Health-related activities of Big Tech

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Abstract

While the German health sector has often been criticised for its slow uptake of novel digital products, other health systems have been significantly faster in adopting these products. In the course of this development, Big Tech companies have entered these health systems, particularly in the United States and the United Kingdom. But also in Germany, the involvement of Big Tech companies has become increasingly relevant in recent years. Among these Big Tech companies are the "Big Four" (i.e. Alphabet, Apple, Meta and Amazon) but also companies like Palantir and Oracle which have reinforced their activities in the health sector without much attention of the broader public. In this paper, these health-related activities of Big Tech are described in detail. Also providers of electronic health records and hospital information systems like Epic Systems and Cerner and German companies like the Deutsche Telekom and SAP are taken into account. All in all, fourteen companies are covered and their activities are divided into six categories to facilitate an overview and reveal the different focuses of the companies.

JEL-**classification:** I11, L00, L86, O30, O31, O33, O34

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1 Introduction

While digitalization is proceeding fast in other areas, the German health sector has often been criticised for being out of step with developments in comparable countries. In order to be able to face challenges in the health sector, media, associations, insurance representatives and politicians all seem to agree that the process of digitalisation has to be accelerated. While these developments have only recently been reinforced in Germany, progress in other countries, probably most notable in the United States and Great Britain, has shown that Big Tech companies have been able to use this overarching wish for new digital solutions as an entrance gate into the health sector. The Covid-19-pandemic seems to have reinforced this development even further.

It is the aim of this paper to describe the activities of these Big Tech players in the health sector in detail. Besides the "Big Four", i.e. Alphabet, Apple, Meta and Amazon, sometimes supplemented to "GAFAM" by Microsoft, also other important players like Palantir and Oracle and companies which focus on the implementation of electronic health records (EHRs) like CompuGroup Medical, Dedalus Healthcare Group, Epic Systems and Cerner are included. Also, the activities of certain companies with a prolonged importance especially in the German health sector like SAP and Deutsche Telekom are taken into account.

The various activities of Big Tech will be described company by company. To facilitate an overview over activities despite their huge variety, they will furthermore be divided into six categories for most companies, namely (1) Health Apps and Smart Devices, (2) Data Analysis, (3) Electronic Health Records and Hospital Information Systems, (4) Innovation of Treatment, (5) Logistics and (6) Other Activities. By doing so, it is also possible to show that different players focus on different activities and follow different strategies, e.g. some try to be active in all categories while others do not. Within each subsection a chronological order is pursued unless content-related reasons suggest other approaches. The descriptions for the sub-categories are supplemented by a summary of the findings for each company (7). Since the companies in Sections 12 to 15 all have a clear focus on offering either electronic health records or hospital information systems (or both), their activities are described in chronological order without dividing them into categories.

2 Alphabet

Alphabet is a US-American holding dating from a restructuring of *Google* in 2015. Google was founded in 1997 in Mountain View, the centre of the Silicon Valley, and originally famous for its search engine. Its activities nowadays range from autonomous vehicles to building up fiber-optic networks and the company is ranked as the 9th biggest company by revenue in the United States in 2021 (Fortune Media 2021). Google had been active in the health sector already for several years before Alphabet was founded. Its scope of activities in the sector is varied and has been increasing even further recently, especially since the foundation of its subdivision *Verily* in 2015.

2.1 Health Apps and Smart Devices

Google started being involved in the Health App-Sector in 2013 when it invested in *Doctors on Demand* in the start up's first funding round via its venture capital section *GV* (back then still called *Google Ventures*). At this time, Doctors on Demand had just released its app which connects patients with doctors for video consultations (Pai 2013). The company has a reputation of being an innovator in the sector and has been the first telemedicine company to include lab tests in its services. In 2020, the Doctors on Demand network included 700 doctors with 1,000 more waiting to be included (Rosenbaum 2020). GV, however, has apparently not been among the investors again in any of its following funding rounds.

In 2014, Google's Augmented Reality-device *Google Glass* was made available for the public. The technological capabilities of the device, e.g. hidden audiovisual recordings in public spaces, in connection with Google's market power triggered several public controversies which ultimately led to a restriction of sales to selected companies and institutions (Eveleth 2018, Bastian 2020). However, it is again easily possible to buy the device also as a private person according to Bastian (2020). Google Glass' applications in the health sector are manifold: The surgeon Dr. Rafael Grossman has used the device to stream one of his surgeries live to his students (Price w.y.). *Pristine*, a start up which was founded in Austin, Texas in 2013, develops apps specifically for Google Glass which can be used by surgeons, nurses and anaesthetists, and companies like *Philips* and *Accenture Technology Lab* have been collaborating with Google to show surgeons heartbeat, blood pressure and oxygen levels of their patients directly on the device (Price w.y.).

In 2015, the *Google Life Sciences*-department was renamed: *Verily* was founded to become the unit in which all company activities with a focus on biosciences are coming together (Cook 2017). Robert Califf, a former FDA-Commissioner and Karen DeSalvo, health official in the Obama Administration, are playing major roles in Alphabet's newly found department (Al Idrus 2019).

Among Verily's first projects was *Liftware*, a smart device designed to help people with Parkinson's disease with eating. The cutlery, which had already been available since 2013, back then without participation of Google, is equipped with a small computer which is able to distinguish between intended and unintended movements. Thus, tremors can be detected and balanced by Liftware in order to simplify the eating process (Price 2015).

Another early project of Verily was the development of a smart contact lens supposed to be able to measure blood glucose levels (Otis 2018). *Alcon*, a *Novartis*-department specialized on eye-diseases, had also been included in the project which was stopped in 2018 since it turned out to be impossible to establish a consistent connection between glucose levels in tear fluids and blood levels. Despite of this setback, the companies continued to work together on other projects including adapting contact lenses helping with hyperopia and smart lenses to improve eyesight after cataract operations (Handelszeitung 2018, Otis 2018)

Verily's collaboration with *Dexcom* was another Diabetes-related project. Dexcom is a company founded in San Diego in 1999 with a focus on developing continuously measuring glucose sensors for both Type 1- and Type 2-diabetics. Alphabet's role in this partnership, which does not seem to be directly connected with the aforementioned project with Alcon,

is the advancement and miniaturization of the electronic sensors (Comstock 2015).

Also in 2015, Verily was included in the foundation of a new company: In partnership with *Johnson&Johnson* the *Verb Surgical Inc* was created in the Silicon Valley. The joint venture aimed to develop smart devices and robots for surgeons who were also included in the development-process themselves (Johnson&Johnson 2015). However, Verily left the collaboration in 2019, which is thus completely Johnson&Johnson-owned since then (Rachal 2019a). Subsequently, the company continued its work on smart surgery-devices on its own under the name *Surgical Insights Platform* (Verily w.y.e).

2015 was also the year in which Alphabet became active in the Indian health sector for the first time. It invested in the company behind *Practo*, a health app which enables users to meet doctors for video consultations as well as to arrange meetings in person and also integrates services of other providers like hospitals. Among the other investors in Practo was the Chinese holding *Tencent* (Velayanikal 2015). By now, Practo has expanded its services and is available in more than twenty countries (Practo 2022).

Another company in which Alphabet invested at that time, was *Spruce*, the developer of an app which enabled patients to take photos of skin changes and send them to their dermatologists for further inspection (BioSpectrum 2015). Spruce had made its services available in 2014 but stopped its services in 2018 due to billing problems in the complex US-health sector and low uptake, allegedly owing to missing word-of-mouth-recommendations because of the shame associated with skin diseases. The company now develops the *Care Manager* which can be used by doctors and hospitals for scheduling appointments, messaging, video-consultations and the creation of chronological patient histories (Craig 2018).

In 2017, Alphabet acquired the Seattle-based start up *Senosis Health* which had focused on health monitoring and offered a range of health apps, among them *Bilicam* and *Hemaapp*: *Bilicam* can be used by midwives and mobile nurses to detect bilirubin via smartphone-cameras and *Hemaapp* used smartphone-cameras to non-invasively measure blood hemoglobin concentration (Boyle 2017). Senosis Health had been closely connected to the *University of Washington* and previous start ups founded by Senosis-founder Shwetak Patel had been sold to the computer hardware-provider *Belkin International* and the trade company *Sears* (Beiersmann 2017, Cook 2017). Media coverage suggests that not Alphabet itself but *Nest*, which back then operated as an independent unit before it eventually was merged into *Google Home*, bought Senosis Health, a fact that Alphabet seemed eager to keep confidential (D'Onfro 2018b). Nest, which had been acquired by Google in 2014 for 3.2 billion USD, originally had focused on smart home devices like thermostats but recently seems to have bought several start ups which produce devices that are able to measure sleep- and lung-functions of their users (Kuchler 2020). Other media coverage mentions Nest's plans to integrate its products in retirement homes (Farr and D'Onfro 2018). Alphabet also filed a patent application for a toilet seat which is able to measure heartbeat and blood pressure, and bought *Knit Health*, a company offering a *smart baby monitor* underlining the company's ambitions in the field of ambient sensors (Kuchler 2020).

In the same year, Alphabet's *DeepMind*-department, which eventually was merged with *Google Health* in 2019, collaborated with the developers of *Streams*, an app used for diagnosing acute kidney damage. The partnership triggered controversies in the UK since health

data of 1.6 million patients of the *Royal Free Hospital* in London was used without their knowledge and against applicable law (Powles and Hodson 2017, Kuchler 2020, Pilkington 2019, Comstock 2017). Eventually, Streams was acquired by Alphabet in the end of 2018 (CB Insights 2021). In 2022, Alphabet faced a class-action lawsuit due to the unlawful use of patient data (Lovell 2022). DeepMind also has health data sharing agreements with four additional hospitals in the UK (Yeo 2021).

At the same time, Verily presented two versions of its *Study Watch* which is part of its collaboration with the health-start up *iRhythm*, a start up founded in San Francisco in 2008: The *Investigational Study Watch* is used in clinical trials and for research purposes while the *Study Watch for ECG and Irregular Pulse Monitor* is a FDA-approved device used in care collaborations with selected partner institutions. The Study Watch is only available on prescription and doctors are able to access the collected data after use (Verily w.y.d). The partnership of the companies also aims to find new ways of identifying auricular fibrillation, a field on which Alphabets's rival *Apple* is very successful with its Apple Watch (see *Section 3.1*) (Rachal 2019b).

Interestingly, it took until 2021 for Alphabet to become active in the market for activity trackers which are available publicly: After a lengthy struggle with competition authorities, with a long list of requirements issued by the European Union and despite of warnings by Amnesty International due to high risks for the human right of privacy, Alphabet acquired the market pioneer *Fitbit* which had been founded in San Francisco in 2007 and had been the world's fourth biggest provider of wearables ranked by units sold in 2019 (CB Insights 2021, Rondinella 2019).
Among many other projects, Fitbit is collaborating with the government of Singapore within the scope of the *Fitbit Inspire*-programme. Participants in the programme do not have to pay for the required Fitbit-devices but it is mandatory that they spend 10 USD monthly for one year for premium features like digital one-to-one training (Advisory Board 2019). Singapore's initiative to fight rising numbers of diabetes and heart diseases is called *Live Healthy SG* and according to Fitbit's CEO James Park also *Apple* was among the competing actors for Fitbit's role in the partnership (Farr 2019f) (see also *Section 3.1*).
In 2021, a data set of the New York-based digital health company *GetHealth*, which included 61 million records of fitness tracker-users including their names, GPS-records etc. was accidentally publicly available online. Besides data from *Apple*-devices (see *Section 3*) and Microsoft's smart watch *Band* (see *Section 6.1*), data of Fitbit-users was also affected. Only a few hours, after GetHealth was notified, the company managed to fix the problem (Osborne 2021).

In another attention-attracting collaboration, Alphabet announced to work together with Apple in 2020 to offer governments the interface for developing contact tracing apps during the Covid-19-pandemic. While many states, including Germany and France, first had preferred a solution in which the collected data is stored centrally (Böck 2020, Oerding 2020), they soon had to realize that they were not able to offer a functioning app without support of Apple and Alphabet and thus resigned themselves to the companies' wish for a decentralized approach (Böck 2020, Nosthoff and Maschewski 2021, Scheuer and Klöckner 2020).

2.2 Data Analysis

One of Google's first activities in the health sector was its investment in *23andme* via Google Ventures in 2007. 23andme, founded in the Silicon Valley in the same year, is a biotechnology company. Its name refers to the 23 pairs of chromosomes possessed by humans (Dowideit 2008). When the company began analysing genetic information of private persons, it did so without permission of the FDA (Farr 2020b). Until 2018, the genetic information of 3 Million people had already been analysed by the company, its service is also available in Germany and its self-proclaimed aim is to develop a genetic cartography of 98% of the world's population (Dowideit 2008). 23andme's services include testing on 200 different hereditary diseases and 99 risk-dispositions. The price of an analysis has dropped from initially 999 USD to 99 USD (Dowideit 2008, Wendt 2014). The company also operates its own research department and customers are encouraged to help by participating in surveys whose results can then be linked to their genetic information. A laudatory speech of 2019's Big Brother Awards, won by the company's competitor *Ancestry* due to selling genetic information to the pharmaceutical industry, mentioned a partnership of 23andme, whose data stock seemed to be only half as big as the one of Ancestry back then, and *GlaxoSmithKline* according to which the pharma company paid 23andme 300 million USD in order to be able to use the genetic information it collected (Weichert 2019). Google is also associated with Ancestry via its *Calico*-unit (see *Section 2.4*) and analyses anonymized data to find similarities in DNA-profiles of people who live exceptionally long. In the same way, information of publicly available biobanks is used (Zeizinger 2019). Before she stopped working for 23andme in 2009, one of its founders, Linda Avey, mentioned that the company would not be disinclined to connect its services with the ones of Google Health (Dowideit 2008).

In 2011, Google Ventures invested in *Foundation Medicine* and *DNAnexus* for the first time. Founded in Boston in 2010 and also backed by investments from Bill Gates, Foundation Medicine focuses on genome analysis in order to develop new cancer treatments (Crunchbase w.y.c, Grabar 2015). Its services, which are already in use in 20 countries on three continents, help doctors to decide on the right therapy by creating reports which analyse the genomic profile of the tumour and refer to relevant clinical studies. In 2017, over 67,000 Foundation One-tests were ordered by doctors with costs of a single test amounting to 5,800 USD (Fidler 2018). In 2015, pharma giant *Roche* became the majority shareholder and in 2018 it took over Foundation Medicine for 5.3 billion USD (DeAngelis 2020).

DNAnexus is a Sofware-as-a-service-company which was founded in Silicon Valley as a spin-off of *Stanford University* in 2009 (Baresky 2018). It offers cloud-based administration and analysis of DNA sequence data and also collaborates with *Microsoft* (Lee 2017a). In partnership with the *Baylor College of Medicine* the company conducted the hitherto largest cloud-based genome-analysis including the analysis of complete genomes of 3,751 individuals (DNAnexus 2013). While the company also uses Alphabet's cloud services, for this project *Amazon Web Services* was chosen to provide the required cloud-infrastructure (Amazon Web Services 2014). In contrast to other early Google Ventures-investments which were not followed by further investments, DNAnexus also received money from Alphabet in 2014 and 2020 underling the company's importance on the health market (Crunchbase w.y.b). By now, its services are used by nearly all important clinical diagnostic and pharmaceutical companies and also national medical centers belong to its customers

(DNANexus 2020).

In 2013, Google was the main investor in a funding round for *Flatiron Health*, making the investment its second biggest after *Uber* until this date (Hartmans 2016). Flatiron had been founded by former Google-employees Zach Weinberg and Nat Turner after talks with one of Google Ventures' leading managers Krishna Yeshwant. The company collects genome and health data of cancer patients and suggests different treatment options on this basis. It was Yeshwant who recommended this focus by emphasizing the market size of cancer research and therapy: "Oncology alone is the size of the advertising industry, if not larger" (Hartmans 2016). In 2016, *Roche* invested in Flatiron and two years later, the pharma giant acquired the company for 1.9 billion USD as part of its "personalized healthcare strategy" (Muoio 2018). By then, Flatiron's Health Record Software was already used by 265 cancer clinics and 12 companies with focus on oncology. Its partners included the leading biotechnology company *Amgen* and pharma company *Celgene* which was acquired by the pharmaceutical company *Bristol-Myers Squibb* in 2019 for 74 billion USD (Kewon 2018, Kansteiner 2021).

Another company in which Google invested in 2013 is *SynapDx* which was based in Massachusetts and aimed to detect developmental disorders of children, especially autism, via blood tests. However, the company terminated its services in 2017 because its hypotheses on the early detection of autism proved to be wrong (Stendhal 2017).

In 2014, Google joined the *Global Alliance for Genomics and Health*, a consortium promoting standards for the collection and analysis of genome data, better interoperability and the establishment of an "internet of genomics" (Wendt 2014). Among the other members of the consortium are *Amazon Web Services*, *Microsoft*, *Amgen*, *AstraZeneca*, *Glaxosmith Kline*, *Merck & Co, Inc* and *Alibaba Cloud* (Global Alliance for Genomics & Health w.y.).

In the same year *Google Genomics* (which by now has been renamed *Cloud Life Sciences*, not to be confused with *Verily* which was called *Google Life Sciences* until 2015, see above) went online. Interestingly, while many of Google's moonshots triggered much media coverage, the foundation of its genomics-unit seemed to pass nearly unnoticed (Wendt 2014). Since the genome of one individual already has storage requirements of about 100 gigabyte, target-oriented searching in genome databases requires usage of algorithms, a field on which Google is able to rely on its experiences with its search engine. One of its aims is to make comparisons of the genetic material of healthy and sick people more cost-efficient. Partner institutions, hospitals and universities are enabled to search through Genomics' complete databases. It was not specified on the projects' website whether data is available in anonymised or pseudonymised form (Wendt 2014).

Still in 2014, one of Google's most discussed projects started: The so called *Baseline Study* which aims to define what constitutes a healthy organism and to derive risk factors from this definition. The by now infamous quote "We've mapped the world, now let's map human health" originates from Baseline's website (Verily w.y.a). The project was started under the roof of Google's moonshot-department *Google X* (since 2016 only referred to as *X*) (Amadeo 2014) which was also in charge of the development of *Google Glass* and responsible for the acquisition of the British *DeepMind*-laboratory for 500 million USD in 2014 (Alter 2014). Later, Verily took over the Baseline Project which will collect and analyse an unprecedented amount of health data of 10,000 volunteers (Maschewski and

Nosthoff 2020). Participants are equipped with Google's *Study Watch* (Verily w.y.c) (see above), pass through blood-, urine- and stool-tests as well as complete genome analyses conducted by Verily (Grabar 2015, Alter 2014) and have their sleeping patterns measured by sensors attached to their beds (Hamzelou 2017). By now, the study has been divided into several sub-projects including the *Weight Study*, the *Mirai Depression Study*, the *Skin Study*, the *Gut Research Project* and the *COVID-19 Immune Response Study* (Verily w.y.c). Additional health tech-devices associated with the study have been published by Verily including *Photo Studio* which can be set up by participants at home to take high-quality pictures for the Skin Study (Verily w.y.b). Project-partners include *Stanford University*, *Duke University* and the *American Heart Society* (Verily 2022b).
The Baseline Study has been triggering controversies right from the beginning since the depth of the data in combination with Google's handling of data in the past concerned data privacy activists. In order to participate in any of the studies, volunteers first need to create a Google-account being subject to a separate privacy policy and it remained unclear which data will be covered by which policy (Lomas 2017). Additionally, Verily is allowed to access IP-addresses and location information if participants of the study have switched on these features on their devices (Verily 2022a).
In 2020, Verily stated that it has collected 700 million USD from investors in order to finance new acquisitions and that also Project Baseline will profit from these acquisitions (MobiHealthNews 2020).

In 2015, coinciding with Verily's foundation, a *Precision Medicine Initiative* was announced by US-President Barack Obama in order to improve health by individualising treatments instead of old "one size fits all"-approaches. Verily and *Vanderbilt University* were chosen as partners for conducting the study which includes one million volunteers while existing public institutions, conversely, faced a decrease in funding (Yeo 2021).

Also in 2015, Google Ventures started investing in *Metabiota*, a San Francisco-based pioneer in the field of analysing real-time data and forecasting risks of epidemics. Its founder, Nathan Wolfe, a highly regarded virologist and participant in the World Economic Forum's *Young Global Leaders Program*, had warned already in 2008 that the world was not sufficiently prepared for a global pandemic (Ratliff 2020). Metabiota collaborates with *Amazon Web Services* (AWS o.J.) and the German reinsurance company *Munich Re*. The companies started offering an insurance for potential revenue losses during a pandemic several years ago (Munich Re 2016). Apparently, the insurance had not been bought by a single company. Metabiota's early-alarm system recognized the Chinese city of Wuhan as a potential hotspot for an outbreak of a pandemic as early as December 31, 2019 (Ratliff 2020). A main investor in the company is *In-Q-Tel*, the venture capital arm of the CIA which also belonged to the first investors supporting *Palantir Technologies* (see *Section 7*).

In the same year, Google Ventures invested in *PatientPing* for the first time, a start up which had been founded in Boston in 2013 (Crunchbase w.y.d). The company's product can be integrated into existing hospital infrastructures and notifies all relevant staff if a new event concerning a patient (e.g. an incoming lab result) has occurred. During the Covid 19-pandemic the service was used to notify hospitals when a new patient, who had been tested positive for Covid-19, was transferred to its facilities in order to enable staff to take quarantine measures as early as possible (Landi 2020e). Google Ventures invested in

PatientPing again in 2020. In 2021, PatientPing was acquired by *Appriss Health*, a cloud company with a focus on behavioural health which by now has rebranded under the name *Bamboo Health* (Bryant 2020).

Another Google Ventures-investment of this time was the San Francisco-based Insights-as-a-Service company *Zephyr Health*, founded in 2011, which developed a management system to combine study data and health data based on algorithms enabling the system to merge data from various sources (Belic 2015). Its customers included *Roche* and *Novartis* (Grabar 2015). In 2018, Zephyr Health was acquired for an undisclosed amount by *Anju Software*, a provider of software for the life sciences industry, which is financially supported by the investment trust *Providence Equity Partners* (Weyman 2018).

Still in 2015, Google started working together with the biotechnology company *Biogen* which is based in Cambridge and also has a branch in Germany (Biogen w.y.). The companies are conducting a study on multiple sclerosis aiming to find explanations for the different courses the disease takes for different patients including environmental and biological factors (Chen 2015). Similar to Project Baseline, the study started under the roof of Google X and was shifted to Verily at a later stage. Asked why his company is working with Google, Biogen's vice president of corporate development and strategy, Adam Koppel, replied: "What Google can do that a biopharmaceutical company can't is pool all this data - and they have the queries and search tools to create signals from noise in a way I don't think any of us can do on our own" (Terry 2016).

That conceding sensitive data to Alphabet is nevertheless still controversial was shown in the same year when a patient of the *University of Chicago Medical Center* sued both the hospital and Alphabet for conceding and analysing his data (Miliard 2020). Alphabet was using health data of the hospital's patients to train its algorithms and to conduct predictive analytics-projects. In this context, the hospital had shared hundreds of thousands of patient records with the company. Allegedly, the shared data had been anonymised but the plaintiff argued that the hospital conceded such amounts of data that it would be easy for Alphabet to re-identify him. In 2020, the case was dismissed: While the judge considered it likely that the data was in fact detailed enough for potential re-identification she did not find proof that Alphabet had actually done so (Miliard 2020).

In 2019, Alphabet started *Project Nightingale*, an undertaking triggering as much media coverage as the Baseline Study. The project was established in partnership with *Ascension*, the second largest US-American healthcare company, being in charge of more than 2,000 hospitals and similar facilities, and enabled Alphabet to access millions of diagnoses, prescriptions, data on hospital stays and other health data (Pilkington 2019, Bolzern 2021). Based on the data, Project Nightingale aims to make proposals for treatments, recommends tests, alarms doctors when it detects deviations and even might propose personnel changes in treatment teams. The data involved in the project are not anonymised and mark the most extensive transfer of health data to a third-party to date. Neither doctors nor patients were asked for their consent or informed about this transfer of data and according to the original agreement, Alphabet would have received even more data on all in all 50 million individuals until mid-2020. The companies only started talking publicly about the project when an anonymous whistleblower shared information on the agreement with the public (Pilkington 2019). In response, Alphabet assured that it will not use any data of Project

Nightingale to sell advertisings but will only use it for developments in the health sector (Elias and Farr 2019). Google Cloud-president Tariq Shaukat reacted to public criticism by asserting that the data "cannot and will not be combined with any Google consumer data" (Shaukat 2019).

