms.[8]. The API strategy aims to create a national catalogue of APIs to standardize and facilitate interoperability, as further detailed in section 5.2.

The goal of separating data from functionality is considered valuable by platform owners, but not universally applicable to all data collected. Data and functionality are still deeply intertwined, making it challenging to fully separate them, especially with the vast amounts of healthcare data collected.[2] According to a non-profit healthcare advisory body, separating data from functionality is crucial to ensure that competition focuses on functionality and innovation, rather than on the healthcare information or the content of care itself. This principle applies not only to IT structures but also to the broader facilitation and delivery of healthcare.[9]

Creating an open market is about the extent to which platforms are opened up in terms of accessibility, access to data, and provisioned national data availability (of software/EHR systems). [7] However, a single central (technical) solution cannot be forced through. [9] In this, the relationship between platforms, the market, and innovation is a critical consideration: stimulating the desired innovation and collaboration while opening up platforms is essential.[7]

Private vs publicly owned platforms

As previously mentioned, there is tension between what is managed by private platforms and what is handled publicly. Competition over platform functionality between public and private healthcare platforms is recognized [1], alongside existing conflicts arising from differing technical and organizational preferences [2]. Public platform owners point to private platforms stating that it is preferred to remain closed towards other platforms, to retain traffic of data on the healthcare platform itself.[2], According to private platform owners and consulting bodies[4],[11], the governments supported platforms alleviate, although the best intentions, only a small part of the pressure of healthcare data availability. Public platform based services are perceived by private platforms as slow and over-regulated. Although private platforms generally aim to support government initiatives, the proliferation of pilots and differing visions has led to a cautious support by platform owners. [4]
Additionally, gaining long-term commitment from governing bodies across switching political parties remains challenging.[4] These public and private platforms are expected to differ in functionality, resources, and capacity and stakeholders expect significant differences in maintenance and governance between public and private platforms. Specifically regarding roles, financing and responsibilities.[7]

Although the openness of the healthcare market as well as free exchange of data is a shared responsibility of the entirety of ''healthcare Netherlands B.V." [9], better patient care should be central over any technical discussions in and of itself[10], but this competition of healthcare providers, as being the platform users themselves, in the form of specializing in provision of care itself, also makes it hard to make above-regional agreements, since there is regional-specific competition also between healthcare providers. Openness of data, might allow insight into inefficiencies in the healthcare sector itself, and causes hesitation in joining platforms for exchange, both public and private based solutions.[9]

What creates further tension between stakeholders in the platform ecosystem, is how creating a ''level playing field" affects competitiveness for platform owners. While the NVS states that dependency on large healthcare software players should be diminished, consultancy interviewee's think that the imminent European level playing field will lead to a winner-takes-all scenario, with competition eventually driving toward a single provider.[9] [10] There is the expectation that larger international platform owners which are going to play a role in the international market of healthcare data exchange [10].

5.2 Technical Boundary Resources

API Development and Standardization Requirements

As stated in section 5.1, platform owners and consultancy bodies generally do not view the technical aspect of platform-to-platform openness as a significant challenge. [2] [10] Still, technical boundary resources are further looked into in the context of the API strategy of Nictiz. Platform owners express reluctance to design new APIs for every specific purpose, preferring overarching agreements and universally applicable, generic APIs to reduce workload and complexity. Preferring functionality and reusability over specificity allows them to maintain quality control and ensure high standards. [1] [3]

Stakeholders interviewed from VWS state that the technical aspect is not thought to pose a challenge as well, as it often arises from organizational struggles. [5] The API strategy is thought to help with the separation of data and functionality. Standards, infrastructure, and standardization are closely linked in this process, [5] but especially the standardization of APIs is thought to be essential for creating open systems in healthcare, as it ensures predictable access to data across different systems. [6]

The API strategy focuses on exchange of data as the first step of the NVS, and while this can be technically complex, alignment of initiatives can definitely be a matter of desirability. Establishing uniform technical specifications (and generic functions) is a challenge in a fragmented market. There is a strong need for standardized guidelines for eased implementation, and there is a lack of national consensus on technical agreements. [10]

Suppliers take risks by implementing solutions in pilot environments. Pilot projects do create room for experimentation and error correction, and funding for these pilots reduces the risk for platform providers. Iterative development of technical solutions allows for adjustments during these pilot phases. [9]

However, the technical standardization of APIs does not guarantee actual data exchange. [2] Interoperability as well as platform-to-platform openness require insight into the potentially available APIs before realization. The insight into API (based on the national API library) does enable platform users to envision the required technical aspect before joining a platform itself, therefore increasing technical interoperability. The demands of the platform users are said to be leading in API development, and the bundling of client requests allows for API development with multi-purpose in mind. This while the platform owners also state that APIs are mainly developed for use cases, and the multi-purposeness itself can also arise later. The scope of API use cases, driven by client requirements, therefore varies in extent. [3]

The openness of standards corresponding to the development of APIs is supported by platform owners, particularly to create opportunities for third-party application development. However, some note that it requires additional effort and that the concept will only succeed if there is widespread participation. (API Bibliotheek) [4] Insight into APIs enables visualization of conditions required for connecting systems. [10] When there is enough participation, the API library is thought to increase the pressure for platform owners to develop and present their APIs, and hopefully, next to insight, creates a competition for the development of APIs extending in functionality and standardization. [4] [3] Interestingly, platform owners do not really differentiate between applications and platforms, sometimes even treating platforms as applications themselves, following the same processes. Each new connecting or joining platform is evaluated individually. Again, the scope of the use case resulting from client desires varies, with varying costs and agreements based on each individual use case. The platform owner states that external integration is allowed, but agreements with other third parties have to be present for strict agreements, enforcing data ownership and responsibility by the platform owner to healthcare providers to prevent liability issues. [3]

Advisory bodies, especially those involved with the development of the API strategy, state that the API strategy aims to remove barriers precisely at the technical (interoperability) level, while looking at reusable software specification building blocks.[8] Because they are composed of reusable components, the API strategy focuses on technical interoperability, while ZIBs (Clinical Building Blocks) emphasize content standardization. This approach is expected to enhance interoperability, fostering innovation by enabling the reuse of existing components, which in turn facilitates the creation of new applications and functionalities.[8]

Following up on the standardization levels of the API strategy is not really supposed to be additional work for platform owners, as they are often small nuance differences from what has already been done and there is alignment with connection to international standards, not introducing anything significantly new, but bundling initiatives, must ensure that common-sense guidelines are actually followed. [8] The standards (levels) within the API strategy are developed based on NCSC directions/guidelines. The API strategy is intended to evolve

organically alongside the healthcare IT market, integrating with other existing initiatives and linking to established solutions. [8]

API Library (National Library) as a tool for openness and competitive advantage

Showcasing that certain quality standards are met can contribute to a competitive advantage by showing that better features are offered in comparison to competitors. The empowerment of suppliers to own and publish their data via APIs, avoiding outdated central registries, enhances visibility into existing solutions and identifies which healthcare institutions are already using them to determine potential data exchange partners, thereby promoting interoperability and platform openness. Advance efforts to gain insight into which products are associated with available APIs, including the underlying information standards, content standards, communication standards, and the agreements and frameworks involved, to support interoperability and platform openness. Comparing functionalities in an API library can help strengthen the negotiating position of healthcare providers in talks with ICT suppliers. Better insight is considered to lead to more platform to platform openness. IT Suppliers and platform owners are stimulated to publish and manage their own data via APIs, the need for centralized registries is minimized. This approach will keep data up-to-date and reduces administrative overhead. [8]

Nictiz is figuring out what stimulates suppliers to publish their APIs or not, hoping to work iteratively and learn by doing. [8] Careful consideration is being given to how to encourage the race without deterring parties from joining at all, which is also why the "open API" specification is fairly broadly framed in the API strategy. [8] It is not thought to be harder for smaller companies to be involved with the API library. There are very realistic implementation guidelines; the second level of standardization should already be partly fulfilled in terms of technical requirements when adhering to relevant international guidelines. However, it strongly depends on the use cases. [8]

5.3 Social Boundary Resources

The ministry of healthcare is centralizing agreement systems in the national agreement system, considered by the interviewee's to be social boundary resources.

