The Digital Transformation of the Healthcare Industry: Exploring the rise of emerging platform ecosystems and their influence on the role of patients.

Hermes, Sebastian; Riasanow, Tobias; Clemons, Eric; Böhm, Markus; Krcmar, Helmut

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Münchner Kreis, TU Munich, University Oslo Global Health

Comments welcome!
helmut.krcmar@tum.de

THE DIGITAL TRANSFORMATION OF THE HEALTHCARE INDUSTRY: EXPLORING THE RISE OF EMERGING PLATFORM ECOSYSTEMS AND THEIR INFLUENCE ON THE ROLE OF PATIENTS

Abstract

Digital platform ecosystems represent a ubiquitous phenomenon challenging the logic of creating value within linear value chains. While traditional organizations create value within the boundaries of their firm or supply chain, digital platforms leverage and orchestrate a platform-mediated ecosystem to co-create value. While the logic of two-sided markets has been adopted among various industries, it has lacked adoption and research within healthcare. To the best of our knowledge current IS research struggles to incorporate an interorganizational perspective of the digital transformation of healthcare, neglecting the emergence and interplay of novel market segments and their impact on the role of patients. This study therefore investigates the digital transformation of the healthcare industry by analysing 1941 health organizations found on Crunchbase. We derived a generic value ecosystem of the digital healthcare industry and validated our findings with industry experts from the traditional and the start-up domain. The results indicate 7 new roles within healthcare, namely: information provider, data collectors, market intermediaries, healthcare intermediaries, fiscal intermediaries, data storage, IT service provider and 3rd party provider. Our results further illustrate how these roles intermediate traditional value chains and incorporate platform-mediated ecosystems into the healthcare industry. Furthermore, we identify patient empowerment and remote diagnosis and consultation as pivotal transformation patterns of the patient-healthcare provider relationship. We discuss competition between new entrants and incumbents and elaborate how digital health innovations contribute to the changing role of patients. Our study contributes to the literature on digital transformation and the dual roles of consumers.

Keywords: Platform ecosystem, ecosystem analysis, healthcare, digital transformation, dual roles of patients

1 Introduction

Digital transformation has been defined by Vial (2019) as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies." Following this definition and to the best of our knowledge, most studies within the IS community exploring the digital transformation are primarily concerned with an intra-organizational perspective, such as the transformation of processes, products, and services, organizational structures, or business model (Kaltenecker et al. 2015; Hansen and Sia 2015). Current academic literature of digital transformation in healthcare also follows this trend by either exploring the digital transformation of traditional institutions (Mircea et al. 2010; Roehrs et al. 2017), health information technology (Agarwal et al. 2010), electronic health records (Kane 2015), big data (Kane 2017), mobile applications (Botha et al. 2018) or on the single components of the digital health industry such as mHealth (Handel 2011; Kumar et al. 2013; Luxton et al. 2011) or eHealth (Oh et al. 2005) .

However, research on digital transformation should also take an inter-organizational perspective into account (Jacobides et al. 2018; Puschmann 2017), particularly since digital transformation may substantially influence inter-organizational partnerships in ecosystems when value is co-created among multiple and novel stakeholders (Sarker et al. 2012). As early as 1991, Bakos addressed the transition from linear links to two-sided markets (Bakos 1991), and Parker et al. (2016) more recently postulated a transition from simple two-sided markets to more complex platform-mediated structures. However, these transformations seem almost totally absent from the evolution of the healthcare ecosystem and marketplace (Clemons 2018).

Therefore, the present study aims to understand the digital transformation of the healthcare industry from an ecosystem rather than a firm-level perspective. Consequently, we focus on the impact of new organizations that build upon the opportunities of the digital transformation instead of exploring how the digital transformation changed the processes and structure of incumbents. Drawing upon the e3-value methodology (Gordijn and Akkermans 2001), we aggregated organizations with similar characteristics and value streams into generic roles to answer the following research questions:

RQ1: During the digital transformation of the healthcare industry, which generic roles and value streams are adopted by emerging organizations?

RQ2: How do these emerging organizations shape the role of patients?

The remainder of this paper is structured as follows: first, we analyze the underlying literature of digital platforms and ecosystem analysis; second, we describe our methodology; third, we present the generic roles and the generic value network of the digital healthcare industry; and finally, we discuss the results and briefly present implications and future research.

2 Theoretical background

2.1 Digital Platforms

In recent years, companies drawing upon platform-based business models have increased substantially in number and size (Evans and Gawer 2016). Their emergence has disrupted the way people interact (e.g., Facebook), search for information (e.g., Google), buy products (e.g. Amazon) and utilize services (e.g., Airbnb). By drawing upon value co-creation, ecosystem orchestration and facilitating transactions, digital platforms transform linear value chain into platform-mediated two-sided markets (de Reuver et al. 2017; Constantinides et al. 2018). We define digital platforms according to Constantinides et al. (2018) and Parker et al. (2016) "as a set of digital resources— including services and content—that enable value-creating interactions between external producers and consumers".

In contrast to traditional organizations, digital platforms do not necessarily hold physical assets or produce the final service. While Airbnb has little in common with hotels of linear value chains, so does Apple not actually produce every application within their AppStore. Rather, digital platforms emphasize and facilitate core interactions between communities of the platform ecosystem, comprising consumers, producers, and third party actors (Parker et al. 2016; Jacobides et al. 2018). Both examples illustrate that digital platforms set architectural and governance rules to balance platform control, engage participants, and co-create value for one another (de Reuver et al. 2017; Parker et al. 2016; Ghazawneh and Henfridsson 2013; Tiwana 2015). Platforms therefore transform the way organizations operate, forcing them to adapt their strategies, business models, organizational structures, and approaches to value creation and capture (Evans and Gawer 2016; Cennamo 2019).

Digital platforms create value in two fundamental ways. First, by facilitating transactions and second, by offering technological building blocks that are used by complementors to develop new products and services (Parker et al. 2016; Cennamo 2019; Evans and Gawer 2016). Platforms that facilitate transactions are referred by Evans (2012) as exchange platform which "create value by helping two or more different types of users, who could benefit from getting together, find and interact with each other, and exchange value". Hence, these platforms intermediate dyadic relationships (Rochet and Tirole 2003; Armstrong 2006) and efficiently match buyers and sellers by reducing frictions such as information asymmetry. In contrast, platforms that offer technological building blocks, aim to orchestrate industry innovation by co-creating value with external complementors. According to Tiwana et al. (2010) these innovation platforms are defined as "the extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it, and the interfaces through which they interoperate". Platform owner of innovation platforms provide software connectors called application programming interfaces and software developer kits, which allow complementary innovators to access the technological building blocks and participate in the platform ecosystem. Additionally, some authors argue for community platforms which refer to "a passive agent that enables individuals to access messages from, and disseminates messages to, other members" (Butler et al. 2014). These platforms aim to unite various actors interested in similar content and supporting them to generate and disseminate their content among community members.