In the beginning of 2020, when there were still less than 2,000 confirmed Covid-cases in the US, Verily developed a website with a questionnaire under the roof of Project Nightingale in order to check if participants should be tested for the virus. In response, President Trump thanked the company for offering its help (Reuters 2020). In order to be eligible for being tested, citizens need to log in with a Google-account (Verily w.y.). Questions on how the submitted data would be processed, were not answered by Verily's spokeswoman (Reuters 2020).

In the same year, Alphabet also started a multi-year partnership with the non-profit organisation which operates the *Mayo Clinics*. Also in this partnership, Alphabet seems to be able to directly access patient data (Landi 2019b). The partners aim to develop an algorithm which helps doctors to plan radiation therapy based on this data. Moreover, Alphabet established a branch in Minnesota next to the Mayo Clinic-buildings in order to build up an "AI-Factory" to develop solutions based on artificial intelligence suited to be integrated into the clinical routine. In a statement, Minnesota's governor Tim Walz emphasized the economic opportunities for the state of Minnesota which arise from the company's involvement in the area (Vaidya 2021, Hale 2021).

Still in 2020, *Google Cloud* developed two new AI-tools: *Healthcare Natural Language API* and *AutoML Entity Extraction for Healthcare* were designed specifically for the health sector and are able to analyse and search for information from unstructured texts (Wiggers 2020). As of August 2020, Google Cloud was the world's third-biggest cloud vendor after *Amazon Web Services* and *Microsoft Azure* and followed by *Alibaba Cloud* (Dignan 2021). Google Cloud-customers in the health sector include the *American Cancer Society*, *Ambra Health*, *Moderna* and the *Foundation for Precision Medicine* (Google w.y.). Additionally, Google Cloud is developing a research platform for scientists and universities in a collaboration with the *Massachusetts General Hospital* and the New York-based company *ProofPilot* (MobiHealthNews 2020).

Around the same time, Alphabet published a web-tool named *Covid-19 Community Mobility Reports* using data generated by *Google Maps* to show changes in people's behaviour and moving patterns to analyse if measures taken by the government in the context of the pandemic are having the desired effects. In September 2022, Alphabet announced that it will not publish any new reports starting from October 2022 (Google 2022). The company had already used data from Google Maps for health purposes in the past, for example between 2008 and 2015, when the company tried to analyse flu-activity via its service *Google Flu Trends*, and between 2009 and 2012 to show users the nearest flu vaccination place via the *Google Flu Vaccine Finder* (Farr 2020t).

Since 2021, Alphabet collaborates with *HCA Healthcare*, a US-American hospital chain which treats more than 32 million patients annually in its 186 hospitals. Anonymised patient data as well as data generated by medical devices which are connected with the internet are now saved on Alphabet's servers. The devices are monitored by Google Cloud which means

that patient data can be accessed by Alphabet in real-time. The partners aim to develop algorithms which will improve efficiency in HCA's hospitals, help doctors in their decision-making process and to monitor patients' health status (HCA Healthcare 2021, Evans 2021, Tobias 2021, Bolzern 2021).

Also in 2021, Alphabet started a partnership with the US-American health insurance company *Blue Shield of California* which uses *Google Cloud*-services to facilitate its payment procedures. For instance, Google Cloud will enable patients to see which parts of the costs of a treatment they will have to cover themselves in real-time (Blue Shield of California 2021). Blue Shield of California has also been collaborating with *Oracle* for several years (see *Section 9.2*).

2.3 Electronic Health Records and Hospital Information Systems

While Electronic Health Records (EHR) have started to gather public attention in Germany only recently, Google's first attempts to succeed in this field occurred already back in 2006 when the company started its project *Google Health*. The associated EHR was officially made available to the public in 2008 but only three years later Google terminated the service (Dolan 2011, Jercich 2021). Users could save information on their general health status, allergies, lab results and medication. In the United States, the service was not subject to regulation by the *Health Insurance Portability and Accountability Act (HIPAA)*, which has been introduced in 1996 and regulates the security of health data transfers, since Google is neither a healthcare provider nor an insurance company (taz 2008). The platform used the results to create health profiles of every user and to point to individual risks and intolerances. While Google promised that it would not use health data to send individualised advertisements to users, it was planned that third parties could pay Google in order to obtain access to certain data sets (Datenschutz-Bremen 2008).

After this first rather unsuccessful attempt, it took nearly ten years until Alphabet conducted another project focusing on an EHR. Then, the company joined a group led by *PricewaterhouseCoopers* to apply for the development of a new EHR-system for the US-American *Department of Defence* (Tech Monitor 2015). However, also this second attempt was not successful and the deal being worth 9 billion USD finally went to the group of *Cerner*, *Leidos* and *Accenture* (Terry 2016) (see *Section 14* and *Section 15*).

As described in *Section 2.2*, there has apparently been a change in Alphabet's strategy concerning access to health data in recent years. Instead of providing its own EHR, the company now collaborates with hospitals to get access to their EHRs as can be shown for example and probably most strikingly for Project Nightingale. The company has by now also applied for a patent for predicting future health status on the base of aggregated EHR-data (Murphy 2019).

Fittingly, Alphabet confirmed in a blog post in 2020 that it is working on a new EHR-tool (Feinberg 2019). While at first not many details were publicly available, it seems that the company designs the tool to rather integrate with other EHRs instead of replacing them. All health records from other systems could be collected in the new search-friendly database allowing physicians to get an overview of patients' health status more conveniently. In

February 2021, the project was named *Google Health Care Studio* and more details on its functioning were mentioned in a blog post according to which Care Studio will allow physicians to quickly search through patient information and to bring together medical information from different systems (Kuraitis, Anderson, and Parker 2021, Matthews 2020). The tool will also be able to give recommendations concerning treatment and diagnostics. Apparently, *Ascension Health*, which collaborated with Alphabet already in Project Nightingale (see above), will be the fist company to test the new tool which could make Alphabet's aforementioned patent even more valuable (Matthews 2020). It remained unclear whether Alphabet is planning to offer its Care Studio free of charge which might create considerable pressure on dominant players on the market for EHRs like *Epic Systems* and *Cerner* (Kuraitis, Anderson, and Parker 2021) (see *Section 14* and *Section 15*).

2.4 Innovation of Treatment

In 2012, Google Ventures was the leading investor in the seed funding-round for *Transcriptic*, a company which focuses on projects like the development of robotics technology for scientific experiments (Shu 2012). In 2019, Transcriptic merged with *3Scan* and was renamed *Strateos*. The new company's aim is to automate processes in chemistry and biology in order to accelerate the development of new drugs (GlobeNewsWire 2019).

One year later, Google Ventures started investing in the San Francisco-based company *One Medical* which operates several hospitals with a focus on using digital technologies like EHRs and telemedicine consultations with doctors in nine cities in the United States. Patients can pay a fee of 199 USD annually to use the services but payment via health insurances or employers is also possible (Crunchbase w.y.g, One Medical w.y.). Alphabet does not only belong to the biggest investors but is also one of One Medical's most important customers accounting for 10% of the company's revenues. Alphabet covers the fees for its employees while One Medical operates clinics in the neighbourhood of Alphabet's office locations. In 2020, 400,000 members were using the services of One Medical which, in the same year, decided to go public. Its biggest investor is the private equity company *Carlyle Group* (Farr 2020c). In 2022, *Amazon* announced its plans to acquire One Medical (see *Section 5.4*).

Another company that Google Ventures invested in at this time is *Rani Therapeutics* which was founded in San Francisco in 2012 and develops pills which, after being swallowed, emit small syringes into the intestinal wall of the patient (Crunchbase 2022b, Shubarth 2020). This should make drug intake more comfortable and thus help to reduce the high number of deaths due to low adherence. First clinical trials with humans with drugs from *AbbVie* and *Astra Zeneca* were conducted in 2019 (Hale 2020) but Rani Therapeutics also develops its own drugs (Shubarth 2020). Google Ventures continued supporting the company with further investments in 2015, 2017 and 2018. Rani Therapeutics is by now regarded as unicorn (Shubarth 2020).

Also in 2013, *Calico* (short for *California Life Company*) was founded. The company, which became a subsidiary of the back then newly founded Alphabet-holding in 2015, focuses on research and the development of therapies for age-related diseases (Grabar 2015).

Its CEO Arthur D. Levinson is also a member of the administrative board of *Apple* and known to be a Silicon Valley-pioneer (Zeizinger 2019). Calico's vice-president is Cynthia Kenyon, a cell-biologist who, in the 1990s, had found that worms with specific gene mutations live twice as long as comparable worms. In a CNN-interview from 2015, the founder of Calico, Bill Maris, took the view that it would be hypothetically possible for humans to live for 500 years. While precise goals, methods and intermediate results are not disclosed to the public, it is known that Calico is cooperating with different partner companies: In its collaboration with *AbbVie*, a Chicago-based pharma company, Calico is responsible for basic research and AbbVie concentrates on implementation and commercialisation of the products. The companies share the expenses and profits arising from their partnership (Zeizinger 2019). An update to the companies' agreement was published in the beginning of 2021 (AbbVie 2021). The collaboration of Calico and *Ancestry* is described in *Section 2.2*.

Meanwhile, Google's moonshot unit X has been working on the development of so called nano-pills since 2014. The pills are swallowed by the patient in order to enable extremely small sickness-detectors to be sent through the whole body. If they meet sickness molecules on their way, they attach to them which is in turn registered by a sensor outside the body, e.g. in a smartwatch. This way, X is aiming to find signs for diseases like cancer (Grabar 2015, PraxisVita 2014). After much media coverage in the beginning, no information more recent than 2017 could be found on the nano-pills-project.

In 2015, GV invested in *Alector*, a company based in California, which tries to find new treatments for Alzheimer's disease by crafting molecules that enable the body to stop processes leading to neurodegeneration (Garde 2015). Other investors in Alector include Calico-partner *AbbVie* (Tindera 2018) and *MRL Venture*, an investment fond of *Merck & Co Inc* (Grabar 2015). GV supported the company, which also signed a deal with *Johnson&Johnson* (Garde 2015), with a further investment in 2018 (Tindera 2018).

In another Alzheimer's disease-related partnership GV invested in the San Francisco-based company *Denali Therapeutics* (Grabar 2015). The company, which develops medicine and aims to advance treatment options for Alzheimer's, also uses certain GV-services for its data management in sectors like marketing and human resources (Ungerleider 2017).

"What if we could repair broken genes?", asks the website of *Editas Medicine* (Editas Medicine w.y.), which was founded in 2013 in Cambridge in order to develop gene-modifying methods to find new treatment options. Google Ventures invested in the company in its funding round of 2015 with Boris Nikolic, publicly known to be a scientific advisor of Bill Gates, being this round's leading investor (Crunchbase w.y.f). In the course of a study conducted in partnership with *Allergan*, a subsidiary of *AbbVie* and famous for inventing Botox, the company was the first to use the CRISPR-method to modify the genes of a living person (Stein 2020). Since 2015, Editas has been cooperating with *Juno Therapeutics* aiming to find new treatments for cancer (Grabar 2015). Juno Therapeutics, which had focused on gene therapies to heal leukaemia, was acquired by *Celgene* (which was in turn acquired by *Brystol-Myers-Squibb (BMS)* only one year later (Bristol-Myers Squibb 2019)) in 2018 (Celgene 2018).

Since 2015, Alphabet has been a supporter of *Oxford Science Innovation*, a venture capital

company which mainly cooperates with the *University of Oxford* (Grabar 2015). The company uses research conducted by the university and supports so called "spin-outs", companies with business models that are based on this research. One of these spin-outs, *Vaccitech*, which was founded in 2016, is a co-developer of the *Astra Zeneca*-vaccine, one of the most widely used vaccines during the Covid-19-pandemic (Tyler 2017, Strasburg 2021). The aim of Oxford Science Information is to advance commercialisation of research in order to be able to compete with major US-institutions like Stanford University (Tyler 2017). Among its investors besides Alphabet is also the Chinese enterprise *Tencent* (Oxford Science Enterprises w.y.). Several former employees of Alphabet are now working for Oxford Science Innovation, among them Demis Hassabis, the founder of *DeepMind* (Agnew 2015).

In 2016, Verily started a partnership with the British pharma company *GlaxoSmithKline (GSK)*. The aim of the newly found company *Galvani Bioelectronics* is to develop bioelectrical medication for the treatment of different chronic diseases (Diabetologie Online 2016). Verily holds 45% of the company's shares and both partners agreed to invest up to 540 million GBP in a time span of seven years and to bring their copyrights and patents into the partnership. GSK has already been active in the area of bioelectrical medication since 2012 and tries to show that diseases like arthritis, diabetes and asthma can potentially be treated with the help of miniature implants which are able to modify electrical nerve signals that are impaired if the aforementioned diseases occur. Verily can be helpful in this area due to its experience in miniaturizing electronic devices, developing software for clinical solutions and data analysis. The head office of the new company is in Stevenage in the United Kingdom but it was planned to establish a second office in Silicon Valley (Diabetologie Online 2016). GSK is also a producer of vaccines and has several branches in Germany (GSK w.y.).

In the same year, Verily and the French pharma group *Sanofi* established their joint venture *Onduo* which aimed to help people with diabetes to live healthier lives. Both companies invested 500 million USD in the beginning of their partnership. While Sanofi brought in its clinical expertise, Verily developed the software and offered its data analytics skills as well as knowledge in miniaturizing electronic devices (CHEManager 2016). The joint venture also aimed to connect devices of other companies, among them *Dexcom* (Muoio 2019) (see *Section 2.1*), with each other. Within the scope of a restructuring of the company, Sanofi stopped being part of Onduo in 2019 but planned to stay active as a financial supporter of its projects (Muoio 2019) .

In 2017, GV invested in *Compass Therapeutics*, a Boston-based company which tried to develop antibody- and immunotherapies for cancer patients (Crunchbase w.y.e). Three years later, the company was acquired by *Olivia Ventures* but is still operating under its old name (Al Idrus 2020).

Also in 2017, GV invested in the Silicon Valley start up *Grail* which aims to find ways how to detect cancer earlier when patients do not have any symptoms in order to improve chances of recovery (Lee 2017b, Herper 2017). Market-readiness of Grail's services was at first predicted to be reached in 2019 (Steenhuysen 2016). More recent media coverage discusses a commercial partnership of the company with the British *National Health Service (NHS)* to trial its newly developed *Galeri Test* (Gregory 2020). Grail's CEO Jeff Huber is a former Google-employee (Herper 2017). Among the other investors in Grail are *Amazon*

(see *Section 5.2*), *Bezos Expeditions*, *Johnson&Johnson* and Bill Gates (Lee 2017b).

Alphabet also casts an eye on the market for clinical trials on which it has established numerous partnerships with companies like *Pfizer*, *Sanofi* and Japan-based *Otsuka*. Among the company's aims on this field is to make the recruitment process faster and to integrate health data from different sources (Oschmann and Stephani 2019).

2.5 Logistics

In 2015, GV invested in *TinyRx*, a San Francisco-based pharmacy network including a medication delivery service. Users could enter their prescriptions into a form on the company's website from where they were transferred to local pharmacies. Subsequently, TinyRx picked up the medicine and delivered it free of charge for its users. Revenue was generated by sharing agreements with the participating pharmacies and express deliveries for which the company charged 10 USD per delivery (Pai 2015). In 2016, TinyRx terminated its services (Crunchbase w.y.h).

By now, Alphabet has developed the potential to deliver medicine itself with the drones which are part of the company's *Wing*-project that in the beginning belonged to the company's *X*-unit but has become an independent subsidiary in 2018 (X 2018). At first considered to be rather a gimmick, Alphabet surprised the public in the middle of 2022 by announcing that Wing-drones had completed 50,000 commercial deliveries in the first quarter of the year showing its massive potential (Beer 2022). Areas served include the San Francisco Area and areas in Texas, Bonython in Australia and near Finland's capital Helsinki. Besides *UPS*, Wing is the only company with a full licence to operate delivery drones in the United States (Beer 2022).

2.6 Other Activities

Probably more than any other Big Tech-company, Alphabet has tried to establish itself as an actor in the insurance sector. In 2015, Alphabet invested 32.5 million USD in *Oscar Health Insurance* via its private equity firm *Google Capital* (by now renamed *CapitalG*) (MacMillan 2015). Oscar Health Insurance was founded in New York in 2012 by Joshua Kushner, brother of Jared Kushner who worked as senior advisor for Donald Trump during his presidency (D'Onfro 2018a). The insurance company offers its customers different plans and focuses on telemedicine and transparency of its premium system. Its business strategy has been referred to as a "move straight out of the Silicon Valley playbook: limit choice, and deliver a better user experience instead"(Molteni 2017). Apparently, Oscar Health does not contract a huge variety of doctors but uses its data-science-skills to find out which doctors suit the need of its members most and then concentrates on contracting these. In order to do so, the insurance analyses insurance claims to develop a new taxonomy of health care providers with about 400 sub-categories. It also bought Medicare-data to build a predictive model to determine how often certain services will be needed by its members and then connected their customers' place of residence with doctors' locations to arrive at an efficient number of specialists in each category and location (Molteni 2017). In 2016,

Oscar Health and Verily considered taking over care for low-income earners on *Medicaid* in Rhode Island but ultimately decided against doing so (D'Onfro 2018a). In 2017, Oscar Health implemented its own EHR, which collects all health information in one place, the so called *Clinical Dashboard* (Pflanzer 2017). In 2018, Alphabet invested 375 million USD in Oscar Health. Including further investments by Verily and CapitalG, Alphabet now owns 10% of Oscar Health. At the same time, former Google-employee and *Youtube*-CEO Salar Kamangar started working for Oscar Health (D'Onfro 2018a). In 2020, 400,000 people were insured by the company which expanded its business to 14 additional states (Lovett 2020a). In 2021, Oscar Health started selling shares in its initial public offering and in 2022, the number of Oscar-insured people exceeded 1 million (Walton 2022).

Also in 2015, Alphabet decided to invest in the US-American health insurance company *Collective Health* via GV for the first time (Business Wire 2015). Further investments followed in 2018 and 2019 (Crunchbase 2022a). Collective Health was founded in 2013 in San Francisco. It aims to find new solutions for companies who offer health insurance for their employers themselves. By making health information transparent and available, it should become easier for employees to make informed health choices and employers are enabled to structure their benefits more flexibly based on data analysis. Collective Health sums up the company's goals on its website: "We're not building another health app or gadget – we're building a complete solution to replace your employer health insurance." (Diab and Batniji w.y.). Among others, *Uber*, *Pinterest* and *Activison Blizzard* belong to the company's customers (Business Wire 2018). Since 2021, Collective Health cooperates with the *Healthcare Service Corporation*, the fifth-largest health insurer in the United States (Minemyer 2021a). Collective Health had also supported the medication delivery service *tiny Rx* before it stopped its services (see *Section 2.5*).

In 2016, Adam Koppel, vice-president of *Biogen* stated that he is sure that Alphabet is aiming to replace the *Centers of Medicare & Medicaid Services (CMS)*: "They want to take over CMS...And they will say that to you" (Keshavan 2016).

In 2018, Verily established a partnership with *Walgreens Boots*, the biggest pharmacy-chain in the United States. The partnership includes different projects, ranging from a pilot project to improve patient adherence to a diabetes-app which is developed by *Onduo* (see *Section 2.4*) and offered to Walgreen's employees and their family members (Walgreens Boots Alliance 2018). Walgreens also collaborated with other tech companies including *Philips* and *Microsoft* and with the latter it developed a Covid-19-risk-test (Landi 2020c). Walgreens is a competitor of *Amazon* on the pharmacy market since Amazon acquired *PillPack* (see *Section 5.5*).

In 2020, Verily and *Swiss Re Corporate Solutions* established a new health insurance: The *Coefficient Insurance Company* (by now renamed *Granular Insurance Company*) is a stop loss insurance which is aimed at employers who offer insurance for their employees themselves. According to Verily's CEO Andrew Conrad, the company aims to provide precision risk solutions with better cost control for employers, and plans to integrate its product with other Verily-solutions like mobile health devices in the future (Lovett 2020b). One year after its foundation, the Granular Insurance Company already counted 100,000 insured individuals (Verily 2021).

In 2020, Alphabet joined the *Health Equity and Access Leadership Coalition* which deals with the effects of the Covid-19-pandemic on society and drafts recommendations for politics to fight the resulting inequalities. Among the members of the coalition are also other tech companies like *Microsoft*, *HP* and *Intel* (Muoio 2020a).

In the same year, Verily started its *Healthy at Work*-programme which includes Covid-19-symptom checks, testing facilities and questionnaires in which employees are asked to give information on their health status (Muoio 2020b).

Alphabet often is the first contact point for people searching for medical advice as well as well-rated doctors and hospitals in their local area via its search engine (Gleiss, Kohlhagen, and Pousttchi 2021). The company states that 7% of all Google search queries are health-related (Rawal 2020). The functioning of the engine's algorithms is not disclosed to the public but is crucial for search results and their sorting (DeMers 2020, Rainey 2021) and thus for doctors' visibility for potential new patients. In the Covid-19-pandemic, the German Ministry of Health collaborated with Alphabet and achieved that official information by the ministry's health portal *gesund.bund.de* was displayed preferentially. In this context, Rudolf Thiemann, the president of the German *Federal Association of Newspaper Publishers*, spoke of an unique and novel attack on the freedom of press (Focus 2020) and the partnership has been prohibited by now (Frankfurter Allgemeine Zeitung 2021). In a similar manner, also developers of health apps are dependent on Alphabet's *Play Store*, the market leader in the field of app-stores, for distribution (Gleiss, Kohlhagen, and Pousttchi 2021).

2.7 Summary

What strikes most about Alphabet's activities in the health sector is their enormous variety. There does not seem to be a single section of the health market in which Alphabet has not least tried to establish itself as a player. This also includes the market for health insurance in which other Big Tech companies have not been as active yet. More than its Big Tech-competitors, Alphabet has extended its activities in the sector by investing in existing companies and start ups. Not all of these investments have been successful and the same is true for the company's own projects like the early implementation of an EHR with Google Health. While media coverage sometimes suggests that Alphabet and other Big Tech companies have appeared in the health sector only recently and suddenly, it is rather true that the company already has been active in this sector for a long time and intensified it efforts significantly in 2015 at the latest. While it seems clear that the company plans to expand its role in the health sector in the future, it is hard to predict how its ambitious and often secret projects under the roofs of Verily and X will develop.

3 Apple

Founded in 1976 as one of the first providers of personal computers, Apple has increased its product range especially since the beginning of the millennium when it developed several iconic devices like the *iPod* (2001), the *iPhone* (2007), the *iPad* (2010) and the *Apple Watch* (2015). Ranked by revenue, Apple was the third biggest company in the United States

in 2021 (Fortune Media 2021) with the iPhone accounting for nearly 50% of its revenue (McGee 2022). The company started its activities in the healthcare sector in 2014 and has reinforced its efforts in recent years. In 2019, its CEO Tim Cook famously said that "Apple's greatest contribution to mankind...will be about health." (Gurdus 2019c)

3.1 Health Apps and Smart Devices

The *Geisinger Health System*-hospital in Danville, Pennsylvania already equipped its staff with *iPads* in 2011 (Strand 2020) and has implemented a far-reaching infrastructure of Apple-devices by now. The staff does not have to rely on unhandy work stations to transport heavy personal computers to patients beds anymore and can use apps like *Haiku* and *Canto* by *Epic Systems* (see *Section 14*), which are installed on the iPads, to retrieve new results directly in the hospital room. It is also possible to order medication at the bedside (Apple w.y.c). The hospital says that it also wants to learn more about the patient experience and for that reason it implemented different IT-devices at its hospital beds to establish an *Interactive Patient System* (Geisinger Health 2016). This means that also patients are equipped with iPads while staying at Geisinger's hospital on which they can use apps like *MyChart Bedside* (also by Epic Systems) which for example shows them their lab results in a patient-friendly manner (Apple w.y.c). Patients are also able to retrieve general information on their diseases and the devices are used as a means of distraction before surgeries, especially with children, which has allegedly reduced the necessity of prescribing sedatives before surgery. In the intensive care ward for infants iPads are used to connect mothers with their children via *FaceTime* (Apple w.y.c). Another Apple-project at Geisinger is *Classroom Connect* which enables children who have to stay in the hospital for a longer period of time to avoid social isolation and to follow class via iPad (Jamf 2020). A similar use of iPads is possible for patients who have to stay in quarantine because of an infection with Covid-19 (Strand 2020).