The Role of Agreement Systems in Social Boundary Resources

Social boundary resources are considered comparable to agreement systems, such as TWINN, as highlighted in the interviews. It is regarded as effective because it operates as an infrastructural framework and remains independent of specific IT suppliers.[1], [2], [5], [10].(TWINN has since become the basis for a centralised national trust/agreement system. While there is a national intention to unify agreement systems, a significant barrier lies in understanding their contents; comprehension remains challenging, and a strong consensus has yet to be reached. By choosing a national agreement system, this potentially saves money for healthcare providers and IT suppliers by centralising (technical) investments. The agreements within Twinn are continuously evolving, with no clearly defined end goals in the current agreement system.[1]

According to both public and private platform owners, the biggest challenge in agreement systems is reaching consensus across multiple sectors. The variation in services provided by different healthcare sectors makes it difficult to connect and align these services. Both public and private platform owners also acknowledge that different stakeholders have varying interests in their agreements. Healthcare in the Netherlands is described as a highly political landscape with diverse and often conflicting interests, making it challenging to reach consensus on these technical solutions. [1] [2]. Given the complexity and scale of programs and ambitions in the healthcare market, it is essential to allow practical experience to guide the development of agreement systems.[3]

In this quest for interoperability and openness, tough decisions have to be made about what will be technically standardised, not technical standardised en what exchange is done with the help of an integrative party. [3]The more an agreement system is used the more value it creates, contributing to the (agreement) system's maturity and the advancement of standardization.[5] Finding early adopters who can catalyse adoption of these systems remains a challenge. Continuous open discussions are essential for reaching collective agreements on solutions, fostering the necessary collaboration.[5] Collaboration is most effective when stakeholders share common understandings and objectives, with leadership playing a critical role in aligning everyone around the same foundational principles for greater consensus. [6]. This involvement is required to achieve integrative cooperation, considered mainly a cultural challenge to get every player involved and committed to change.[9]

There is also a growing desire for data exchange (by healthcare providers)beyond what is mandated by the Wegiz, and agreement systems are seen as a valuable tool for standardizing the format of this data exchange.[5] The NVS strategy outlines a general principle that financing and innovation are tools for creating a solid foundation that supports innovation efforts. [7] Innovation is said to thrive on several key principles: financing and support, creating mechanisms for funding, evaluation, monitoring, supporting start-ups and scale-ups, and generating public insights for better collaboration.[7] The NVS does not address much about the relationship between innovation, platforms, and the market itself beside that an innovation and learning based climate is essential for the successful development of healthcare systems. [7]

5.4 Policies laws and regulations

Regarding the policies and regulations, high-over it was asked to interviewee's to what extent the sharing of data is stimulated for platforms, also outside the mandatory subset of data by the Wegiz and what considerations are for going for open exchange and how the Wegiz encourages platform-to-platform openness. Since it is seen as being a "flywheel" for "open" data sharing and the creation of an "open ecosystem" therefore examined how this compares to platform openness by influencing the formulation of platform boundary resources. The findings around the questions asked about the NVS are also included here, but have emerged less, being indicated by the experts that the NVS is more of a healthcare system-wide target state, and the strategy possibly including stimulation for platform openness complimenting the vision, has not yet been published and therefore could not be included.

However, fewer ad-hoc, one-to-one solutions have emerged due to increased commitment and awareness due to IZA and the Wegiz. [9] The IZA, NVS, and Wegiz all influence the IT provider's roadmap. [9], the next step in the NVS, is said to connect (healthcare) ecosystems (with social boundary resources) [10]

Wegiz

The interviews clearly showed that data is exchanged between a multitude of platforms and services, often beyond the mandated set of data by the Wegiz, particularly when there is a financial incentive. Private platform owners state that when the desire of platform users is formulated, beside legal mandated exchange, financial incentives is the next logical motivator for API development as well as hard requests from the ''healthcare IT market", or bundled demand from platform users.[1]. This bundling, articulating and unifying the needs of platform users has proved difficult.

The responsibility to comply with Wegiz, and EHDS, regulations on data exchange rests with healthcare providers, indirectly affecting the business policies of platform owners. This reliance on IT suppliers (platform owners) for the facilitation of this compliance, creates an interdependency that may slow down this compliance process.[16]

Openness of platforms, (in regard to data availability) beside the mandated exchange of data by the Wegiz, comes about with difficulty and in consultations in which the exceptions are said to make the rule, instead of focusing immediately obtainable results which can already be implemented gradual and incremental. [2]

While the Wegiz does stimulate data exchange according to platform owner 2, the current stimulated healthcare, efforts (e.g., BgZ) are said to have limited functional value for healthcare institutions. However, perceived by platforms owners, the Wegiz does facilitate the most clear direction in data exchange, due to being "set de jure", while still being a ''framework" based law allowing for iterative and maintaining continuous alignment in realistic goals. The Wegiz also said to work as an accelerant by ensuring that the right organizations get to know each other. [9]

The ''flywheel effect" of the Wegiz, is stated to be originating from the building blocks used in mandatory exchange can be reused for other exchanges.[8] In which mandated exchange is seen as a form of openness.[12] In that regard, in relation to the Wegiz, the pareto principle is named by consultants and platform owners alike, considering the first (20%) initial steps in healthcare data exchange to be possible will lead to the majority of important data (80%) being able to be transported.

The Healthcare sector seeks clarity and direction from VWS on what is mandated under Wegiz and how to implement it, [6] VWS is said to must take the lead, as the NVS outlines how governance should be organized in the Netherlands, al though remaining subordinate to European regulations,[7] there is a request for legal mandate included in the governance to truly enable interoperability.[9] These national guidelines are needed to support

uniform implementation and provide accountability for (healthcare) suppliers. [6] The national agreement system will encompass technical aspects which are compliant with data exchange policies and regulations, providing a basis for compliance beyond just the technical interpretation of data exchange itself.[5] These agreements in the agreement system are not (yet) legally binding, but IT suppliers again express concerns over high implementation times and associated costs.[6] This increased amount of regulation, especially besides the Medical Specialist care (MSZ) sector, is acknowledged to set back smaller platforms in terms of competition power. [6] These smaller companies struggle to stay up to date and comply with laws and regulations, delaying data exchange incentives. [9]

Liability in platform(-to-platform) openness for healthcare data is currently unclear, and poses a challenge. Clear legal frameworks are needed to define responsibilities between parties to enable effective exchange of data.[7]
Both EHDS and Wegiz aim to create a level playing field for IT suppliers, focusing on ensuring fair competition rather than mandating complete data openness across platforms through legal enforcement. Instead, the goal is to establish frameworks that promote interoperability and secure data exchange, allowing platforms to collaborate effectively without compromising proprietary standards. The NVS is pushing the healthcare information system to be more willing to change and collaborate. [10] However, regulation must avoid repackaging old solutions as innovations. There is a risk of legislation overshadowing intrinsic motivation, especially in early stages. Regular evaluation of regulations like Wegiz is necessary to assess their real impact and ensure they support innovation rather than hindering it. [10]

5.5 Security considerations

Security concerns within the healthcare IT landscape are marked by ambiguity, particularly the perception of data "safety". Overemphasis on security measures can inadvertently hinder progress in system implementations [3] Major organizational and legal challenges arise when granting access to core healthcare data, with data-sharing initiatives often constrained by fears of breaches in patient privacy and professional confidentiality. This can contribute to obstruction of openness initiatives and also foster a climate of risk aversion, where leaders hesitate to take decisive actions due to personal liability concerns. This hesitation is compounded by heightened focus on security after incidents, further slowing progress.[2]

There is a bit of ambiguity around "safety" in healthcare implementations, with overemphasis on it hindering progress [3]Certification and licensing significantly influence platform owners' decisions on data openness, especially when it comes to integrating third-party data into core systems. [3] There are major organisational and security challenges in granting access to core data, and there is legal risks of data sharing due to (security) breaches of patient privacy and professional confidentiality, hindering openness initiatives. [2] Again, the challenge is mainly present when writing data back into the core platform by third parties; impacted by the extent to which the proprietary product can remain guaranteed.[3]

In this, certification and licencing influences openness decisions as well[3] in addition there is reluctance for leaders to make decisive actions due to personal liability concerns, compounded by heightened focus on security after incidents, further slowing openness progress. [2] The risk of sharing data, lies with the sharing side. These risks, although inevitable, must be retrospectively justified for each new use case. The trade-off between perceived risk and the contribution of data-sharing platforms must be carefully considered to foster trust in these initiatives [3] The willingness to share data, or openness, is thought to go hand in hand with the juridical aspect of data ownership. [5] Trust is needed in this, from a risk management perspective, data protection impact assessments could help increasing data sharing initiatives and interoperability efforts [4] Trust is required because the issue of responsibility and liability in the event of an incident involving patient data presents a challenge for platform-to-platform openness.[7]

Despite these obstacles, there is a keen willingness within the sector to share data, but it must align with the legal framework governing data ownership[7]. Presently, there is a lack of comprehensive risk analysis that balances security concerns with the overarching goal of improving healthcare quality. [10].

5.6 Change Management and Governance

Challenges in change management and governance

Reaching agreements and consensus between platforms has been challenging due to the lack of top-down guidance since the cancellation of the nationwide EHR system. The decision by VWS to halt the initiative led to varied, decentralized approaches, with each party, logically, resolving issues independently. [1],[2] This resulted in a multitude of agreement systems and overlapping frameworks, causing platforms to adopt conflicting standards.

Additionally, competing healthcare platforms often promote their own unique standards, closely tied to their underlying IT architectures.