Digital platforms do not only change the way of competition (Cennamo 2019) and strategizing (Parker et al. 2016), they also impact consumers by incentivizing them to co-create value within the ecosystem. For example, digital platforms in the sharing economy can be conceptualized as evolving organizations composed of actors who collaboratively share, consume, and compete (Gerwe and Silva 2018). Thus, the roles of actors in an ecosystem are not fixed, but can evolve (Gawer 2014). An example is Airbnb for who provides a scalable integration of consumers, providers, and prosumers into their platform-mediated ecosystem. Airbnb orchestrates these user roles by utilizing governance mechanisms such as defining the degree of openness and rating mechanisms (Tiwana et al. 2010) and incentivizes consumers to engage in the role of provider. Hence, they become prosumers.

2.2 Ecosystem analysis

Ecosystems with actors that have unique, supermodular, or non-generic, complementarities require the creation of a specific structure of relationships to create value (Jacobides et al. 2018). Different methods exist to first visualize and second analyze ecosystems, such as conceptual, heuristic, mathematical, ontological methods, or cluster analysis (Basole et al. 2018; Arreola González et al. 2019). We focus our attention on the e3 value methodology by Gordijn and Akkermans (2001), which is a rigorous, conceptual modelling approach for ecosystem analysis and visualization (Böhm et al. 2010; Riasanow et al. 2017). Its aim is to define how economic value is created and exchanged within a network of actors. It offers a graphical approach, that helps define and analyse multienterprise relationships by aggregating similar organizations into generic roles. The main concepts of e3-value are the following (Gordijn and Akkermans 2003):

- *Actors:* refer to economically and often legally independent entities. They are represented by rectangles.

- *Market segments:* refer to a set of actors that exhibit common characteristics and that value objects equally. They are represented by three rectangles.

- *Value objects:* refer to objects, such as services, goods, or money, exchanged by actors. They are represented as text next to the value exchanges;

- *Value ports:* refer to actors signaling that they want to offer or request value objects. This concept allows to abstract internal processes. They are represented by triangles.

- *Value interface:* refer to ingoing and outgoing value offerings. Actors can have one or more value interfaces. This concept represents the mechanism of economic reciprocity. They are represented by small rectangles with rounded edges.

- *Value exchange:* refer to actors willing to exchange value objects. They are represented by arrows connecting two value ports.

3 Methodology

The present study was guided by the e3-value methodology proposed by Gordijn and Akkermans (2001) and Gordijn and Akkermans (2003) and built upon the work of Böhm et al. (2010) and Riasanow et al. (2017). The e3-value methodology is a rigorous modeling concept used to define and visualize how and with whom economic value is exchanged. We first conducted a literature review to identify the entities and value streams of the traditional healthcare industry. We then conducted a second literature review to identify the entities and value streams of the digital healthcare industry and built the initial e3-value models of both industries. Thereafter, we analyzed the organizational data from the Crunchbase database and conducted expert interviews to iteratively refine our e3-value models until all data was coded and insights from experts reached theoretical saturation. The iterative refinement process is illustrated in figure 1. The process ended after three iterations.

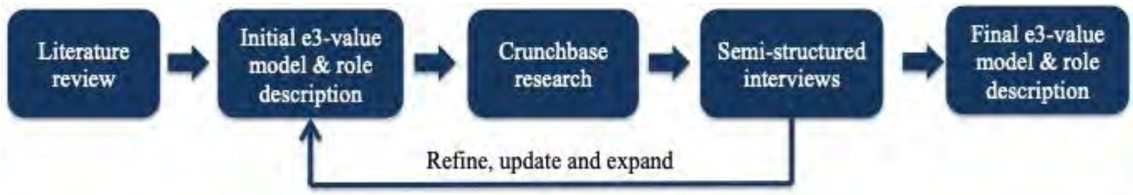

Figure 1: Research process

3.1.1 Literature reviews

Both literature reviews were built upon the review process and categorization of concepts proposed by Webster and Watson (2002). However, our goal was to go beyond a descriptive review towards a review of understanding the digital transformation and its entities and value streams (Rowe 2014). According to Reis et al. (2018), the number of articles on digital transformation significantly increased after 2013. We therefore employ the year 2013 as proxy for the beginning of literature about digital transformation. Consequently, our first literature review ranged until 2013 to assess the roles and value streams within the traditional healthcare industry, whereas the second literature review started in 2014 to assess new roles and value streams within the digital healthcare industry. For the traditional health industry we used the following query to scan scientific databases: ((“Health care system” OR “health care industry” OR “health care”) AND (stakeholder OR “value network” OR “value chain)) and the following query for the digital health care industry: ((“Health care” OR healthcare) AND (digitalization OR digitization OR “digital transformation” OR “digital innovation”)) and (“Digital health” AND “innovation”). After refining the initial hits and conducting backward and forward search, we obtained 56 articles for the traditional industry and 64 articles for the digital industry. Each article was reviewed for entities, their descriptions, and value streams. Additional information about the search process is listed in Appendix D.

3.1.2 Data extraction and screening

We used Crunchbase, a socially curated database of organizations, organizational members, and investors, in order to extract organizational data to code generic roles and value streams to model our ecosystems. According to Basole et al. (2018) Crunchbase data is suitable to model ecosystems due to a large number of entries. We use the organizational description of each organization to derive roles and value streams. Crunchbase offers a comprehensive database of incumbents and startups (Marra et al. 2015). Additionally, startups at all funding stages are listed in the database, which allows researchers to capture business model innovations (Marra et al. 2015; Perotti and Yu 2015). All entries on Crunchbase are verified before they are released online. Crunchbase, therefore, allows to extract a comprehensive overview of traditional and novel organizations related to an ecosystem and related technologies[1]. In cases where Crunchbase didn't provide sufficient information, we used the organizations website, press articles, and news articles to derive the according role and value streams. We used the following search terms in the company description to determine the list of healthcare-related entities: mHealth, eHealth, digital health, telehealth, telemedicine, and wearables. These keywords corresponded to digital technologies or trends in the healthcare industry (Iyawa et al. 2016). This led to a list of 1987 globally emerging and established organizations within healthcare. A total of 46 companies were excluded from the coding list because they either did not demonstrate any relevance to the healthcare industry or were closed and no longer active.

3.1.3 Coding of Roles and Value Streams

With the remaining 1941 organizations, we used structured content analysis, including an inductive category development based on Mayring (2010) and Miles and Huberman (1994) to identify the roles and value streams within the traditional and digital healthcare industry. First, one of the coders used the organizational descriptions derived from Crunchbase to develop codes for the generic roles. For example, the generic role TeleHealth provider is connected to the concepts such as: online service, real time, medical consultation, asynchronous communication, see Table 1.