In 2014, Apple established its *Health Kit* which enables third parties to develop their own health apps (Apple w.y.f, Spiegel Online 2018). Together with the *Health*-App, which was also released in 2014 (Apple 2022b), it is Apple's first product that has been developed specifically for the healthcare sector. Users of the Health-App are able to enter activity-, nutritional- and health data manually but it is also possible to import data from apps and devices (e.g. of glucose measurement devices) from third-parties (Gleiss, Kohlhagen, and Pousttchi 2021). By now, data from tens of thousands apps of different vendors can be integrated (Apple w.y.e). Data can be shared with family members via the app and a *Medical ID* is generated which offers important information for first responders in case of an emergency (Shibasaki 2020). According to Apple, it is completely up to the users which data they want to save and which apps are enabled to access them and the company says that it does not access any health data which is saved in the app (Apple 2021b). With the aforementioned Health Kit it is possible to develop apps which are able to interact with the original Health-app, for example by passing or receiving health data from the app. One of the first companies to use the Health Kit was the EHR-giant *Epic Systems* (Sullivan 2014) (see *Section 14*). The Health-app is continuously complemented by new functions. Since 2021, it is able to analyse walking stability and risk of falls (Apple w.y.h) and to create trend

analyses of overall health status. An example is the app's ability to detect if the blood pressure in one week is considerably lower than in the week before and to inform users about this development (Apple 2021b).

In the same year, Apple strengthened its activities in the health sector by making its *Activity*-App available which enables users to track their training sessions (Apple 2014). In 2020, the app was renamed *Fitness* (Guyot 2020). The app has become famous for its three *Activity Rings* which users are supposed to close everyday. There is one ring for calories burnt, training minutes and for each hour in which the user has spent at least one minute standing, respectively. It is possible to share results with friends and to start competitions which are won by the person who has closed the highest amount of rings within the last 7 days. After using the app for 180 days, it is able to display health- and activity trends (Apple 2014, Nosthoff and Maschewski 2019).
In 2020, Apple announced *Fitness+* (originally, the project had been called *Seymour*), a video on demand-portal which is free of advertising and streams clips with workout-instructions. There are also yoga-, rowing- and dancing-courses available and users are able to display real-time data from their Apple Watch in the upper half of the screen while working out (Farr 2020m, CB Insights 2021, Apple w.y.g). Additionally, the *Time to Walk*-feature has been introduced in 2021 which enables users to listen to a podcast that is hosted by different celebrities while they are exercising (Apple 2021d). Apple started operating Fitness+ in the course of the Covid-19-pandemic when many people started exercising at home but it remains to be seen if the company will be able to compete with major players in the sector, especially *Peloton* which was very successful during the first phase of the pandemic (Farr 2020m). However, there has been a dramatic drop in revenues for Peloton since then leading to a major crisis and many dismissals in the company (Kort 2022a).

In 2015, the Health Kit was complemented by the *Research Kit*, an open source framework which enables the development of apps with a focus on the execution of clinical trials and participant recruitment. The aim of the project is to improve medical research and it is emphasized that enabling participants to engage in a study via their iPhones will make participation much more attractive compared to obligations to travel to respective facilities. It is possible to develop apps not only for skilled app developers but also for physicians and patients (Apple w.y.i, CB Insights 2021).
An example for an app based on the Research Kit is the *Autism and Beyond*-App by Ricky Bloomfield, at the time of development a physician at *Duke University*, who was later hired by Apple (Siwicki 2017). The app displays video clips on children's iPhones and at the same time films their reactions with the phones' front cameras. Subsequently, algorithms analyse the emotions and behaviour patterns of the children in order to make an early diagnosis of autism possible (Duke Institute for Health Information w.y.). The Duke University itself was also among the first users of the Health Kit when it partnered with *Epic Systems* to integrate patient-generated data into their EHRs (see above and *Section 3.3*).
Also *EpiWatch*, the first scientific app which relied on usage of the *Apple Watch*, was developed using the Research Kit. Here, the sensors of the watch collect physiological data during an epileptic seizure and in an upcoming version of the app, these data will be used to develop a seizure-detector which warns users that a seizure might occur in a timely manner (Johns Hopkins w.y., Apple w.y.c).

2015 was also the year in which the first version of the *Apple Watch* was released (Snell 2015). Already in the same year, the smart watch was implemented in a program of the *Ochsner Medical Center*, a hospital near New Orleans, which is regularly ranked as one of the best hospitals in the United States. Furthermore, Ochsner Health System operates 12 additional hospitals in the United States. In the course of the *Ochsner Hypertension Digital Medicine Program*, the hospital distributes Apple-devices to its patients in order to be able to detect unperceived high blood pressure (Apple w.y.b). The program is designed for patients who do not need acute treatment inside a hospital but still might profit from regular supervision. Also white coat high blood pressure patients, whose blood pressure only rises because they are afraid of doctor's appointments, might profit from the program. While blood pressure is regularly measured by the Apple Health-app on iPhones, the Apple Watch sends notifications that remind users to take their medicine and to engage in sporting activities. After filling in a questionnaire, participants are sent to the *O Bar*, which mimics the look of Apple Stores, where they receive their Apple-devices including a personalized preinstalled collection of apps (Apple w.y.b). By now, the hospital has expanded the program to the treatment of other diseases like diabetes, COPD, asthma, arthritis and high cholesterol levels and also uses other services provided by Apple (Apple w.y.b).

To improve the treatment of their patients, the physicians at Ochsner use their *iPhones* to display patient lists with room numbers, information on newly arrived patients and new lab results to avoid unnecessary delays. Apps like *Haiku* by *Epic Systems* (see above and *Section 14*) enable staff to retrieve patient information already on their way to work and the *MyChart Bedside*-app (also by Epic Systems, see above and *Section 14*) allows patients to see which medication they received at which time, who belongs to their care team and which appointments they will have in the course of the day (Apple w.y.b). Also telemedicine-appointments belong to the daily routine at the Ochsner Health System, a development which has been accelerated by the Covid-19-pandemic: While there were less than 4,000 consultations at Ochsner's facilities in 2019, there were 120,000 until May 2020 (Collins 2020b).

The *Apple Watch Generation 4*, which has been released in 2018, was the first device with an electrocardiogram-function certified by the FDA (Becker 2018). The associated app is able to classify the measured values as sinus rhythm, auricular fibrillation with or without high heart rate or inconclusive due to problems with recording. The measured values, graphs, date and time are subsequently exported as PDF-files into the *Health*-app for inspection by a physician (Apple w.y.j).
The device is now also able to send alarm notifications after measuring the heart rate if users are not physiologically active but still have a high heart rate. If the cardiac rhythm is irregular in a way that hints at the danger of potential auricular fibrillation, the watch notifies its user. This alarm-function is CE-certified and the app is authorised for anamnesis in several countries including Germany (Heuzeroth 2019). In a clinical trial, which compared the analysis via Apple Watch with an electrocardiogram conducted by a cardiologist, the watch reached a specificity of 99.6% for the classification of a sinus rhythm and a specificity of 98.3% for the classification of auricular fibrillation (Apple w.y.j).
The Apple Watch is now also able to measure six-minute-walking distance, stride length and walking asymmetries: metrics which enable analyses of the so-called "functional (aerobic) capacity" (Farr 2020j) which is relevant for physicians of different specialisations. In

this context, Apple also collaborates with *Zimmer Biomet*, one of the world's biggest producers of cardio and orthopaedic products (Farr 2020j).
During the Covid-19-pandemic, Apple also introduced a feature which shows users how to clean their hands appropriately including a timer, motion sensors and a sensor listening to the sound of water (Apple 2020).
Additional new features of the Apple Watch seem to be aimed especially at older people and include an emergency pass which displays relevant information for first responders on the lock screen in case of an emergency (Apple w.y.m) and a fall detection which enables users to start an emergency call or to indicate a false alarm respectively by closing the associated display with one fingertip. If the user does not react within one minute, the watch automatically starts an emergency call and also informs designated contact persons (Apple w.y.n).
Newer features of the watch, which increase its attractiveness for the elderly, might be interpreted as response to critics claiming that the people who own the device already are mostly young and profit least from a continuous monitoring of the heart rate which might even turn out to be disadvantageous because it potentially triggers fear and leads to unnecessary doctor's appointments (Tsukayama 2018, Wetsman 2020).
The watch has been advertised by the slogan "The future of health is on your wrist." (Sherr 2020).

In 2016, Apple introduced the *Care Kit*, another programming environment for app-developers, this time with a focus on monitoring and improving health in everyday-life (Siwicki 2017). One aim is for instance to complement doctor's visits with information from the resulting apps to obtain a more complete picture of the patient's health.
Among the most popular apps based on the Care Kit was the *Corrie Health App*, which had been designed by *Johns Hopkins University*. It offers users support in the time after a heart attack, helps to monitor heart rate, medication intake and sporting activities and transmits data to the care-team which, in turn, is enabled to send users appointment reminders (Apple w.y.b, Apple w.y.a).
Another app developed via Care Kit is the *Caremap App* created by the *Duke University Health System* and the *Boston Children's Hospital* which enables daily monitoring of symptoms and the healing progress in order to reinforce a more individualised treatment (Caremap w.y.).
The New York-based start up *One Drop*, which was founded in 2015, also developed its eponymous app via Care Kit. The app is designed for diabetics and enables them to draw connections between their blood glucose level and their well-being. One Drop also allows its users to share data with family members and physicians (Apple w.y.k). Other institutions, which have collaborated with Apple via Research- and Care Kit include the *American Heart Association*, *Emory Healthcare*, *Harvard Medical School*, *Sage Bionetworks*, *Stanford Medicine*, *Yale School of Medicine*, *University of Oxford*, *University of Hong Kong*, *University of Cape Town* and the *Universitätsklinikum Freiburg* (Apple w.y.l). The latter was the first German research institution to develop an app via the Research Kit. The development of the *Back on Track*-app has been supported by the German software company *Design IT*. It was used in a study on patients with anterior cruciate ligaments to collect data on different care strategies and patient satisfaction (Universitätsklinikum Freiburg 2015).

After being much more hesitant than other tech companies in the field of sleep tracking and also not offering associated functions in early versions of the Apple Watch, Apple acquired

the Finnish sleep tracking company *Beddit* in 2017 (Farr and Kovach 2019). In 2019, Apple additionally acquired the start up *Tueo Health* which had developed non-contact sleep sensors enabling parents of children with asthma to track their breathing patterns in their sleep (Farr and Kovach 2019).
Since 2020, an update of Apple's operating system enables users to track their sleep with their Apple Watch. Apparently, Apple tries to differentiate itself from its competitors in this field like *Fitbit* by offering nudges for sleeping goals instead of showing complex metrics and analyses which might trigger orthosomnia, a sleep-related fear which might result from pursuing perfect sleep via wearables (Farr 2020i). Apple's program is called *Wind Down* and enables users for example to set a time starting from which the display of their watch will get darker and no notifications will be shown (Farr 2020i).

In the course of the Covid-19-pandemic the *York Teaching Hospital NHS Foundation Trust* and the *NHS Grampian* introduced *iPads* to enable their hospitalised patients to stay in touch with family and friends without the mutual risk of being infected with the virus. The hospitals apparently chose iPads for these tasks because of their easy handling for both staff and patients, their supposedly good data protection and manifold scopes of application (NHE 2020). Third parties like the software developing company *Jamf*, which focus exclusively on implementing Apple-products in companies and institutions, ensure that the iPads can be given from patient to patient without revealing personal data being saved on the devices. For instance, the company offers its *Jamf Healthcare Listener* for a so-called "digital sterilization" of patient-iPads, deleting all personal data and defaults from the devices automatically as soon as it is entered into the EHR that the patient has been released from the hospital (Jamf w.y.).

In another effort related to the pandemic, Apple updated its voice assistant *Siri* which is now able to answer questions about Covid-19-symptoms. Depending on the severity of the described symptoms, Siri will recommend to call 911 or to stay at home and wait, respectively. Siri is also able to refer users to Apple's *App Store* where they will find telemedicine apps to arrange an appointment with a doctor. Its answers are based on information from the *US Public Health Service* and the *Centers for Disease Control and Prevention* (Farr and Stankiewicz 2020).

Despite the aforementioned activities it was Apple's collaboration with *Alphabet* (see Section 2.1) in order to develop an interface for contact tracing apps which attracted most media coverage during the first phase of the pandemic. The project had been named *Bubble* at first (while Alphabet had named the project *Apollo*) and among others Dr. Guy Tribble, vice-president of Apple for software and often referred to as "privacy czar", was involved in the development (Farr 2020n). As already mentioned in *Section 2.2*, the companies put pressure on countries who wanted to use the interface to save data in a centralized manner and succeeded (Scheuer and Klöckner 2020). While some researchers criticised that also the decentralized approach reveals much information on users of the app (Köver 2020), others were surprised about the companies' efforts to protect the personal data of app users: Marcel Salathé, a Swiss epidemiologist, commented on Twitter: "...I would not in a 100 years have predicted this: U.S. tech companies provide a privacy-preserving framework to do digital contact tracing, and some European countries are lobbying them to lower the standards." (Farr 2020n)

In Germany, the *Corona Warn App*, which also relies on Alphabet's and Apple's support, at first had been celebrated as a major escape route from the pandemic, with some actors even demanding its use to become mandatory for every citizen (DW 2021), but the app was not able to meet the high expectations and it was disputed among experts if the technology is helpful for improving the process of contact tracing (Rosenbach 2022). In 2021, new functions were added to the app which is now also able to display the vaccination status of its users and to check them in at events and in restaurants (Die Bundesregierung w.y.).

In 2020, Apple started its partnership with the government of Singapore. Together, they launched the *LumiHealth*-app which allows Singaporeans to earn money by going for a walk, meditating or improving their quality of sleep. In order to participate, people have to own an Apple Watch and in the course of two years they can earn a maximum of 280 USD for pursuing healthy habits. It was discussed if also Covid-19-vaccinations could be rewarded via the app. Participants can compete in different contests, which are composed according to socio-demographic factors, so that senior citizens, for example, will not have to compete with professional athletes (Farr 2020h). The government of Singapore had already started a similar project with *Fitbit* in 2019 in which Apple had also wanted to participate initially (see *Section 2.1*).

Apple also has a partnership with the *UVA Children's Hospital* in Charlottesville where Apple-devices are used to monitor infants whose status does not make inpatient treatment mandatory but calls for continuous monitoring (Apple w.y.c). This way, the infants can potentially be released from hospital months earlier which considerably unburdens parents who sometimes live far away from the hospital. Families are equipped with a scale and an *iPad* and then can transfer the relevant values into the infants' EHRs via the *Locus Health App*. The physicians are able to configure each device individually in order to make the transmission of all relevant values (e.g. nutrition, oxygen values etc.) possible. This approach is also used for children who undergo chemotherapy or have received an organ donation. Besides the advantages for families, the procedure also makes hospital beds available to new patients (Apple w.y.c).

In 2022, Apple published a document on its website in which the company offered proposals how its *iPhone* could be used to improve nursing care in hospitals. The potential advantages include secure video calls and messages between staff members, automated alarm notifications, which reach doctors even if their iPhones are in "do not disturb"-mode, scans of patients' wristbands and barcodes on pharmaceutical packages and thus fewer incidents of wrong medication, scanning and printing of instructions, mobile documentation of vital functions and wound documentation and automated integration of data in EHRs. Thus, according to Apple, usage of iPhones in hospitals has the potential to replace many devices, which only have a single function, and to free time for staff to take care of their patients (Apple 2022a).

The company also offers its *Apple Business Manager* to companies, a software which has been designed to facilitate the integration of Apple-devices in the infrastructure of other institutions. For example, the Business Manager enables hospital employees to share an *iPad* and to implement individual accounts to keep sensitive data private. It is also possible to distribute new applications wirelessly and securely (Apple w.y.b).

3.2 Data Analysis

In 2016, Apple hired Stephen Friend, the co-founder and former president of *Sage Bionetworks*, a non-profit organisation which aims to make science more transparent and to engage patients in research processes. The company also used Apple's Research- and Care-Kit (see above). Before the foundation of Sage Bionetworks, Friend had worked for *Merck & Co, Inc* for 10 years (Siwicki 2017).

In the years 2017 and 2018, Apple collaborated with the *Stanford University School of Medicine* to conduct the *Apple Heart Study* with more than 400,000 participants. The aim of the study was to find out more about the detection of auricular fibrillation (Garcia et al. 2022) and it culminated in a new Apple Watch-feature which alarms users if their heart rate is irregular (see above).
In follow up study on auricular fibrillation, Apple collaborates with *Johnson&Johnson* since 2020. With 150,000 participants the study is the biggest randomized study dealing with cardiovascular diseases so far (Farr 2020u). The participants of the study are all 65 years or older and divided into the two groups who either use an Apple Watch with its *ECG*-app and irregular rhythm notification feature (see above) or the *Heartline*-app on their iPhones. Participants, who do not own an Apple Watch, are eligible to buy it for 49 USD + taxes at *Best Buy*-branches and the remaining costs are borne by the companies. It may take up to three years until first results of the study are published. The health start up *Evidation Health* was also named as a collaborator but it is unclear which role exactly it plays in the project (Farr 2020u).

In the frame of another research collaboration, which started in 2017, Apple and the *Palo Alto Veterans Institute for Research* aim to find out more about periphery artery diseases. In order to do so, the partners use the *VascTrac*-app on Apple-devices to analyse physical activity. As of 2022, the study is still ongoing (Farr 2020j, Vasctrac w.y.).

In 2020, Apple started a whole string of new collaborations with research institutions to conduct different health studies:
For example, Apple partnered with the *Harvard T.H. Chan School of Public Health* and the *National Institute of Environmental Health Sciences (NIEHS)* to conduct the *Apple's Women Health Study* (Harvard T. H. Chan School of Public Health w.y., Advisory Board 2019). The study aims to find out how lifestyle choices and socio-demographic factors influence the menstrual cycle, infertility, menopause and gynaecological diseases. Based on the data, which are collected by the *Apple Watch* and the *iPhone* via the *Apple Research App*, the development of innovative products in this sector shall be supported and by now first preliminary results have been published (Harvard T. H. Chan School of Public Health w.y., Apple 2021c).
The Apple Heart and Movement Study is conducted together with the *American Hearth Association* and the *Brigham and Women's Hospital* (Advisory Board 2019). The study investigates correlations of cardiac diseases and physical activity and tries to identify factors which improve health and mobility. Data are collected via the Apple Watch and then made available to researchers via the Apple Research App (American Heart Association w.y.).
The *Apple Hearing Study* is conducted together with the *University of Michigan School of Public Health*. The study analyses how noise pollution affects hearing ability and stress

level. In order to so, the Apple Watch and iPhone measure headphone volume and environmental noise over the course of time (University of Michigan w.y.). Apple plans to offer the generated information to the *World Health Organization (WHO)* and first results have already been published in March 2021 (Apple 2021a).
In a collaboration with *Anthem*, the second biggest insurance company in the United States, and other partners like the *University of California* and the health-tech company *CareEvolution*, Apple tries to find out if the Apple Watch enables asthmatics to find better ways of dealing with their disease. A study with 900 participants is conducted for two years which also analyses whether collected data from Apple Watches and iPhones predict severe cases leading to hospitalization. While owning an iPhone was mandatory for participants, the Apple Watch and the *Beddit Sleep Tracker* (see above) were provided by the companies (Farr 2020f).
In another study with the University of California, which relies on these three devices, Apple analyses whether factors like sleep, physical activity, heart rate and daily routines have an impact on the course of depressions and anxiety disorders (Farr 2020a).

In an effort to support epidemiologists to fight the spreading of Sars-Cov-2, employees of Apple, *Amazon* and *Alphabet* worked together in their free time to establish the *covidnearyou*-website. Citizens were enabled to fill in their health status and in case they felt sick, could indicate if they suffered from symptoms specific for Covid-19. The collected information was meant to help with analysing the onset of the pandemic as long as there were not enough testing facilities available (Farr 2020n).
Similar to *Alphabet* (see *Section 2.2*) and *Meta* (see *Section 4.2*), Apple also offered a tool to find out if people were complying with the government's social distancing rules during the pandemic. The tool was based on data from *Apple Maps* and enabled users to see how the number of search queries concerning specific routes had developed during the pandemic. The data were not connected to individual Apple IDs so that it was allegedly not possible to analyse individual movement patterns (Haselton and Farr 2020).

3.3 Electronic Health Records and Hospital Information Systems

As already mentioned in *Section 3.1*, *Epic Systems*, one of the biggest EHR-companies worldwide, was among the first actors who used Apple's *Health Kit* to develop its own apps (Sullivan 2014, Apple w.y.b). An example for this collaboration is the *MyChart*-application which is used for instance in the *Ochsner Medical Center* (see above). For example, values measured by blood pressure cuffs are transmitted into the respective EHR via Bluetooth and the data are then directly available to the care team which is able to give the patients feedback sooner than before (Apple w.y.b) (for more information on the apps *Haiku*, *Canto* and *MyChart Bedside*, see *Section 3.1 and Section 14*).

The *Duke University Hospital* was among the first health institutions to transmit patient-generated data into the respective EHRs. For this purpose, the hospital used the *Health Kit* in combination with its existing hospital infrastructure based on the products of *Epic Systems* (Siwicki 2016).

In 2016, Apple acquired the health start up *Gliimpse*. The start up's goal had been to collect

the "bread crumbs of health data" (Siwicki 2017) which are generated by the individuals themselves and to bring them together in a single platform. Gliimpse had also used artificial intelligence in order to analyse the information in different EHRs and to merge them in a standardised language (Siwicki 2017).

One year later, Apple started collaborating with the start up *Health Gorilla* which is based in the Silicon Valley and focuses on healthcare interoperability. Its services are primarily aimed at physicians who are enabled to display patient data including blood values etc. on their *iPhones*. Also sharing EHRs with other physicians is facilitated with the app. There is also a version of the app which can be used by patients free of charge (Siwicki 2017).

In 2018, 39 hospitals (among them the *Ochsner Medical Center* (see above) started using Apple's *Health Records*, an application which enables users to access various health data concerning vaccinations, medications and allergies with their smartphone and to store health information from the hospitals' EHRs on their devices. Besides Epic Systems, also *Cerner* (see *Section 14*) and *Athenahealth* are among Apple's partners for this project (Spiegel Online 2018). While the more extensive use of health records in the recent past had focused on the transmission of information between health professionals, this project also enables patients themselves to store their respective health data on their own devices (CB Insights 2021).
Both *Alphabet* (see *Section 2.3*) and *Microsoft* (see *Section 6.3*) had already pursued the approach of making health data accessible for the patients themselves before but both projects had been terminated because of their lack of success. Apple, however, might profit from better conditions due to technological improvements since the early attempts of its competitors and a political framework in the United States which supports an easier transfer of digital health data. Two former members of the Obama administration, for instance, were favourably disposed towards Apple's project in an article for the Harvard Business Review in which they took the view that it "could really shake things up. And that is what the U.S. health system needs." (Blumenthal and Chopra 2018). Additionally, many experts claim that better interoperability between EHRs would make care much more efficient in the United States. Some observers think that Big Tech companies would be perfectly suitable for taking over the market by implementing a universal standard and that Apple might be a good candidate because patients might trust the company more than its competitors because it does not rely on selling user data (Gurdus 2019a). Apple claimed that it has no access to any health data which is transmitted into its Health Records-app (Apple w.y.d).
As of 2022, Health Records is only available in the United States, Canada and the United Kingdom (Apple w.y.d).

In 2020, employees of Apple and *Microsoft* appeared as speakers in a meeting of the *Carin Alliance* which supports better access of patients to their health data. *Alphabet* and *Cerner* are also supporters of the alliance while *Epic Systems* is a prominent opponent revealing an interesting dual role of the company, being a partner of Apple on the one hand and being opposed to one of its central goals in the health sector on the other hand (Farr 2020g).

As described in *Section 3.1*, the *UVA Children's Hospital* uses the *Locus Health App* to enable parents to transmit health data of their children to the hospital which makes shorter hospitalisation times possible (Apple w.y.c).