This lack of consensus is further strengthened by the challenge in the articulating of requests from platform users to platform providers. [7] There is however, the notion that complexity hinders progress, leading to a desire to oversimplify issues. This is compounded by a lack of understanding of each other's work processes and needs, along with further challenges in transitioning from existing structures due to misaligned incentives and business models [10] Next to this fragmentation and lack of consensus, there is difficulty in decision-making due to challenges in proper change management, and difficulty in the translation of agreements into concrete actions [2] The platform owners questions if the decision making party has the right knowledge and asks the right questions for getting the required facts to be in touch with the market, considering that there are many initiatives with lack of market alignment. [3]

A lack of visibility and insight into possibilities limits innovation, as not knowing what is feasible restricts the solutions that can be implemented. [7] There is also an element of 'not invented here' syndrome, where stakeholders (IT suppliers/platform owners as well as healthcare providers) prefer to develop solutions themselves rather than adopt external ones, relating to closeness on the producer side of a platform.[7] Openness initiatives are also thought to be perceived as a threat to market position of IT providers, leading to resistance out of fear of the losing of a competitive edge. This makes it hard to stimulate IT suppliers to innovate and allow exchange of data due to market position. [6] (This is in line with Mosterd as well as the KPMG rapport regarding market forces)

Addressing these change management challenges is thought to require mobilizing a small group of leaders to drive systemic change in collaboration with the government [101]. This effort should take an iterative approach toward a flexible long-term goal, driven by leaders committed to prioritizing patient care over self-interest [10]. Often the initial hype of healthcare initiatives is followed by slow progress. Continuous investment and attention are thought by public platform owners to lead to ensured growth of the concept over time, but the balancing of current solutions, functioning and initiated now, and initiatives working towards a more farsighted solutions, is vague and is experienced as being distorting.

Platforms owners do look to the government for input on what national agreements are to be adopted, and strongly prefer national agreement over regional based preferences, understanding the necessity to make ''painful governmental choices" to further the healthcare IT market. Interviewees feel that there is reluctance by VWS to make tough decisions to avoid conflict and satisfy all parties, hindering progress.[2] Stakeholders also express the need for greater alignment, and maximizing the effectiveness of existing efforts by charting existing knowledge and products instead of duplicating work and initiatives.[5]

VWS steers on the one hand towards a decentralized combinational network of platforms and also states on the other hand that the Cumuluz-concept, (federative system), is planning to be included in the national agreement system. [5] Seeing both as partial solutions. [6] Still requiring further development to address broader governance and data exchange challenges,

VWS is working on a roadmap and timelines to ensure the delivery of its initiatives. [6] This delivery however, is challenging due to the varying of the current legacy based situations for each healthcare providers, contributing to this lack of consensus regarding the most desirable IT solutions.[5] The lack of consensus, is also thought to be fault to the fact that multiple organizations manage standards in the field, contributing to fragmented consensus and governance. VWS has outlined that the Nationaal Vertrouwensstelsel (NVS) is its envisioned framework for taking governance over healthcare data exchange. [6]

Platform owners think that proper and healthy market regulation means the creation and supporting of a well-functioning market by taking governance. Only an increase in regulation mainly sets back smaller platforms, because to keep up with the latest commitments, there is no room for innovation when you have limited development capacity. [3]

Focusing on patient care leads to improved outcomes, but power dynamics and conflicting interests can hinder progress [10] Good governance strikes the balance between maintenance, change, and releases while fostering innovation. While these ideals are clear, there is a request to VWS to become concrete in actions and direction, as many stakeholders feel a need for more clarity and accountability. [5] The government has a challenging role in maintaining this oversight due to the perceived distance from the market making it challenges to set right and manageable compliance priorities manageable for providers.[1], [2], [10] Some state that the role played by VWS should mainly be as a policy influencer and financial distributor, not solely as a regulator[10] Central government

control on the topic of data exchange helps centralize and create consensus. The NVS brings a positive shift in thinking to the landscape; there is more focus on getting the basics right. What the vision for the future from VWS self is unclear. There is uncertainty about where VWS's leadership and ''taking of governance" begins and ends and to what extent frameworks and rules should be set that everyone must follow, and where it should stop.[9] However, still VWS must take the lead, as the NVS outlines how governance should be organized in the Netherlands[7]. Recognizing the shortcomings of a market-driven approach to "open" healthcare data exchange, VWS is now adopting a more proactive role to ensure that its vision is realized. [6]

API strategy as governance tool

There is narrow collaboration required between platform owners to map out essential information who they are, their developed specifications, deployed software, and compliance with quality criteria. [8] The formulation of the API strategy follows a bottom-up approach, developed in collaboration with the field based on goodwill. Simultaneously, working with VWS adds a top-down influence, further strengthening and facilitating its implementation.[8] The API strategy is built on creating consensus with suppliers by collaboratively developing the API library, including developer support and tooling to help suppliers publish APIs, incorporating involvement and trust.[8] Further governance initiatives by VWS should be set up together with platform owners as well.[8] Sustainable solutions are desired, a big-bang implementation is not possible since it infringes on innovation agendas and the tech-stack of platform owners. [8]

5.7 Financial considerations

When examining platform openness and the setup of boundary resources, financial incentives for data sharing and openness considerations emerged as factors, as detailed below. This is mainly from a governance based perspective, not delving into the proven efficiency strokes of network effects by platforms, but more why financial considerations around openness and exchange is difficult to achieve.

Financial structure of the healthcare IT market

Funding and financial resources are considered limiting factors for innovation [7], with current financial incentives hindering openness. It is noted that the provided financial stimulations are often at odds with fostering innovation and data exchange [1]. A challenge in these financial allocations is the desire for clear insight into outcomes, whether the focus is on infrastructure or innovation, accompanied with a well-defined end goal [7].

Private platform owners also point out that there are multiple "cross-investments" disturbing the market itself, also because healthcare insurance companies and the ministry of healthcare are developing and competing themselves with applications and platforms on the market. These build in financial incentives are thought to be ''stimulating disinvestments" on the market side, which leads to high uncertainty for market participants because of the volatility of the Dutch market.[3] These multiple cross-investments disturbing the market creates challenges in establishing a stable and competitive environment. [5]

Another financial consideration in openness decisions is that suppliers prefer less frequent iterations of implementation due to the significant effort and expenses involved. These implementation capacity challenges exist not only for suppliers but also for healthcare providers.[6] Hesitation in implementation is mainly due to costs, as it requires commitment, but for certain generic functions, this is fairly mitigated by VWS.[9] A careful trade-off is needed to build something which is sustainable and does not need constant adjustments, while being able to adapt to new requirements and stakeholder needs. A well informed choice is preferred.[9]

Greater data exchange tends to increase transparency among connected platform users, which could expose revenue sources and inefficiencies within healthcare organizations. While this transparency can help identify efficiencies and optimize cost structures, support for it often diminishes when leadership perceives it as a potential negative financial impact. The concern is that revealing these details could threaten existing revenue models for these platform users, leading to resistance against further openness and sharing of data. [10] Increased transparency and openness in that regard can also reveal efficiencies and influences of cost structures in healthcare, which adds another barrier to consider.[2]Hospitals as platform users specifically are thought to lack sufficient financial reserves themselves, with resilience far below recommended levels[10] [9] Hospitals' financial resilience barely above zero, however, there is still thought on the other hand to be still too much absence of financial risk systems hospitals due to guaranteed support[10] For healthcare providers, these shallow margins does make it challenges to transition towards other IT functionalities for exchange.

Financial interests does complicate relationships between healthcare providers and IT suppliers, since revenue considerations play a role within healthcare organizations and costs associated with friction or change, which are required for transitioning, prevent initiative to change.[2]These multiple cross-investments disturbing the market are recognized by platform owners and government IT advisors. [7] "Perverse" financial incentives hinder cooperation between healthcare providers. [9] Therefore there is little incentive to grant access or increase openness towards other platforms by platform owners as well, due to fear of potential loss of operating models. [1]

One-time financial impulses are not always aligned with the purpose of supporting long-term initiatives. These temporary financial solutions can fail to address core issues often obscure deeper systemic problems in healthcare [9]. As noted in the interviews, "The challenges in the national healthcare IT transition are not necessarily found in IT" [9], but rather in found in the demands of the healthcare market. [9],?? Financial incentives such as grants (VIP5) do stimulate product development, but doesn't necessitate quality of product. [3] As stated by "1 referring to an American saying form their healthcare counterparts, "Quality often doesn't pay money".

Insurance companies are said to hold the official power in the healthcare system, said to prioritize risk-avoidance over fulfilling their regulatory role in the system. There is uncertainty about insurers' role in driving of digitalisation initiatives despite their success in promoting appropriate care and the prevention agenda, and the system could benefit from more involvement from insurers beyond risk management. [10]

Challenges in financial allocation

Financing and funding is currently said to be insufficient for digitalization of healthcare on the one hand[10]While financial interests dominate, with stakeholders reluctant to cede control despite increased funding, conflicting interests will persist even when more budget is available and the systemic lock-in is mainly caused by these conflicting interests, with financial incentives attempting to stimulate change but failing to address deeper issues. [10] Especially consulting bodies state that there are concerns regarding smaller or niche platforms and companies are struggling more to stay up to date due to an increase in regulations and to remain compliant with laws and regulations.[9] [10]

There are concerns that unstructured funding can lead to scattered, ineffective initiatives [10] Therefore there is a request for system-level evaluation of progress and direction in healthcare initiatives and long-term agreements with health insurers is required for IT cost management and corresponding direction. Platform owners also think that the IZA financials enables a decentralised creation of a variety of platforms which could benefit of more centralized control. While the funding from the IZA is accelerating the digitalization of healthcare, some believe that IZA initiatives require more substantial financial support to achieve a fully functional national system. But on the other hand, there is a perceived lack of urgency for digitalization, attributed to the availability of financial resources, despite widely discussed demographic challenges, such as workforce shortages in the healthcare ecosystem [9].

6 Discussion

To start this discussion, what stood out most is that the used and explained concepts are open to broad interpretation. This section will first elaborate on how a couple of these concepts revolving around openness are perceived in practice in this research.

Notably, in this research, the formal definition made regarding digital platforms, does not specify how data itself is stored, which clarifies an observed confusion in the interviews regarding the difference between *data* platforms with centralized data storage and the concept of digital platforms of Gawer [2014], which does not yet specify or elaborate on any infrastructural- or storage configuration decisions made. Platforms which consider themselves more of infrastructural provisions for data exchange can in this conceptualisation be compared with platforms which do store data, strengthened by to the focus on the boundary resources in the platform periphery.

In the interviews, the concept of "platform owners" was often used interchangeably with "IT suppliers," , since platforms are provisioned by IT (EHR system) suppliers as well. Still, careful attention was given to distinguish between data platforms, digital platforms, and EHR systems as well as consideration of the specific type of openness and stakeholder involved, to maintain the specificity and relevance of insights for each type, but possible commonalities and shared aspects in these findings and underlying motivations are acknowledged.

As seen in section 5.1, there is disagreement about what the concepts of interoperability and data availability entail in relation to platform to platform openness; indeed, based on these interviews, platform-to-platform openness in itself was not a common topic of conversation. The focus is more on achieving interoperability, mainly between healthcare providers, as depicted by the NVS plateau's as well. in which the creation of an "open ecosystem" and the "opening up of the market" is mentioned, which in most documents goes hand in hand with the notion of a the creation of a level playing field and the desire of achieving nationwide data availability. The relationship that platform-to-platform openness has in relation to these concepts varies depending on the stakeholder.

Specifically in the analysed documents, the expression or ambition to "separate data and functionality" is articulated. What this entails varies considerably depending on the specific policy or advisory document consulted. Separating data and functionality can involve making data and systems interoperable, thereby allowing systems to be functionally linked[16]. Alternatively, it could refer to the federative arrangement of data on "one" platform[11]). Separating data and functionality is also described as having a standardized data model through the use of APIs, mainly focusing on the accessibility of data[20]. This approach aligns most closely with current practices based on the interviews, describing the separation of data and functionality as primarily enabling the ability to write back into platform owners' (and users') databases. This is achieved by decoupling data from applications through the use of appropriate data models, ensuring data is no longer hard-coded to specific applications. This is mainly seen as an ideal picture, or a "black and white scenario" as only a fraction of data can currently be unlocked this way, with much of it still tightly coupled to applications and rendered useless without them. The relationship between the provision of boundary resources and the separation of data and functionality is not deeply explored, but it is evident that data must be structured to enable boundary resources for platform exchange and interaction. The extent to which this requires data to be decoupled from applications or prepared for exchange remains unclear based on this research. This underscores the openness consideration that when data is closely tied to the revenue models of (EHR) platforms, there is little incentive to pursue the suggested separation of data and functionality, except in cases of mandated exchanges or specific use-cases requiring openness towards other platforms.

For platform owners, the idea that increased openness leads to greater innovation for the platform itself is only moderately present, favouring selective openness and mainly when regulatory or competitive pressures demand it. Based on the interviews and the platforms involved, platforms are viewed more in terms of transactional platforms with a focus on data exchange rather than innovation based platforms. Depending on the platform, especially when it comes to data exchange, there is often no clear distinction between data producers and consumers, as both are frequently healthcare providers, nor between the role of platform providers and owners. In some cases, third-party applications are connected, in line with literature on a use-case basis, in which the interviewed platform owners not yet differentiate clearly between apps and platforms in their current openness considerations.

Due to this transactional focus, there is mainly linear value development observed on the platform itself, with minimal emphasis, at least in this research, on truly bringing consumers and producers together or fostering (two-sided) network effects through the platform, mostly adopting linear based transactional business models.

Only one stakeholder involved as platform owner, mentioned the plug and play principle, offering a "best of suite" based platform, providing a single unified platform with al functionalities integrated, with the idea of offering more scalable solutions, enabled by modularity, allowing for less dependency on capacity and knowledge to the platform users themselves. Platforms with a more innovation based focus, aim to move beyond the mentioned "best of suite" solutions toward "best of breed" approaches, emphasizing curation and providing enhanced functionality by offering interactions between users groups.

It could be stated that the comparison of interoperability of healthcare providers and interoperability between healthcare platforms are two different intended purposes of the concept. With interoperability for healthcare providers more focussed on data exchange across different care based settings and standardizing information flow for direct healthcare outcome, and interoperability between platforms in literature being more emphasized on the interaction of systems within an *platform* ecosystem, more regarding data sharing standards, such as the API strategy and the use of boundary resources, more focussed on compatibility for providers for innovation purposes, not to mention attempting to apply this concept across multiple digital platforms and their ecosystems. Although the concept of interoperability between healthcare platforms and interoperability between healthcare providers differ somewhat in scope, both share the goal of enabling data flow within the healthcare ecosystem.

The organizational level of interoperability models does, in a way, incorporate openness between platforms, as the driver for the actual data exchange is identified at that layer. However, when it comes to platform-based interactions, if a stakeholder is unwilling to engage in interoperability discussions for any reason, this research frames it as an openness issue within a platform context, resulting from barriers named such as trust, costs considerations or limited governance, which are not incorporated in interoperability considerations spanning multiple platforms.

6.1 Technical Boundary Resources

The primary challenges identified in this study are more organizational and policy-based over technology based, which is partly expected given that most interviewees are affiliated with the government or supportive of government perspectives. Still, there are diverse interpretations of the contribution of the "API Strategy" across different stakeholders as to the influence it has to platform to platform openness. The API strategy is seen by many as a means of opening up the market. The API library does ensure that when enough parties are connected, there will eventually be more insight and existing opportunities in the healthcare landscape, which may result in a race for functionality and efficiency.

Regarding the formulation of API's as technical boundary resources in light of the API strategy, platform owners emphasize the necessity for broad participation for platform providers/IT suppliers, to justify the additional standardization efforts, since the focus is on individualized integrations with varying agreements tailored to specific platform user use-cases, further underscoring that these client-specific demands mainly influence the extend of data exchange and interoperability achieved. The reusability and profitability of these incentives will remain guiding principles in API development ensuring sustainable value across multiple use cases. This while VWS concentrates more on the essential role of API standardization in creating open systems and do encourage the alignment with existing solutions and market practices in the further evolving of the API strategy.

The concept of "open APIs" in the API strategy also highlights how the idea of openness can be interpreted in multiple ways, whether it refers to the method of invocation or the data itself. This unclarity in defining whether the focus around "openness" is on standardization or access is presented in most documents referring to the strategy. Since the API library of the API strategy is published only recently, it would be interesting to see what further motivates platforms to join and publish their APIs beside mandated sets as indication for openness considerations.

While APIs indeed facilitate an opportunity to connect, curating the purpose and usefulness of APIs is important and the use of APIs as a boundary resource in the Netherlands should not be viewed as the solution to everything. The concept itself is not new; data has been exchanged through APIs since "the earlier days of the internet". What is new regarding API's, in Dutch healthcare, however, is the formal listing and mandating of how to implement them. While the API strategy does not directly facilitate increased data exchange between platforms, it does support openness because mandated API publications can be bundled in the API library, and interoperability due to concrete standardisation- and quality requirements that a Rest API should meet as API-qualifications.

6.2 Social boundary resources

The topic of social boundary resources, in relation to the actual agreements made between individual platforms, was not comprehensively covered in the interviews. An a high-level the comparison was made by drawing parallels with agreement systems as contributions to openness in the form of social boundary resources. During this research, the government expressed its intent to support the TWINN agreement system as an interpretation of a national trust-based framework. While the influence and significance of agreement systems like TWINN are recognized, this research focused more on stakeholders' perceptions and the challenges associated with these systems, rather than the specifics of the agreements themselves. The emphasis was more on barriers on platform openness opposed to understanding the motivations behind choosing TWINN as an agreement system.

Continuous involvement of multiple platform owners is necessary for further organic development of such system in practice. Although the national agreement system facilitates the establishment of social boundary resources by setting technical standardization agreements, it was not found in this research what extend which platforms will share their data. Nonetheless, adherence to laws, regulations, and coherent technical agreements within a national agreement system can incentivize participation, to alleviate regulatory and privacy concerns for platform owners and users. The idea that security concerns inhibit openness among platform owners is consistent with Mosterd's conceptualization. The uncertainty over who holds responsibility in the event of data breaches poses significant barriers to collaboration and openness, as platform owners, as well as healthcare providers, fear both personal and organizational liability inhibiting the development of social boundary resources. When trust is minimal due to security issues and unclear accountability, the willingness to share data and collaborate declines. In this context, agreement systems, often referred to as "trust frameworks" for good reason, can indeed contribute to openness between platforms.

6.3 Financial and governance considerations

Comments about financial funding for digitization initiatives when asked about platform openness came up frequently, mainly in two directions based on the interviews around this funding regarding exchange and opening up the healthcare ecosystem. There is "too much" and there is "too little" money. Next to the fact that money is always a means to an end, these statements are thought to arise from the shifts and focus in financial contributions, frequently being passed back and forth, leading to a lack of clarity about where the primary focus should lie. The properly assigning of financial incentives is said to be hard mainly because of the systemic lock-in caused by the conflicting interests, with the financial incentives attempting to stimulate change but 'failing to address deeper issues.'

The healthcare IT market follows the healthcare market, making it difficult to achieve openness if the underlying cost structure does not support it. Tighter structuring of subsidies and strict regulations for the stimulation for more openness have already been highlighted as necessary measures,[16] but focusses mainly on the digitalization of healthcare, not on the underlying cost structure of healthcare itself as potential limitations in openness of their digital complementation.

The transformation effort is being addressed in a decentralized manner, with multiple fragmented initiatives. Health insurers, who form the funding body, not only oversee the funds but also evaluates the (platform-based) transformation (IZA) requests. This makes for a significant influence over the direction taken in the use of platforms towards national data accessibility. The IZA funds have led to the establishment of more platforms in various regions specifically for data exchange and while interviews suggest these initiatives have boosted data sharing within regions, their effect on platform-to-platform openness is varied. These regional platforms set up by healthcare providers make it difficult to maintain connections at a national level due to the varying platform configurations. When considering platforms, one could argue that a larger user base amplifies network effects. The creation of fragmented, regional-specific platforms results in smaller user bases, reducing the overall value they provide. It is understandable that multiple approaches are being pursued, as also recommended to VWS in the D&A report, and that immediate national alignment has its own challenges.

It is notable that the stakeholder interviewed at VWS indicated that the NVS is seen as the way to take control and give direction to governance, while the party involved in drafting the NVS has so far stated that it (the vision itself) does not yet provide a concrete method for stimulating innovation or exerting control for platform to platform openness.

Unclarity in roles and lack of legal mandate in combination with the sheer size of players in the healthcare market, makes for indecision resulting in boundary resources between healthcare providers that are set up cautiously, in poor consensus, or not at all, in which the acceptance of centralised agreement systems in this regard

for the creation of consensus could provide a basis for improving openness between platforms.

Although boundary resources are seens as a more stable foundation for the study of platform governance, where "control over the interfaces amounts to control over the platform and its evolution" [66], this primarily applies to providing acces to applications for innovation opportunities. Based on this research, while this concept for the facilitation of the arm's-length relationship could be extended to platform-to-platform relationships, it cannot be applied as-is due to the more complex openness considerations that arise from the greater fragmentation of solutions and varying interests when moving beyond a single platform ecosystem.

There is, of course, inherent resistance to change, a focus on immediate concerns, and redundancy in development work for platforms.[67] Moving beyond these issues in a complex, multi-actor environment requires a nuanced approach. In any setting, there will be discrepancies between established and emerging solutions, with each party approaching implementation from its own technological perspective. This results in ongoing tension around the "right" solution, whether in the form of a single integrative data platform or infrastructure or multiple decentralized, connected solutions. Achieving synergy among various options while advancing toward a shared goal is crucial while across debates on architectural preferences, agreement systems, and interoperability standards, remaining a (political) balancing act. Engaging stakeholders in collective, inclusive decision-making aligns with a mature change management approach and is recommended for platform governance.[7] While the proposed separation of openness between platforms from interoperability concepts can allow for more focussed discussions and research, in practice consensus on every concept may not be entirely necessary for progress in itself, particularly when dealing with these political and organizational aspects. Often, the most challenging task is ensuring the right stakeholders are engaged in the process, but nevertheless should allow to follow some form of negotiated truth.

6.4 Laws and regulations

While the Wegiz mandates openness for a subset of data and enforces interoperability through standardized formats, how this stimulates the extension of openness for platforms beyond the mandated set of data, following the "vliegwiel" principle, is anticipated to be found mainly in the reusability of the components of the established APIs. According to the interviews, the mandatory standardization for data exchange, such as the BgZ, is expected to therefore facilitate reusability for provisioned technical boundary resources outside the mandated set, contributing to openness.

Platform owners are cautious about extending data sharing beyond legal mandates, again citing concerns over costs and maintaining control over their product. VWS and advisory bodies oppose this and advocate for broader data exchange to improve healthcare outcomes, though the lack of clarity and support in the implementation poses challenges for the platform owners.

Compliance with frameworks like Wegiz and EHDS raises concerns for platform owners and consultancy firms due to the high costs and time demands, while government entities view these regulations as essential for standardization and interoperability, potentially underestimating the burden on IT suppliers. Based on the interviews, there seems to be a balance between innovation and legal compliance. Mainly consultancy firms and platform owners warn that over-regulation risks can hinder innovation, whereas government and advisory bodies often prioritize compliance, even if it limits flexibility. Smaller companies, in particular, struggle to meet compliance standards, hindering competition and innovation. On the one hand, there is the desire to reduce dependency on major players, yet on the other, there is a push to create an open (healthcare) ecosystem by mandating standards and exchange. An increase in regulation for facilitating interoperability could increase market entry barriers, further strengthening incumbent positions, reducing openness of the overall system. Thus, it is important to note that enforcing data sharing in itself does not automatically equates to achieving platform (to platform) openness, and caution for over-regulation may be in place since it could actually hinder the goal of a truly open and collaborative (and competitive) environment.

6.5 Limitations on method

Limitations on document and interview analysis

Documents provide a stable source of evidence and were used prior to the interviews to clarify key concepts and establish a foundational understanding. However, the public documents analysed in this study, while recently released, may lack precision or specificity in their execution and are sometimes subject to change as the market

evolves, particularly concerning implementation details and alignment with market developments.

Regarding interviews, while as a method they are targeted and can focus clearly on the case study topics, as well as being insightful and rich in information, there is a weakness in poor questioning, a response bias in the sense that interviewee's might just say what the interviewer wants to hear, as well as the tendency to incompletely recall information. Since only a single interview is performed with each candidate, this did not allow for no opportunity to further zoom in on aspects of the conversation that were possibly unclear or could benefit from additional clarification.

Awareness of potential interviewer bias is crucial, and efforts were made to maintain objectivity throughout the process. This was achieved by adhering closely to the interview questions, avoiding leading questions, and actively encouraging participants to share information freely. Face-to-face interviews provided the opportunity to observe non-verbal cues, offering additional context and meaning to participants' answers and enabling more targeted follow-up questions. However, given the politically sensitive nature of the topic, there remains a risk that some responses were influenced by participants' desire to provide socially or politically desirable answers, especially on such a complex and theoretically challenging subject.
While an in-depth approach was taken for this research, it is possible that nuances in depth and rigour were missed. While a holistic approach was attempted, given the vastness and complexity of the healthcare landscape, certain solutions or ongoing initiatives were inevitably excluded. For example the strategy of the national vision as well as the ongoing governmental initiatives for a nationwide covering network based on the D&A report used in this research.

More emphasis could have been placed on existing literature concerning digital "systems of systems," particularly regarding openness considerations between these digital platforms in relation to the EHDS regulation, but this was beyond the scope of this study. A comparison with countries outside the Netherlands, such as Nordic countries and Taiwan, was not included in this study, though it would offer valuable insights for future research, especially given the origins of mandating interoperability. The use of mandated interoperability standards and open API strategies, as seen in Nordic literature, was excluded due to scoping considerations and the fundamentally different healthcare funding models. Unlike the competition-based social health insurance framework in the Netherlands, Nordic countries primarily rely on tax-based funding for their healthcare systems.

Limitations in analysing platform typology

This research acknowledges that it did not sufficiently compare various healthcare platforms through out the sector to identify their types and the specific value units they offer. Greater insight into platform types and core functionalities could further clarify current openness decisions toward other platforms. Additionally, while this research does not fully address the role of commercial or public funded facilities, these types of platforms have emerged as central and competitive players in providing platforms and infrastructure that facilitates exchange. A closer examination of healthcare platforms could explore how commercial platforms function in comparison to public or semi-private initiatives and how these differences influence market dynamics. Private and public platforms often attribute market disruptions to one another, underscoring the importance of considering platform ownership when evaluating platform-to-platform openness in healthcare in relation to data exchange. It also stands to reason that public platforms would have different motivations for platform-to-platform openness compared to commercial platforms. While this research focused on documents influencing the formation of boundary resources, the relationship and incentives for developing such resources will vary depending on platform types. It is therefore essential to consider the platform's core purpose, whether data exchange constitutes the primary value it provides, the types of users it serves, and the nature of its platform owners or sponsors.

Reflection on involved stakeholders and included models

A platform-based perspective was maintained during the interviews, avoiding an overemphasis on the viewpoints of healthcare providers themselves, as they are categorized as platform users in this study. However, still the competitive relationship between healthcare providers themselves came up as hindering openness and the degree of autonomy in digitalization efforts results in fragmented solutions hindering interoperability between them.

As to comment specifically on the exclusion of platform competitors from the interpretation of the model of Drewel et al. [2021], The relation with competitors, although left out due to scoping considerations, could be argued in hindsight that platform to platform openness is in essence about the alignment, finding of value and the overcoming of disagreements between competing platform ecosystem, opposed to complementers or part-

ners who do not compete with the core (value mechanisms) of the platform. Courts, partners and competitors were also not adopted from the original model for scoping considerations. Courts as a role is fused here with legislators, seen as being the subsequent step of legislature once legal directives are not met. Platform partners, are not included, since it would not be considered a form of platform to platform openness, but more of an addition of an extra functionality or module to the platform, not competing with the value created on- or by users on the platform.

The level-based model of Ondrus et al. is based on the telecom industry, focusing on the ignition phase of platforms up to the point of self-sustainability. The continuous development of platforms is not included, as the article centers on the prior to launch phase of a platform. Applying Ondrus et al. [2015]'s model to a consolidated market may require additional consideration, along with a more detailed explanation and initial validation of openness at the different levels. This is because in the ignition phase, platform interoperability is described as interdependent on the success of user adoption across platforms. This dependency may not hold in a consolidated (platform) market, where the interactions and dependencies of distinct user groups are more established.

While the sharing of IPRs (Intellectual Property Rights) by platforms was excluded from this research based on the definition of Mosterd et al. [2021] and Karhu et al. [2018], which suggests that platforms cease to exist when opening up their core or become integrated, there is an argument to be made that resource openness can also be a valid form of platform-to-platform openness, depending on the nature of the IPR. IPR can encompass elements such as adopted data models, proprietary software or algorithms and analytical models. Data itself is not necessarily owned by platforms and does not necessarily have to be considered part of a platform's IPR. Additionally, I do not fully agree with the assertion that if IPR are shared, the platform will integrate and ceases to exist. An example provided by Karhu involves the provision of IPR is the open Android project, where the architecture of the platform is completely made open-source. While partial openness may forfeit certain IPRs, this does not invalidate its potential contribution to platform-to-platform openness. For instance, the partial provision of resources, such as sharing a platform model, can promote platform-to-platform openness as long as the platform core continues to exist independently.

Health insurers were not included in this study, while they are recognized as contributing players influencing platform rules and the distinction between commercial and non-commercial infrastructure. Mentioned in interviews as key influencers within the platform ecosystem, they indirectly impact openness by setting data access and interoperability standards that providers must meet to qualify for publicly funded services, in addition to offering data exchange services themselves.

Including the healthcare insurance parties as well as platform users for a more holistic understanding would be logical when considering driving forces for the arranging of boundary resources for platform tot platform openness. While the approached stakeholders were positioned at the highest conceptual level, so not in healthcare practice or further practical implementation, openness of platforms and interoperability can really be a policy based issue where the connection with practice is sometimes not felt, which is why it is even more important for future research to expand the number of stakeholders, especially in the direction of platform users, to be able to set a direction that keeps all stakeholders involved.

Other key stakeholders, particularly within VWS could have been more involved at a relevant level in these specific thematic discussions, currently limiting the focus on themes such as platform-to-platform openness in the envisioned national infrastructure and its relation to the national agreement system. Unfortunately, VWS was unable to facilitate an in-depth conversation with key players involved regarding these initiatives, so this research acknowledges a potential lack of input due to limited information on ongoing governmental initiatives for platform-to-platform openness as an infrastructural solution.

Further questions to VWS would have focused more on their perception of the way the Wegiz will facilitate the frequently mentioned "flywheel effect" for "open data exchange," since the current interpretation is based on mainly platform owners themselves. Therefore further exploring what "open" entails in that context, next to how (platform) innovation is stimulated within the ICT market and how this relates to the market "openness", as indicated in various policy documents. Additionally understanding how platform-to-platform openness fits within the national based infrastructure for healthcare exchange, and how the distinction between public and private platform openness is managed would have been an interesting addition.

It is acknowledged thoroughly that the methods used are interpretive in nature, while being used for exploratory research, explored quite a wide range of topics, this does impede the strengths of the found results. A more thorough in depth coding analysis on the interviews due to a market with concepts involving this broad, touching

this many stakeholders was not feasible within the current time constraints. For future research, the Q-method could be used to quantify the subjectivity of subjects, further capturing opinions and views around platform openness, too look in turn into requirements for desired platform openness for each major stakeholder in digital healthcare.

7 Conclusion

This research introduces a distinction between platform-to-platform openness and interoperability, addressing a gap in literature. While interoperability focuses on compatibility through standards, protocols, and infrastructure, openness involves governance, accessibility, and strategic decisions influenced by economic and legal factors. Differentiating these concepts is critical, particularly in healthcare platform ecosystems, where their interchangeable use can lead to misunderstandings. Platform-to-platform openness, measured through access openness facilitated by boundary resources, accounts for strategic accessibility while maintaining platform autonomy. Interoperability remains essential for compatibility but can also reflect openness considerations when compliance with standards entails costs or investments. Challenges in interoperability may stem from underlying struggles related to platform-to-platform openness. Factors such as market dynamics, organizational maturity, and the direct costs associated with maintaining interoperability standards, which can restrict openness considerations, are not necessarily directly accounted for in interoperability models.

While the notion that interoperability and platform-to-platform openness always go hand in hand is prevalent in consulted literature and governmental documents and both concepts relate data exchange, a strong focus on interoperability and standardization alone does not necessarily contributes to openness between platforms. By distinguishing between platform-to-platform openness and interoperability, discussions could benefit by reducing the tendency to frame interoperability issues solely as openness considerations, and vice versa. While a universally agreed-upon definition of these concepts might not always be necessary for addressing large, complex challenges, provided the right stakeholders are engaged, this distinction can help to come to a more focused, negotiated truth. Regulatory and organizational strategies then can address challenges regarding openness and interoperability separately, ensuring that solutions are tailored to the distinct concepts.

To address the main research question, how boundary resources contribute to platform-to-platform openness, this research highlights that boundary resources hold potential to facilitate platform-to-platform openness. However, in healthcare, the current focus remains primarily on interoperability efforts. The usefulness of technical boundary resources in the form of API's is acknowledged, particularly in the API strategy and related documents referring to it. Social boundary resources in the form of agreement systems, are increasingly recognized for their role in fostering interoperability, enabling trust and collaboration, which are essential for platform-to-platform openness. However, the achieving of interoperability can overshadow the organizational requirements and openness considerations necessary for successful data exchange.

Based on this research, contrary to what is mentioned in included documents and reports, the API strategy by itself will not achieve the separation of data and functionality. The API strategy is mainly focussed on standardisation and improvement of interoperability, not on openness between platforms. The race for publishing APIs in the library can foster competition based on functionality rather than data, but caution is needed in attributing the "separation of data and functionality" entirely to this initiative.

Boundary resources themselves serve as facilitators for openness or as support for realising openness considerations, whether their implementation is mandated by law or driven by efforts beyond regulatory requirements. The drivers and barriers associated with the formulation of boundary resources are closely linked to broader considerations of platform openness. For commercial parties, these considerations include costs related to implementing technical boundary resources, concerns about security and data liability, and the need to maintain a competitive edge. Additionally, the potential loss of existing business models and market position plays a role in openness decisions as well. In the context of healthcare, platform-to-platform connections are also regarded as a form of infrastructure, aligning with the transactional focus of digital platforms and the sharing of healthcare data observed in this study. Boundary resources, being a concept mainly used in relation to platform innovation by facilitating the arm's length interactions in the platform periphery, can serve as tools to enable an interconnected system of platforms.

Platform owners based on this research do not clearly differentiation in the use of boundary resources for platform to platform openness compared to openness towards complementers. Openness toward complementers focuses on expanding platform functionality by integrating third-party tools and services, which are typically platform-specific. In contrast, platform-to-platform openness requires collaboration, shared standards, and

agreements across multiple platforms. These two forms of openness, in essence user-level openness on the producer side and openness towards other platforms, serve distinct purposes and might require different strategies and without clear differentiation between the two, boundary resources may not be optimized for their intended goals.

Regulators

These findings could contribute to solving problems regarding interoperability and openness of healthcare platforms, ultimately leading to improved patient outcomes. This could support policy makers and regulators in the creation of regulations and agreements that stimulate innovation and collaboration beyond mandated exchange. Mandating interoperability standards and exchange of subset of data does not inherently increases overall openness between platforms. For policymakers, mandating data exchange is viewed by reports and stakeholders in the interviews as a necessary final step to achieve interoperability. However, based on this research, no additional stimulation for platform openness beyond legal mandates through the use of boundary resources was identified. Innovation could be stimulated not solely by increasing mandates and regulations but by aligning incentives more effectively and providing clear direction for the governance structures outlined in the NVS. Transitioning toward platform-based markets presents a distinct challenge, as it necessitates a fundamentally different governance strategy to address the complexities of such ecosystems, in this, there is hesitation in the formulation of boundary resources is attributed to financial allocations and unclarity in current roles and provisions in the healthcare ecosystem. This fragmentation in these incentives is widely underlined, accompanied by a risk that an excessive focus on a multitude of smaller efforts may leave the main, larger initiative overlooked. This misalignment among various initiatives could lead to inefficiencies and it would be unfortunate if, in hindsight, significant financial investments were made without achieving the transformative impact that is collectively aimed for.

Multiple interpretations of the roles and functioning of the API strategy and the NVS further complicate progress, highlighting the need for a "negotiated truth" among stakeholders. The complexity of the healthcare IT market makes it understandable that aligning all initiatives is challenging, often resulting in parallel efforts. However, a perceived lack of overall coordination and limited visibility into associated costs indicate a critical need for improved governance to foster increased commitment and better stimulate the formulation of boundary resources for platform openness.

Future research for regulators might further explore how to make the pursuit of data availability, even if it requires altering business or data models can be made more appealing to platform owners within the healthcare ecosystem. To address complex issues in this domain, which will often remain unstructured and contested, uncertainty should be seen as a shared problem, not an isolated one. Next to this negotiated truth, the creation of incentives for platform participants to engage meaningfully in the process of change towards more openness is essential.

Platform owners

For platform owners, interoperability enables the (technical) capability for data exchange and collaboration between platforms but does not inherently foster the user-driven interactions or scaling mechanisms that typically drive network effects platforms strive for. The idea that increased openness leads to greater innovation for the platform owners itself is only moderately present, favouring selective openness and mainly when regulatory or competitive pressures demand it. While increased interoperability through standardization enhances compatibility and openness facilitates third-party integrations and complementary services, it does not inherently ensure platform participation or drive value creation on the platform.

For network effects to occur *between* platforms, there must be a facilitation of value-adding activities that incentivize active participation and interaction among users, preferably across these platforms. This would involve creating shared benefits that span multiple platforms, such as improved user experiences or enhanced service offerings that allow for economies of scope or attract more users and, in turn, encourage further growth and engagement.

Platform-based businesses require innovative governance structures to maintain trust and manage user interactions, ensuring sustained growth. Platform to platform openness is an option to join ecosystems aiming for all platform participants to benefit. Many platforms still operate within a linear value chain, focusing inward and maintaining distinct roles for platform users, such as app developers (producers providing functionality) and end-users, without fostering direct connections. The best-of-breed approach, which prioritizes integrating

only top-performing components, limits the potential for network effects and overlooks the distinction between openness toward applications and openness toward other platforms. To overcome this, more open platforms could shift focus to offering a diverse range of applications to enhance functionality, competition and foster broader connectivity.

Unclarity in the (initial) core digital value that the platform aims to realise and facilitate should be clear before openness towards other platforms is enabled. Based on this research, currently, platforms primarily focus on transactional healthcare data exchange. To evolve towards a more innovation-driven approach, increased openness is suggested as a key enabler. Achieving this does require deliberate strategies and alignment among stakeholders and the platform ecosystem to move away from these individual linear based models.

Platforms frequently concentrate on certain healthcare sectors, such as medical specialist care, but hold potential to expand further into other markets such as primary and community care, enhancing connectivity across the healthcare ecosystem. Increased platform to app, as well as -to platform openness could be a viable option to enable not only exchange of data, but look into value creation beside the functioning of current transactional based platforms, by adopting a more curating role.

To conclude, boundary resources themselves serve as tools that enable platforms to activate their periphery and facilitate interactions, whether for data exchange or outsourcing development opportunities. In addition to being of value for platform owners, boundary resources also hold potential as a means for steering openness initiatives within the platform environment. Although platform-to-platform openness has been minimally explored in depth for healthcare, it shows promise in addressing wider infrastructure, innovation, and exchange challenges.

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Consent Form

xx/xx/2024

Participant Study Information

Dear Mr/Ms. *Name candidate*,

You are invited to participate in a Master's research study titled: ''*Exploring the role of boundary resources in platform to platform openness in healthcare*''. This study is carried out by Jasper van der Doelen for the Master Management of Technology in assignment of the TU Delft, with ChipSoft as separate internship supporter.

The purpose of this research study is to gather further insights and contribute to knowledge on platform openness. The arms-length relationship between platforms at the technical interoperability layer will be investigated, focusing on current boundary resource usage and associated challenges, especially in the context of emerging regulations.

The interview will take approximately 45 to 90 minutes to complete. The study's participants include owners and experts of Electronic Health Record (EHR) data platforms, who will be interviewed to provide insights, opinions, and perspectives on the research topic. The data will be used for consolidation of concepts and exploring current and envisioned applications. We will be asking you to answer the questions in this semi-structured interview as honestly as possible.

As with any online activity, the risk of breach is always possible, which involves the potential risk of impacting the company's competitive advantage or your reputation if sensitive or proprietary business information is disclosed. Your answers will be treated with the utmost confidentiality. We will minimize risks by taking mitigation measures, including data aggregation, secure institutional storage of data only accessible by the TU Delft research team and the destruction of personal identifiable information when no longer needed. These procedures are part of a reviewed data management plan, approved by the Human Research Ethics Committee (HREC).

Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to omit any questions during the interview and make contact in case of further questions or concerns regarding the study's purpose, scope, and intended use of the findings and usage rights. One the following page, a required consent form can be signed in order to start the interview.

xx/xx/2024

Explicit consent form

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
1. I have read and understood the provided study information, 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 understand that taking part in the study involves an audio-recorded interview, supported by written notes. The recordings will be transcribed as text after which the recording will be destroyed. The transcription will be sent to me for substantive review and confidentiality check.	☐	☐
3. I understand that the (identifiable) personal data I provide will be destroyed at the latest December 2024.	☐	☐
4. I agree that my responses, views or other input can be quoted *anonymously* in research outputs.	☐	☐
5. I give consent to the information above.	☐	☐

Signatures

_____	_____	_____
Name of participant	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.

Jasper van der Doelen

_____	_____	_____
Researcher name	Signature	Date

Study contact details for further information:

Corresponding Researcher
Name: Jasper van der Doelen

Responsible Researcher
Name: Mark de Reuver

A Interviews

The transcribed and anonymised interviews are described here.

A.1 Interview protocol

After a short introduction and expressed gratitude for participating and requesting if I may tutoyeren during the conversation, anonymity and structure of the research is stressed by going through the consent form. After that, the main research questions is elaborated and the core concepts are followed through together, elaborating on the made division of boundary resources into technical and social aspects, steered and facilitated in functioning by laws and regulations. This elaboration is made because of the already existing identified ambiguity surrounding concepts. After the thematic introduction, there is room to dive deeper into subjects in this semi-structured interview, depending on the expertise and experience of the interviewee. Prior to the interview, the position of the interviewee was further examined in order to place their alignment of expertise within the made distribution of boundary resources as well as stakeholder type, to direct questioning during the interview, when applicable. Being particular relevant for interviewees with highly specific knowledge of policy documents and/or advisory papers. The general thematic introduction send before each interview together with the figures it refers to is depicted below.

The main research question of my study is:

> *"How do boundary resources contribute to platform-to-platform openness in healthcare?"*

In this study, a platform is defined as a socio-technical system with a modular technical foundation that provides interactions, transactions, or services for various actors. Platform openness, in this context, refers to the extent to which one platform provides access of its resources towards another platform. Furthermore, boundary resources are defined as the agreements and software that enable other platforms to make use of the platform; see figures 1 and 2 in the appendix for a simplified setup. Boundary resources can be divided into a technical and a social aspect. The technical aspect focuses on APIs and how they facilitate openness in light of the current API strategy from Nictiz. The social aspect includes agreements, dependencies, and guidelines regarding openness between platforms. Both the social and technical aspects are influenced by policies and regulations, specifically including Wegiz, IZA, and NVS, as seen in figure 3.

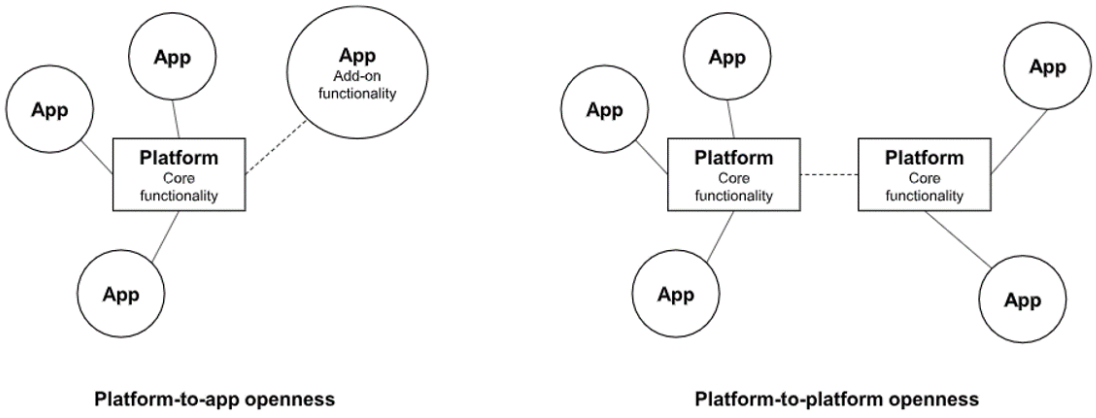

Figure 1: Difference between openness between platforms and openness of applications, adopted from Mosterd et al. [2021]

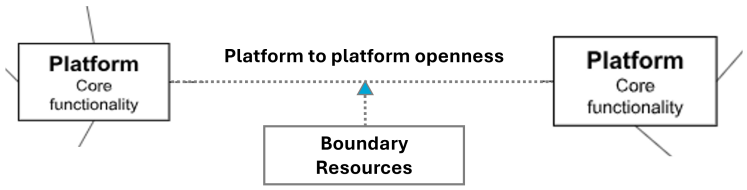

Figure 2: Boundary resources facilitate platform to platform openness.

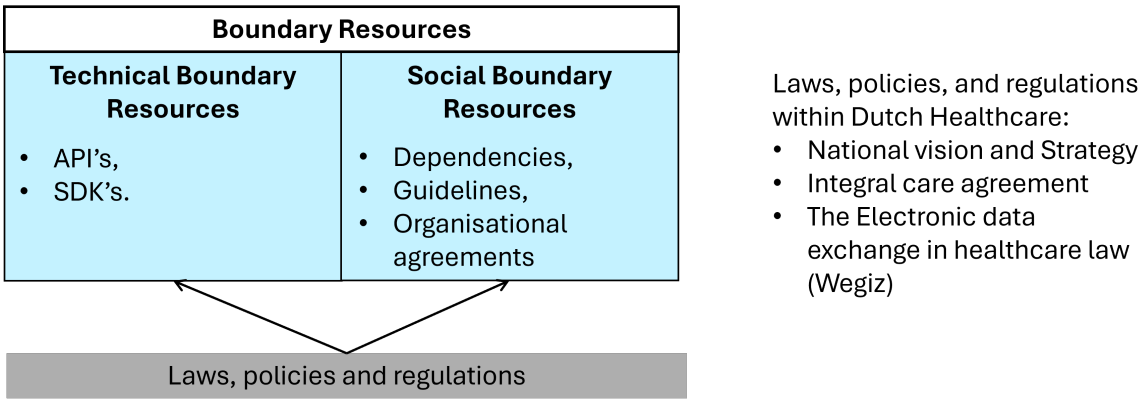

Figure 3: Boundary resources can be technical or social and are influenced by policies laws and agreements

A.2 Interview questions

The template questions below were used as guidelines for the semi-structured interviews.

- **Platform-to-Platform Openness**
  - What is required to facilitate platform-to-platform openness?
  - What are the challenges of opening up platforms in healthcare?
  - What does the process of platform-to-platform collaboration look like, and what are the challenges in it?
  - What are obstacles in realizing boundary resources for openness?
  - How do you see the separation between data and functionality as named in documents such as the NVS and API strategy?
  - Why is the separation of data and functionality necessary for openness between platforms?
  - How does openness between platforms relate to the regional platform initiatives realized under IZA?
  - What are the biggest obstacles in facilitating openness between private and public platforms?
  - What are the key components of the National Vision and Strategy that impact platform-to-platform openness in healthcare?
- **Technical Boundary Resources**
  - How does the API strategy of Nictiz influence the configuration of technical boundary resources?
  - How do you view the role of the API strategy in creating an open ecosystem?
  - How does this relate to the configuration and use of boundary resources?
  - How will an open API strategy contribute to openness between platforms?
- **Social Boundary Resources**
  - What are the challenges in establishing agreements on openness between different platforms?
  - What motivates stakeholders to formulate (social) boundary resources for their platforms?

  - What are the challenges in formulating social boundary resources for openness between platforms?
  - What are the main considerations (for platform X) when deciding whether or not to collaborate with other platforms?

- **Laws, Policies, and Regulations**
  - How do laws and regulations contribute to the configuration of boundary resources?
  - What are the challenges for platform owners in complying with laws and regulations like the Wegiz?
  - What are the main challenges in mandated data exchange between platforms?
  - Why is the Wegiz seen as the catalyst ("vliegwiel") for open data exchange?
  - What motivates platforms to exchange data beyond the mandated set of the Wegiz?
  - How is openness of digital platforms stimulated?

B Standards for health data records and exchange

There are several health standards for the uniformisation and standardisation of healthcare data and processes.[12] Since are mentioned in the interviews, and to provide a feeling for the various standards and their interactions, the most prominent and frequently used ones are described here. Standards used for interoperability in healthcare can be categorized into different types, such as governance-policy based frameworks, semantic and terminology standardization, syntactic and data exchange formats and architectural guidelines.

Interoperability, ethical, security, and regulatory concerns must all be resolved before the anticipated advantages of an integrated digitally accessible electronic health record can become a reality. With the possible advent of the European Health Data Space(EHDS), interoperability calls for european governance and policy based frameworks for regulation and security. The European Interoperability Framework is created to offer recommendations and principles for configuring compatible digital public services, and incorporates an organisational, semantic and technical layer, and incoporates combined information systems and "real world" systems.[68] [5] Where the voluntary European interoperability framework was lacking in terms of results, the new regulation interoperable Europe mandates compliance of EU states.[69]

Regarding syntactic and data exchange, one international standard for the electronic exchange of healthcare data is Fast Healthcare Interoperability Resources (FHIR), developed by Health Level Seven International (HL7). This non-profit organization provides this framework specifically for the exchange, integration, sharing, and retrieval of electronic health information. FHIR enables interoperability by providing a standardized way to represent and exchange healthcare data. 'FHIR resources' are defined which cover clinical and administrative concepts as well as their relationships. Implementability is prioritized, and the more frequent adoption of FHIR contributes to a common understanding of information models within healthcare ecosystems. The standardized representation of healthcare concepts in FHIR resources is in turn crucial for supporting the integration of data exchange services.

Next to data exchange standards and EU based interoperability frameworks, for semantic and terminology standardisation there is the Systematized Nomenclature of Medicine, Clinical Terms (SNOMED-CT or SNOMED) which is a terminology system. SNOMED provides standardized codes and terms to accurately represent clinical information, like diagnoses, procedures and findings and is used for the translation of terminology between healthcare providers. It is used for unambiguous recording and transfer of healthcare information, by enabling the translation of terminology between healthcare providers and next to that make connections between the disease process and client conditions and to establish relations between medical concepts. Other external terminologies with a comparable function to SNOMED exist, such as the Logical observation Identifies Names and Codes (LOINC), which focusses more of the usage of universal names and ID codes for laboratory and clinical test results.[70]

Specifically in the netherlands Zorginformatiebouwstenen (ZIBs), or Care Information Building Blocks, are developed, which are foundational elements designed to facilitate semantic interoperability within the healthcare sector in the Netherlands. These building blocks functions similar to how Clinical Information Models (CIMs) function internationally, which are also defined by the International Organization for Standardization(ISO). The unambiguous registration of healthcare information allows for semantic interoperability, ensuring that the intended clinical meaning is carried over clearly in the application and infrastructure layer. To achieve this clarity of language the proper usage and alignment of ZIB's and SNOMED for semantic interoperability is required. ZIB's are also integrated into FHIR profiles, enhancing compatibility with the global data exchange standards.

Lastly there are standards specifically for EHR systems. OpenEHR is an open source technical architectural standard, allowing for a vendor-neutral framework for representing and sharing clinical information in a standardized way in EHR systems. OpenEHR, FHIR and SNOMED-CT as standards work together. FHIR provides the structure for data exchange and SNOMED provides the standardized terminology and codes to represent the clinical concepts within that data. To put the relation of OpenEHR in perspective to FHIR and SNOMED, OpenEHR provides a model and approach for a persistent representation of clinical data in EHR's, while FHIR focuses more on the interoperability and exchange of that data. Both are able to work with terminologies like SNOMED CT to ensure semantic interoperability of clinical concepts. Further instances of resources for IT architecture resources, are e.g. the ISO/TR14639, which aids in the development of eHealth architecture by providing best practices and principles for setting up IT architectures in healthcare.[71]