Table 1: Example of the coding process

Organization	**Crunchbase description (extract)**	**Coded role**
Zava	Zava is an online doctor service in which real GPs prescribe real medicines in real time. Zava offers trustworthy, affordable and regulated medical consultations without the need for a face-to-face visit. (…) And you don't have to see a doctor in person. (…) Simply complete a medical questionnaire, place your order and their doctors will check the treatment you've requested is suitable for you (…) Their service doesn't end when you receive your order. If you have any questions at all about your treatment or condition, you can contact one of their doctors free of charge	TeleHealth provider

[1] For data gathering we used a Crunchbase Premium account, since the free account limits the use (and amount of) available company data

Next, inspired by the codes and the organizational descriptions from Crunchbase, descriptions for the generic roles were developed, for example see Table 2.

Table 2: Example of the derived role description

Role and Description	**Example(s)**
The **telehealth provider** enables medical consultations offered through digital technologies using synchronous or asynchronous communication (Jung and Padman 2015).	Teladoc, eVisit, iCliniq

Afterwards, the organizational descriptions and the descriptions of the generic roles were given two additional raters, who independently coded the organizations to the generic roles. All raters compared and discussed their coding for calibration purposes. We aimed to establish intercoder reliability to ensure a consistent and reliable coding of the generic roles. For this purpose, we used Fleiss' Kappa as measure for the validity of the intercoder reliability. Fleiss' Kappa allows for the computation of the intercoder reliability of k raters (Fleiss 1971) and ranges from zero to one, with one indicating an almost perfect agreement among raters. In each of the three iteration rounds, three raters independently coded a sample of 100 organizations to become familiar with the refined coding scheme. Throughout the coding, the raters discussed discrepancies to reach consensus and equal understanding for each role description. After coding the three samples, Fleiss' Kappa indicated an intercoder reliability of 0.76 in the first round, 0.81 in the second round, and 0.84 in the third round, reflecting acceptable intercoder reliability (Fleiss 1971). Therefore, we decided to have one rater code the remaining organizations. The total number of organizations for each new market segment in the digital healthcare industry are listed in appendix C.

3.1.4 Visualization and Validation

In the next step, we use the e3-value method to visualize the digital healthcare ecosystem based on the identified roles and value streams. The expert interviews were conducted with healthcare experts or founders of digital health companies using a semi-structured approach (Myers and Newman 2007). The interviewees have significant experience in healthcare and digital technologies and are working either in a leading position or in information technology-related functions. Table 3 provides additional information about the interviewees. The e-3 value models and the roles and their description were sent to the interviewees in advance. This allowed them to become familiar with the models and prepare feedback. Three of the interviews were conducted in person. The rest was conducted via online or phone conversations. Interviewee 1 and 2 were interviewed in the first iteration, interviewee 3 and 4 in the second iteration and the remaining interviewees in the third iteration. Six of the interviewees were working for companies representing the traditional healthcare industry (Interviewee 1, Interviewee 2, Interviewee 3, Interviewee 8, Interviewee 9, Interviewee 10). The rest of the interviewees were employed in companies that emerged through the digital transformation in the healthcare sector (Interviewee 4, Interviewee 5, Interviewee 6, Interviewee 7). All interviews were recorded, transcribed and inductively coded.

Table 3: Overview of the interviews

Interview #	Duration	Interviewee's position	Domain
1	55:29	Business Development Director	Medical device manufacturing
2	37:59	Controlling and Business Analysis	Medical device manufacturing
3	28:54	Incubation Manager Healthcare	Medical device manufacturing
4	33:57	Co-Founder	BioMarker Collector
5	36:16	Co-Founder	Digital Insurance Company
6	34:15	Co-Founder	Administration Software (IT Service Provider)
7	25:34	Founder	Data Science and Business Consulting
8	20:36	Clinical Consultant	Medical device manufacturing
9	54:16	Manager Digital Healthcare R&D	Medical device manufacturing
10	36:52	Consultant Healthcare	Business consulting

4 Results

4.1 Generic Roles and Value Streams of Emerging Organizations the Digital Healthcare Industry

The results indicate that during the digital transformation of the healthcare industry emerging organizations converted into 19 new market segments (depicted as actors for better readability), which are represented by 7 generic roles in the digital healthcare ecosystem (see table 4 and figure 2). The market segment Incubator/ Hub/ Accelerator has been added to the traditional role of 3rd party providers. The description of the generic roles within the traditional industry and the ecosystem visualization can be found in Appendix A and B. We observed that the emerging organizations incorporate a major transformation in their value propositions in contrast to traditional organizations. Interviewee 4 summarizes the transformation as follows:

> *"There is a shift from a reactive healthcare service to a proactive one, to really try to improve and foster your health and try to get healthier, prevent getting sick, instead of trying to get healthy again when you are sick." (Interview 4)*

Many of the new roles in the digital healthcare industry act upon this shift by concentrating on *disease prevention, disease prediction, and self-care.* Roles focusing on disease prevention provide users with the opportunity to avoid chronic pains and diet-related illnesses, achieve improved mental health, increase their lifestyle quality, and enhance their cognitive functions. Disease prediction refers to the roles adopting novel, digital technologies such as big data, machine learning, and artificial intelligence to predict treatments, diseases and health risks. For example, the market segment of population management tool providers builds upon this transformation by offering analysis software to decrease the costs of healthcare providers and reduce the health risks among patients. The third pillar of the new value proposition is self-care, which is defined as a "naturalistic decision-making process addressing both the prevention and management of chronic illness, with core elements of self-care maintenance, self-care monitoring, and self-care management" (Riegel et al. 2017). Patients are actively contributing to medical decision-making and even performing procedures and examinations on their own (Sharon 2017). Table 4 depicts the generic roles, market segments and descriptions of the emerging organizations. Figure 2 illustrates the value streams among them.

Table 4: Description of the new market segments and roles of the digital healthcare ecosystem

Role	Market segment	Description
Information provider	**Forum/Community**	Forums and communities promote collaboration and distribution of information among members. They allow members to track progress with clinical scales, learn more about their condition, share information, and receive emotional support from peers (Smith and Wicks 2008). Examples: Citizen Health and PatientsLikeMe
	Knowledge/Education platform	Knowledge and education platforms are used by patients and specialists. Patients can look for information on drugs, check symptoms, and ask for a second opinion. Specialists can upload information, articles, and journals or ask for information or a second opinion (Martin 2012). Examples: Cureus and FairMedOnline