3.4 Innovation of Treatment

While Apple has equipped its devices with various health functions and made considerable progress concerning the integration of its services into hospital infrastructures, it has so far not focused on innovations of treatment itself.
A considerable exemption is the establishment of high tech clinics for its employees under the name *AC Wellness* since 2018 (Farr 2019b). Potential goals are health improvements of employees and thus the reduction of health costs and absenteeism in the short run and a transformation of the whole health system in the long run. The clinics could be interpreted as pilot projects in which new health tools might be tested before they are offered to other health providers (Gleiss, Kohlhagen, and Pousttchi 2021, Farr 2018b, Farr 2019b). It was not publicly known if Apple is able to access health data of its employees when the project was announced. The clinics are situated in Cupertino and Sunnyvale, next to Apple's headquarters. AC Wellness is a separate company which means that the treating physicians are not employed by Apple but only Apple-employees and their relatives are treated in the clinics (Farr 2019b). Since 2019, AC Wellness collaborates with *Color Genomics* to offers genetic analyses for Apple-employees for free. Different from its competitors *Ancestry* and *23andme* (see *Section 2.2*), Color Genomics does not sell its tests directly to customers (Farr 2019b).

3.5 Logistics

As of October 2022, no activities of Apple in this section have been found.

3.6 Other Activities

In 2014, Apple made headlines by offering its employees money if they decided to vitrify their eggs in order to postpone their wish to start a family (Wendt 2014, Kaiser 2014).

The company also received media coverage for its personnel decisions. In 2016, Apple employed Mike Evans, a physician from *St Michael's Hospital* in Toronto who operates a Youtube-channel with 70,000 followers and is known to be a mobile health-enthusiast. In the same year, Apple also hired Rajiv Kumar, who had previously worked in the paediatric hospital of *Stanford University*. One year later, Apple employed Sumbul Desai who had developed a telemedicine-service named *ClickWell Care* before (Siwicki 2017).

While the company has not been as active on the health insurance market as its competitor Alphabet, it is in negotiations with different US-American health plans to offer *Apple Watches* to insured persons (CB Insights 2021).

Analogous to *Alphabet*'s *Play Store*, which is described in *Section 2.6*, Apple's *App Store* offers developers of health apps a possibility of distributing their applications (Gleiss, Kohlhagen, and Pousttchi 2021). Worldwide, the two stores combined reach a market share of 98% (Laricchia 2022). Previous lawsuits of Apple with app developers like *Epic Games* (not to be confused with the aforementioned Epic Systems) shed light on the enormous market

power of the duopolists leading to high revenue cuts which they are taking from developers (Muth 2021). This likely has an impact on developers of health apps.

3.7 Summary

Apple's activities in the healthcare sector are clearly focused on its popular devices: iPhone, iPad and Apple Watch. On the one hand, the company has managed to implement these devices in many hospitals in the United States and on the other hand, they are used in studies and clinical trials for which Apple has worked together with several renowned research and health institutions. The company rather focuses on offering the devices, apps and its app development kits to third parties than to analyse big amounts of data itself. While competitors like Alphabet and Microsoft had offered their EHR-services much earlier, Apple might have managed to catch the right moment to succeed with its Health Records-service. In this context, it might be an important advantage for the company that it has avoided any scandals concerning the misuse of sensitive data so far.

4 Meta

Meta Platforms is a technology company which was founded under the name *Facebook* by Mark Zuckerberg in Menlo Park in 2004. It is mainly known for operating the social network Facebook with 3 billion monthly users (Kelly and Guskin 2021). The company has been responsible for some of the biggest deals in the field of Big Tech with its acquisitions of *Instagram* for 1 billion USD in 2012 and *WhatsApp* for 19 billion USD in 2014 as the most popular examples (Canon 2020). Meta's customers can use its services free of charge and the company generates 98% of its revenue with the advertising business on its platforms (Kelly and Guskin 2021). Similar to its Big Tech competitors, Meta has already been active in the health sector for several years but the company seems to face the problem that users do not trust it with handling their data, especially since the *Cambridge Analytica*-scandal which was disclosed in 2018 and in the course of which the data of several million Facebook-users was collected by the British consulting company without their consent (Reader 2019). The renaming to Meta Platforms was announced in the end of 2021 and explained by the company's new orientation away from social networks towards the establishment of a metaverse (Meta 2021).

4.1 Health Apps and Smart Devices

In 2014, Facebook acquired the Finnish tech company *ProtoGeo* which had developed the fitness tracking-app *Moves*. The app tracked physical activity in everyday life and calculated the calories burned (Heise Online 2014). When ProtoGeo was acquired by Facebook, the app had already been downloaded by 4 million users. The developers promised their customers that no data would be transmitted to Facebook after the acquisition but only one month later, they had to revise their promise (Bergert 2018). In 2018, all Moves services were terminated due to declining user numbers (Meta Newsroom 2018).

In the same year, Facebook closed one of its biggest deals when it made its first step into the hardware business by acquiring *Oculus*, a Californian producer of Virtual Reality (VR)-glasses, for 2 billion USD. Oculus had been founded by the 19 year-old Palmer Luckey in 2012 and the capital for its foundation had been raised on the crowdfunding platform Kickstarter. The glasses were at first aimed at gaming enthusiasts and when Facebook acquired Oculus, it had not yet been able to offer a single marketable product (Lindner 2014). In 2016, the first headset for consumers, the *Oculus Rift CV1*, was released (Oculus VR 2015). Since 2017, Oculus-devices are used in the training of surgeons in the *Children's Hospital Los Angeles (CHLA)* to simulate rare decision situations. A representative of CHLA praises the advantages of the new training possibilities: "Thanks to the immersive power of VR, we can replicate these training scenarios in true-to-life fashion, complete with paramedics rattling off symptoms, nurses and techs urging you to make a decision, and distraught parents praying for their child's survival" (Oculus VR 2017). Apparently, Oculus has also been used for surgeon training in other health institutions (Oculus VR 2017). Facebook has also acquired several further companies from the VR-sector (Alcantara, Schaul, Vynck, and Albergotti 2021).

Although representatives of both companies had promised that Oculus would remain an independent unit at the time of the acquisition, it was merged into Facebook's newly found company unit *Facebook Technologies, LLC* in 2018. One year later, the last founding member left Oculus and in 2020, *Oculus Connect* was renamed *Facebook Connect* and Facebook's VR- and AR-unit got the new name *Facebook Reality Labs*. In the same year, Facebook announced that it will become mandatory for Oculus-users to sign in with a Facebook-account in order to be able to use the services in the future. While Facebook justified the decision because it facilitates sharing of information between its platforms, it claimed that it would still be possible to keep friends-lists of the services separate. Users and data protectionists criticized the company claiming that it is not clear how to avoid information tracking and the use of the collected data for personalized advertising (Oculus VR 2022, Robertson 2020). In September 2020, Facebook stopped selling its Oculus Quest-device in Germany because it was investigated whether the requirement to have a Facebook-account in order to use the device violates the *General Data Protection Regulation (GDPR)* (Sauter 2022). In 2021, Facebook started implementing targeted advertisements in VR-environments but claimed that no motion data and voice recordings would be used for targeting (Rodriguez 2021b). In the same year, Mark Zuckerberg announced on the French tech-conference *VivaTech* that he could imagine that more and more sports and fitness courses will be held in VR-environments in the future (Graham 2021). Since August 2022, it is again possible to use Oculus-devices without a Facebook-account but instead a Meta-account is needed for the login. It remained unclear if Meta will start selling its devices in Germany again after these changes (Oculus VR 2022, Sauter 2022).

In 2020, *Facebook Reality Labs* announced that it is additionally working on AR-glasses under the name *Project Aria* (Sauter 2022). Facebook was also collaborating with the eyewear brand *Ray-Ban* to develop smart glasses which were released under the name *Ray Ban Stories* in the United States and several other countries including Canada, the United Kingdom and Italy but not in Germany in 2021. The device allows users to take pictures and to record short videos but does not include AR-features so far (Lindner 2021). Facebook's CFO David Wehner had announced that this release was only a small step in Facebook's pursuits in this sector (Rodriguez 2021a).

As of 2022, Meta is still very active in the field of AR- and VR-research and lists several new publications on this topic weekly on its company website (Meta w.y.).

In 2017, Facebook announced that a unit with 60 employees, who were assigned to the company's *Building 8*-section, which was responsible for Facebook's secret moonshot-projects (Fussell 2020), was working on *brain computer interfaces*, which enable the creation of written texts by merely utilizing the user's thoughts and without having to rely on implants. According to the announcement, the interfaces scan the brain of its user 100 times a minute in order to convert the imagined words into text. Allegedly, it is possible to write 100 words per minute with this method which would be five times faster than typing on a smartphone (Constine 2017). Additionally, the interfaces will enable users to navigate through VR-environments by utilizing their imagination. Facebook is developing the interfaces together with several renowned health and research institutions, among them the *Washington University School of Medicine*, *Johns Hopkins Medicine*, *Johns Hopkins University's Applied Physics Laboratory*, *UC San Francisco* and *UC Berkeley* (Constine 2016). A competitor on this field of research is the start up *Neuralink* which was founded by Elon Musk. Building 8 was also working on a project which focused on enabling users to hear with their skin (Constine 2017). Regina Duncan, at that time the head of Building 8, had worked for *Google* and the *Defense Advanced Research Projects Agency (DARPA)* of the US-American *Ministry of Defense* before but left Building 8 in the end of 2017 after only 18 months. In the end of 2018, Building 8 was dissolved but Facebook assured that its projects would be progressed in other sub-divisions of the company like *Facebook Portal Group* and *Facebook Reality Labs* (see above) (McCracken 2018). According to media coverage in 2021, Facebook was still working on the development of the interfaces (Reader 2021).

In 2019, Facebook acquired the tech company *CTRL Labs* for an amount between 500 million and 1 billion USD (Pluta 2019, Rodriguez 2019). The New York-based start up had been founded in 2005 and developed an app which allows users to give commands in VR-environments and to use their smart devices by utilizing the muscles in their wrists. For this purpose, the company has developed a wristband which recognises the electric signals that are sent from the nerves to the muscles and translates them into the respective handling instructions for the digital devices. One of the co-founders of CTRL Labs, Thomas Reardon, had previously been employed by *Microsoft*. Facebook planned to merge CTRL Labs into its subdivision *Facebook Reality Labs* (see above) (Pluta 2019).

In the same year, Facebook released its health tool *Preventive Health*, which is part of the company's smartphone-app. Preventive Health sends users notifications and reminders concerning vaccinations, recommended medical check-ups etc. The tool was developed together with the *American Heart Association*, the *American College of Cardiology*, the *American Cancer Society* and the *Centers for Disease Control and Prevention* (Reader 2019). Users enter their age and gender and receive the respective recommendations on this basis. Additionally, they receive information on the exact components of the measure, on how often the measure should be repeated and why the measure has been recommended. All information can be shared with other people on the user's Facebook friendlist (Reader 2019). Facebook assures that it cannot access any test results and will not share any data with third-parties. If users *like* the Facebook sites of physicians, health institutions or medications, the company will however use this information for targeted advertising (Fussell 2020). Else-

where, the company states that "...no information exchanged in the feature would be seen outside a small group of Facebook employees..." (Rohrer 2019) casting doubt upon the accuracy of the former statement. Data protectionists also warned that Facebook had assured that it would not access data, which it later accessed nevertheless, already in the past. But there were also more favorable comments that the company's initiative might help to increase the low number of Americans who registered for the so called "high priority"-check ups (only 8% in 2015) by reaching especially the poor and less educated parts of the population. The tool also shows citizens without health insurance where they can receive check-ups free of charge (Fussell 2020, Rohrer 2019).

In 2021, several media reported that Facebook is presumably developing a health tracker which includes a messenger-function (Reader 2021). Some reports spoke more specifically of a smartwatch with the ability to integrate services of third-parties like *Peloton* (see *Section 3.1*) and enough features to largely replace a smartphone (Muoio 2021). However, there has been no official confirmation of these reports so far.

4.2 Data Analysis

In 2013, Facebook acquired the start up *Mobile Technologies* from Pittsburgh which focuses on the development of voice recognition software and algorithm-based translation (Constine 2013).

In 2017, Facebook started its *Blood Donation*-tool in several countries which enables users to find out where they are able to donate blood in their region (Brodwin 2019). The project started in Bangladesh, India and Pakistan and until June 2018, 11 million users had registered (it was unclear how many actual donations had been enabled exactly by the tool) (Budaraju 2018). In 2019, the service also started in the United States which led to a rise in the number of new blood donors of 19% in participating facilities (Hutchinson 2021b). People who signed up receive a notification of the *Red Cross* if a blood donation is needed nearby. They can then decide whether they want to donate blood themselves or share the notification with friends. While the service is focused on institutions in the United States, person-to-person contacts are encouraged in Bangladesh, India and Pakistan. According to Facebook, this is due to a lack of infrastructure in these countries but in India health experts criticised the tool for supporting black market structures for blood donations leading to exorbitantly high prices (Brodwin 2019). On the *World Blood Donor Day* in June 2021, Facebook announced that more than 100 million users in 37 countries are now registered for the service. In India and Brazil, 14% of the new blood donors in the year in which the service had been made available said that they had become blood donors because of Facebook's initiative (Hutchinson 2021b). In Europe, the tool was only available in Finland, the United Kingdom and the Netherlands as of 2021 (Jin 2021).

In 2018, Facebook started a collaboration with *NYU Langone Health* to establish the research project *FastMRI* (Facebook 2020, Reader 2021). By applying artificial intelligence (AI), the partners try to make MRI-scans significantly faster than they are nowadays. AI is used to generate complete scans from less raw data which accelerates the process. The world's biggest data set of MRI-scans of the knee was used to train the algorithm. Facebook

stated that all data were anonymized and no Facebook-data was used when the data set was generated. According to a study, the results of the algorithm were as good as the ones of the common approach. The project is different from other AI-approaches in medicine since it does not try to replace physicians but rather to make their work faster and more efficient. The project is still in progress and Facebook and the NYU Langone Health have made their data, models and programming codes publicly available to enable other researchers to contribute and staff at health facilities to try whether the approach is working with their MRI machines (Facebook 2020).

Since 2018, Facebook uses AI to identify contents on its social platforms which hint at suicidal intentions (Goggin 2019). The algorithm flags the contents and subsequently, Facebook-employees check them and decide whether they send information material containing contacts of support structures or even inform the company's law enforcement team (Facebook w.y.). Data protectionists criticised these pursuits and demanded that information on suicidal intentions derived from applying machine learning must be considered sensitive health data (Goggin 2019).
In the same manner, Facebook invented a tool to refer people to a governmental crisis hotline who try to buy opiates or search for possibilities to fight their addiction in its social networks (Facher 2018).

Also in 2018, Facebook's subdivision *Building 8* (see above) tried to get access to patient data from different hospitals including the *Stanford Medical School* and the *American College of Cardiology* in order to combine these data with data from its own social network (Fussell 2020, Farr 2018c). The data would have been anonymized but by applying methods like *hashing*, the company would have been able to merge the data nevertheless (Farr 2018c). Facebook assured that this would happen only in order to support research by the medical community. The aim of this research would have been to analyse potential connections between cardiovascular diseases and relationships with friends and family and to examine how social connections could be taken into account while treating these diseases. Shortly after the announcement, the *Cambridge Analytica*-scandal became known to the public and the project never proceeded past its planning phase (Fussell 2020, Reader 2021, Farr 2018c).

In 2019, a study revealed that several period trackers including *Maya*, *Flo Health* and *MIA Fem* shared user data with Facebook (Lakshmanan 2019). Maya, for example, shared information on the mood of its users, when they had sex and whether the sex was protected or not. Apparently, Maya stopped sharing this information after the publication of the study. Despite stricter data protection in iOS, also the data of Apple-users was shared and users were not informed about the transfer of data to Facebook. Shortly before, it had become known to the public that many popular apps share user information with the company even if their users do not have a Facebook-profile (Lakshmanan 2019).

In 2020, more than 30 million people participated in a *Covid 19-Survey* which Facebook conducted in its social network together with the *Carnegie Mellon University* which also used the data for its pandemic forecasts (Reader 2021). Besides questions concerning symptoms, mask wearing behaviour and compliance with social distancing rules, Facebook also collected socio-demographic information. The company assured that it does not have direct access to the data and started a contest for researchers who could access the collected data

and win a cash prize donated by Facebook for the best scientific achievement (Farr 2020t).

In the frame of its *Data for Good*-initiative, Facebook also started conducting its own analyses of topics related to Covid-19 in 2020. They included "co-location data" indicating the probability that individuals will meet each other in a certain region, "movement range trends" and a "social connectedness index" which was designed to show where people might need additional support, for example because their friends live in a different federal state (Farr 2020l). Facebook emphasized that it does not use individual movement patterns and that no individuals, who do not comply with Covid-19-rules, would be identified. Public Health Experts praised the programme and stated that Big Tech-initiatives might be particularly helpful because of the high amount of people they reach (Farr 2020l).
In another effort related to Covid-19, Facebook partnered with the *Harvard T.H. Chan School of Public Health* to create maps which show the development of people's movement and travel patterns in order to help epidemiologists to get an overview over the occurrence of infection (Reader 2021). Also, institutions like the American *Red Cross* use the company's *disease prevention maps* to find out where their help is needed most (McGorman and Pompe 2019).
After much criticism, Facebook also made efforts to fight the spreading of fake news about the pandemic and especially vaccinations on its platforms. The company now also reaches out to users who liked the respective contents, informing them why they have been deleted, giving them the option to unsubscribe from the authors and showing them where they can find facts about the pandemic (Reader 2020). While some commentators, including US-President Joe Biden, who even accused Facebook of killing people by disseminating fake news, think that the company still has to do more to solve the problem (Breuninger 2021, Reader 2020), others took the view that it should not be for Big Tech companies to decide which information is shown and which is not (Strossen 2022). Facebook was also criticised for deleting several profiles including groups with information on holistic healing and Far-Eastern traditional medicine without indicating any reasons in the past (Raphael 2019).

In 2021, Facebook worked together with *NYU Langone Health* to develop a software which aims to predict whether the symptoms of a Covid-19 patient will become worse in the course of the illness. The goal is to prevent untimely hospital discharges and to enable a more precise requirement planning for oxygen in hospitals. The evaluation is based on chest X-rays and the partners claim that their model is better than human experts in predicting if more intensive care actions are needed up to four days in advance (Shead 2021b).

4.3 Electronic Health Records and Hospital Information Systems

Different from other Big Tech companies, Meta has not yet been active in the EHR- and HIS-sector. In a sector, which relies heavily on handling sensitive health data properly, this might be due to a lack of trust in the company which had also impeded its collaboration with the Stanford Medical School and the American College of Cardiology. According to an article in the Washington Post, which is based on a survey from the end of 2021, only 20% of US-Americans trusted Facebook with their personal information, while 53% trusted *Amazon*, 48% trusted *Alphabet*, 44% trusted *Apple* and 43% trusted *Microsoft*. In the same survey, only 10% of respondents took the view that Facebook has a positive impact on

society (Kelly and Guskin 2021).

4.4 Innovation of Treatment

Except for its *FastMRI*-project, which is described in *Section 4.2*, no activities of Meta in this sub-category have been found as of October 2022.

4.5 Logistics

No activities of Meta in this sub-category have been known as of October 2022.

4.6 Other Activities

In 2012, Facebook enabled users to display their organ donor status in their user profiles and on the same day, the number of people, who registered as donors in the United States, reached 13,000 compared to an average number of 600 new donors daily (Johns Hopkins 2013). Andrew M. Cameron, a surgeon at the *Johns Hopkins University School of Medicine*, which partnered with Facebook for a study on the topic, stated that no campaign had generated such a short-term response ever before. The number of donors was still rising twice as fast as usually after two weeks. However, it will take many years to find out whether the people, who registered as organ donors, actually donated organs. (Johns Hopkins 2013).

Similar to *Apple* (see *Section 3.6*) Facebook started offering its employees money if they decide to vitrify their eggs in 2014 (Wendt 2014, Kaiser 2014).

In 2016, Facebook hired Fred Abnousi, a former cardiologist and professor at *Stanford University*. Abnousi, who was also part of the company's attempt to access patient information from Stanford Medical School and the American College of Cardiology (Farr 2018c), stated that he sees working for Facebook as a chance to find out more about the social determinants of health (Reader 2021).

In 2017, *Facebook Health*, an initiative for advertisers in the health sector, held a meeting under the name *Health in the Era of Mobile*. The aim of the meeting was to make the platform more attractive for advertisers from the pharmaceutical sector who still relied more on advertising in television and print media more than other branches back then (Farr 2017a).
In 2019, spending of pharmaceutical and healthcare companies on mobile advertising in Facebook's social network reached nearly 1 billion USD. Among the companies, who spend most on advertising on Facebook, were *Pfizer*, *Merck & Co, Inc*, *Allergan* and *GlaxoSmithKline*. Facebook assured that memberships in its support groups and users' medical histories are not used to target ads but interests and user behaviour can be factors determining which ads are shown to users (Tiku 2020).
In a *Pharmacy Sales Impact Study*, which Facebook conducted together with the market research company *Kantar* and six health companies including *Elmex*, *Bepanthen* and *Doppelherz*, it could be shown that demand for the companies' products in pharmacies increased

by 5-7% during and in the weeks after displaying video advertisements for the respective products on Facebook and Instagram. In stationary pharmacies, the effect even remained for a longer time (Bonsai Research 2020).

In 2021, Facebook announced the foundation of the *Alliance for Advancing Health Online* in which it will work together with renowned institutions and companies like the *WHO*, *Merck & Co, Inc*, *Weltbank* and the *CDC Foundation*. The alliance aims to find out how social media and behavioural economics can be used to improve health outcomes and the project is planned to proceed for several years. In the beginning, it was planned to focus on increasing vaccination rates and the partners agreed to make research results publicly available as soon as possible (Hutchinson 2021a).

In the same year, Facebook announced that it will only allow employees to return to their offices who are fully vaccinated against Covid-19. At the same time, the company offered most of its full-time employees the possibility to work from home also after the end of the pandemic (Feiner 2021a).

Meta serves as an important source of health information for many people. While Alphabet's search engine is often the first contact point for these people, many of them rely on the health information which is disseminated in various Facebook groups that focus on specific diseases (Farr and Oreskovic 2014, Lupton 2014). These so called *support communities* often include several thousand participants who exchange their personal experiences. According to Melissa Adams van Houten, who manages a private Facebook group on gastroparesis with more than 21,000 participants, it was discussed to transfer the group to another platform when the Cambridge Analytica-scandal became publicly known but it turned out to be impossible to find a community site with as much flexibility and options indicating Facebook's market power in this sector (Pantuso 2018). The high number of participants in the support communities also hints at the relevance of decisions on the deletion of health information discussed in *Section 3.2*. In 2019, the company enabled users to participate in the support communities anonymously (Farr 2019e).

4.7 Summary

Meta's activities in the health sector seem to be focused on the application of artificial intelligence (FastMRI) and the utilization of its social networks. Here, the company aims to inform users about health topics in its support communities, influence their health behaviour with its Preventive Health and Blood Donation programs, conducts surveys and data-analyses (Data for Good) and offers pharma companies the possibility to display targeted advertisements. Meta's research on virtual reality devices (Oculus) and brain computer interfaces might have a considerable impact on the health sector in the future but it seems to be too early to assess their relevance. Meta's activities in the health sector are not as diversified as the ones of some of its competitors. While the company has recently reinforced its engagement with several projects related to Covid-19, it faces the problem that health data are often considered to be very sensitive and that people seem to trust it even less with handling their data properly than its Big Tech competitors.

5 Amazon

Founded as a mail order company for books in Seattle in 1994, Amazon has developed to be the second biggest company in the United States listed by revenue since then (Fortune Media 2021). Still being mostly known to the public as a mail order, the company is involved in many lines of business which are not directly related to its core business with its cloud-unit *Amazon Web Services (AWS)* at the forefront. While AWS accounts only for 14% of the company's revenues, it is responsible for 74% of its profits (Pope 2022). In 2020, Amazon was the company that invested the highest amount in research and development worldwide (Statista 2020). The company started being involved in healthcare much later than some of its competitors like Alphabet but has increased its activities rapidly in recent years although it has remained reluctant to speak publicly about its strategy in the healthcare sector. Big Tech-expert Scott Galloway said in 2019 that he believes that Amazon might be on its way to become the most valuable health company in the world (Galloway 2019).

5.1 Health Apps and Smart Devices

In 2009, Amazon acquired the online shoe retailer *Zappos* which cooperated with *Under Armour*. The aim of the cooperation was the development of a *Gear Tracker* which enabled users to keep track of the distance which they have already covered with their running shoes (Tam 2014).

Although Amazon has also been developing other smart appliances in the meantime, it is hard to imagine someone who will not think of the company's voice assistant *Alexa* at first when it comes to the field of smart devices. The technology for Alexa was acquired by Amazon in 2013, apparently in order to compete with *Apple*'s *Siri* (Lunden 2013), and subsequently used in combination with the smart *Amazon Echo*-speakers developed by Amazon-subsidiary *Lab126* as its frontend (Stone and Soper 2014). In the beginning, Alexa was only able to follow rudimentary commands in peoples' homes like playing songs via connected music systems or setting alarm clocks but subsequently, Amazon started enabling third parties to develop additional functions, so called *skills*, which soon led to a high number of new application types (Amazon w.y.a). Amazon also offered companies its *Alexa Custom Assistant* which enables them to develop their own voice-assistants based on Alexa-technology (Curic 2021). By now, companies like *BMW*, *Deutsche Bahn* and *Spotify* are among its partners (Hansen and Zota 2016). 20,000 products of various companies interacted with Alexa already in 2018 (Heater 2018) and the voice assistant has also become a popular tool in the health sector (see below).

Already in 2016, one year after the first devices had been sold, the *Boston's Children Hospital* developed an app for the Echo-devices which enables Alexa to answer questions of worried parents, for example when their child has a fever and they need advice what to do about it (Gärtner 2019d, Plewinski 2016).

Since 2018, Alexa is able to detect the health status of its users by analysing deviations from their usual voice and to play fitting advertisements. The matching products can then be ordered directly via Amazon which has filed a patent for this approach in 2017 (Flemming

2018b).

Additionally, Amazon planned to implement its voice assistant on more wearables which have been developed by third parties (Flemming 2018b). For this purpose, a sub-unit of the company, the so called *Project Dylan*, worked together with *Lab126* to establish the development-tool *Alexa Mobile Accessory Kit* (Flemming 2018a). One of the results of the project was Alexa's new capacity to analyse mood-swings of its users via a wristband which is coupled with a smartphone-app. The research subsequently culminated in the smart wristband *Amazon Halo* which was released in 2020 (Farr 2020e, Gärtner 2020c).
The development team also includes the popular cardiologist Maulik Majmudar, who was hired by Amazon in 2018 after working for the *Health-Care Transformation Lab* in the Massachusetts General Hospital which, in turn, is cooperating with *Google Cloud* since 2020 (see *Section 2.2*). Like many other fitness trackers, Halo contains a heart rate monitor, an accelerometer, a temperature sensor and its own app but its unique feature are two integrated microphones which connect the wristband with Alexa (Moorstedt 2020). Users are also able to receive a bodyscan by taking photos in underwear which are used by Amazon to generate a 3D-portrait, to analyse the body fat percentage and to forecast how the user will look in the future if the company's proposals on how to lose weight are followed (Gärtner 2020c, Farr 2020e). Based on algorithms and the collected data, Amazon also makes proposals concerning potential improvements of the health status of its users and works together with the *American Heart Association*, *Harvard Health Publishing* and *Weight Watchers* in this context (Farr 2020e). So far, Halo is only available in the United States where it can be used for 64.99 USD in the first six months (Farr 2020e). The device has no connection with the *Amazfit*-fitness-trackers which are developed by the Chinese company *Zepp Health Corporation*. However, some of these devices, for example the *Amazfit GTS 2*, also include an Alexa-integration (Amazfit w.y.). Data protectionists are alarmed especially because of Halo's ability to analyse mood-swings and, above all, see the feature as an opportunity for Amazon to display even more personalised advertisements. The device also received considerable attention in the German media including warnings that Amazon might accumulate a vast variety of health information by combining shopping data with data collected by the Halo-device (Fuest 2020, Moorstedt 2020).

In 2017, the *Amazon Diabetes Challenge* started, a contest in which the developer of the best Diabetes-app with Alexa-support could win 125,000 USD donated by Amazon. The contest was supported by the pharma company *Merck & Co, Inc* and the consultancy *Luminary Labs* and was won by the health company *Wellpepper* with its app *Sugarpod*, an interactive Diabetes-plan with integrated voice control (Eckmann 2018).

Since 2019, the British *National Health Service (NHS)* has a partnership with Amazon. The NHS recommends patients with mild symptoms to ask Alexa for advice at first instead of directly seeing a doctor (Siddique 2019, Gärtner 2019a). In order to be able to give good advice, Alexa uses the website of the NHS to search for the according information. The service should for example help blind and older people for whom it is difficult to search for information online themselves. The former British Health Minister Matt Hancock hoped that the new service will disburden general practitioners and pharmacists. It is part of a long-term plan to integrate more and more digital services in the British health system. The NHS does not provide any Alexa-devices but the services can be used via a free app

(Siddique 2019). The NHS and Amazon stated that the company will not use any patient data which is disclosed while using the service. According to the contract it is however possible for Amazon to use the health data provided by the NHS including "copyrightable content and data and other materials." This licence applies worldwide and the company is also allowed to share the information with third-parties (Walker 2019).
Another Alexa-skill which was designed especially for blind people is the new *Show&Tell*-function which enables users to hold objects in front of the camera of their Echo-devices which Alexa will identify subsequently (Gärtner 2019c).

In the United States, Amazon has meanwhile received the authorisation to exchange data with health providers within the scope of the *Health Insurance Portability and Accountability Act (HIPAA)*. In this context, Alexa learned new skills which were then used in different partner projects: The *ERAS*-program in the Boston's Children Hospital enables parents to ask doctors about their children's health via Alexa (Gärtner 2019d, Plewinski 2016). The start up *Livongo*, which focuses on products for patients with chronic diseases, planned to enable its customers to find out about their blood glucose level via Alexa and the pharmaceutical distributor *Express Scripts* offers its customers to use the voice-assistant to find out about the status of their prescriptions. The device is now also able to tell its users which hospital suits their needs best (Gärtner 2019d).

Another Alexa-related project of this time is the development of wireless earphones which at the same time can be used as a fitness-tracker if they are connected with the voice assistant. Amazon started developing them under the project name *Puget* and apparently wanted to sell them at a considerably cheaper price than *Apple*'s *AirPods* (Kim 2019). However, the earphones do not seem to have reached market readiness to date and there is no recent information on their development status.

An incident in 2019 shows that it might be dangerous to rely on information given by Alexa too heavily. A user, who asked Amazon's voice assistant for information on the cardiovascular system, received the answer that it would be best if she stabbed herself in the heart to fight over-population. In an official reply, Amazon said that it had fixed the problem. It was assumed that Alexa had been referring to information from a faked Wikipedia-article (Blake 2019).

Since 2020, Amazon is working together with the care company *BestBuy Health* to develop an Alexa-equipped smartphone to facilitate communication between elderly people and health providers (Ahmed 2020). In the same year, the company also started a partnership with the hospital network *Christiana Care* to develop a *Home Care Coach* which creates nursing plans and enables patients to ask Alexa questions concerning these plans (Christiana Care 2020). Still in the same year, Amazon presented the *Care Hub*-feature which enables family members to supervise relatives who are in need of nursing via an activity feed. In order to make this possible, the dependent has to install an Alexa-device in his household while the family members only need to install the Alexa-app on their smartphones. Subsequently, their accounts are connected which enables the users, for example, to see when Alexa was activated for the first time on a particular day or for how long the device has not been activated. It is also possible to name emergency contacts. If the dependents activate Alexa by saying "Alexa, call for help", the persons in question will receive a SMS or a push message. Thus, family members can be notified even if no phone is reachable for

the dependent (Plewinski 2020a). The *Service Guard Plus*-skill allows Alexa-users to be connected to an emergency hotline which can then contact the police, the fire brigade or an ambulance where appropriate (Gärtner 2020f).

In 2021, Amazon was working on a new sleep monitoring feature under the project name *Brahms*. Apparently, it will include a millimetre wave-radar which would enable users to put the device on a bedside-table from where it could monitor their breathing patterns (e.g. to detect sleep apnea syndrome) and movements during their sleep. It is seemingly still unclear if the device will reach market-readiness (Herbig 2021).

Since 2021, Alexa-devices in the United States are also able to react on barking dogs and crying babies and users are able to establish individual routines concerning Alexa's reactions. If Alexa is triggered by a screaming baby for example, its routine could make Alexa play soothing music or dim the lights (Plewinski 2021a).

As can be seen for the NHS-partnership (see above), Amazon is hesitant on giving information about its usage of data which is generated by the use of Alexa. Since many people are surrounded by Alexa devices in their whole living environments (ambient computing), this has triggered much attention of data protectionists. In 2018, Alexa accidentally sent 1,700 voice recordings of an American couple to a user in Europe. Although the user informed Amazon right away, the company only reacted after German media had reported about the case and offered the couple a new Alexa-device and a free Amazon Prime-membership as compensation (Bleich w.y., Statt 2018). After a request of US-Senator Chris Coons, Amazon confirmed that only users themselves are able to delete the generated data and that they will be stored on the company's servers infinitely otherwise . But even if users know about this and decide to delete their data, some data are exempted from deletion. It is for example not possible to delete how Alexa reacted on certain commands and also settings for alarms and reminders for appointments cannot be erased. Furthermore, third-parties who develop skills for Alexa are also allowed to collect and analyse user data themselves (Nickel 2019).

An Amazon activity in the health app sector except from its projects around Alexa is its partnership with *Xealth* in 2018 (Farr 2018a). Xealth offers a digital platform for health apps which enables physicians to select and order suitable apps for their patients and is also supported by *Novartis* (Landi 2019c).

In 2019, Amazon acquired *Health Navigator*. The digital health start up was founded in 2014 by the physician David Thompson who is famous for having developed the *Schmitt-Thompson Triage Protocols* which help nursing staff to send patients calling the hospital to the right ward. Health Navigator offers online symptom checks for its users and helps partners to send patients to appropriate health providers. Many of Health Navigator's business clients are telemedicine providers themselves. The deal marked Amazon's first health-related acquisition after *PillPack* (see *Section 5.5*) (Farr 2019a). Before the acquisition, Health Navigator had also collaborated with *Microsoft* (Lee 2017a).

5.2 Data Analysis

As described in *Section 2.2*, *Amazon Web Services (AWS)* was used as infrastructure for the hitherto largest cloud-based genome analysis by *DNAnexus*, a company which was also supported by investments of *Google Ventures*, in 2013. DNAnexus continued its partnership with AWS also in the following years and its CEO Richard Daly takes the view that the products of AWS enable companies to conduct clinical studies which would not have been possible before (Amazon Web Services 2014).

Also Amazon's investment in *Grail* in 2017 is Alphabet-related because GV is among the investors in the Silicon Valley start up, too (see *Section 2.4*). Grail's aim is to detect early signs for cancer in the patient's blood (Farr 2020o). In order to achieve this goal, it has large data storage requirements and a high demand for computing power which made the company a suitable aim for AWS-services. Experts also assume that the company might be interesting for Amazon because of its activities in the large Asian market. Shortly before the investment, Grail had merged with the Chinese start up *Cirina* and announced a new data center region in Hong Kong (Lee 2017b, Farr 2017b). More recently, the genetic engineering company *Illumina* (which had already held 10% of the start up's shares before) has acquired Grail for 8 billion USD without permission of the EU-commission which announced a closer investigation of the deal. Illumina subsequently filed a suit at the EU-court, taking the view that the commission is not responsible and emphasizing that the possibility for Illumina to offer Grail's tests in the EU might save the lives of up to 100,000 Europeans (Finke 2022).

In 2018, Amazon developed a cloud-service which is called *Amazon Comprehend Medical* and was designed especially for healthcare purposes. It enables users to find relevant data from unstructured texts like doctors' notes and health records and thus to enable faster diagnoses. The service is already in use, for example in the *Fred Hutchison Cancer Research Center* in Seattle where it helps to recruit patients for clinical trials. Involved researchers say that Amazon Comprehend Medical reduced the time to process a document from hours to seconds (Kass-Hout and Wood 2018, Berger 2018). Amazon is paid for the service monthly and based on the volume of text which has been processed. There are no long-term fees or minimum charges (Berger 2018). Amazon emphasized that no data is stored or used for training of algorithms (Kass-Hout and Wood 2018).

In 2020, Amazon began an alliance with the *Pittsburgh Health Data Alliance* which aims to develop models based on artificial intelligence in order to be able to detect diseases like cancer earlier and to improve treatment (Pittsburgh Health Data Alliance 2019).

While Amazon's lacking interest in data protection around its Alexa-services has gained much media coverage, problems concerning protection of other customer data had not gained much attention until 2021, when three former employees gave insider information to the public. According to them, they informed Amazon at first internally about the company's weak points before they were expelled as a reaction to their criticism. According to Garfield Benjamin, a British scientist, the so called "right to be forgotten", which is a much discussed topic among data protectionists, could not be implemented by Amazon even if the company wanted to, simply because it does not know which data it has on its customers: "Amazon has grown so fast, it doesn't know what it owns...They don't know where their

data is, so they don't know if they are protecting it correctly" (Manancourt 2021) He sums up: "It seems bizarre – although perhaps unfortunately all too common – that a company so intent on making data its primary business should have such poor practises...Is their hubris so great, their assumed power so unassailable, that they see themselves as completely untouchable?" (Manancourt 2021). Apparently, several former Amazon-employees still have access to sensitive customer data. The company also employed several lobbyists in Brussels who were for instance fighting against the implementation of the *E-Privacy-Directive* (Gärtner 2020e). While the former employees are harsh in their criticism against Amazon in general, they emphasize that their criticism is not directed against AWS which is described as being "world-beating in terms of data security" (Manancourt 2021).

Like Alphabet, AWS is a member of the *Global Alliance for Genomics and Health* (Global Alliance for Genomics & Health w.y.). It also works together with *Metabiota* (AWS w.y.b) and has a partnership with the US-American healthcare company *Change Healthcare* which aims to establish a cloud-based network for claims and payments of physicians and health insurances. In 2021, the companies worked together to analyse socio-economic factors associated with Covid 19-cases (Drees 2021a).

5.3 Electronic Health Records and Hospital Information Systems

Different from *Alphabet*, Amazon has not yet pursued any plans to establish its own EHR but the company has partnered with other players in the field of EHR and HIS.

Since 2016, AWS collaborated with Salt Lake City-based *3M Health Information Systems*, one of the world's biggest providers of healthcare software. Its products are used in 7,500 hospitals in 20 countries. In a case study published by Amazon, David Frazee, CTO of 3M says that AWS allows his company to fully concentrate on analysing issues directly connected with healthcare while AWS takes care of all IT-related problems. A major advantage of AWS' cloud services is their scalability which allows 3M to react flexibly on different order situations (Amazon 2016).

In 2017 and 2018, AWS worked together with the advertising agency *Ogilvy*. In this context AWS mined EHRs for patients who might be undiagnosed for a certain kind of narcolepsy via machine learning technologies and then offered the results to Ogilvy which allowed the agency to contact the patients with advertisings for fitting pharma products (Snyder Bulik 2018).

As already described above, Amazon offers its cloud-service *Amazon Comprehend Medical* since 2018. While not being designed exclusively for usage with EHRs, its seems obvious that they belong to the major fields of application for this new service.

In the end of 2020, Amazon launched *Amazon HealthLake* in order to help to standardize health data from different sources by using machine learning. The service is able to collect data from different data silos and subsequently store them in a central data lake in the cloud of AWS (Landi 2020a). Since EHRs still use various different formats, health providers face many problems if they try to create a complete picture of their patients' health. HealthLake is able to normalize the data automatically, sort it into a timeline and display standardized

labels for medication, diagnoses and procedures which helps providers to find relevant information. At the same time, there was an announcement that EHR-giant *Cerner* decided to intensify its partnership with AWS to benefit from its machine learning technologies (see *Section 15*). The companies also worked together in projects on topics like burnout of health staff (Landi 2020a).
Other customers using Amazon HealthLake include the healthcare information management company *Ciox Health* (Landi 2020a), the *Rush University Medical Center* in Chicago, *Cortica*, which focuses on health services for children with autism, *CureMatch*, offering individualised treatment in the field of oncology, and *Medhost* which helps its more than 1,000 business customers to standardize patient data via HealthLake (AWS w.y.a).

In 2022, the US-American healthcare provider *Geisinger*, which operates 11 hospitals and several smaller health facilities and pharmacies, decided to migrate its complete digital infrastructure including all EHRs to AWS (Siwicki 2022). By doing so, Geisinger hoped to become more cost-efficient and to enable clinical staff to spend more time with their patients (for information on Geisinger's partnership with *Apple*, see *Section 3*).

5.4 Innovation of Treatment

In 2018, Amazon started a partnership with the Irish consulting agency *Accenture* and *Merck & Co, Inc* which aims to increase productivity in the development of drugs (Accenture 2018).

In the same year, Amazon started planning to establish a clinic for its employees as a pilot project. The announcement came shortly after *Apple*'s announcement to build its own hospitals (see *Section 3.4*). The project started two years later in a cooperation with the primary care-start up *Crossover Health* which operates and staffs all of the 17 health centers as of 2021. The centers are all located next to Amazon locations (Best 2021b, Landi 2021a). Other customers of Crossover Health, which was founded in 2010, include *Apple* and *Microsoft* (Landi 2021a). The health centers offer Amazon-employees all relevant health services, same day-appointments, additional services like health coaching and physical therapy and 24/7-availability on the phone. According to Amazon, more than 75% of its employees are living in a 10 mile range around one of the centers and 115,000 employees were already using the services (Landi 2021a).

In 2019, Amazon started its *Amazon Care*-program, another service, which, at least at first, targeted its own employees (Best 2021b). Amazon Care was a telemedicine health portal which offered 24/7-virtual care and personalized health services. At first, Care had only been available for employees in Seattle but in 2021, Amazon expanded the services to all its employees (Landi 2021b). Subsequently, it was also possible for other companies in the United States to use Amazon Care (Coombs 2021). Stock prices of competitors offering health services for employers, like *Teladoc* and *CVS Healthcare*, fell as a reaction to this announcement showing the significance of Amazon's step (Kort 2021a). The hotel chain *Hilton* belonged to Care's first customers (Torrence 2021a). While at first only acute cases had been targeted, Care was later also able to help with chronic diseases and offered on-site appointments providing an alternative to consulting a general practitioner (Kort 2021a).

While enrolling in Amazon Care was free and not having any influence on agreements with other health providers, there were fees for special services like video care-visits and visits from mobile care nurses. They were paid through the Care-app which was linked with the users' Amazon-account (Amazon w.y.b).
In August 2022, Amazon announced that it will terminate all Care-services in the end of the year naming no exact reason other than that it was "not a complete enough offering for the large enterprise customers we have been targeting, and wasn't going to work long-term." (Palmer 2022a). While the announcement took some observers by surprise, others saw their view confirmed that the health system might just be too complex for Big Tech companies to succeed (O'Donovan 2022).

Under the name *Grand Challenge*, Amazon is working on projects for the future involving the application of machine learning. While so far not much is known to the public concerning these projects, CNBC reported in 2018 that the project aims to develop a cure for cancer, is led by Babak Parviz who invented *Google Glass* (see *Section 2.1*) and also employs several former *Google X*-employees (Kim 2019). In 2020, it was revealed that Grand Challenge is also trying to invent a vaccine for common colds (Farr 2020d).

In 2021, Amazon started two new health programs which were aimed exclusively at its employees and their families: *Resources for Living* focuses on their psychological well-being and offers personal consultations on-site, on the phone or via messages three times a week. An associated app supports the employees via cognitive behavioural therapy. *WorkingWell* focuses on health and security at the workplace and offers safety training as well as stretching and relaxation exercises (Gärtner 2021b).

In 2022, Amazon announced its plans to acquire *One Medical* which runs nearly 200 medical practices with a digital tech focus in the United States for customers who pay a yearly amount for their membership (Miranda 2022, Kort 2022b). The company is backed by money from *Alphabet* which is also one of its most important business customers (see *Section 2.4*). If the shareholders and regulation authorities approve, the deal will be Amazon's biggest acquisition in the healthcare market and its third-biggest overall (after the acquisitions of *Whole Foods* and the movie studios *Metro-Goldwyn-Mayer*) with a selling price around 4 billion USD (Kort 2022b). Observers see parallels to the company's acquisition of Whole Foods (see *Section 5.5*) in 2017 which meant a step away from purely digital services to more visibility in stationary trading. In this context, One Medical's facilities have been seen as a complement to the Amazon Care-services until the company surprisingly decided to terminate these services in 2022 (see above) (Miranda 2022). One Medical partnered with more than 8,000 companies as of September 2022 who offered its services to their employees. It offers 24/7-availability and appointments within 24 hours (One Medical w.y.). *CVS*, a major competitor of Amazon in the pharmacy market (see *Section 5.5*), had also begun to build up small medical practices in some of its branches shortly before (Kort 2022b).

Only shortly after releasing information on the planned One Medical-deal, it became publicly known that Amazon was also involved in an auction for *Signify Health*, a provider of technology for in-home care (Palmer 2022b). Amazon was competing for the deal with CVS and *UnitedHealth Group* and according to media coverage, Signify's value is even higher than the one of One Medical. In September 2022, it was announced that CVS succeeded in the auction and will acquire Signify Health for 8 billion USD (Minemyer 2022).

Also in 2022, Amazon joined a group of 375 organisations in asking the Senate to renew the extensions of payment for telehealth consultations which had been introduced in the course of the Covid-19 pandemic (Goldman 2022).

5.5 Logistics

Already in 2016, Amazon established its delivery service *Prime Now* in Berlin and in Munich which meant that some products were delivered to users of the service within two hours. Since 2017, also over the counter-drugs and pharmacy-exclusive cosmetics of the *Bienen-Apotheke* in Munich have been among these products (Apotheke Adhoc 2017). Interestingly, the head of the pharmacy, Michael Grintz, contacted Amazon with the idea and not vice versa (Müller 2017). Users of Amazon Prime received their express-orders within one hour for 6.99 Euro per delivery and other users received their orders for free at a later date (Przegendza 2017). In 2021, Amazon abandoned the partnership without commenting on the reasons. Its service Prime Now has been replaced by *Amazon Fresh* which focuses on the delivery of food products (Hollstein 2021).

One year later, Amazon-executives met with managers of the Dutch-German mail order-pharmacy *Shop-Apotheke*, allegedly to discuss an acquisition. Shop-Apotheke denied Amazon's acquisition plans subsequently, Amazon was not available for a comment concerning the rumours (Handelsblatt 2017, Hollstein 2017).

In 2017, Amazon acquired the organic market chain *Whole Foods* which operated about 456 shops at the time of the announcement (Hirsch and Dastin 2017). Amazon paid 13.7 billion USD for the acquisition. Users of *Amazon Prime* could subsequently order Whole Foods-products online for free and Amazon installed lockers inside the shops in which they could pick up their Amazon orders after shopping (Hirsch 2018). In 2020, Amazon was criticised for ranking the shops by variables like area, unemployment rate etc. to estimate the probability of the foundation of labor unions in order to be able to ban such developments from the beginning (Gärtner 2020g).

In 2018, Amazon established a new private brand, *Amazon Basic Care*, which sells more than 60 products like hair restorers but also prescription-free medications and might also be used by Amazon as an instrument to put pressure on suppliers of branded products in the sector (Borsch 2018).

Also in 2018, the *Arcadia Group*, a British retail company and parent enterprise of *Topshop*, started selling medical products like glucose measurement devices exclusively via Amazon under the name *Choice* (Lineaweaver 2018). By now, the Arcadia Group has filed for insolvency (Nelson 2020).

In the same year, Amazon acquired *PillPack* including the company's sales licences for 753 million USD. The start up from Boston had started delivering drugs in personalized blister packagings in 2014. Customers receive their drugs in small packagings which contain their daily dose of medication, subsequent orders are automated and there is a 24/7 customer service available (PillPack w.y., Farr 2019g). *Google* and *Facebook* had listed the company as a drug manufacturer at first which increased the barriers to display advertise-

ments on their platforms (Farr 2019g).
The development of PillPack's own software *PharmacyOS* for automation of renewed prescriptions, insurance billings etc., which started in 2017, led to high costs that were not met by fast growth during Pillpack's first years. The software is apparently not only used internally but also by drug manufacturers, physicians and health insurances to make their processes more efficient (Farr 2019g).
Amazon was not the only company interested in buying PillPack. Among others also its rival *Walmart* had shown intentions to acquire the start up (Farr and Hirsch 2018) but allegedly, PillPack's executives were convinced that Amazon shared their view on the lack of consumer orientation in the pharma market the most. Other observers think that PillPack-executives realized that Amazon might become a strong new competitor on the drug market and that this conclusion drove their decision to sign the deal with Amazon (Farr 2019g). Amazon itself might have been interested in getting in touch with Pillpack's clientele which is between 50 and 60 years old on average and thus way older than Amazon's customers. Additionally, the average Pillpack user spent about 5,000 USD in 2018 (if insurance payments and private payments are added together) while the average Prime user only spent 1,300 USD (Farr 2019g). Observers also hypothesized that Amazon might have been interested in obtaining Pillpack's sales licences without which it is not possible to sell prescribed drugs in the United States. Pillpack had licences for all but one state in the US and establishing *Amazon Pharmacy* (see below) would probably not have been possible without them (Sagonowsky 2018). After closing the deal, neither Amazon- nor PillPack-representatives were available for public comments (Farr 2019g)

In 2017, only one year before Amazon acquired Pillpack and established Amazon Basic Care, Stefano Pessina, CEO of *Walgreens*, had still told investors that he does not "believe that Amazon will be interested in the near future in the next few years in this market" (Farr 2019c) but the described activities show that Amazon is trying hard to establish itself as a major player in the drug market which has been dominated by companies like Walgreens and *CVS* so far.
In the United States, drug prices are not subject to the interventions by the government but entirely negotiated on the market. In these negotiations, Pharmacy Benefits Manager (PBM) are playing a major role. They are contracted by health insurances and negotiate drug prices with pharmacies and thus decide how much insured persons will have to pay (Farr 2019g). Often, they are integrated with a wholesaler or a pharmacy chain which, in combination with the lack of transparency of price negotiations, has led to the impression that the resulting prices often are way too high (Feldwisch-Drentrup 2016). Also CVS, one of the 20 biggest companies in the world ranked by revenue, operates as a PBM with its subsidiary *Caremark* and apparently made 60% (116 billion USD) of its total revenue in 2018 this way (Farr 2019c). Pillpack also relied on these PBM to reach the patients whose drugs are paid by their health insurers. According to their own statements, these PBM represent 90% of the insured persons in the US. Although Pillpack-CEO TJ Parker said, that there are no according plans for the near future, these PBM are now afraid that Amazon might make their services redundant by using its market power to negotiate prices on its own according to analysts (Farr 2019c).
Pillpack had threatened their business with their own mail-orders already before the acquisition. In 2016, *Express Scripts*, the largest PBM, had considered removing Pillpack from

its network. The reputed reason was that Pillpack had defined itself wrongfully as a retail pharmacy instead of a mail-delivery pharmacy. The threat revealed the enormous market power of Express Scripts since the removal would have cost Pillpack instantly about a third of its clientele (Farr 2019g). In a lawsuit in 2019, *CVS* sued Amazon Pillpack because it had hired a former CVS-employee. The background of this complaint was the so called no-competition clause which prohibits former employees from competing with their former employers for 18 months after their employment has ended (Farr 2019c). These legal actions by large PBMs can be taken as hints that they take Amazon's engagement in their field of activity seriously.

Since 2019, Amazon Pillpack is planning to build a huge pharmacy building in Phoenix which is also planned to serve as a distribution center in order to improve its services in the west of the United States (Farr 2019g).

In the same year, Nader Kabbani, who previously had been responsible for *Amazon Kindle* and *Amazon Flex*, became chief of operations in Amazon's pharma unit (Gärtner 2019b).

In 2020, Amazon started operating its own online pharmacy *Amazon Pharmacy* which offers price comparisons for medications and also sells prescription drugs (Landi 2021b, Fuest 2020). It was planned to offer consultation by pharmacists day and night and to enable customers to order their medication and receive reminders via integrated *Alexa*-devices (Fuest 2020). Deliveries are free for members of *Amazon Prime* who are attractive customers for Amazon Pharmacy due to their high average incomes and health expenditures (Reed 2020, Fuest 2020). Due to its market power, Amazon might moreover be able to negotiate favourable conditions with both insurers and drug manufacturers. Direct payers might obtain discounts of up to 80% on generic products (Reed 2020) and Amazon promised that it will not use health data for commercial purposes. The company also operates an online-pharmacy in the Indian city Bangalore under the same name. Besides OTC- and prescription drugs, also glucose measurement devices, massage sets etc. are sold there and discounts of up to 20% are offered on drug orders on India's highly competitive young online-pharmacy market on which also Mukesh Ambani, the richest Asian person by now, is involved (Singh 2020). In the same year, it became known to the public that Amazon considers working together with the large Indian pharmacy chain *Apollo Pharmacy*. It was reported that Amazon would pay 100 million USD in order to obtain the rights to sell and deliver drugs from Apollo's 3,700 pharmacies (Srivastava 2020). Already in 2018, Amazon had planned to invest in the Indian pharmacy chain *Medplus* (Reuters 2018).

According to a report by Reuters, which has not been confirmed officially yet, Amazon is also planning to establish a network of stationary pharmacies which could be integrated into the already existing network of *Whole Foods*-stores (Plewinski 2021c).
If Amazon planned to expand its various pharmacy activities to Germany it might be a successful endeavour according to a survey which was conducted in 2020: Nearly two thirds of the respondents could imagine to buy OTC-drugs via Amazon and nearly 50% could also imagine to buy prescription medicines. Already in a YouGov-survey of 2016, before the company had acquired Pillpack and established Amazon Basic Care, 15% of respondents said that they had already bought OTC-drugs via Amazon (Plewinski 2020c).

Also in 2020, a partnership with *Carrier Global Corp*, the world's largest developer of

cooling systems, started in order to improve supply- and cold chains in the frame of the transport of drugs and vaccines (Carrier 2020).

Amazon is also developing robots which can be used in the shelves of its distribution centers to kill Covid-viruses via UV radiation. This kind of disinfection is however not suitable for use with humans since their immune defence might be suppressed by the radiation (Gärtner 2020a). Amazon also used thermal imaging cameras in several of its warehouses in the United States to measure the body temperature of its employees in order to protect them from infection (Plewinski 2020b).
In another Covid-19-related effort, Amazon worked together with the non-profit health provider *Virginia Mason Franciscan Health*. Together, the partners set up a pop up vaccination center next to Amazon's head office in Seattle. On the first day, the 24th of January 2021, alone, 2,000 people were vaccinated there (Plewinski 2021b).
Additionally, the company started its *Amazon Diagnostics*-unit which offers self-tests for Covid-19 (and sexually transmitted diseases) and also established a market place for third-parties who sell their own self-tests (Gärtner 2021b).
Moreover, Amazon sent a letter to President Biden in which it offered to help fighting the pandemic by converting logistics centers to vaccination centers and by making its information- and communication-resources available (Clark 2021). The company also announced that it planned to invest 4 billion USD to help in the fight against the virus (Faulkner and Kastrenakes 2020).
However, there were also hints that the company does not always meet its own expectations: In 2020, Tim Bray, vice-president of Amazon Web Services, resigned due to the company's treatment of employees in its logistics centers in the course of the pandemic. Shortly before, several workers had been dismissed by Amazon after they had criticized insufficient safeguards against infections at their working places (Gärtner 2020d).

Still in 2020, Amazon began its partnership with the US-American *Red Cross*. Via *Amazon Sidewalk* the partners aim to monitor the supply chain of blood donations between different delivery points and distribution centers. Sidewalk is a neighbourhood-network (a so called mesh-net) which consists of different smart home devices that are connected via Bluetooth Low Energy (similar to the functioning of Germany's *Corona Warn-App*). Data transfers of up to one kilometre are possible; the more users are connected to Sidewalk, the bigger the scope of the network. As part of the same project, Amazon is also working together with the positioning chip-developer *Tile* in order to enable users of Sidewalk to retrieve lost pets and keys (Gärtner 2020b).

5.6 Other Activities

CNBC reported in 2017 that Amazon is working on different projects in the healthcare sector under the name *1492* which alludes to the date of the discovery of America. However, it was not specified what the projects deal with in detail. In the fist half of the year, the description "a1.492" appeared in several job-advertisements and LinkedIn-profiles but it then disappeared completely after July 2017 (Kim and Farr 2017).

In 2018, Amazon, the US-American holding *Berkshire Hathaway* and the US-American

bank *J.P. Morgan Chase* founded a joint venture which was called *Haven Healthcare* and aimed to improve healthcare and to lower costs in the health sector (Son 2021). Haven was designed to be a non-profit organisation and its CEO was the surgeon Atul Gawande (Toussaint 2021). The companies also planned to establish a joint health insurance for their employees (Kort 2021b). Similar to CVS' lawsuit against Pillpack, the health insurance company *United Health* filed a lawsuit against Haven for hiring one of its former employees but the motion was denied in 2019 (Farr 2019c).
In 2021, Haven dissolved without naming a reason. Observers stated that the differing goals, which the companies tried to achieve independently from each other, alongside with numerous personal problems might have caused the end of Haven (Son 2021, Toussaint 2021).

Amazon started selling pre-built hospital rooms of the New York-based company *EIR Healthcare* via its Marketplace in 2019. EIR Healthcare aims to establish more transparency on the market which allegedly is dominated by companies with non-transparent price structures (Farr 2019h).

In 2020, Amazon began a partnership with the Irish consulting agency *Accenture* in order to modernize the digital platforms of the Japanese pharmaceutical company *Takeda Pharmaceutical* (Takeda 2020).

In the same year, there were rumours that Amazon might be interested in offering health insurance for companies which sell their products on its marketplace. Amazon had sent a questionnaire to these employers, asking them about their satisfaction with their current health insurance and also tried to get information about the premiums they have to pay. The final remark of the questionnaire read:"[w]e will keep you informed as we explore how Amazon may be able to support your needs better" (Del Rey 2020) In the United States alone, 900,000 vendors sell their products via Amazon Marketplace (Del Rey 2020).

In the course of the Covid-19-pandemic, Amazon banned dealers from its *Marketplace*-platform who set unreasonably high prices for disinfectants and protections masks. Subsequently, the German *Federal Cartel Office* investigated against the company because some dealers were apparently banned without reason (Greis 2020).

In an effort to improve its heavily criticized working conditions, Amazon established *AmaZen* in 2021: Employees are now able to access boxes which are set up in the company's distribution centers and should enable them to take a relaxing break. Short videos with meditation instructions are displayed and the boxes contain plants and a soothing blue fanlight (Gärtner 2021a). Several years before, the company had attracted public attention because it paid workers in German distribution centers a premium of up to 10% of their incomes if they called in sick seldom. The highest premium could only be reached if all team members called in sick rarely enough (Laude 2017).

5.7 Summary

While Amazon is more hesitant than competitors like Alphabet and Apple to talk publicly about its engagement in the health sector, it is obvious that the company has established it-

self as a major player by now. As one might expect, it especially relies on its strengths in the sector of logistics and the attacks of established actors in the pharma market give hints that Amazon's activity in the sector of delivering medication is taken very seriously, especially after its acquisition of Pillpack in 2018. But also the high number of health institutions relying on the cloud services of AWS and the growing integration of Alexa-devices show that Amazon is highly active in health markets. Similar to Alphabet, the company however also had to face apparent setbacks with the end of its joint venture Haven and the surprising termination of all Amazon Care-services in the end of 2022. Since the exact reasons for these decisions remain unknown to the public due to the company's communication strategy, it is unclear what they mean for Amazon's engagement in the health sector in the future.

6 Microsoft

Microsoft was founded in Albuquerque, New Mexico, in 1975 by Bill Gates and Paul Allen and was the 14th biggest enterprise in the United States measured by revenue in 2021 (Fortune 2022b). The company focuses on the development of software and is famous for its operating system Windows and the software bundle Microsoft Office. In recent years, the company has broadened its field of activities, mainly by acquiring other companies, like the social network for business contacts LinkedIn in 2016 (Postinett 2016) and the instant messaging and video call-service Skype in 2011 (Bright 2011). After first attempts to establish itself as a player on the health market, which started in 2006, the company restructured its Microsoft Healthcare-Team as part of its research- and artificial intelligence-unit and abandoned several of its former projects in the years 2016 - 2018. Since then, Microsoft has clearly reinforced its activities in the sector.

6.1 Health Apps and Smart Devices

In 2014, Microsoft started selling the first version of its smartwatch with fitness tracker-functions *Microsoft Band* in a limited amount in the United States. The device contained ten sensors and enabled users for example to measure their heart rate and track their sleep and calorie intake (Popa 2014). In the end of 2015, the company presented a successor device, the *Band II*, which was also sold in Canada, Australia and the United Kingdom (Callaham 2016). In the end of 2016, however, Microsoft terminated the product line and deleted all information about the devices from its website (Foley 2016a).

In 2015, the company introduced its *Microsoft Health*-app which could be accessed both via smartphone and personal computer. The app enabled users to analyse their physical activity via diagrams, import activity data from third-party apps and to receive incoming messages (Microsoft Devices Team 2015). In 2019, the company terminated its support for the app and all remaining applications which had been connected with its *Band*-devices (see above) (Microsoft 2019).

In 2017, Microsoft announced its *Healthcare NExT Initiative* for which it partners with various health companies and institutions. The aim of the initiative is "to dramatically transform health care" (Lee 2017a) according to the company. The initiative combines many

different projects which all have in common that they “establish a new model at Microsoft for strategic health industry partnerships” (Lee 2017a).

One of these projects is the company’s *Health Chatbot Technology* which enables partner institutions to develop their own tools in order to improve communication with their patients (Foley 2017, Lee 2017a). Among the first users were the US-American health company *Kaiser Permanente* and *Children’s Healthcare of Atlanta*, a non-profit health provider for children which runs several hospitals (Hawkins 2021b). The telehealth provider *MDLIVE* used the technology to let its patients perform ”self-triage” before they see a doctor and *Premera Blue Cross*, one of the biggest health insurance companies in the United States, utilized it to offer more health information on its website (Lee 2017a). In the past, Microsoft had an unspecified partnership with the *Health Navigator* symptom checker in the context of its chatbot technology (Lee 2017a) which, however, seems to have been terminated as of 2022. Health Navigator had been acquired by *Amazon* in 2019 (see *Section 5.1*).

During the Covid-19-pandemic, Microsoft’s communication application *Teams* became a standard tool for the coordination of health collaborations in different health systems including the British *National Health Service (NHS)*. The application is compatible with the *Health Insurance Portability and Accountability Act (HIPAA)* (see *Sections 5.1 and 2.3*) (Hawkins 2021b).
In 2021, Microsoft worked together with the New York-based digital health company *Teladoc Health* to include telemedicine applications for hospitals and other health providers in Teams. At the time of the collaboration, Teladoc Health was already active in 130 countries (Hawkins 2021b). In 2022, it became known to the public that New York’s biggest health provider *Northwell Health* plans to implement the Teladoc platform in many of his hospitals to extend its telemedicine services (Torrence 2022).
Another health company collaborating with Microsoft and using the company’s Teams-integration is the digital mental health provider *Headspace* which merged with another digital health company named *Ginger* in 2021. The newly found enterprise *Headspace Health* is estimated to have a market value of 3 billion USD and owns the world’s biggest mental health data set. The enterprise reaches 100 million users, partly via their health insurances, partly via companies like *Starbucks*, *Adobe* and *Unilever* who grant their employees access to the meditation- and mindfulness practices that Headspace Health offers in addition to establishing contact to psychotherapists and psychiatrists (Condon 2021).
In the same press conference, in which Microsoft announced its partnership with Headspace, the enterprise also gave notice of new so called “wellbeing”-features to be included in its Teams-application. The new features included the possibility to praise colleagues, to perform reflexion exercises and, curiously, even a feature which enables employees to digitally commute from their workplace, in order to reduce negative impacts of the Covid 19-pandemic on the working climate (Tung 2021).

In 2021, the enterprise reinforced its endeavours to strengthen telemedicine application by utilizing its *Microsoft Cloud for Healthcare* in order to integrate the virtual sphere in health facilities. (Microsoft w.y.a). According to Microsoft, the main aims of Cloud for Healthcare are to improve patient engagement, cooperation of medical staff and availability and analysis capabilities of health information (Microsoft 2022). By now, there are various health companies and institutions which use Cloud of Healthcare for a variety of purposes.

In the frame of this initiative, Microsoft also intensified its partnership with *Northwell Health* (see above) by implementing a chatbot extension called *NORA* in its *Teams* application. NORA had been developed by researchers of Northwell Health, who relied on *Microsoft Azure*- and *Microsoft Office*-technology in the development process, and was used to enable medical staff to instantly access information from EHRs on their mobile devices (Microsoft 2021c, Medcity News 2022). Another application created by Northwell Health in the frame of Cloud for Healthcare is the *Rounding*-app which was developed based on *Microsoft Power Apps*, a platform which enables third-parties to develop their own apps. Rounding has enabled Northwell to facilitate tracking of patient care plans (Microsoft 2021c).

Also the *St Luke's University Health Network*, a non-profit health organisation, which operates more than 10 hospitals with 16,000 employees, started working with *Teams* in the beginning of the Covid-19 pandemic. The application was used to coordinate the cooperation of medical staff, to keep contact with quarantined patients, to upload documents, which subsequently could be edited together, and to entrust researchers with data analysis projects (Microsoft 2020b).

Also in 2021, Microsoft announced a partnership with the Indian hospital chain *Apollo Hospitals* to offer a health and wellness app to the employees of *Microsoft India* (Hawkins 2021b).

6.2 Data Analysis

In 2006, Microsoft acquired the data platform *Amalga* which had been developed by physicians and researchers of the *Washington Medical Center* in 1996 (initially, the platform, which is used to merge health data from different medical systems, had been named *Azyxxi*) (Hawkins 2021b). After the acquisition, the platform was used by various hospitals in the United States, including the *Johns Hopkins Health System* (Chan 2009) and also integrated in other Microsoft-projects like *HealthVault* (Foley 2009) and *Caradigm* (Horowitz 2013) (see below).

In 2017, Microsoft introduced *Microsoft Genomics* as part of its Healthcare NExT Initiative. The service is aimed at facilitating genome analyses and is based on the company's cloud computing platform *Azure*. Microsoft collaborates with the Finnish software developer *BC Platforms* and the US-American data analysis company *DNANexus* (Lee 2017a) which had been backed with several investments by *Alphabet* in the past (see *Section 2.2*).

In 2019, Peter Lee, vice president of Microsoft, announced the *Microsoft AI in Health Partner Alliance* in a blog entry. The aim of the alliance is to overcome barriers concerning the use of health data. Partners of the alliance are enabled to profit from training programmes and get access to technology, data sets and the expertise of Microsoft employees (Lee 2019). *Walgreens Boots Alliance*, the biggest pharmacy chain in the United States and competitor of *Amazon* (see *Sections 2.6 and 5.5*), joined the alliance in order to connect patients with health providers via their mobile devices and to strengthen prevention and reduce visits in the emergency rooms this way (Lee 2019). The Catholic non-profit health system *Providence* collaborated with Microsoft to strengthen data based decision-making in its hospitals

and to use voice recognition applications in its cancer therapy programs. The partners also founded a flagship "clinic of the future" near Seattle (Lee 2019).
The research enterprise *Adaptive Biotechnologies* asked for Microsoft's machine learning capabilities in order to support its project of decoding the human immune system (Lee 2019).
The European pharma company *Novartis*, which also collaborated with *Alphabet* (see *Section 2.1*) and had plans to acquire *PillPack* (see *Section 5.5*), joined the alliance to facilitate the development of new treatment options. Both companies planned to use their AI-capabilities in order to develop new medications (Lee 2019).
In the frame of the newly found alliance, Microsoft also partnered with *Nuance Communications* which it acquired in 2021 (see below). The companies planned to develop a solution which records doctor-patient-consultations so that doctors do not have to invest time in taking notes because transcripts of the consultations are created automatically (Lee 2019).
Another company, which joined the alliance to work together with Microsoft, is the US-American health enterprise *Humana*. Microsoft signed a 7-year-deal with the company, which aims to promote more holistic ways of health provision. Through data analysis and AI, more personalized treatment options and a higher adherence should be enabled. The partners also planned to use smart home devices in the course of their project similar to *Nest* (see *Section 2.1*) (Lee 2019). Microsoft had been active on the market for smart thermostats for some time (Költzsch 2017) but seems to have abandoned this project by now.

In 2020, *MVP Healthcare*, a regional health insurance company in the United States, used *Microsoft Dynamics 365* in order to merge data from insured persons, which had been spread on many different sources before, in a single program (Microsoft 2020a).

In 2021, Microsoft and the *University College London Hospitals NHS Foundation Trust (UCLH)* announced a collaboration which aims at finding out how artificial intelligence may be used to improve health provision by the NHS (Hawkins 2021b).

In the same year, it became publicly known that 38 million data sets with private data were available in the internet without any access restrictions via various apps which had been developed with *Microsoft Power Apps* (see above). The data, for instance, contained information from contact tracing apps and information on vaccination status. The leakage occurred due to a misconfiguration of the Power Apps platform. The data were freely available online because the platform had chosen the variant without access restrictions as the default setting (Newman 2021)

After acquiring *Nuance Technologies* in 2021 (see below), the two companies founded an *AI Collaborative* together with the *Health Management Academy* in 2022. Similar to the partnership with UCLH, the aim of the collaborative is to explore the possibilities of AI-usage in the health sector. It planned to start operating in September 2022 (Kantor 2022).

In 2022, a psychiatric clinic in Australia operated by *Bethesda Healthcare* implemented *Microsoft Cloud for Healthcare* (see above) to merge patient data from various sources in one place in order to facilitate information exchanges between different facilities and to gain a better overview over carried out and recommended treatments (Smith 2022).

6.3 Electronic Health Records and Hospital Information Systems

In 2007, Microsoft started a beta version of its EHR called *HealthVault* (The Economist 2007). The aim was to facilitate health data exchanges between patients and physicians. In order to be able to do so, the company also integrated the data platform Amalga into its EHR-project (see above). Different from *Alphabet*, Microsoft also displayed targeted advertisements in its EHR-platform if users opted in (Tiedge 2008). In 2017, Microsoft introduced *HealthVault Insights* as part of its Healthcare NExT Initiative. The company utilized its innovations in the field of machine learning to generate new insights into patients' health, improve their adherence and to integrate the patients themselves in the treatment process based on the data stored in HealthVault (Lee 2017a).
In 2019, Microsoft announced that it will terminate all services connected to HealthVault and all patient data, which had remained on the company's servers until November 2019, were deleted. Microsoft did not name specific reasons for its decision to abandon its EHR-project but observers stated that HealthVault's termination fitted into the general company strategy at this time to step away from services which were addressed at end users (the company had also stopped selling eBooks and music in its online store) (Foley 2019). According to *Get Real Health*, a health technology company form Rockville, users could seamlessly transfer their health data from HealthVault into the company's own EHR-platform *Lydia*. Microsoft recommended its customers to either contact Get Real Health or *FollowMyHealth*, a company which offers an EHR for smartphones in the United States, for the transfer of their health data (Foley 2019).

In 2015, Microsoft cooperated with *Epic Systems* (see *Section 14*). Hospitals using EHRs operated by Epic could now use the company's *Hyperspace*-application (the front-end of the EHRs) on Microsoft's virtualization platform *Hyper V* and store rarely used data in the company's *Azure*-cloud (Hawkins 2021b).

In 2017, Microsoft partnered with the *University of Pittsburgh Medical Center (UPMC)* which operates more than 25 hospital and offers its own health insurance with about 3 million insured persons (Lee 2017a). The partnership is part of Microsoft's Healthcare NExT Initiative and contains several common projects. At first, Microsoft and UPMC focused on finding ways to disburden physicians in UPMC's hospitals from electronic information input and processing in order to allow them to spend more time with their patients. The services resulting from the projects were supposed to be implemented in UPMC's facilities first but could also be sold to other institutions at a later time (Lee 2017a).

As already mentioned in *Section 3.3*, employees of *Apple* and Microsoft participated in an event of the *Carin Alliance* in 2020 in order to support the alliance's aim to improve patients' access to their health data.
In the same year, Microsoft introduced an advanced version of its *Azure IoT Connector for FHIR*. FHIR stands for *Fast Healthcare Interoperability Resources*-Standard, which is a standard that aims to enable and facilitate the transfer of patient data between different systems, and the Azure IoT Connector can, for instance, be used by physicians to access information on patients which are generated in their everyday lives (Best 2021a).

Microsoft's communication platform *Teams* has become considerably more important for communication in hospitals during the Covid-19 pandemic (see above) (Roy 2020).

In 2021, Microsoft acquired *Nuance Communications* for 19 billion USD making it one of the company's biggest acquisitions to date (Kovach 2021). Nuance is an AI-company with a focus on voice-recognition and -analysis solutions and had made two thirds of its revenues in the health sector. 85% of the Fortune 100 companies worldwide had relied on Nuance's applications and 77% of the hospitals in the United States had been full-service partners of the company (Microsoft News Center 2021). Microsoft stated that Nuance's health-related activities were the main factor driving the acquisition (Makris 2022) and that the deal had at once doubled the size of its market reach in the health sector (Microsoft News Center 2021). Microsoft hoped that acquiring Nuance would enable the company to record and manage patient data even better. One of Nuance's products, *Dragon Ambient eXperience (DAX)*, automatically transfers doctor-patient-consultations in written form which enables a direct transfer of information obtained during the consultation into the patient's EHR (Best 2021a).
Microsoft and Nuance had already partnered for different projects years before the acquisition (see above). Even before, Nuance had been involved in the development of *Apple*'s voice assistant *Siri* (Best 2021a, Spiegel Online 2021).

Microsoft has close ties with both US-American EHR-giants *Epic Systems* and *Cerner* (see *Section 14*) (Farr 2020q). Both companies seem to rely heavily on Microsoft's cloud services (Obermaier 2022, Torrence 2021b) although it remains to be seen how this situation will change after Cerner's acquisition by *Oracle* which had invested heavily into its own cloud infrastructure recently (see *Section 9*).

While Cerner is in favour of Microsoft's endeavours to enable patients to get access to their personal health data, Epic Systems is opposed to these plans (Farr 2020g).

6.4 Innovation of Treatment

In 2017, Microsoft presented its AI-based software *InnerEye* as part of its Healthcare NExT Initiative. The software can be used for radiotherapy planning and enables to perform 3D-scans of patients in several minutes instead of several hours. Microsoft announced that the software would democratize imaging processes via AI and the company also wants to enable physicians and researchers to develop their own AI-models based on its cloud service *Microsoft Azure* (Lee 2017a, Microsoft w.y.b).

Another part of the initiative enabling innovative treatment options is *Microsoft Office 365 Virtual Health Templates* which, in combination with Microsoft's *Skype for Business*-application, enables health providers to contact their patients wherever they are residing at the moment (Lee 2017a). The customers of this new service include the healthcare communication platform *RingMD*, *Careflow*, which develops a cloud-based EHR and solutions for hospitals who want to offer digital services, the Swedish e-health-provider *Cambio* and Microsoft's former partner in the *Caradigm*-joint venture *GE Healthcare* (see below) (Lee 2017a).

In 2020, Microsoft developed a *Plasmabot*, a chatbot which was designed to question people who had recently recovered from an infection with Covid-19 to find out if they would be suitable donors of blood plasma. At this point of time, researchers hypothesized that either

blood plasma transfusions might heal infected persons or that the plasma might be used in order to develop medications until a vaccination would be invented (Farr 2020s).

In the same year, Microsoft once again partnered with *Adaptive Biotechnologies* (see above) and with *Illumina* (see *Section 5.2*). The aim of the collaboration was to analyse blood samples of Covid 19-patients to better understand why the disease turns out to be lethal for some patients while others show hardly any symptoms at all. The blood samples had been anonymized before they were examined (Farr 2020p). Adaptive Biotechnologies had been focused on the analysis of blood samples of patients suffering from various diseases already for a longer time and the company aims to offer an "immune check-up" with which patients can be tested on contagious diseases, cancer and autoimmune diseases. However, the company states that it still might take a decade until the test will be ready for use. Illumina brought its DNA-frequencing capabilities into the project and Microsoft contributed its cloud capacities and ML-algorithms (Farr 2020p).

Microsoft also partnered with *Infermedica*, a company which was founded in Wroclaw in 2012 and offers companies its symptom-checkers and triage-tools (Jak 2020). The companies developed the *Microsoft Healthcare Bot* which was also used as symptom checker by the *CDC* in the course of the Covid 19-pandemic. According to the CDC, Microsoft had no access to patient data in the frame of this collaboration (Lyons 2020).

Also in 2020, Microsoft started collaborating with the French insurance company *Axa* which was operating in 64 countries as of 2021. The companies set up an e-health-platform on which users are able to perform symptom-check-ups, arrange doctor's appointments and to access further telemedicine-services. Microsoft contributed its AI-technologies, its cloud service *Azure* and its various already existing partnerships in the health sector. Pilot projects started already in 2020 in Italy and Germany where Axa-customers could use the self-assessment tool, a solution for telemedicine consultations and a "medical concierge". It was planned to extend the service to Switzerland, the United Kingdom, Belgium and Spain in 2022 and in the long run, the platform shall also be made available to third-parties in order to improve the information exchange between health providers and patients (Orizet 2021).

Still in 2020, *Rancho Las Amigos*, a rehabilitation centre in California, started working together with the wearables company *Sensoria Health* which is a partner of Microsoft in the frame of its *Cloud for Healthcare*-initiative (see above) and used *Microsoft Azure IoT Central* and the *Azure API for FHIR* to continuously monitor its patients with diabetes (Microsoft 2021a). Some of these patients faced a high risk of amputation of a foot and were equipped with boots by the Italian producer *Optima Molliter* which on the one hand stabilized their feet and on the other hand also transferred data to both patients and medical staff who, in turn, were enabled to send patients feedback on their wearing behaviour (Microsoft 2021a).

Microsoft's *AI in Health Partner Alliance* (described in more detail above) is likely to also have implications for innovation of treatment. This is plausible especially for the company's partnership with *Novartis* to use AI in the field of medication development (Hawkins 2021b).

6.5 Logistics

As of September 2022, no activities of Microsoft in this category could be found.

6.6 Other Activities

In 2012, Microsoft partnered with *GE Helthcare*, the healthcare unit of the US-American *General Electric Company*, one of the biggest conglomerates worldwide, to found the joint venture *Caradigm* which aimed at improving the provision of health (Horowitz 2012, General Electric 2012). Except from *HealthVault* (see above), Microsoft shifted all of its health activities into the joint venture but subsequently sold all of its shares in 2016, shortly before it started its *Healthcare NExT Initiative* (see above). However, Microsoft announced that it still planned to act as a partner of Caradigm in the future (Foley 2016b). In 2018, Caradigm was acquired by *Inspirata*, an IT-service and consulting company which specializes in cancer research (Hawkins 2021b). The end of Microsoft's participation in the joint venture meant that the data platform *Amalga* (see above), which also had been shifted into Caradigm in 2012, was no longer part of the company.

Shortly after the end of Microsoft's participation in Caradigm, the company implemented a new *Microsoft Healthcare*-team and hired Joshua Mandel, who had been employed by *Alphabet*'s *Verily* (see *Section 2*) before (Hawkins 2021b).

As part of its Healthcare NExT Initiative, Microsoft also announced to introduce a software called *CGI Proper Pay for Claims Analytics* which aims to uncover insurance fraud (Lee 2017a).

In 2020, Microsoft hired former *GE Helthcare*-CEO Tom McGuiness who became vice-president in the company's healthcare unit. Microsoft had previously abandoned its joint venture with GE Healthcare (see above). Before, the company had also employed Greg Moore, who had previously been working for *Google Cloud*, and David Rhew, the former Chief Medical Officer at *Samsung*. In March 2020, Peter Lee, who had been responsible for Microsoft's healthcare sector, was promoted to chief of *Microsoft Research* which hints at the importance of the health sector for the company (Farr 2020r).

In 2021, the company announced that it will extend its *Microsoft Tech for Social Care*-unit to the field of elderly care. The unit offers its tools and services at favourable conditions to non-profit organisations. The extensions meant that elderly care institutions could use the company's technologies for rates up to 75% beneath the usual prices and could also apply for further support by training programmes (Spelhaug 2021). Especially since the beginning of the Covid 19-pandemic, the utilization of IoT-technologies for monitoring patients remotely and of care robots had been widely discussed in the field of elderly care (Horwitz 2021).
One of the fist organisations to profit from Microsoft's new offer was the *Deutsche Rote Kreuz (DRK)* which used *Microsoft 365-Cloud Technologies* like *OneDrive*, *Teams* and *Share Point* to fulfil its task as usual despite the pandemic. For instance, Teams was used to enable residents to keep contact with their relatives despite visiting bans. The DRK considers to keep on using Microsoft's solutions also after the end of the pandemic emer-

gency (Hawkins 2021a).
Microsoft estimated that the extension of its program enabled 75,000 organisations worldwide to access its technologies at favourable conditions. The company also planned to implement its *Microsoft Cloud for Nonprofit*-program universally after a successful pilot project in 2021 (Spelhaug 2021).

The hospital chain *HCA Healthcare*, which also collaborates with *Alphabet* (see *Section 2.2*), is a partner company of *Microsoft Cloud for Healthcare* (see above) and uses *Microsoft Defender for Endpoint* to ensure cyber security in its facilities (Microsoft 2021b).

6.7 Summary

Microsoft has been active in the health sector for a long time. However, there has been a considerably discontinuity due to the company's decision to abandon all of its health projects in 2016 (except for HealthVault which was terminated in 2019). The start of its Healthcare NExT Initiative in 2017 marked a new beginning for the company's engagement in the health sector and since then Microsoft has massively reinforced these activities. According to observers, these developments might be connected to the appointment of Satya Nadella as new CEO in 2014 since which the company has been focussing on its cloud capabilities with Microsoft Azure and has been entering partnerships with many renowned health institutions and companies (Farr 2020q). Microsoft emphasizes that it aims rather to act as a partner of health providers than to compete with them and the company has a clear focus on B2B-activities compared to its Big Tech competitors whose offers are often directly aimed at patients or customers.

7 Palantir

Palantir was founded in 2003 and is known to be a "key company in the surveillance industry" (Krempl 2020b). One of its founders is Peter Thiel who was among the first investors in *Facebook* (Waldman, Chapman, and Robertson 2018) and the foundation of the company was supported by investments of *In-Q-Tel*, the venture capital arm of the *CIA* (Krempl 2020b). Palantir is famous for its collaboration with the US-Amercian secret services and by now the company also partners with police departments in Germany, for example in North Rhine-Westphalia and Hessen (*Hessendata*) where it helps to merge data bases and to search social media for indications of criminal activity (Krempl 2020a). Most activities of Palantir are based on two software projects: *Palantir Gotham* which was designed for anti-terror-analysts and *Palantir Foundry* which is mainly used by hedge funds and financial service providers. Palantir's engagement in the health sector is less well known but the company has reinforced its activities recently in the course of the Covid-19 pandemic and is active especially in the health sectors of the United States and the United Kingdom.

7.1 Health Apps and Smart Devices

In 2021, Palantir invested in the digital health company *Babylon Health* which was founded in London in 2013 (Davison 2021, Levy 2021). The company offers telemedicine appointments (*GP at Hand*) and an AI-based chatbot for symptom checking via its app. At the same time, it was announced that Babylon is merging with the special purpose acquisition company *Alkuri Global* (Winston and Strawn 2021). The new company operates under the name Babylon and its market value is estimated to exceed 4 billion USD (Downey 2021). In the same year, it also became known to the public that Babylon is using Palantir's *Foundry*-software in order to improve healthcare provision in the United States. The resulting *Health Graph* is supposed to combine health data of its users from isolated sources to allow a more holistic view on their health. 80 billion data points were generated by combining data from over 100 sources by Foundry during the first two months of its use (Davison 2021).
Since 2016, Babylon is collaborating with the *Government of Ruanda* in order to support the public health system. The partnership was extended in 2020 and Babylon now offers telemedicine consultations to every citizen starting from the age of 12 (Postelnicu 2020). Since 2020, the company partners with the US-American health network *Mount Sinai Health Partners* to increase the use of its app in the state of New York (Landi 2020b). The company expected to generate 80% of its income in the United States in 2021 (Levy 2021). In 2016, also the founders of *DeepMind*, which had been acquired by *Google* in 2014 (Shu 2014) (see *Section 2.2*), invested in Babylon (O'Hear 2016).
Babylon has been criticised for "cherry-picking" of patients, questionable reliability of its artificial intelligence and dishonest advertising methods. While the company promises to enable patients to book appointments for video consultations within seconds and with waiting times of just a few hours, it also states that the service might not be suitable for patients with a wide range of serious issues (mental health problems, dementia, complex physical needs,...), a limitation which would not be accepted from common general practitioners (Bhatti 2017, Downey 2021).
Babylon CEO Ali Parsa took the view that his company will succeed in developing digital twins of its customers with the support of Palantir (Shead 2021a).

7.2 Data Analysis

Since 2018, the *U.S. Department of Health and Human Services* is using software from Palantir to reveal Medicare-fraud, for example the prescription of large amounts of opiates. For instance, the company creates maps which indicate hotspots of drug activity to give hints in which regions there might be high incidences of prescription fraud. The company also analyses which providers prescribe most opiates in certain areas, how long patients travel to obtain opiates and if patients have previously been treated by physicians who had been accused of fraud (Chapman 2018).

Also the *Centers for Disease Control and Prevention (CDC)* have collaborated with Palantir already several times. Among the projects were measures to contain Ebola, manage Antrax pathogens and to fight food-borne diseases (Nyczepir 2022). In the course of the Covid-19-pandemic, Palantir supported the CDC by managing the vaccination process (see *Section*

7.5).

In 2020, the British *National Health Service (NHS)* transferred data of millions of patients to Palantir and the London-based AI-company *Faculty* in order to contain the spread of Covid-19 (Gould, Joshi, and Tang 2020, Mageit 2021). These measures only became known to the public when initiatives like *opendemocracy* and *Foxglove* put pressure on the NHS. Allegedly, these interventions have also been responsible for the NHS' decision to terminate its cooperation with Palantir after the end of the pandemic (Mageit 2021).
The aim of the cooperation was to integrate data concerning the pandemic from different sources in one large data platform and also *Alphabet*, *Amazon* and *Microsoft* partnered with the NHS in the course of this project (Gould, Joshi, and Tang 2020). At first, the project had been framed as temporary measure to improve resource allocation in the beginning of the pandemic but in December 2020, the NHS extended its partnership with Palantir for two additional years (Gould, Joshi, and Tang 2020, Clark 2022). The transmitted data had not been anonymized but only pseudonymized and re-identification of the patients was not precluded. The NHS remains owner of the data at any time which allegedly limits Palantir's possibilities to analyse the data (Gould, Joshi, and Tang 2020) but it was not specified what this limitation meant exactly.
Palantir's part in this project had not been advertised publicly. The company had offered its software to the NHS already in 2019 but had not succeeded at the time (Shead 2021a).
The extension of the partnership in December 2020 triggered massive protests by a wide range of organisations and, led by opendemocracy and Foxglove, about 50 other organisations joined a campaign in order to persuade the NHS to stop the project (Shead 2021a, Davis 2021). Participants referred to Palantir's role in drone strikes and immigration raids and worried that its engagement in the British health system "will have a negative impact on patient trust, particularly among minoritized communities who may feel a threat from big government" (Shead 2021a). Neither the British Government nor Palantir commented publicly on the protest but in 2021, the government decided to terminate parts of its collaboration with Palantir (Downey 2021). While the British *Department of Health and Social Care* stated that it is "seeking to move away from reliance on third-party data analytics platforms and software" (Shead 2021c), Palantir assured that the terminated parts of the partnership had been intended to be temporary already from the beginning (Davis 2021). While a 23 million GBP contract remained in force, the *Adult Social Care Dashboard* which had been maintained by Palantir before, was moved to a new system which is called *EDGE* and was developed by the British company *BAE Systems* (Shead 2021c).
The British government is proceeding with its plans to integrate health data from various sources and planned to make all treatment data from 55 million citizens available for researchers and other third-parties including private companies in a single data platform. Patients, who do not want to participate, have the possibility to opt out (Foxglove w.y.).

In the same year, also the US-American *Department of Health and Human Services* collaborated with Palantir which has developed a version of its software *Palantir Foundry* that is specifically tailored to the demands of the department (Banco and Ackerman 2020, Clark 2022). The collaboration resulted in the data platform *HHS Protect Now*. The Department stated that 187 separate data sets were merged into the platform which contained information on crucial variables like hospital capacities, inventories, supply chain data and political actions taken by the states to contain the virus. HHS Protect Now also relies on "private

sector partner contributions of data" (Banco and Ackerman 2020) and developed quickly to be the central contact point for all data related to the pandemic in the United States.

Besides the United Kingdom and the United States, also Greece decided to work together with Palantir to contain the spreading of the Covid-19 pandemic and implemented its software Palantir Foundry in 2020. In the end of the year, the partnership was reaffirmed (Gordon 2020)

In the same year, Palantir offered German state governments to use its Foundry-software free of charge in order to contain the pandemic. The Hessian state government consisting of the CDU and the Green Party at first planned to implement the software to create an overview over the spreading of the virus, hospital capacities and the supply of protection gear but then decided against doing so when it faced strong criticism of the opposition (Krempl 2020a). However, Hessen already has a partnership with Palantir in the field of fighting criminal activity which is called *Hessendata* and uses Palantir's *Gotham*-software (Krempl 2020b).
Apparently, also the German Federal Government received Palantir's offer but did not show interest in implementing its software (Krempl 2020b).

Also in 2020, the French pharmaceutical company *Sanofi* decided to use Foundry to build a data platform for real world evidence. The platform contains data of more than 300 million patients whose sources range from EHRs over billing data to data which were generated by wearables. Foundry is able to update the platform automatically as soon as new data is available and its analytical machine learning tools support the company's researchers with the conduct of epidemiological studies (Palantir w.y.).

In 2021, it became known to the public that Palantir is among the *Day 1 members* of the *GAIA-X*-initiative which aims to build up a trustworthy and competitive data infrastructure in Europe (Krempl 2020b). Among the other members are many medium-sized enterprises from Europe but also other Big Tech companies like *Amazon*, *Microsoft*, *Alibaba*, *Siemens*, *Deutsche Telekom* and *SAP* (GAIA-X 2021).

In the same year, Palantir partnered with *MSP Recovery*, a company which was founded in 2014 and focuses on healthcare reimbursement recovery solutions. Palantir's role in the partnership is to implement its Foundry-software in order to merge information from different sources like EHRs and billing data to enable health providers to increase billing accuracy (Diaz 2021).

Also the Swiss drug manufacturing company *Roivant Sciences* is using Palantir's data analytics tools since 2021. As part of the same deal, Palantir also invested 30 million USD in the company (Levy 2021).

Only four days after the deal with Roivant Sciences had been announced, Palantir closed a similar deal with the biotechnology company *Celularity* from New York (Levy 2021).

In 2022, the pharma company *Merck* which is based in Darmstadt and had been the parent enterprise of *Merck & Co, Inc* (see *Sections 2.2, 2.4, 3.2, 4.6, 5.1, 5.4*) until World War I, started collaborating with Palantir for a project called *Syntropy*. The aim of the project is to accelerate digitalisation processes in the health sector and, more specifically, to enable genome analyses by using AI. Merck had already previously worked together with Palantir

to improve its production processes of pharmaceuticals and its supply chain management (Merck 2017, Waldman, Chapman, and Robertson 2018).

In the same year, Josh Harris, vice-president of Palantir, stated in an interview at the World Economic Forum in Davos that he thinks that the Covid 19-pandemic changed the way how companies and institutions think about the use of data. He also said that the company sees *Amazon Web Services* and *Microsoft* as partners and not as competitors (CNBC 2022).

7.3 Electronic Health Records and Hospital Information Systems

In 2022, a study, which analysed the impacts of Long Covid based on health record data of the *National COVID Cohort Collaborative (N3C)* and which was published in The Lancet Digital Health, used Palantir Foundry to integrate and harmonize the data of different EHR-formats (Pfaff et al. 2022). The study was supported by the *National Institutes of Health (NIH)* and the N3C-platform contains data on 13 millions US-citizens of whom 5 million had already been infected with Covid-19 and 100,000 are assumed to be Long Covid-cases making the platform one of the biggest Covid-related data bases in the world (Pfaff et al. 2022). Many data go back to the year 2018 and the participating institutions committed themselves to update the data for at least five years (NCATS 2022). A NIH-committee decides if access is granted to researchers depending on the respective purpose and until June 2021, 215 projects reaching from analyses on ventilator use to fight the spread of the virus to the impact of Covid-19 on menstruation had been permitted. Melissa Haendel, who works for the collaborative, stressed the relevance of the pandemic for building up the platform: "We never would have gotten everyone to give us this degree of data outside the context of a pandemic, but now that we've done it, it's a demonstration that clinical data can be harmonized and shared broadly in a secure way, and in a transparent way" (Ferguson 2021). While the data are allegedly anonymized, zip codes and dates of treatment are not deleted, which potentially enables reidentification. Privacy laws in several states prohibit institutions from participating in N3C (Ferguson 2021).

Within the framework of its partnerships with *Sanofi* and *MSP Recovery* (see *Section 7.2*), Palantir uses its Foundry-software to merge EHR-data with health data originating from other sources (Diaz 2021).

7.4 Innovation of Treatment

Besides its aforementioned collaboration with *Merck* in order to improve the company's processes of production of medicines (see *Section 7.2*), no activities of Palantir in this sub-category could be found.

7.5 Logistics

The HHS Protect Now data platform (see above) is not the only measure for which the US-government partnered with Palantir in the course of the Covid-19-pandemic. The Trump

administration also decided to collaborate with the company to organize the distribution of vaccinations as soon as they were available. The project had at first been named *Operation Warp Speed* and was later renamed *Countermeasure Acceleration Group* in the Biden-administration (Clark 2022). In order to accelerate the vaccination progress, the *Centers for Disease Control and Prevention (CDC)* used Palantir Foundry to set up the so called *Tiberius Platform* which integrated data from many separate data silos on a local level and soon became the backbone of the vaccination programme in the United States. In 2022, the contract with Palantir was renewed and now also other medical products related to Covid 19 can be distributed via the Tiberius Platform (Nyczepir 2022).

7.6 Other Activities

In 2020, the Japanese insurance company *Sompo*, which also founded the joint venture *Palantir Technologies Japan K.K.* together with Palantir, invested 500 million USD in the company (Lee 2020).

In 2021, Palantir hired William Kassler, a former leading employee of *IBM*'s *Watson Health* (Feiner 2021b) (see *Section 8.2*). Kassler became the company's US government chief medical officer. He took the view that many technology companies which try to get into the healthcare sector lack knowledge of its functioning and that he might provide this knowledge to Palantir. He also stated that the health system might profit from tech solutions, particularly regarding supply chain problems, sudden increases in case numbers of certain diseases and unequal treatment of different ethnic groups (Feiner 2021b).

In 2022, the *United States Department of Health and Human Services (HHS)* and Palantir signed a contract for a partnership over five years. HHS-employees are now allowed to use the company's services in order to fulfil their tasks, also when they are not related to the Covid 19-pandemic and Palantir received 90 million USD for offering its services (Clark 2022).

7.7 Summary

While discussions on the entry of Big Tech companies in the health sector usually concentrate on the GAFAM-companies, Palantir has succeeded to establish itself as an important player, too. The company mainly focuses on its abilities in the merging of health data from various sources, an important capability in the health sector where data originates from many different sources which are difficult to harmonize, like, for example, hand-written doctor's notes. This might have become even more relevant due to the new legislation in the United States which prescribes better interoperability of health data. The recent increase of Palantir's activities in the health sector is an ideal-typical example showing how the Covid-19-pandemic has accelerated market entries of Big Tech into health. While the British Government had not reacted on the company's offers before the pandemic, it eventually started using Palantir's services in its Covid-19 response and in the United States, Palantir succeeded in establishing itself as a major player in the fight against Covid 19 by building up both the central data platform HHS Protect Now and the infrastructure for the

distribution of vaccinations, the Tiberius Platform. Observers stated that the company might intend to expand its activities in the health sector in Europe because European laws limit the use of its tools in the area of combating crimes and terrorism (Shead 2021a). But also in the health sector, Palantir faces many conflicts due to its heavily criticised role in projects related to data extraction and crime control based on algorithms.

8 IBM

The *International Business Machines Corporation (IBM)* was founded in Endicott, New York already in 1911 and in the beginning, the company developed punch cards, scales and clocks (IBM w.y.a). Since then, IBM has developed to become one of the largest IT- and consulting companies in the world. It had a revenue of 57.35 billion USD and employed over 280,000 workers in 2021 (Alsop 2022b, Alsop 2022a). IBM operates branches all over the world, several of them also in Germany (IBM 2019). Between 1992 and 2020, IBM was the company which applied for the most patents in each year (IBM 2021b). The company's activities in the health sector began already in the 1990s and in the recent past, there was much media coverage on IBM's attempts to implement its AI-project Watson in various health-related fields. In 2022, it became known to the public that the investment company Francisco Partners will acquire IBM's Watson Health unit.

8.1 Health Apps and Smart Devices

In 2021, IBM belonged to the consortium which was in charge of the implementation of the *CovPass*-app in Germany that enables users to verify their vaccination status. The other companies participating in the consortium are the German blockchain technology company *Ubirch*, the IT-company *Bechtle*, which operates about 100 branches in the DACH-region, and *govdigital*, an association which was founded in 2019 to establish IT-solutions in the public sector (Oeltermann and Leufgen 2021).
The consortium also developed the counterpart to the app, the *CovPassCheck*-app, which enables for example airport staff to check for the authenticity of the certificates (Oeltermann and Leufgen 2021).

Also in 2021 and in a similar manner, IBM cooperated with the State of New York to establish the so called *Excelsior Pass*. The service is based on the company's *Digital Health Pass*-platform and enables for instance customers in shops to verify their vaccination status (IBM 2021a).

8.2 Data Analysis

Already in 1973, the *Micromedex*-platform, which contains evidence-based health information, was introduced. The platform is still operating and has been complemented by AI-based search capabilities, which facilitate the process of accessing relevant information, by now (Merative w.y.).

In 1997, IBM's computer *Deep Blue* defeated the incumbent world chess champion which was seen as the starting point for the company's new focus on research on artificial intelligence (McClain 2011). Nearly ten years later, in 2006, IBM used the name *Watson* for a computer, which was build to succeed Deep Blue, for the first time (Bittermann 2019).

Since 2011, IBM was collaborating with *Nuance Communications* in order to teach its artificial intelligence Watson to understand spoken language (IBM 2011). Nuance was acquired by *Microsoft* in 2021 (see *Section 6.3*). It remained unclear whether the partnership of IBM and Nuance was still operating at this time.

Also in 2011, IBM acquired the software company *I2 Inc.* which focused on developing visual investigative analysis software. The company had been considered to the main competitor of *Palantir* (Waldman, Chapman, and Robertson 2018) (see *Section 7*).

In 2014, IBM set up an own business unit around its Watson-AI which contains a portfolio of various artificial intelligence applications. One year later, an own branch for activities in the health sector named *Watson Health* was established (Merative w.y.).

In 2015, IBM acquired *Merge Healthcare* for 1 billion USD (Dignan 2015). Merge's solutions had focused on the analysis of medical image data from different medical fields which originated from about 7,500 different medical facilities. The aim of IBM was to connect the images with other data via its Watson Health-AI in order to recognize certain patterns concerning anomalies etc. Observers interpreted the acquisition as a hint that IBM believed that healthcare is the field on which the capabilities of Watson have the best chances to be monetized (Dignan 2015). In 1990, Merge participated in the establishment of the *DICOM*-standard for medical image data which is still in use nowadays (Merative w.y.). Merge's cardiology software *Cardio* and its automated documentation tool *Hemo* were already established in 1995 and 2000, respectively, and have often been awarded with *Best in KLAS*-Awards. Its solution for clinical trials, *Clinical development*, has been used in over 3,000 studies in more than 100 countries with about one million patients (Merative w.y.).

In 2016, IBM acquired *Truven Health Analytics* for 2.6 billion USD. The company had developed solutions for data management and data analyses and offered services and consulting for companies in the health sector. After the deal had been closed, it was merged into IBM's *Watson Health*-unit (Reuters 2016). Truven Health Analytics had established *System2*, which offered data analysis-capabilities for employers, health plans and Medicaid agencies already in 1981. The service was later renamed *Advantage Suite* and is now called *Health Insights*. It is used, for instance, by the US-American insurance and finance company *Prudential Financial* to analyse data of its employees in order to find out how their satisfaction, health status and productivity are correlated with each other (IBM w.y.h). 40% of the Fortune 100 companies are customers of the service (Merative w.y.).

Since 2016, the *Liberty Mutual Insurance* uses the *Watson Benefit Manager* to enable their employees to select the most suitable health insurance plan. For this purpose, the programme accesses patient data of the last 18 months and uses its AI to find the best plan (Cooper w.y., IBM w.y.c).

In 2019, the German pharmaceutical company *Boehringer Ingelheim* started a partnership with IBM. In the frame of this pilot project, the companies aim to become the first conduc-

tors of clinical trials with the implementation of blockchain-technologies (Transkript 2019).

One year later, the research organisation *Biorasi* started collaborating with IBM. Biorasi was founded in Miami in 2003 and helps its partners to facilitate clinical trials and to bring medical products to the market more swiftly (Crunchbase w.y.a, Business Wire 2020). In the frame of the partnership, the company uses IBM's *Clinical Development Platform* which enables the storage of all data on a central platform that can be accessed by all authorized persons 24/7. According to the partners, Biorasi was able to reduce the time for setting up a data base by 25% and total costs of a project by 50% by using the platform (Business Wire 2020).

In 2020, IBM introduced the *Annotator for Clinical Data* which aimed at the retrieval of health data by means of natural language understanding. The service enables to access important clinical information from unstructured data (IBM w.y.f).

In 2021, IBM presented its *Imaging AI Orchestrator*, a cloud-based AI-service which supports radiologists with imaging processes and disburdens IT-departments of medical facilities by outsourcing of certain tasks to IBM. One of the first customers of the new service was *Life Image*, the largest network for the exchange of medical images in the world (IBM 2021c).

Also *HealthPartners*, a health provider from Minnesota, uses Watson Health for the analysis of patient image data (Boush w.y.b).

IBM also cooperated with the Australian research organisation *Southern Star Research* and supported its endeavour to set up a platform for clinical trials (Cooper 2021).

On its website, IBM offers health insurance data and patient data from EHRs in order to enable a better understanding of the Covid 19-pandemic free of charge. The data originate from the company's *MarketScan*-research program which includes various data sets that merge anonymized individual health data. The program includes data of 273 million patients which partly date back to 1995 (IBM Watson Health 2021).

8.3 Electronic Health Records and Hospital Information Systems

In 1993, IBM implemented the health platform *Sundhed* in Denmark (see below) which also enables medical staff to access health information from the EHRs that are saved on the platform by now (von Grätz 2007, Management und Krankenhaus 2013). It is not clear since when this feature is available on Sundhed and it could not be established if IBM is still in charge of operating Sundhed since *Epic Systems* had won a bidding for operating the *Sundhedsplatformen* in some Danish regions in 2013 (Allen 2019) (see *Section 14*).

In 2008, IBM released *iConnect Access*, a completely web-based platform, which enables medical staff to view image data of their patients via a web-browser (Sertoglu 2021). In 2021, the company collaborated with the Japanese company *Ricoh*, which develops solutions for office communication and production printing, to extend the use of 3D-print-applications in the health system. In a new version of iConnect Access, medical staff is enabled to use image data, which is stored on the platform, to create 3D-models of their

patients and print them, subsequently (Sertoglu 2021).

In 2009, IBM and the Danish *Thy-Mors*-hospital experimented with a 3D-health record which included a three-dimensional avatar of the respective patient (Monegain 2009). The current status of the project remained unclear.

In 2015, IBM partnered with *Epic Systems* to apply for the development of a new EHR-system for the US-American *Department of Defence*. The partners reached the group of the last three candidates (unlike *Alphabet* whose application was not successful) but in the end, the group of *Cerner*, *Leidos* and *Accenture* closed the deal (Boulton 2016) (see *Sections 2.3, 14 and 15*).

In 2019, the *Hardin Memorial Health Hospital* in Elizabethtown, Kentucky, was the first hospital to implement IBM's *Watson Imaging Patient Synopsis Solution*. The software is equipped with AI which enables medical staff to find relevant information in EHRs swiftly by searching though both structured and unstructured data. The solution is cloud-based and due to its interoperability, it can be accessed from all of the hospital's locations (IBM w.y.b).

One year later, also the *Tidal Health Peninsula Regional Hospital* in Salisbury, Maryland started a partnership with IBM. *IBM Micromedex with Watson* was implemented into the hospital's EHR-system from Epic Systems and thus enabled medical staff to receive answers on questions concerning patient data in spoken language (Moen w.y.).

In 2020, IBM partnered with *Siemens Healthineers*, a German provider of medical technology, to implement the health platform *teamplay digital health platform connect*. The aim of the platform is to facilitate the exchange of patient data between different health providers and it enables the sharing and discussing of image data with colleagues in different locations. The platform uses the same technology as the Austrian EHR *Elektronische Gesundheitsakte (ELGA)* and the *Elektronisches Patientendossier (EPD)* in Switzerland. However, the companies emphasized that their product is not meant to be a competitor for the EHR provided by the *gematik* which is in charge of implementing the *Telematikinfrastruktur (TI)* in Germany. Instead, the platform aims to complement the EHR with its focus on interoperability between different providers (kma Online 2020, Siemens Healthineers 2022).
The platform has already been tested by Germany's largest hospital, the *Charité*-hospital (kma Online 2020). In the course of the Covid 19-pandemic, the service *teamplay images* for the sharing of medical image data was offered free of charge for 90 days (Siemens Healthineers w.y.).
The *Schweizerische Post* set up its own health platform *Cuore* based on the technology of teamplay digital health platform connect which enables a connection between all common IT-systems via its connector component (Siemens Healthineers 2022).

Besides its project in collaboration with Siemens Healthineers, IBM is also one of four providers of EHR-systems in Germany which are authorized by the *gematik*. IBM, for instance, implements the EHR for the statutory health insurances *Techniker Krankenkasse*, *Viactiv* and *Barmer* (Fritz 2021).

The *Utica Park Clinic* in Tulsa implemented IBM's *Phytel*-solution into its new EHR-system by *Epic Systems*. By doing so, the hospital staff is enabled, for example, to send appointment reminders to patients and the hospital reduced the no-show rate by 5 - 8%

(Boush w.y.a). Other hospitals, which implemented Phytel, include the *Ogden Clinic* in Utah and *Loudoun Medical Group* (IBM w.y.d).

8.4 Innovation of Treatment

In 2014, IBM collaborated with the *New York Genome Center* to use a version of its AI *Watson* in order to enable innovations in the field of genome analyses in the therapy of cancer (Al Idrus 2017b).

In 2017, the leading physician of the cancer-unit in Kopenhagen's *Rigshospitalet* criticized the use of *Watson for Oncology* which had been implemented in the hospital and 230 further clinics worldwide, including the *Yale Cancer Center* and the *Cleveland Clinic*, in order to support the physicians during their search for the best therapy options for the respective patient (Meier 2018, Begley 2015). The Rigshospitalet terminated the collaboration with IBM subsequently (Ross and Swetlitz 2017). In the aftermath of these events, internal IBM-documents revealed that the company had apparently already known earlier that its AI was not able to fulfil the high expectations that the company itself had fuelled. According to these documents, leading IBM-employees had been informed about uncertain and wrong recommendations by Watson and still continued to praise their software in media reports. One article cited the example of a 65-years old patient with bleedings for whom Watson recommended medication which could be lethal for patients suffering from bleedings. IBM did not deny the fact itself but emphasized that it concerned an artificial test case and not a real patient (Ross and Swetlitz 2018).
Experts stated that too small data sets and bad data quality (for example due to wrongly tagged X-ray images) might have hampered the training of the AI. Additionally, the fact that there are various different treatment guidelines in different countries might have caused problems for Watson which was mainly trained with data from the United States (Ross and Swetlitz 2017, Meier 2018). While the software seemed to achieve good results in analysing quantitative data and diagnosed cancer reliably, the problems began when qualitative data, for example from doctor's notes, were involved. Since this kind of data accounts for about 80% of the health information contained in EHRs, this caused serious problems for Watson when it came to recommending the best treatment (He 2020).
Also the German *Universitätsklinikum Marburg* and *Universitätsklinikum Gießen* had tested Watson for Oncology but were happy when they were able to terminate the project according to media coverage (Stieler 2018).

In 2017, IBM began collaborating with the genetic engineering company *Illumina* (see *Sections 5.2, 6.4*). The aim of the partnership is to standardize genome-interpretations in the course of cancer therapies (Al Idrus 2017a).

IBM Research partners with the *Michael J. Fox Foundation* in order to develop machine learning models of the prognosis for the progression of Parkinson's disease based on first symptoms. The same company unit also partners with the *Juvenile Diabetes Research Foundation* to implement a ML-model and with *Boston Scientific*, a US-American provider of medical technology, to facilitate tracking and understanding of chronic pain (Spinner 2022).

8.5 Logistics

Apparently already in 1993, IBM implemented the health platform *Sundhed* in Denmark's health system. The platform is still in use and the central contact point for both patients and doctors. With the required authorisation it is possible to arrange doctor's appointments, store prescriptions and to access patient data from electronic health records via the platform (von Grätz 2007, Management und Krankenhaus 2013).

8.6 Other Activities

In the company's publication called *Reinventing Healthcare*, which was probably released for the first time in 2006, IBM creates a future vision for improvements in the health sector which could be implemented until 2015. Besides a new focus on prevention, IBM recommended to orient the health system increasingly to market logic and to rethink patients as self-responsible consumers who are in charge of maximizing the utility they receive from the health system. Societies should be enabled to decide whether health care should remain a social right or if it should rather become a service which is traded on markets (IBM w.y.i).

In 2019, IBM started collaborating with the insurance company *Aetna*. The companies aim to implement a blockchain network which enables Aetna to improve its evaluation and payment processes (Landi 2019a).

In 2020, IBM offered its *Watson Works*-solution to employers who planned to enable their employees to return from home office to their workplaces in the course of the pandemic. The solution uses AI-based data analyses to determine the right point of time for the return and is able to register deviations of the body temperature of employees and violations against safety rules likes wearing a mask at one's workplace (Loomis et al. 2020, IBM w.y.). Watson Works consists of several components: *Tririga* supports room planning and determines which places can be occupied and which have to be left empty to ensure compliance with social distancing rules (IBM w.y.e). The *IBM Return to Workplace Advisor* used in combination with *Tririga Reservations* guarantees that only employees with a "green" health status return to their workplace. In order to be flagged as "green", employees have to fill in a questionnaire with health questions. Subsequently, they are able to reserve a workspace and the cleaning staff automatically receives the order to disinfect the workspace (IBM w.y.e). As soon as the "green" employees arrive at their workspace, they are monitored by cameras via *Maximo Worker Insights* and if two of them violate social distancing roles, automated notifications are triggered and the violation is stored in a database (IBM w.y.j). The continuous monitoring of employees also facilitates contact tracing if there is a Covid-19-case despite the precautionary measures (Loomis et al. 2020). While IBM emphasized that the sharing of personal health data with employers is voluntary and employees have to opt in before the process starts (Loomis et al. 2020), it remains questionable whether the option not to opt in was a realistic choice for most workers during the peak phase of the pandemic.

In January 2022, it became publicly known that Christian Klose, the former head of the subdivision for eHealth and the *Telematikinfrastruktur* in the German Ministry of Health, has

been hired by IBM where he is employed as client manager. Klose's job change raised criticism because of IBM' involvement in the implementation of an EHR-system in Germany (Borchers 2022) (see above).

In the beginning of 2022, it became known to the public that IBM will sell its *Watson Health*-unit to the investment company *Francisco Partners* (Botelho 2022, Landi 2022, Volkert 2022). Besides its software, also the associated health data sets are part of the acquisition which also includes the data collected in the frame of IBM's *MarketScan*-programme (Landi 2022) (see above). The exact terms of the deal were not disclosed but apparently IBM hoped to earn about 1 billion USD by selling its health unit which seemingly had not been profitable until the end (Volkert 2022). Observers interpreted the deal as a sign that it is not enough to own a huge amount of health data; there also have to be the capabilities to analyse and interpret them. Although, this is exactly, what IBM was claiming to be its strength, it seems that external observers did not have as much confidence in the company. There were also rumours that IBM might try to sell additional company units in order to be able to fully concentrate on its business with cloud-services (Botelho 2022). In June 2022, Francisco Partners announced that it has completed the acquisition and that Watson Health will now be named *Merative*. The private equity firm *True Wind Capital* and the global investment firm *Sixth Street* will be investing in Merative (Francisco Partners 2022).
Francisco Partners has already been active in the health sector before: For instance, the company has invested in *GoodRx*, an app, which enables its users to find the cheapest prices for their medication and which is used by 17 million US-Americans monthly (Francisco Partners w.y.). In the end of 2020, it acquired the calorie-tracker app *MyFitnessPal*, which had previously been owned by *Under Armour*, for 345 million USD (Francisco Partners 2020).

8.7 Summary

After being active in the health sector with few projects already for decades, IBM reinforced these activities by several big acquisitions (Merge Healthcare, Truven Health Analytics) in recent years and focused on establishing its AI Watson Health in various health contexts. If Watson truly is capable of achieving what IBM promised in its own announcements, has been heavily disputed and the termination of its use for support in the detection and treatment of cancer in several hospitals seems to be an example for the gap between theory and practise in the health sector which already several Big Tech companies had to face. IBM's visions for future health-systems, which are recommended to be orientated along market-logics according to the company, and its proposals for monitoring solutions in order to enable safe workspaces during the Covid 19-pandemic, reveal a surprisingly radical view on these topics. The acquisition of Watson Health by Francisco Partners in 2022 shows that besides the tech giants also large investment companies are gaining influence in the health sector.

9 Oracle

Oracle is a developer of software and hardware which was founded in Austin, Texas, in 1977. The company has been a market leader in the area of databases on which businesses run their accounting and supply chain applications already for centuries. Oracle's main competitor is *SAP* (see *Section 10*) and the companies have fought each other in a lawsuit which extended for several years (Finkle and Levine 2014). The company is also operating as a data broker enabling companies to display targeted advertisements based on its databases. In 2016, the company announced that it is able to offer 3 billion profiles which were generated from data of 15 million websites in its *data marketplace* which also allows to generate an *Oracle ID Graph* that merges all captured consumer interactions into one consumer profile and enables companies to track their potential customers across different devices (Christl 2017). Oracle has acquired numerous companies in its corporate history, among them the cloud marketing platform *Responsys* for 1.5 billion USD in 2013 (Oracle 2013) and the data broker *Datalogix* for 1.2 billion USD in 2014 (Forbes 2015). Oracle has been active in the health sector since the beginning of the century but has recently intensified these activities, a process which culminated in the acquisition of *Cerner* (see *Section 14*) in the end of 2021.

9.1 Health Apps and Smart Devices

In the course of the Covid-19-pandemic, Oracle cooperated with the *CDC* in the United States to offer its *v-safe after vaccination health checker*, a smartphone-based tool which enables users to report side-effects of vaccinations (Lindquist 2021). Afterwards, a study in the New England Journal of Medicine, which was based on the data generated by the tool, analysed side-effects of vaccinations for pregnant women (Lindquist 2021). As of August 2021, over 9 million citizens had already used the tool (Gomez 2021).

9.2 Data Analysis

In 2004, the British *National Health Service (NHS)* closed a deal with Oracle which enables the NHS to use Oracle's products for prices that are up to 50% below their usual market price (DHI News Team 2004). The aim of the collaboration was on the one hand to standardize the databases of the NHS and on the other hand to implement the *Electronic Booking Service* which enabled patients with a referral of their general practitioner to book hospital appointments online. The health service had already been a customer of Oracle before and at the time the deal was made public, 70% of the NHS-trusts were using software by Oracle, for example in order to operate their finance systems. The NHS had started a similar partnership with *Microsoft* (see *Section 6*) in the year 2000 (DHI News Team 2004).

In 2007, the US-American non-profit healthcare provider *Harvard Pilgrim Healthcare* started a transformation process, which was planned to take eight years, with the help of *Oracle Health Insurance Components*. In the frame of this project, the company was able to increase the rate of payment claims, which were processed automatically, from 85% to 91%

(Ryan 2016). The partnership also lasted after the end of the transformation process enabling Harvard Pilgrim Healthcare to react quickly on new regulations, for example in the course of the Covid-19 pandemic, according to the company's CIO Deborah Norton (Oracle 2021a).

In 2010, the US-American health insurance company *Anthem* (see *Section 3.2*) became a member of the *Oracle Partner Network*. Members of this networks are enabled to implement Oracle's applications easier, to use specialised versions of the applications and to let their employees be trained by Oracle-staff (Anthem Healthcare 2010). The collaboration is still proceeding and in a video, which was uploaded to Oracle's website in 2021, Rick Misch, vice-president of Anthem, states that especially the standardisation of payment processes in one platform, which is accessible for all employees, is an advantage of partnering with Oracle (Glenn 2020).

In the same year, Oracle acquired *Phase Forward*, a company, which was specialised on developing software for the health sector, for 685 million USD. The company's software as a service (SaaS)-product *Integrated Clinical Research Suite* had already been used in more than 10,000 clinical trials at the time of the acquisition (Oracle 2010). Companies like *AstraZeneca* and *GlaxoSmithKline* had been among Phase Forward's customers (Fierce Biotech 2010).

In 2015, the NHS also decided to use *Oracle Machine Learning Solutions* to improve healthcare and cut costs. In the course of the partnership, the *Data Analytics Learning Laboratory (DALL)* was established and the NHS identified a potential for savings of 156 million USD in the fist three months of the partnership (Oracle 2015).

In 2016, the US-American health provider *Arlington Orthopedics* used Oracle's cloud services to modernize its human resources management. During the implementation process, also the IT company *Sensa Analytics* was involved in implementing the system on-site (Banks-Louie 2016).

In 2017, the British *Western Sussex NHS Foundation Trust* started using *Oracle Service Cloud* to establish its *Family Assist*-platform for expectant parents. The platform can be accessed from all common end devices, informs users about pregnancies and local points of contact and also enables them to chat with medical staff if the information provided is not sufficient (Oracle 2017).

In 2019, the South Korean *Sejong Hospital*, the country's only hospital which is specialised on cardiology, started using *Oracle Cloud Analytics* and *Oracle Autonomous Data Warehouse*. These applications continuously collect data on the patients during the care process which are subsequently used by the medical staff to make informed decisions on the further course of treatment (Oracle w.y.).

In 2020, the US-American health enterprise *Humana*, which offers a private health insurance and also collaborates with *Microsoft* (see *Section 6.2*), started a partnership with Oracle in order to modernize the payment transactions with insured persons (Oracle 2020e). The shares of medical expenses, which have to be covered by the insured persons themselves, are often not paid correctly which leads to costs of approximately 43 billion USD in the United States annually. The payment system established by Oracle aims to change the sys-

tem so that these shares are directly paid on-site at the time of the treatment. The system also enables payments by *Apple Pay* and *Samsung Pay* (Oracle 2020e).
The collaboration of the companies also includes other Oracle-activities: For instance, Humana wants to use AI to make better choices relating to reimbursement for medical expenses. An example might be a patient whose insurance tariff does not allow for further doctor's appointments in a certain month which forces him to go to the hospital. Instead of this binary decision, a suitable AI might anticipate this and enable the doctor's appointment to save costs. Apparently, Humana also hopes to cut wage costs by substituting employees with algorithms (Oracle 2020e). The implementation of these solutions for customers was planned for the beginning of 2022 (Oracle 2020e).

In the same year, the Australian *Woolcock Institute of Medical Research* decided to collaborate with Oracle in order to use the company's *Oracle Autonomous Data Warehouse* (see above) for its research on sleeping disorders. In the course of this project, billions of data points concerning the patients were analysed (Oracle 2020i).

Also in 2020, Oracle started cooperating with the US-American non-profit health organisation *Adventist Health* which had acquired several hospitals before and faced the problem that administrative processes were organised in different ways in the respective hospitals. