Health data co-specialization model. A study of MedTech incumbents-born digital healthcare platforms

ABSTRACT

The limited success of digital healthcare platforms prompts discussion on how to benefit from digital innovations. So far, scholars have analyzed technological innovation, capabilities, network effect and business model contributions to advance digital healthcare platform performance. However, the role of health data as a co-specialized complementary asset is yet to be unveiled. We address this knowledge gap through the multiple-case study of three global digital healthcare platforms initiated and orchestrated by MedTech incumbents. The study conceptualizes data as a co-specialized complementary asset and explores the assumptions of health data co-specialization. We extend profiting from innovation (PFI) and platform literature by offering health data co-specialization model based on three components: data power mobility, data completeness, and data integrity. Furthermore, the study has practical implications for platform owners suggesting structural changes in collaboration to ensure data co-specialization critical to reap benefits from digital healthcare platforms.

Keywords: Digital platforms, health data, assets co-specialization, healthcare, MedTech incumbents, multiple-case study

INTRODUCTION

For more than a decade the focus of investors in digital healthcare platforms has been fixed on the technological advancements, network effects, and search of relevant business models (e.g., Pundziene et al., 2022). The incentives to innovate are dependent on the benefits, whether social or private, retrieved from the efforts, and hence the development of digital healthcare platforms prompts discussion on how to benefit from digital innovations in healthcare context (e.g., Wass & Vimarlund, 2016; Yang et al., 2022). However, as the combination of digital technologies and healthcare is a highly complex one to manage, comprehending the phenomena is challenging – and integral for succeeding (Cenamor & Frishammar, 2021; Hurmelinna-Laukkanen et al., 2021). So far, the return on investments especially reported by MedTech incumbent-born healthcare platforms is disappointing (Pundziene et al., 2022). Therefore, it is not surprising that more research about the digital transformation of healthcare has emerged (Hermes et al., 2020).

Although scholars have analysed business model innovations and other related aspects of digital healthcare platforms (e.g., Gawer, 2014; Cusumano et al., 2019, Cusumano et al., 2021; Cozzolino et al., 2021), prevailing practical challenges (e.g., Pundziene et al., 2022) suggest, the question of how to benefit from digital healthcare platforms remains open. Profiting from innovation (PFI) framework (Teece, 1986) provides an overarching view on how to profit from innovations, but the complex healthcare context seems to require more detailed examination of that framework. Even with recent considerations on PFI where digital platforms have been acknowledged (see Teece, 2018), there is a lack of deeper analysis.

In the PFI framework, co-specialized complementary assets are defined as valuable resources that feature bilateral or multilateral dependence between two or more platform actors or platforms (Teece, 1986). Furthermore, asset co-specialization can be seen as mutual investment by platform

actors or platforms in resources, processes, and structures, which facilitates information and knowledge exchange (Teece, 1992; Santoro & McGill, 2005). To date, it has become evident that data plays a central role in digital healthcare innovation (Kemppainen et al., 2019). We argue that health data is an object of co-specializations because it emerges in the process of collaboration between the patient, healthcare provider, and MedTech incumbent that typically provides relevant data collection and/or processing infrastructure. A patient is connected t more than one healthcare provider who uses more than one brand of medical devices linked to more than one digital platform. Consequently, the health data of an individual patient is stored and processed by multiple different platform owners. Siloed and fragmented patient health data becomes a glass-sealing that impedes the value creation and capture from the digital healthcare platform. Thus, none of the platforms possessing a fragment of a patient's health data can move forward or scale-up. Based on these considerations, it can be expected that co-specialisation of health data unveils new opportunities of value creation and capture.

However, some scholars (e.g., Ceccagnoli et al., 2010; Jacobides et al., 2006) regard asset co-specialisation not as a facilitating, but as a limiting factor for business growth in uncertain environments. Considering this notion together with the above setting that points toward health data co-specialization being even a necessity in digital healthcare platforms, more research is needed on the benefits and challenges of health data co-specialization as well as on its role in terms of benefitting from digital healthcare platforms.

In this study, we aim to understand the nature and role of health data co-specialisation and how it can mitigate value impedance preventing digital healthcare platforms from succeeding and reaping satisfactory benefits. We examine data co-specialisation by building on empirical evidence from three global MedTech incumbent-born digital healthcare platforms. We deploy an explorative

multiple-case study to investigate how these three digital healthcare platforms co-specialise health data, and to understand the most prevalent challenges in these platforms, and how the diverging platform providers overcome the challenges and facilitate the benefiting-from-innovation processes among the platform members. Interview and archival data from three incumbent MedTech companies forms the basis of the analysis.

Our study offers three-fold theoretical contributions. First, we build on and extend profiting from innovation (PFI) framework (Teece, 1989, 2006, 2018) by applying and evaluating its principles in a less investigated context. Although some scholars claim that PFI fits mainly traditional industries, our study suggests that the framework can explain business performance of data-based innovations. Second, we extend classification of co-specialised assets (Jacobides et al., 2006) by adding health data completeness instead of complementarity and data integrity as second-order theme in line to power mobility component. In contrast to some earlier studies and Jacobides et al. (2006) notion, our paper provides empirical evidence that health data co-specialisation is not a limiting, but a critical factor to the digital platform success. Third, we present two novel components of health data as a co-specialised asset – completeness and data integrity specific to the digital healthcare platform context and critical to co-create and capture value from digital technologies in general.

Our study has important implications for digital healthcare platform owners and healthcare policymakers. It shows that to mitigate value impedance and benefit from digital healthcare platforms, platform owners need to invest in health data co-specialization, which will increase health data 1) data power mobility, 2) data completeness, and 3) data integrity. Data completeness and integrity are vital in creating value for digital healthcare platforms and their users, so promoting these is needed. Furthermore, data co-specialization can initiate a chain reaction that

can potentially lead to successful M&A deals between incumbents and start-up-born platforms (Brueller & Capron, 2021). Consequently, policy implications call for reviewing and creating an appropriate regulatory environment for health data co-specialization agreements that also can be seen as quasi-organizational structures facilitating health data exchange (Kogut & Zander, 1992).

In the following sections, we will first discuss the digital healthcare platforms and their central features. We then discuss how profiting from innovation is a stream of discussion that helps to understand how benefits can be gained from such platforms. Next, we turn our attention to data as a key resource and consider its co-specialisation as an activity that generates value for the platform actors and platforms. Empirical evidence from the three MedTech incumbent-born digital healthcare platforms facilitates the development of the theorising, and we summarise the learnings from the empirical and theoretical materials in the concluding remarks.

THEORETICAL BACKGROUND

Data and Digital Healthcare Platforms

Healthcare has evolved as a highly professionalized sector with unique features (Mol, 2008). During the 1960s and 1970s, healthcare providers such as hospitals started to differentiate themselves structurally and strategically (Salge, 2012). Following these developments, a range of regulations was introduced and implemented in the field (Miller & French, 2016) to promote public involvement, accountability, and transparency (White, 2000; Porter & Teisberg, 2006). From the 1990s onwards, the rationalisation of care processes and restructuring have played a prominent role (Cabral et al., 2019; Cendán & Good, 2006; Wiik & O'Hara, 2021). With digitalisation being intertwined in these developments (Agarwal et al., 2010), data, information, and knowledge developed, shared, and applied in operations by different stakeholders from healthcare

professionals to innovating companies and patients have become increasingly important (Hurmelinna-Laukkanen et al., 2021; Länsisalmi et al., 2006). As Kemppainen et al. (2019, 45) note, "the contemporary environment for healthcare presents a constant need for innovations that use (heterogeneous) data."

Data is highly relevant for the latest healthcare innovations, especially those building on digital advances such as decision-support solutions (Dowd et al., 2018; Meskó et al., 2018; Nambisan et al., 2019). Varied data from electronic health records to personal data that impact healthcare costs, quality, and outcomes are needed (Meier, 2013). The challenge is that potentially valuable, relevant data is typically dispersed, and its use is highly regulated (Kemppainen et al., 2019; Vazirani et al., 2019). These issues make collaboration and cooperation a natural approach t adopt (Djellal & Gallouj, 2007; Gulbrandsen et al., 2016), even if it requires specific attention in organising and management.

The platform economy has brought with it expectations regarding how different actors can function in fields such as healthcare (Cenamor & Frishammar, 2021; Hautamäki & Oksanen, 2018). While digital tools based on machine learning-derived algorithms and advanced data analytics can enhance quality and efficiency, they do not work well if left separated and isolated from each other (Halamka & Cerrato, 2021). As Nambisan et al. (2019) suggest, several firms have established digital platforms to promote advanced data analysis, virtual care, and varied health and well-being services. These platforms enable the engagement of different actors to share data with their peers, subordinates, and relevant stakeholders (Hermes et al., 2020; Islind et al., 2019). However, these platforms are not without challenges. The multiple motivations, existing hierarchies that direct the use of information, and need to balance between privacy (of individuals, e.g. patients) and efficient data use (e.g., by innovating companies) present intricate dilemmas (Kemppainen et al., 2019).

Co-specialized Complementary Assets

Profiting from innovation (PFI) framework emerged as an attempt to explain why innovating firms often fail to generate significant economic returns from innovations when other market players (e.g., customers, imitators) manage to reap the benefits (Teece, 1986). As a start, Teece (1986) identified three fundamental building blocks of PFI: appropriability regime, dominant design, and complementary assets. The last are of interest in this study. Typical examples of complementary assets include brand, distribution channels, and complementary technologies/products/goods (Afuah & Tucci, 2013 Dahlander & Gann, 2006; Leiponen & Byma, 2009).

Teece (2006, p.1134) suggested that "perhaps the most important contribution of PFI is that it defined and developed a taxonomy around complementary assets and technologies: specialised, co-specialised, and generic". While generic assets refer to those that do not need to be tailored to the innovation and are always available in an industry and can be easily accessed, specialised assets indicate that innovation and the complementary assets are unilaterally dependent. Finally, co-specialised assets are those featuring bilateral dependence, and co-specialisation refers to the mutual adaptation of two firms or assets (Teece, 1986, 2006, 2018; Jacobides et al, 2006). Co-specialisation, in particular, is relevant as in recent years, scholars have increasingly realised the importance of not only the individual, current appropriation, but also the interdependent, future appropriation set in a networked environment (Ahuja et al., 2013; Yang et al., in press).

Co-specialisation is considered to consists of two components. First, complementarity refers to the extent to which two mutually adapted firms can generate superior value in combination. Second, power mobility captures the extent to which it is easy to replace one set of complementary assets with another (Jacobides et al., 2006). These two components have been differently emphasised over time. With the prevalence of the digital economy, complementarity has become more

prominent regarding saving time and money when building digital ecosystems. On the other hand, power mobility has become a regular process to accommodate the dynamics of ecosystem players.

Co-specialisation concept is well established in the theory of the firm, however, so far it has limited visibility in the theories of platforms. Thus, there is lack of comprehension on how health data co-specialisation creates value to platforms actors and platform owners.

Conceptualizing Health Data as Co-specialized Complementary Assets

While previous studies focus on the development of digital platforms to facilitate data applications and to generate insights from the relevant analytics (e.g., Zutshi et al., 2019), this study proposes that health data can be conceptualized as a co-specialized complementary asset. In digital platforms, different actors are networked to exchange resources and co-specialized complementary assets to produce and sustain innovations (Blomqvist et al., 2005; Chesbrough, 2003; Laursen & Salter, 2006), and considering the relevance of data as a resource in the healthcare context, this proposition is grounded.

In the healthcare context, data is strictly regulated and privacy concerns are constantly present, which influences the health data accessibility by tech firms. Thus, a common practice of tech companies to access data and develop innovations is building collaborations with individual healthcare providers such as hospitals. Closed strategies where collaboration is limited may, for example, slow down the identification of the best use cases of general-purpose technologies (such as AI; see Yang et al., 2021), and MedTech incumbents are therefore shifting towards the open platform to allow third parties to use (and test) their technology in parallel (e.g., Pundziene et al., 2022; Aghdam et al., 2020). In digital healthcare platforms, specialised actors are connected through the platform and health data as a co-specialised asset is bilaterally dependent on

innovations (Teece 1986; Teece et al., 2022). To utilise the full potential of digital technology, such as IoMT, AI, VR/AR in creating value-based healthcare services, digital healthcare platforms are dependent on complete and high-quality data set along the patient pathway (Han & Ma, 2022; Mankletow et al., 2022; Bettencourt-Silva et al., 2015). The value of co-specialized assets comes from its use cooperatively with other assets. Such cooperative use of co-specialized assets is both value enhancing and new market creating (Giustiziero et al., 2022), which also applies to healthcare.

At present, donors and owners of the health data are diverse and self-contained, which most of the time stalls integration of health data into one meaningful patient pathway. Siloed and fragmented health data impedes advances in personalised, predictive, preventive, and participatory medicine as all of it rests on accessibility of right health data (Pundziene et al., 2023). Health data as co-specialised assets are critical for value creation and capture when building digital healthcare platforms as the data can have zero value in separate use and life-saving value in joint use. "Bundled" or complete health data-based solutions also associate with revenue enhancement for the co-specialised platform actors or platforms (Pitelis & Teece, 2010, p.1256). Co-specialisation of health data can also emerge when specific data is idiosyncratic and not instantly available in the market (also called a "thin" market). Therefore, creating and capturing data co-specialisation benefits is closely related to platform actors' or platforms' integrated efforts empowered by their dynamic capabilities. Although data co-specialisation can bring potential risks (e.g. added value by co-specialisation can be appropriated by different parties without the asset owner's approval), it can be critical for systemic innovations, such as digital healthcare platforms (Pitelis & Teece, 2010; Giustiziero et al., 2022). For example, complete health data sets cannot be co-specialised among platform actors or platforms. In that case, the complete data set will need to be created

internally, which is associated with huge time and financial investments in the healthcare system (a highly regulated industry).

Previous studies have not yet clearly indicated how data can emerge as a co-specialised asset; we also have limited knowledge on how platforms can facilitate the co-specialisation of data. This paper aims to uncover these issues and advance understanding of health data as co-specialised assets using an exploratory multiple-case study method.

RESEARCH METHODOLOGY

Exploratory multiple-case study of MedTech incumbent-born digital healthcare platforms

This paper uses an exploratory multiple case study and investigates three large MedTech companies. All of them are owners of digital healthcare platforms, and we are interested in studying how they co-created co-specialised health data with other platform members. A multi-case research design enables comprehensive observations of complex relational processes (e.g. Eisenhardt, 1989, Eisenhardt & Graebner, 2007) and is particularly useful for generating new insights from theoretically novel phenomena (Edmondson & McManus, 2007). We intend to explore how these incumbents in collaboration with the different platform actors generate data as a co-specialised asset, which is crucial in driving success in digital health. Notably, although ecosystems evolve over time, we do not engage in this paper into process research explaining longitudinal changes of ecosystems (Langley 1999).

The three incumbents – MedTech A, MedTech B, and MedTech C – were selected for several reasons. First, all of them are prominent companies that have invested heavily in developing major digital platforms that could serve as the digital backbone infrastructure enabling and driving the digital revolution in the healthcare industry. Second, these firms are incumbents that can be

compared as they have been competitors in the healthcare industry for several decades already. Their strategic position and choices are similar, and they face similar challenges related to the emergence of digital giants who are entering the healthcare market as well as start-ups with revolutionary technology-based medical solutions. Third, the records of these three companies on the platform development and in-depth information about the opportunities and challenges in generating co-specialised data-based applications with ecosystem partners were available, which allows clear and rigorous analyses.

Data collection

The empirical materials were gathered primarily through in-depth interviews with participants from the three MedTech companies and some ecosystem partners. We organised separate interviews with each company. In total, we conducted 43 interviews and 48 hours with key informants. They were identified using a snowball sampling approach – key informants were asked to recommend people who had an active role in different phases of the relationship (Sjödin et al., 2016, Sjödin, 2019). The interviewees included business developers, R&D managers, project managers, and data and software engineers. All interviewees were actively involved in the development or commercialisation of the digital healthcare platforms. These interviewees allow us to generate a comprehensive understanding of the platforms of the three companies and how data applications are co-created with different ecosystem partners.

Table 1 provides a summary of the data collection. The interviews took 68 min on average and were held face-to-face or via calls. Interviews were all recorded and transcribed. The transcripts provided the basis for the data analysis with the help of MAXQDA and NVIVO. We triangulated our data by comparing multiple interviews and by applying a review of documents (Jick, 1979).

In addition, we performed document studies, reviewing company reports, agreements, and project documents to validate and provide context to our respondents' views.

Insert Table 1 about here

Data analysis

We followed an interpretive research approach to give voice to the managers, engineers, and health professionals actively involved in the healthcare platform development and the co-creation of data applications with other ecosystem players (see Clark et al., 2010). The data analysis was based on a thematic analysis approach, which provides ways to identify patterns in large, complex data sets (Braun & Clarke, 2006). The thematic analysis offered a means of identifying links within analytical themes. Through a series of iterations, overarching themes could be identified so that an empirically grounded model could be developed. We followed the Gioia's method to conduct data analysis in severalsteps (Gioia et al., 2013).

The first step in our data analysis was an in-depth analysis of the raw data (i.e., the interview transcripts). We identified first-order categories of codes that reflect the views of the respondents in their own words, with attention to repeated concepts shared among the respondents. The second step consisted of examining the first-order categories to detect links and patterns and combining them. This iterative process yielded second-order abstract and theoretical themes. The next step involved the generation of aggregate dimensions that represented a higher level of abstraction. Here, we used insights from the literature to form more theoretically rooted dimensions. In other words, the aggregate dimensions (built on the first-order categories and second-order themes) present a theoretically and practically grounded categorization.

Description of the Cases

MedTech A company's digital healthcare platform case description

MedTech A company established and launched to the market digital multisided platform for healthcare providers and partners, that provides diverse solutions and services to the healthcare providers and covers the entire spectrum of healthcare. The digital healthcare platform aims at nurturing the digital healthcare ecosystem by bringing together healthcare, MedTech and digital platform solution providers as well as conjoining their data, applications and services.

MedTech A company's digital healthcare platform combines and assesses data from imaging, in-vitro diagnostics and medical documentation. The data is generated through the data-base, connecting MedTech company's customers who have agreed to become a part of the digital healthcare ecosystem. Besides, the digital healthcare platform allows exchanging data and knowledge within and beyond their institutions worldwide. The Platform is meant to contribute to value-based healthcare by enacting fast, simple, safe and seamless interaction between providers of data and knowledge. Finally, the platform is providing its customers with aggregated data that is useful for diverse purposes, e.g. predictive analysis and improved diagnoses as well as therapy choices.

MedTech A company concluded that the success of the digital healthcare platform depends on the number of digital service providers that contribute to the platform. Thus, important part of the platform is open application programming interfaces (APIs) that empower application developers and solution providers to create complementary services which are integrated into the digital healthcare platform. Platform also creates added value to the service providers as they can access one of the largest pools of in-vivo and in-vitro data, and healthcare providers network.

One of the leaders of the digital health services of MedTech A company commented that in order to pursue value-based healthcare, it is critical to help healthcare providers to digitalise and create a network for sharing data and knowledge. In his opinion big data should serve healthcare providers with deeper insights and more effective analytical, diagnostic and care process management, and, thus, create clinical and operational value. Finally, the leader stated that such a major digital transformation, including a digital healthcare platform, can succeed only when all parties (e.g. MedTech companies, healthcare providers, partners, etc) are working together.

The digital healthcare platform operates on the cloud-based network and was recognised for its data privacy and safety; it provides different levels of privacy in compliance with relevant regulations. Currently, it contains millions of data records from hundreds of customers (healthcare providers) sites what helps to generate valid insights for clinical purposes.

To sum up, the digital healthcare platform serves as an open ecosystem to application, service providers, MedTech companies, data providers and enables them to offer to healthcare providers more accurate and efficient decision-making and increase effectiveness and productivity.

MedTech B company's digital healthcare platform case description

MedTech B, one of the largest software, IT, and Could service companies, is a pioneer in developed cognitive artificial intelligence (AI) platform with initial interest in healthcare industry. Empowered by various AI solutions such as natural language processing, deep learning and expert system, MedTech B Health offers platforms and solutions for managing and analysing clinical data, assisting clinical decision making, customizing clinical trial development, and so on. It works closely and collaboratively with healthcare providers to facilitate their care delivery to patients. It

also works with other partners such as researchers and data scientists to develop and refine its platforms and solution. Partnership is an important data source of MedTech B Health.

The digital transformation and advancement constantly reshape the healthcare industry. MedTech B Health seizes the chance by providing smarter and more connected IT solutions to manage medical data, automate organisation's administration and concentrate more on patients. To be more specific, MedTech B Health provides multiple functions such as interpreting medical images with highly accurate AI algorithms, analysing scientific literature and previous medical cases to seek for treatments of different forms of diseases, and identifying cancer treatments combined with more clinical details than human doctors can manage. Customised functions are also evolving with the requirements of customers to cope with ever-changing clinical needs.

MedTech B is still a leader offering AI-embedded platform. During the vertical collaborations with healthcare providers, MedTech B has demonstrated great potentials in integrating and processing various types of unstructured data including medical records, images and scientific literature. However, in some cases, MedTech B did not go off as expected. The reasons are manifold. First, the high costs of development with needs for data and experts countered off the benefits of MedTech B. Second, the limited amount of high-quality clinical data weakened the performance of MedTech B, as AI algorithms are data driven. Third, applying AI to health care is cutting-edge but at the same time risky, as some explorations are deemed to be futile attempts. Fourth, the mistrust of the public on AI and the strict regulations of healthcare data hampers the wide application of digital healthcare platforms.

To cope with those challenges, MedTech B recently started to adopt a more open-innovation strategy for the platform. Remarkable milestones include the introduction of platforms that allow outsiders to access to MedTech B, and the release of a set of Application Programming Interfaces

(APIs). In addition, MedTech B sold part of its healthcare business (healthcare data and analytics assets) to sharpen its focus.

MedTech C company's digital healthcare platform case description

MedTech C is a leading European health technology company focused on improving people's health and enabling better outcomes along a continuum from healthy living and prevention to diagnosis, treatment, and home care. Healthcare providers face barriers in their attempts to improve healthcare outcomes and lower the cost of care based on a more effective use of medical data. Regulatory issues and standardisation—or lack thereof—can fuel the creation of siloed systems and hospitals and healthcare systems traditionally had very disparate architectures with siloed data. This complicates everything from improving care to reducing costs, to building new software solutions.

The health technology company has been working for about 10 years on the development of a digital Platform leveraging technology as well as clinical and consumer insights to deliver integrated solutions. The primary function was to create links that consolidate records data from a healthcare provider's partners with MedTech C devices designed to help monitor the health of patients at home.

In recent years MedTech C describes the platform as a healthsuite system of engagement which is conceived as a layered platform consisting of foundations capabilities (e.g. IoT and device management, data storage & management, privacy and access control, etc.) systems of records and engagement capabilities (e.g. such as for journeys for pregnant women or for diabetes patients and oncology patients). The health suite of engagement works on systems of records with information about patient history, clinical documents, notes protocols, etc. The digital healthcare platform is a

cloud based digital infrastructure to use data effectively in care pathways, MedTech C medical solutions, and solutions from other partners that make up the healthcare ecosystem such as payers, vendors, healthcare providers, governments and retail.

The Health Suite system of engagement should enable MedTech C and its partners to develop products as services systems and devices, and individuals within the healthcare ecosystem should be able to interact with data that come from across a number of different systems of record. MedTech C had success so far in building an ecosystem with different devices manufacturers, integrators in the medical industry, and the company developed some initiatives with pharma companies. There is however quite some inertia from the main ecosystem partners such as payer, vendors, healthcare providers and government to embrace healthsuite as the foundational digital infrastructure to connect the dots over the entire health continuum. Major barriers we detected are the investment cost, perceived data security risks, reputational and income loss for clinicians, the need to learn new skills, lock-in effects, and the preference of healthcare actors to own their own medical data. In other words, technically the healthsuite is a highly effective digital infrastructure, a foundational platform that could break down the data fragmentation in the healthcare sector, but the ecosystem building has been slow and is far from complete as most important players in the industry are not yet connected.

In this sense, it is interesting to follow up the recently signed multiyear strategic partnership agreement for connected care solutions with an association of 28 regional hospitals. In doing so, hospitals standardize systems, reduce costs, act together and learn from each other. Their strategic direction is to move care to the patient's home wherever possible. In making this move, removing the burden from the patient and the care provider is central and they do this by using MedTech C'

latest technological innovations in the field of patient monitoring and population health management.

RESULTS

The results of the intra and cross-case analysis provided us with a broad picture of the health data as a co-specialized complementary asset in the context of MedTech incumbent-born digital healthcare platforms. Relying on the interviews and the analysis of the prior literature, we defined health data as a co-specialised complementary asset as a degree to which it stimulates "physical integrity" (integrity of technological infrastructure and processes) between the co-specialising partners; completeness of data; bargaining on sharing inputs and outputs of data between the co-specialised partners (power mobility) and interdependence of co-specialised partners while building products or services based on data (complementarity). This definition combines various aspects of the PFI literature, starting with Teece's (1989, 2006 and 2018) definition of co-specialised assets as assets that are mutually dependent with innovation. Later, Jacobides et al. (2006) provided some granularity by naming two components of co-specialisation – complementarity and power mobility. Complementarity stands for the extent to which to mutually adapted assets can produce superior value in combination. Power mobility defines the extent to which companies have limited alternative options that leads to bargaining and flexibility problems (Lambert et al., 2020, Hurmelinna-Laukkanen and Ritala, 2009). In our cases, we have analysed health data as co-specialised assets and its components with the aim to understand better why and what health data componenst are critical to successful value creation and capture in the context of MedTech digital healthcare platforms.

We further provide data structure (please see Figure 1) illustrating the pathway from the 1st order concepts to the aggregated theoretical dimensions. As a result of the analysis we have arrived to

two less discussed dimensions under the prior research of the co-specialised assets. The analysis is structured based on the aggregated theoretical dimensions and supported with quotations from the interviews.

Insert Figure 1 about here.

Power mobility as bargaining power of platform actors

Power mobility is acknowledged to be a significant bottleneck in managing complementary assets (Jacobides, 2006). In healthcare multiple sides have to cooperate to complement health data, thus there are complex relationships between the complementors in addition to the heavy regulations. Thus, bargaining power is important to convince complementors to share data, but also to maintain them for the long period of time. Health data use rights are critical to data users:

> *MedTech A: "recognising that gaining insight from vast amounts of data is critical to their [MedTech, Pharma, start-ups] long-term competitive advantage"; "and its data use rights that we have to obtain." (Manager, digital business)*

> *MedTech B: "You can apply AI technology if you have access to the right data." (Innovation manager)*

This is even more true to Start-ups as they do not have that good healthcare providers network as MedTech incumbents:

> *MedTech C: "And you could also trigger a wave of innovation because, again, a lot of start-ups today, they can't progress because they don't have access to data." (Head strategic partnerships)*

If users lack bargaining power they can be isolated from health data and thus fail building innovations.

Data suppliers (e.g. healthcare providers) bargaining power rests on the monopolist gateway of health data intake as being a front line to the patients:

> *MedTech A: "Currently sending data from a hospital into a cloud, including patient data can only happen after long discussions with the hospital." (Partner management expert);*
>
> *MedTech B: "The hospitals have the data. They have the healthcare data that MedTechB needed to train its AI. We needed to ingest vast quantities of healthcare records, and hospitals can be very proprietary about that kind of stuff" (Researcher A)*

On the other hand, healthcare providers' data sharing is hurdled due to the lack of proper data management infrastructure and high liability in the case health data are mistreated:

> *MedTech C: "Hospitals and healthcare systems have traditionally had very disparate architectures with siloed data that they sometimes have trouble sharing internally, and much more externally. This complicates everything from improving care to reducing costs to building new software solutions. It can even harm patients" (Chief Architect digital systems)*

Finally, the owners of the health data are individuals/ patients that need to consent the usage of their data. Consent a right and obligation of the individuals/ patients given by the law is a main bargaining power of the owners of the data:

> *MedTech A: "And the contract or the consent to use this application needs to be consented by the patient as much as by the provider." (Partner business expert)*

MedTech B: "Hospitals have the data, but that's patients' data. So, without patients concerned, people cannot use patients' data, right?" (Innovation manager)

Two stage consent seeking practice burdens innovations to take speed and scale:

MedTech C: "The need for patients' and providers' consent to get access and use their data is frequently a problem, as they don't have an overview of their medical records while the benefits ae not always clear to them" (Hospital director)

It is important to notice that data mobility is not explored to the same extent as health data as a co-specialized asset, thus there are little known about bargaining power dynamics among multiple sides of platform actors. Our study spotlight that smooth sharing of health data can enhance digital healthcare innovations, however the relationships between users, providers and owners need to be professionalised (e.g. creating formative and normative processes and standards, that would also accelerate emergence of the dominant design) eliminating redundant obstacles, sharing co-created value, however assuring safety and ethics at the required standards.

Completeness of health data

Besides power mobility of data, less discussed theme is *completeness of health data.* Health data is spread across diverse stakeholders of healthcare ecosystem. In order to create value through the application services or AI several stakeholders need to join efforts. *Completeness* of data is critical because fragmented data creates a gap in understanding a disease performance along the patients pathway. This is a significant obstacle in advancing quality of healthcare services, however also and opportunity to digital healthcare platforms to mitigate the gap and pursue completeness of data.

Co-specialization of data also results in accessing sufficient *breadth of data* to arrive to meaningful clinical insights:

> *MedTech A: "We have the lab data, we have the data from the scanners, and they were all in different databases. So, we are trying to put all these together, analyse the data in order to send some value-added services" (Innovation consultant)*

Cloud-based platform enable MedTech incumbents to collect health data from diverse sources and assure breadth of data vital to digital healthcare services:

> *MedTech C: "Our platform is an open, cloud-based platform that collects, compiles and analyses clinical and other data from a wide range of devices and sources." (Head digital Business development)*

Besides breadth, a relevant *depth of health data* is needed to assure valid and reliable clinical decisions:

> *MedTech A: "So there is a layer at the bottom, which essentially is pulling together the data from different hospitals systems. So, the patient comes to the hospital, and there are different data streams coming in from different systems." (Platform development expert)*

> *MedTech B: "AI probably can do a good job putting people in the clusters. The problem is it doesn't have enough data to help figure this out." (Researcher B)*

Depth of health data is also created by accessing individuals/ patients' data at home:

> *MedTech C: "The digital platform … began as a data-exchange network. Its primary function was to create links that consolidate records data from a healthcare provider's*

partners and satellite offices with Medtech3 devices designed to help monitor the health of patients at home" (Strategic business development)

Finally, clinical scope of health data is another important dimension of completeness of data. At present, only some clinical areas are covered by digital healthcare services and data collection practices:

MedTech A: "Like the pathway companion and the radiology, cancer companion, then the e-health offering, which is more about an infrastructure for data exchange, the care companion, which is a solution for remote patient monitoring for chronic heart failure." (Strategy and innovation expert)

MedTech B: "It [detecting a disease] needs to ingest a different kind of data. For example, medical images, [such as] x-ray images, whatever biopsies or some other images that the medical professionals always have." (Data scientists)

Also digital technologies enabled development of electronic healthcare records (EHR), collecting imaging and monitoring data including from home administered portable and wearable devices.

MedTech C: "Our platform allows collection, integration and analysis of clinical and other data from multiple sources, including medical records, imaging and monitoring data, as well as personal devices and technologies." (Head digital Business Development)

Value capture complementarity allows MedTech incumbents to retrieve non-pecuniary and pecuniary benefits from health data. Integrated data from IoT network, hospitals and patients supports core business services, but also launch new applications such as, e.g. AI based decision support systems.

Accelerating digital healthcare innovations can allow to expand the scope of health data completeness, and, thus, the accessibility and quality of healthcare services across all clinical areas.

Data integrity

The next less discussed theme of health data co-specialization in data integrity of health data. It is not sufficient, however necessary factor for successful health data co-specialization. *Safety of health data* is a basic necessary factor for sharing of data to take place:

> *MedTech A: "The second part is specifically in the healthcare domain is how do we make this secure? I'm increasing the value of the platform because it creates the security standard" (Partner business expert)*
>
> *MedTech B: "You know, we really do value data security, and in that, [we] will be potentially trusted to build models through which customers can feed their own data." (Product manager)*

Security of data is also related with physical complementarity of data when digital technologies need to be constantly adjusted and developed to meet the up to date security standards:

> *MedTech C: "Our platform solutions are secure by design, meeting privacy and security requirements and ensuring systems are always up to date with continuous vigilance." (Head Digital Business Development)*

Complementarity and completeness of health data suffers due to the lack of interoperability of devices:

> *MedTech A: "The biggest challenge for that one is the interoperability" (Marketing expert)*

MedTech C: "Interoperability is super important, the ability to move from cloud to cloud without having high costs…. It's almost of strategic importance and we've seen with COVID that lack of information and the inability to get data from one point to the other has actually costed lives." (Head of Strategic Partnerships)

Emerging interoperability and data sharing standards indicates pre-dominant design phase of the digital healthcare services that features specific challenges for healthcare ecosystem actors:

MedTech A: "I mean, what we provide is the infrastructure to send data to the cloud and get data back. And we also have own solutions, own clinical applications, which are then in the same level as partner apps." (partner management expert); "There are technological challenges of agreeing on common API, on common standards, on how to exchange and interchange data" (marketing expert)

MedTech C: "There is a huge fragmentation of systems, which means there is also very limited interoperability. There are some standards like H7 seven, but they are very loose standards, meaning that there is quite a lot of degrees of freedom for those who implement those standards, which … means that the barriers for interoperability and for connecting and exchanging data are very high." (Head of Strategic Partnerships)

Thus, standards are an important factor to advance co-specialisation of health data among multiple actors of the digital healthcare platform.

DISCUSSION AND CONTRIBUTIONS

We commenced our study by the notion that although Teece (1989, 2006 and 2018) and others (e.g. Pisano, 2006; Jacobides at et., 2006) defined co-specialized complementary assets and provided examples of different industries, there is still little understanding of how health data

operates as co-specialized complementary asset in the context of MedTech incumbent-born digital healthcare platforms. Furthermore, there is no clarity if health data co-specialization limits or adds value to the MedTech incumbent-born digital healthcare platforms growth and prosperity (e.g. Ceccagnoli et al., 2010; Jacobides et al., 2006). Therefore, we have selected cases of three compatible global MedTech incumbent companies that launched digital healthcare platforms that generate and apply data to yield superior value to the diverse platform actors. Our sample allowed us to focus on health data acquisition and sharing processes fundamental to asset co-specialization. Based on the analysis of the multiple-case study results we have detected the co-specialization components proposed and discussed by Jacobides et al, 2006. Besides, the cases we studied revealed the significance of two novel components in health data co-specialization – data completeness and data integrity. In other words, health data does not generate value if it is fragmented and has no common infrastructure that assures the safety of data, unified standards and interoperability of the health data.

The results of the analysis provided us with a robust multifactor measure of health data as co-specialized complementary assets. In addition, our multiple case study unveiled three health data features that help to operationalize health data as co-specialized assets and two of them are specific to the context and not yet discussed in the literature.

Although Jacobides et al. (2006) identified two distinct co-specialization components, such as complementarity and power mobility, however, these two components were not validated in digital platforms and healthcare system contexts. In our study, we delineated second-order themes of these two co-specialization components in the context of digital healthcare platforms (please see table 2). Based on the interview data, we distilled that co-specialization among parties of the digital healthcare platform can be achieved through data power mobility, data completeness and

data integrity. Power mobility as bargaining power for value co-creation and capture should be considered among data users, suppliers, and owners. These distinct roles have specific rights and thus bargaining power. Furthermore, our case study surfaced two novel components of the health data co-specialisation – health data completeness and data integrity. Data completeness is defined by sufficient breadth, depth and scope of health data created by co-specialized parties empowered by the digital healthcare platform. Finally, the integrity of health data such as data safety, interoperability and standards is achieved by co-specialized parties through agreements and adoption of unified technological solutions.

Consequently, we operationalize health data co-specialization with three dimensions: power mobility; data completeness in breadth, depth and scope; and data integrity through data safety, interoperability and standards.

Theoretical contribution

The theoretical contribution of our study is threefold. First, we build on and extend Teece (1989, 2006 and 2018) profiting from innovation (PFI) theory by investigating MedTech incumbent-born digital healthcare platforms context and health data as co-specialized assets in particular. So far, digital healthcare platforms and the healthcare sector more generally are less investigated contexts in PFI. Second, we extend Jacobides et al. (2006) co-specialization classification adding completeness and data integrity as second-order themes to complementarity and power mobility components. Third, we present two novel components of health data co-specialisation – completeness and data integrity in particular significant to the digital healthcare platform context and critical to co-create and capture value from digital technologies and digital healthcare platforms.

Managerial implications

Managerial implications are addressed to MedTech companies, healthcare providers and healthcare policymakers. Our study demonstrates that while digital healthcare platform providers struggle with co-specialising health data, it seems that health data completeness and data integrity is critical to success of all co-specialised parties. Thus, there is a clear need to orchestrate mutual benefits and eliminate value asymmetries among the digital healthcare platform players to co-specialise healthcare data.

CONCLUSIONS, BOUNDARY CONDITIONS AND FUTURE RESEARCH

This article explored health data as co-specialized assets in MedTech digital healthcare platforms as a critical factor to digital platform business success. Our explorative case study of three global MedTech incumbent-born digital healthcare platforms that health data is a valuable resource in digital healthcare platforms and emerges from a collaboration between the patient, healthcare provider and MedTech companies. As health data is mutually dependent between the patient, healthcare provider and MedTech incumbent-born digital healthcare platform, it is a co-specialised asset composed of three main components: power mobility, data completeness and data integrity. Data completeness and data integrity are novel components in co-specialised assets classification, particularly significant to health data. Health data completeness assure sufficient breadth, depth and scope of data needed to achieve value-based clinical outcomes.

Furthermore, data integrity ensures safety, interoperability of data, and data management standards. These two novel components, in contrast to Pisano (2006) findings that asset co-specialisation has limiting effect on business growth, do not in any way restrict digital healthcare platform growth. On the contrary, without the health data completeness and data integrity

MedTech incumbent-born digital healthcare platforms will not be able to create value to multiple actors of the platform, such as healthcare providers, patients and policymakers and, thus, benefit from the digital transformation of the healthcare.

Despite clear theoretical contributions, we acknowledge some limitations of our study. We focus only on three MedTech incumbents. What about Apple and Google? are they in a better position to orchestrate digital healthcare platform ecosystem? The Chinese giants (e.g., Alibaba, Wechat, etc.) are already running such ecosystem, what is the basis of their success, can it be copy and pasted in a Western world.

We didn't talk to other ecosystem partners, which would be interesting to understand differences tensions in the ecosystem approach. We didn't use cases as a specific inroad to understand in a practical way how data access and analysis in an ecosystem /platform setting in the medical world can lead to substantial benefits for all parties involved (especially the consumer-centric approach).

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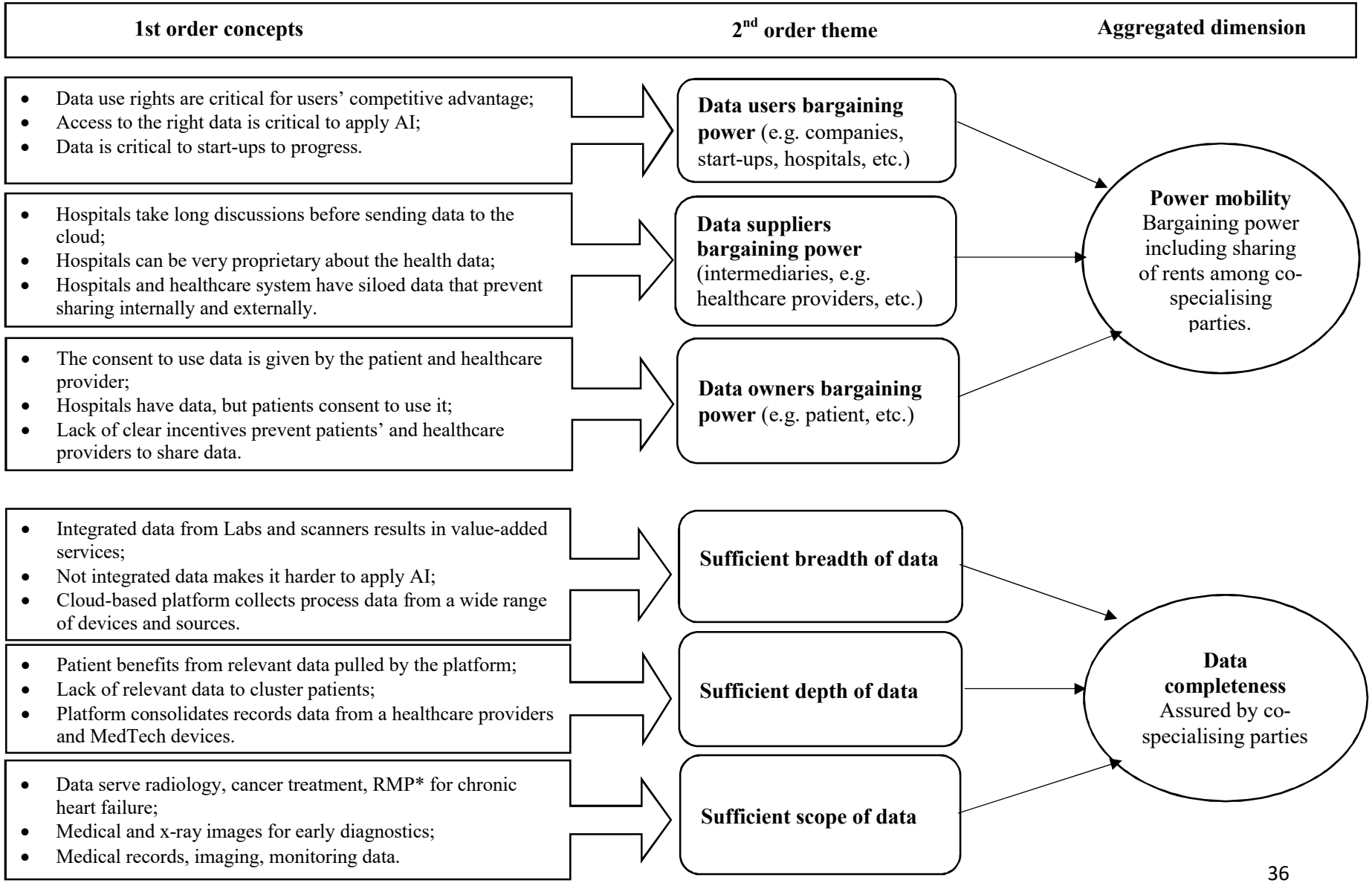
TABLE 1.

Summary of the data collection

Source of data	Use of data	Nature of data		
		MedTech A company's digital healthcare platform, HQ in Europe	MedTech B company's digital healthcare platform, HQ in the US	MedTech C company's digital healthcare platform, HQ in Europe
Semi-structured interviews	Identifying items and theoretical concepts	25 hours of interviews with 17 respondents of diverse competence related to digital healthcare platform development and management	13 hours of interviews with 20 respondents related to artificial intelligence-enabled digital healthcare platform development and management	10 hours of interviews with 4 respondents of different areas in MedTech C digital healthcare, healthcare providers and payers
Publicly available documents (e.g., strategy documents and presentations)	Triangulating interview data and case description	3 strategy documents and 3 presentations	More than 7 strategic documents, 6 presentations, and 3 case studies	2 strategic documents and 1 teaching case.
Online media (e.g., press releases about critical events of platform development)	Triangulating interview data and case description	More than 10 providing information on M&As, new collaboration agreements, partners, etc.	More than 50 documents providing information on the development, collaborations, agreements, etc.	8 documents providing information on the development and collaboration agreements, partners, etc

FIGURE 1.

Multiple case study data structure.



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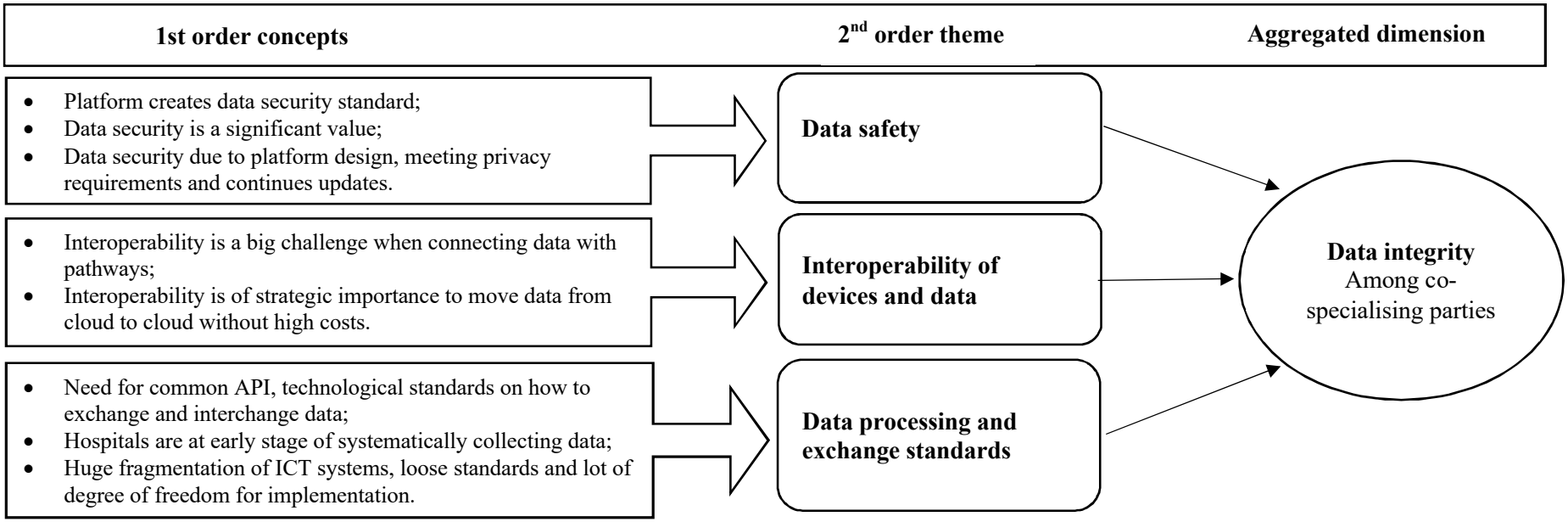
1st order concepts
2nd order theme
Aggregated dimension
Platform creates data security standard;
Data security is a significant value;
Data security due to platform design, meeting privacy requirements and continues updates.
Data safety
Interoperability is a big challenge when connecting data with pathways;
Interoperability is of strategic importance to move data from cloud to cloud without high costs.
Interoperability of devices and data
Need for common API, technological standards on how to exchange and interchange data;
Hospitals are at early stage of systematically collecting data;
Huge fragmentation of ICT systems, loose standards and lot of degree of freedom for implementation.
Data processing and exchange standards
Data integrity
Among co-specialising parties