Healthcare intermediaries	**Telehealth provider**	The telehealth provider enables medical consultations offered through digital technologies using synchronous or asynchronous communication (Jung and Padman 2015). Examples: Teladoc, eVisit, iCliniq
	Patient engagement platform	Patient engagement platforms connect patients and their families with specialists for post-acute care and follow-ups. Specialists can create tasks; prescribe medicaments, diets, and examinations; and educate their patients. This is often enabled through smartphone apps (Martin 2012). Examples: Doorstep Health and DocJournal
	Remote monitoring provider	Remote monitoring builds on real-time and shared data collected by wearables and sensors. Remote monitoring can be inhouse (hospital) or "out of site" (patient is at home, and doctor is in the hospital). Its aim is to ensure that the data are recorded and sent electronically to physicians or specialists (West 2012). Examples: Airstrip Technologies and Heartbeat Technologies
	Emergency communication/Notification network	Emergency communication and notification networks enable specialists to communicate with one another and enable patients and healthcare institutions to notify healthcare providers in emergency cases. These networks help manage emergencies and disaster situations (Botha et al. 2018). Examples: SwifteCare
	Doctor recommender/Online scheduler	Doctor recommender and online scheduler allow patients to search for specialists, book online appointments, view recommendations, write comments, and ask questions (Terlutter et al. 2014). Examples: Jameda and ZocDoc
Data collectors	**IoT/Wearable provider**	Wearables are hardware devices that collect the health data of the body by behavioral sensing. They can be for personal use or for gathering data relevant for specialists by connecting to medical infrastructure, such that specialists can perform long-distance assessments (Hiremath et al. 2014). Examples: FitBit, Misfit Wearables, cardiomedix
	Biomarker collector	Biomarker collectors are health-testing companies that offer at-home lab testing kits. These kits allow patients to derive detailed insights about their health. Biomarker collectors harness DNA to yield personalized information about food sensitivity, metabolism, or important blood values for example. Examples: EverlyWell and myHeritage
	Mobile health/Wellness Apps	Health and wellness apps refer to mobile applications that collect health information from patients. In return, patients can access analyses and functionalities to manage their health (Handel 2011). These apps offer recommendations based on personal data or quick online symptom checks. However, they do not substitute professional diagnosis. Examples: Headspace, Hello Heart, FitWell
Data storage	**Personal health records (PHR)**	PHR are systems that capture health data entered by individuals and store information related to the care of those individuals (Fichman et al. 2011). With PHR, patients can choose what information to add and remove and with whom to share it with in a secure and compliant manner. Example: healthbank innovation AG
	Electronic health records/Electronic medical	EHR/EMR comprise patient health data from previous visits to healthcare providers. These records

	records (EHR/EMR)	can be presented to medical practitioners and shared among healthcare providers. Their primary functions are data retrieval and documentation to improve care and enhance services (Youssef 2014). Examples: DrChrono, Medlium and Clinictracker
Market intermediaries	**Health eCommerce**	Health eCommerce refers to digital companies that offer various healthcare-related services and products. Example: Your.MD
	ePrescription	ePrescription refers to software that electronically generates prescriptions. Its aim is to enable an error-free and understandable prescription, which is directly sent to a pharmacy from the point of care. Furthermore, it can be used by care teams to administer medicines or by pharmacies to review orders and manage the supply of medicines (Kierkegaard 2013). Example: DoseSpot
	Healthcare planner	A healthcare planner aims to improve employees' health. Its digital solutions are sold to employers comprising personalized healthcare plans and recommendations for their employees (Baum et al. 2013). Example: Provata Health
IT service provide	**Population management provider**	A population management provider builds on patient data to offer predictive analytics. The predictions involve (e.g., information on upcoming threats, diseases, or effects of drug use) and help identify risks. These information are used to improve both clinical and financial outcomes (Phillips USA 2019). Examples: InsightRX and cover2protect
	Diagnostic software	Diagnostic software comprises healthcare-related data sets and algorithms. It offers predictive and diagnostic models based on artificial intelligence (AI) and can be bought or subscribed for by a healthcare provider (Interview 7). Examples: MD.AI and algorithmia
	Cloud service provider	A cloud service provider offers software-, platform-, and infrastructure-as-a-service security services and app development (Böhm et al. 2010). Examples: MedStack and Chino.io
3rd party providers	**Incubator/Hub/Accelerator**	Incubators, hubs, and accelerators focus on supporting start-ups by offering consultations, capital, and services. Examples: CME Hub and Health Capital Helsinki

We furthermore observe a shift in the value creation process. While the traditional industry produced and delivered value in linear value chains, the digital ecosystems draws upon value creation in value networks. For the traditional industry for example, a drug manufacturer might sell his drugs to a wholesaler who then sells it to a pharmacy or a hospital. In contrast, the digital ecosystem demonstrates for example how healthcare providers engage with a doctor recommender to find patients while using telehealth services to provide consultation from a distance while using wearables to assess the medical information of the patient. Such network-based value creation has been induced to healthcare due to emerging roles leveraging platform-based business models. Among the 19 new market segments we observed that a large part of them adopted exchange-based platforms. These are for example telehealth provider, patient engagement platforms, doctor recommender, and health eCommerce. While telehealth provider such as Doctor Insta enable medical consultation through video conferencing, patient engagement platforms such as SeamlessMD offer a platform for hospitals to educate, engage and monitor patients throughout their treatment. Regarding community-based platforms we found the market segments of Forum/Community and Knowledge/Education platform building on this platform type. Figure 1 for example is a social networking platform for healthcare professionals to post and comment on medical images. Interestingly, we found no market segment leveraging innovation platforms. This type of platform is rather explored by incumbent firms such as Nike, who launched the Nike+ Accelerator enables external developers to build software using Nike's technology. Besides platform-based business models we also observed how digital transformation leads to digitally enhanced hardware, new digital services, and building upon new digital infrastructure. In terms of digitally enhanced hardware we recognize growing supply of wearables, IoT solutions, and at-home lab tests. EverlyWell for example offers over 30 at-home lab tests ranging from food sensitivity over vitamin tests to metabolism tests and allowing to share the results with physicians and family. The category of digital services comprises market segments such as ePrescription, mobile health/wellness apps, and diagnostic software. Such services build upon the rising amount and variety of health data and novel analytical approaches such as machine learning techniques. Prior research already demonstrated the value of such software, which rapidly and accurately detect diseases (Muelly and Peng 2019), extract new knowledge that would not be thought present by humans (Poplin et al. 2018), and speed-up decision-making. However, these digital services would not be possible without digital infrastructure providers such as cloud or electronic health record provider who represent the fundamental role within the digital healthcare ecosystem. Although these new roles might trigger additional efficiency and reduce costs of healthcare services (Bardhan and Thouin 2013), the interviewees shared a more critical perspective, especially regarding the emergence of intermediaries. Interviewee 5 illustrated the problem as follows:

> *"Now more actors have to coordinate with each other, which requires more overhead. […] All this stuff is supposed to increase effectiveness, increase efficiency. But it is also increasing costs. And the question is, can we actually really pay for that?" (Interview 5)*

The increased cost caused by the continuous emergence of new roles was a major concern that was also mentioned by Interviewee 7. Both interviewees argued that new roles increase costs by placing themselves within the existing value chains and by adding new services to the value chains. Alternatively, while these new roles increase the coordination costs of traditional players, they also reduce the roles of these players and introduce new roles, new functions, and new services. These new players, new roles, and new services are likely to significantly improve patient care, including prediction and preventive care, simultaneously reducing the roles of traditional players while increasing their coordination costs.

Consequently, traditional roles are facing an increasingly complex and intertwined industry. The rising complexity leads to higher costs in terms of identifying valuable actors, coordinating an increasing number of actors, and drawing on their according services. According to the interviewees, these costs will either lower the profit margins of businesses or increase the prices for patients. Hence, increasing the total cost of health care. While this reflects an interesting insight, we argue that it omits efficiencies stemming from improving early intervention and prevention. In other words, it is most unlikely that new levels of interaction and reducing illness will increase the total cost of healthcare or they would hardly be adopted. We argue that the costs of coordinating services will go up, at least initially, whereas the total cost of services delivered, the quality of care, and the need for further care will all be reduced.

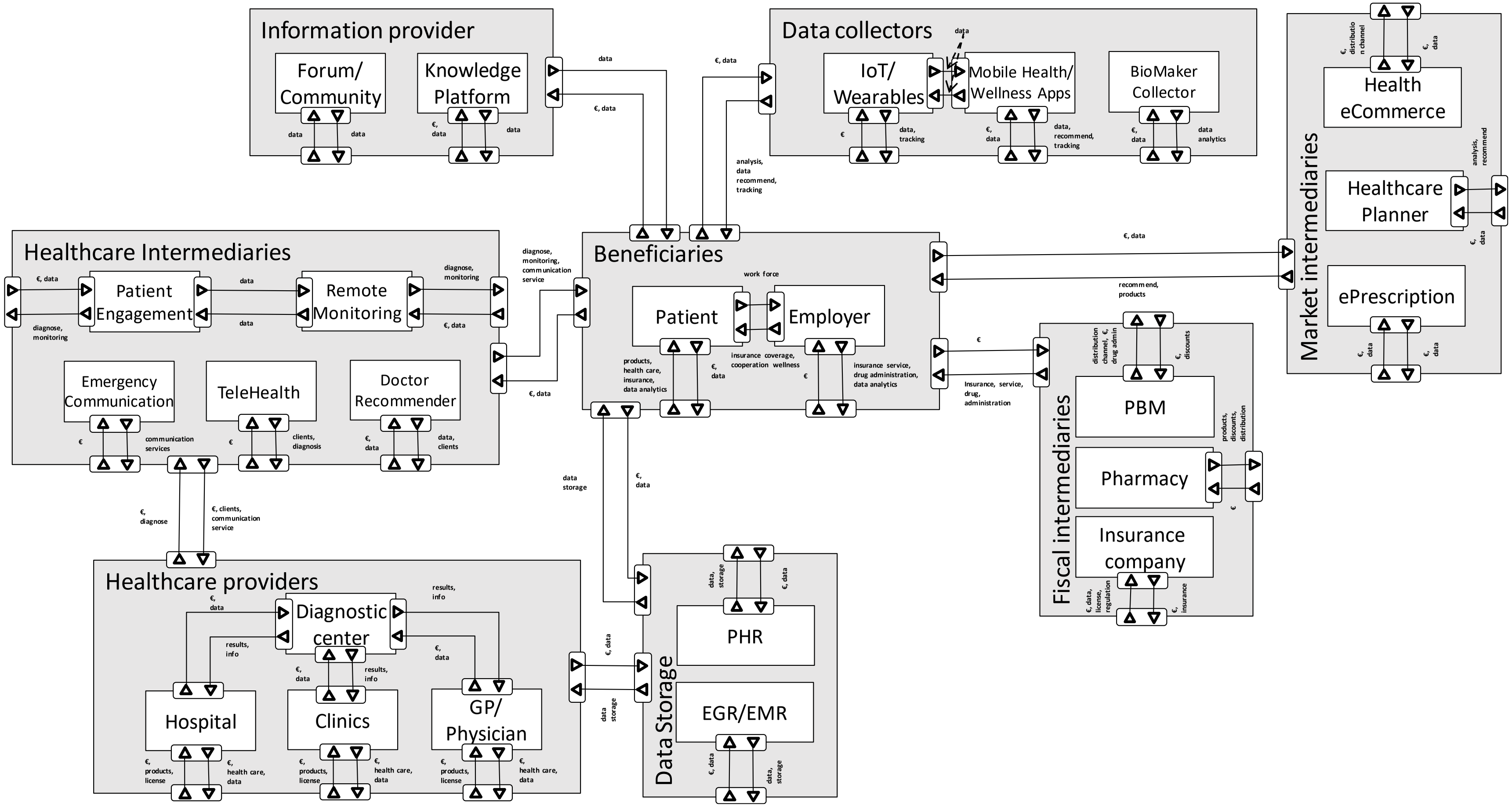

Figure 2: Ecosystem visualization of the digital healthcare industry

Market segments have been depicted as actors for better readability. The grey rectangles around multiple market segments represent generic roles. To further improve readability and reduce complexity traditional generic roles have been omitted (manufacturer, purchaser, 3rd party provider, IT service provider, researchers, NGOs, nursing home and regulators)

4.2 Transformation of the Patient–Healthcare Provider Relationship

While we observed that patients directly interact with healthcare providers in the traditional industry, we found that this interaction is increasingly mediated by data collectors and healthcare intermediaries in the digital industry. Nowadays, patients can access medical information through multiple online platforms and apps without the need to physically visit their healthcare providers.

In the traditional healthcare industry, patients interact with a small number of roles that mainly consist of healthcare providers and fiscal intermediaries. Only a small fraction of patients interact with manufactures due to clinical trials or information events. Aside from the small amount of interaction, we also observed an irregular and low interaction frequency. For example, outpatients rarely interact with healthcare providers or fiscal intermediaries. The process usually involves a couple of visits in a narrow timeframe until the treatment ends. Future visits will generally occur after a longer and unknown time interval. Hence, while the interaction is short-term and asynchronous, the involvement of the patient is also rather passive without much self-involvement. Patients primarily wait for information without proactively asking for it or challenging the opinions and suggestions of their healthcare providers. Consequently, they mostly react to the advice and treatment recommendations of their health care providers.

However, the interaction and the communication between patients and healthcare providers as well as the self-involvement of patients have completely changed because of the digital transformation of the healthcare industry. Patients are confronted with a much higher number of previously unknown actors, such as information providers, market intermediaries, data collectors, and healthcare intermediaries. In contrast to the traditional industry, patients also interact far more often with healthcare providers. This interaction is often mediated by a third party because of the digital services they offer; hence, patients need to develop digital and internet literacy to make use of these services. Digital services do not only increase the interaction frequency between patients and healthcare providers but also provide patients with the option of informing themselves upfront and becoming an active actor in the interaction with healthcare providers. Patients can also engage in self-care to assess their current health status and to proactively find a healthcare provider that matches their personal preferences and quickly share their data. In other words, patients transform from sheer consumers to prosumers of healthcare services.

Therefore, we identify *patient empowerment* as a crucial result of the transformation of patient involvement. Consumers have the opportunity to be better informed and make more informed choices about their health and the services they want to acquire. Interviewee 10 provides a possible explanation for the increased empowerment of patients:

> *"The first part is patient centricity. […] Digital transformation is absolutely supporting this movement because digital companies are giving the tools to healthcare providers to center the patient. […] The patient has got all this information which was not disclosed to him in the old system." (Interviewee 10)*

The transformation of the patient–healthcare provider relationship is also embedded in the cooperation between digital companies and healthcare providers, which enables *remote diagnosis and consultation*. Interviewee 9 provides a concrete example for the benefits of remote diagnosis:

> *"Instead of making an ECG once a month or once a year, you can have a wearable that collect much more data that gets the information about arrhythmia or something that otherwise would obviously be missed. So, with the abundance of sensors suddenly it increases the information content and the possibilities of utilizing this." (Interviewee 9)*

5 Discussion

The study results indicate that the digital transformation of healthcare led to a plethora of novel roles and value streams as well as the blurring of the healthcare and information technology industry. While some roles *reinvent existing solutions* by digitalizing distribution and services, others build upon digital innovations to offer *new medical procedures*. At the same time some roles offer completely *new digital services* for problems that have existed before the digital transformation. While emerging companies reinventing existing solutions are either competing with incumbents or complementing their value offerings, emerging companies offering new digital services face strong competition from technology incumbents. Platform giants such as Google, Amazon, and Microsoft are building the digital infrastructure of the digital healthcare ecosystem and are increasingly aiming to exploit the easy to deploy solutions that do not require strong medical competence. These companies also already control vast amounts of customer-focused data, including health data from wearable devices and lifestyle data from activities scheduling. Large amounts of health-related information can be inferred from an individual's speed of motion (from GPS), health concerns (from searches), and even diet (from online restaurant reservations and online restaurant ordering); none of this information is currently explicitly covered by health-care privacy, and in most jurisdictions using this information within a single firm, to benefit the individual, would not be forbidden.

By leveraging customer data of related industries, trained algorithms (machine learning) and major information technology resources and capabilities, these platform giants enjoy a significant advantage over almost all emerging companies that are focusing on technical rather than medical solutions. Since regulation of the medical app economy has yet not been moving fast, this enables big platform operators to quickly launch new customer-facing services without facing regulatory barriers. Hence, emerging companies face a so called red ocean (Kim 2005) with incumbent health firms when reinventing existing solutions and a red ocean with incumbent platform operators when offering new digital services. A less competitive path might therefore comprise building upon digital innovations to offer new medical procedures. On the one side, big platform operators don't have the medical competence to compete in this domain and on the other side, existing medical companies face multiple challenges of downsizing their current business model in favor for new business opportunities (Velu and Stiles 2013; Christensen et al. 2016). While these conditions are not sufficient to demonstrate that this path is indeed a blue ocean, it seems more fruitful for emerging companies to compete against equivalent companies compared to well-equipped incumbents. However, this path requires new entrants to develop significant medical skills in addition to technical skills, in order to move into areas that will not immediately be dominated by big tech or big pharma.

Our observations suggest that the healthcare ecosystem is indeed following the inevitable progression predicted by Bakos (1991) and Parker and Van Alstyne. They are moving from simple linear value chains to two-sided markets mediated by central marketplaces, and then to complex interacting two-sided markets mediated by platforms with superadditive value creation. High tech companies and software developers have recognized that control over a platform gives large platform operators irresistible competitive advantage; consider Microsoft's destruction of Netscape, or Google's ability to block competitors from Android devices (European Commission 2018). Traditional retailers are finding that it is difficult to compete with platforms like Alexa when they move into home shopping, and traditional manufacturers are finding that it is difficult to function without cooperation with existing platform operators when they moving into smart homes and autonomous vehicles; even in traditional companies, platform operators' control of customer data is emerging as a source of competitive advantage (Schreieck et al. 2019). It seems likely that existing medical systems facing platform operators and platforms like Android and iOS will enjoy significant advantages due to their existing control of patient data.

The transformation of the patient–healthcare provider relationship is informed by various digital technology applications. On the one side, patients begin to evolve from sheer consumers of the healthcare service into prosumers co-creating value with healthcare providers due to digital technologies and intermediaries enabling patients to co-create new services with various roles within the digital industry (Zhang et al. 2015; Hardyman et al. 2015; Lucas Jr et al. 2013; McColl-Kennedy et al. 2012; Vial 2019). Therefore, organizations have a growing opportunity to engage patients with digital technologies to profit from the co-creation of value (Saldanha et al. 2017; Lusch and Nambisan 2015). For example, patients using IoT-wearables, digitizing daily nutrition intake or sharing medical experiences are co-creating value with various healthcare providers. On the one side, their personal health data enables their physicians to provide better care and leverage preventive medicine and on the other side, accumulated health data provides the breeding ground for new diagnostic software and better algorithms.

Such transformation towards co-creation can also be observed on sharing platforms (Ertz et al. 2017; Wirtz et al. 2019), within firm–consumer relationships (Füller et al. 2014; El Sawy et al. 2016), or for smart grids (Grijalva and Tariq 2011). On the other side, patients become more and more empowered and self-reliant. The use of digital technologies encourages patients and consumers to look for more information about health, illnesses, medical treatments, and therapies (Agarwal et al. 2010). Patients can use medical social media platforms to share experiences and health-related data with others. At the same time, comparison portals empower patients to rate and recommend healthcare providers (Lupton 2013), which allows patients to share their individual experiences among each other. Finally, the development of sensors, wearables, and IoT devices and the connectivity between these mobile devices and computers are the key concepts driving remote diagnosis, which alters the patient–healthcare provider relationship toward the digital realm. The tracking and monitoring of patients through these devices are enabling remote services, which provide emergency detection, information management related to medication, therapy, and medical advice (Shah and Chircu 2018).

6 Limitations and Future Research

This study has several limitations. First, our analysis of the empirical data was limited by the subjective coding and the interpretation of the authors due to the qualitative research paradigm that we followed. Different coding and a different theoretical lens might have led to different findings. That is, we might have ended up with slightly different groups of market segments. However, we tried to counteract this limitation by establishing intercoder reliability and by validating our findings with industry experts. Second, our study did not reveal how incumbent firms should manage the implications of the digital transformation. We did not address possible changes to strategy. We did not assess the impact on internal processes and structures. Rather, we concentrated on detecting the interorganizational changes and emerging roles within the healthcare industry. Third, our results are limited by cross-sectional information provided by the Crunchbase database. Future research could explore other methods such as econometrics to include more time-dependent and objective information. A second avenue of future research relates to platform competition in highly regulated industries such as healthcare. In various consumer-facing industries such as social media, food delivery, or travel for example platform competition is very likely to reflect winner take all markets (Katz and Shapiro 1994) demonstrating market convergence due to platform envelopment (Eisenmann et al. 2011). However, sensitive health data, complex clinical trials, control over core-assets, and patent-intensity might alter the common rules of platform competition (Cennamo 2019) which has usually been investigated in less regulated industries (e.g. Meyer and Cennamo 2019; Cennamo and Santalo 2013). Exploring how different industry structures shape platform competition seems therefore fruitful especially as insights for platform regulation might emerge. A third avenue for future research is to compare the impact of the digital transformation in further industries and to compare and synthesize findings in order derive more robust ecosystem theories about digital transformation.

7 Conclusion

Given the lack of empirical research on the digital transformation of the healthcare industry and the lack of an inter-organizational perspective of digital transformation, our research is intended to advance the understanding of which new roles emerged as a result of the digital transformation and how they changed the role of patients. We therefore applied a structured content analysis to inductively reveal the transformation of healthcare by leveraging the Crunchbase database and interview data. The results indicate 7 new roles within healthcare, namely: information provider, data collectors, market intermediaries, healthcare intermediaries, fiscal intermediaries, data storage, IT service provider and 3rd party provider. Our results further illustrate how these roles intermediate traditional value chains and incorporate platform-mediated ecosystems into the healthcare industry. Furthermore, we identify patient empowerment and remote diagnosis and consultation as pivotal transformation patterns of the patient-healthcare provider relationship. Finally, we address the role of patient data as a source of sustainable competitive advantage, both for medical records platform operators and smart phone platforms like Android and iOS. Medical records platform operators have existing health data, while Android and iOS have lifestyle data; new entrants without access to either will be unable to compete.

Our theoretical contribution was twofold. First, our results advanced the literature on digital transformation by contributing a macro and interorganizational perspective of the digital transformation of the healthcare industry. This is theoretically important as the digital transformation represents more than an intraorganizational phenomenon (Fitzgerald et al. 2013). Second, we provide empirical evidence how the logic of platform-mediated two-sided markets disrupted traditional linear value chains within the healthcare industry and what types of platform have been adopted by emerging organizations. Finally, we advanced the literature on the changing role of consumers towards co-creator of value (Füller et al. 2014; Wirtz et al. 2019; Zhang et al. 2015; Hardyman et al. 2015) by illustrating how the role of patients has evolved during the digital transformation of healthcare.

For practitioners within traditional health organizations, the ecosystem models support strategic positioning and competitive analyses. The derived value networks provide practitioners a macro perspective which eases decision making about where to strive for a competitive advantage and where to give up sovereignty. Furthermore, the new value streams help to better understand and serve customers, especially digital natives, who have already been digitalizing their daily life activities and now engage in value co-creation and call innovative healthcare solutions. For practitioners of emerging organizations, we illustrate promising markets and outline where and why they might face so called red oceans (Kim 2005).

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9 Appendix

9.1 Appendix A: Generic roles of the traditional healthcare industry

Table 5: Description of the market segments and roles in the traditional healthcare industry

Role	Market Segment	Description
Beneficiaries	Patient	The patient is a private person receiving healthcare services, treatment, or diagnosis from healthcare providers. On an individual level, patients pay their healthcare provider either out-of-pocket or indirectly through health insurances. Furthermore, there can be a payroll tax on employers and employees through which the costs of health insurance can be shared (Kumar et al. 2011).
	Employer	Employers share the costs for insurance with their employees (Kumar et al. 2011). Employers can also provide corporate health programs to their employees to prevent sickness (Interview 4).
Fiscal intermediaries	Insurance company	Insurance companies accept premiums from patients, employers, and the government. In return, they reimburse healthcare providers for taking care of patients (Kumar et al. 2011). Insurance companies nowadays try not only to cover the costs for healthcare services but also to incentivize their customers to stay healthy in exchange for discounts (Interview 4).
	Pharmacy benefit manager (PBM)	PBMs interact with pharmacies and beneficiaries. They decide on pharmacy charges and provide beneficiaries with access to a nationwide network of pharmacy providers, with whom the PBMs have contracts to offer services and drugs at lower prices. Furthermore, PBMs are able to earn additional revenues through contracting pharmaceutical companies, owning a mail-order facility, or repacking and selling data to the pharmaceutical industry (Garis et al. 2004).
	Pharmacy	Pharmacies can be defined as service shops and be classified, for example, based on the type of merchandise sold or the number of stores. An "independent" pharmacy has less than four stores, whereas "small chains" can have between four and 10 stores under a chain. "Large chains" include more than 10 stores (Jambulingam et al. 2005).

Purchaser	**Distributor**	Distributors or wholesalers are non-manufacturing stakeholders that sell products to merchants, retailers, and contractors, but do not sell in significant amounts to end-users. Distributors simplify product, payment, and information flow owing to their role as an intermediary. Distributors bridge the gap between the goods and the services offered by individual producers and the demand of industrial or retail customers (Fein 1998).
	Group purchase organization (GPO)	GPOs facilitate group buying on a large scale by aggregating the demands of several buyers. GPOs negotiate a lower purchase price with the seller by using the collective purchasing power of the buyers and further lower the buyers' procurement cost by reducing the unit search and transaction costs through scale (Saha et al. 2010).
Manufacturer	**Drug manufacturer**	Drug manufacturers focus on the discovery, development, manufacture, and commercialization of drugs and medications (Shah 2004; Paul et al. 2010). The most important stakeholders to interact with the drug manufacturers are physicians, pharmacists, and the Group Purchasing Organization (Kelle et al. 2012).
	Medical device manufacturer	Medical device manufacturers aim to make medical devices available for use. Medical devices as defined by FDA "range from simple tongue depressors and bedpans to complex programmable pacemakers with micro-chip technology and laser surgical devices. In addition, medical devices include in vitro diagnostic products, such as general purpose lab equipment, reagents, and test kits, which may include monoclonal antibody technology" (FDA 2018).
Healthcare provider	**Hospital**	A hospital is an institution providing medical and surgical treatment and nursing care for sick or injured people (Oxford 2019b).
	Practitioner	Practitioners provide healthcare services to patients, prescribe medication, perform operations, and determine diagnosis. In this study, practitioners comprise doctors, nursing teams, care teams, dentists, physiotherapists, etc. (Interview 10).
	Clinic	A clinic is an establishment or hospital department in which outpatients receive medical treatment or advice, especially of a specialist nature (Oxford 2019a).
	Diagnostic center	Diagnostic centers are healthcare providers, including laboratory services, radiology, and nuclear medicine (Interview 7).
Research	**Research institution**	Research institutions are agencies, organizations, or universities that aim to foster innovation and collaboration in the research and development (R&D) area of healthcare. A distinction can be made between academic R&D (pure fundamental research and clinical trials) and commercial R&D (e.g., drug production).
Regulators	**Regulation authority**	Regulatory authorities use standards to improve data review (e.g., in pharmaceutical companies) (Hammond et al. 2009). Furthermore, they are regulating and classifying medical devices, assuring patient access to "high quality, safe, and effective medical devices and avoiding access to products that are unsafe" (WHO 2019).

	Government	The government uses money generated from taxes to reimburse healthcare providers.
3rd party providers	**Administrative software providers**	Administrative software providers offer information systems to hospital or clinics, which comprise various functionalities, such as patient registration, transfer, admission, and discharge (Hasselbring 1997).
	Business consultant	Many hospitals and care facilities need support when planning and implementing health information systems. In these cases, hospitals are advised to recruit external consultants to develop an according strategy (Brigl et al. 2005).
	Investor	Private equity investors provide funds to companies in the form of growth or equity capital. They often pursue opportunities regarding a large healthcare provider with a stable reimbursement environment, such as acute care services, labs, or nursing homes (Robbins et al. 2008; Stevenson and Grabowski 2008).

9.2 Appendix B: Ecosystem visualization of the traditional healthcare industry

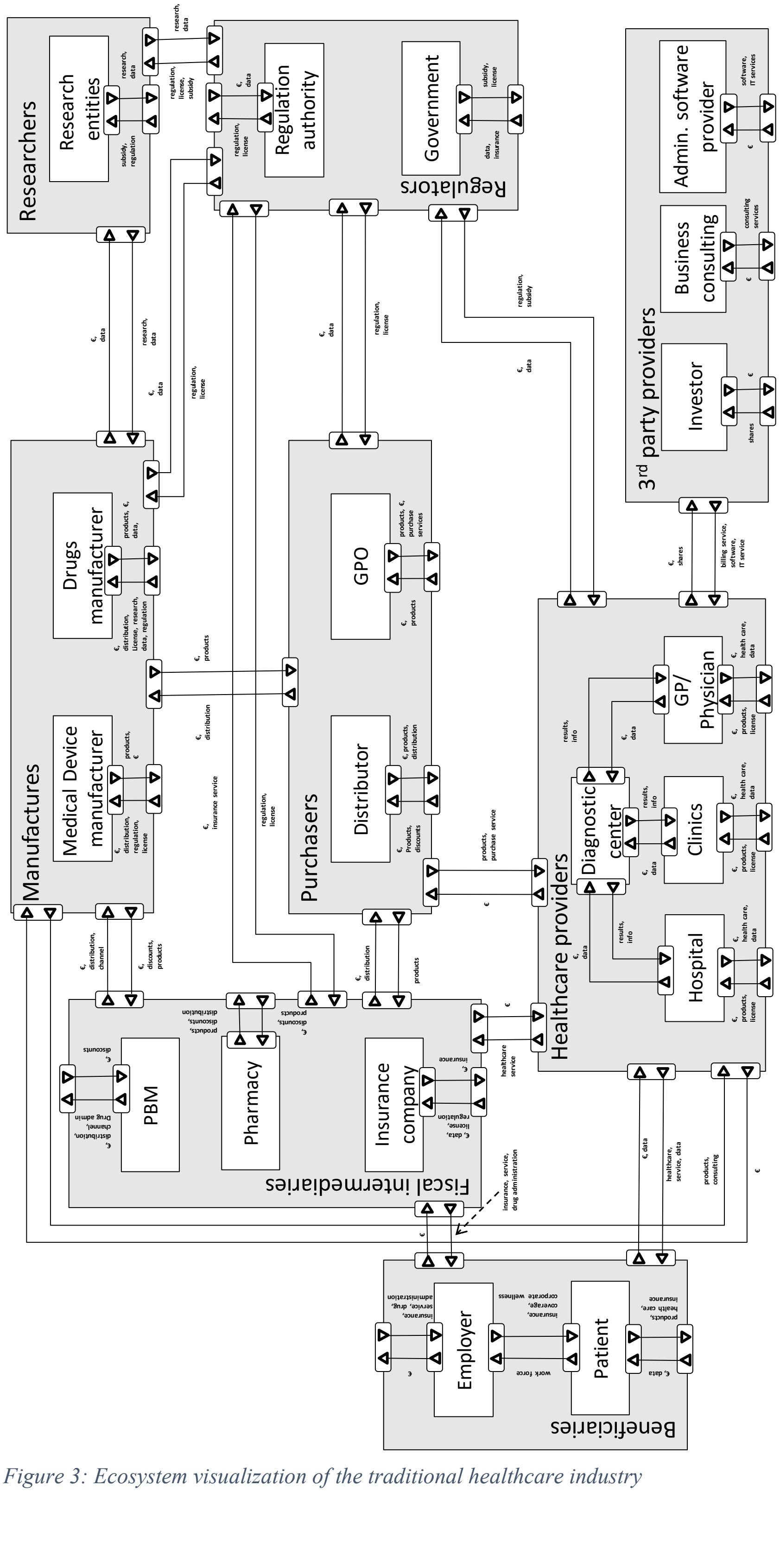

Figure 3: Ecosystem visualization of the traditional healthcare industry

9.3 Appendix C: Amount of organizations for each new market segment in the digital healthcare industry

Table 6: Number of organizations per market segment

Role	Market segment	Number of organizations
Information provider (total: 39)	Forum/Community	19
	Knowledge/Education platform	20
Healthcare intermediaries (total: 365)	Telehealth	177
	Patient engagement platform	146
	Remote monitoring	120
	Emergency communication/Notification network	48
	Doctor recommender/Online Scheduler	51
Data collector (total: 1058)	Wearables/IoT/Sensors	443
	Biomarker collector/Genomics	11
	Mobile health/Wellness apps	604
Data storage (total: 117)	PHR	37
	EHR/EMR	80
Market intermediaries (total: 174)	Health eCommerce	60
	ePrescription	25
	Healthcare planner	29
IT service provider (total: 302)	Population management	43
	Diagnostic tool	60
	Cloud service/development	157
	Administrative software providers	42
3rd-party provider (total: 30)	Incubator/Hub/Accelerator	30

9.4 Appendix D: Literature search process

9.4.1 Search process for the traditional healthcare industry

Search #	Search string	Database/ # of results	
		Accessed via EBSCOHOST	Emerald Insight
1	*"Health care system"* AND *"stakeholders"* (AND KEYWORD=*"health care"*[2])	376 articles	256 articles
2	*"Health care industry"* AND *"stakeholders"* (AND KEYWORD=*"health care"*)	222 articles	111 articles
3	*"Health care"* AND *"value network"* (AND KEYWORD=*"health care"*)	119 articles	85 articles
4	*"Health care"* AND *"value chain"* (AND KEYWORD=*"health care"*)	167 articles	255 articles

The search yielded 1406 unique results which were refined to 150 results based on scanning title and abstract. After assessing the full text of the articles 38 results remained. The forward and backward search yielded additional 18 results.

9.4.2 Search process for the digital healthcare industry

Search #	Search string	Database/ # of results			
		Accessed via EBSCOHOST	Emerald Insight	IEEE Xplore	ACM Digital Library
1	*("Health care" OR "healthcare")* AND *("digitalization" OR "digitization" OR "digital transformation")*	164 articles	87 articles	74 articles	256 articles
2	*"Health care"* AND *"digital innovation"*	183 articles	110 articles	49 articles	43 articles
3	*"Digital Health" AND "innovation"*	107 articles	31 articles	182 articles	87 articles

[2] Only used for Emerald insight search to further refine the results

The search yielded 1117 unique results which were refined to 179 results based on scanning title and abstract. After assessing the full text of the articles 53 results remained. The forward and backward search yielded additional 11 results.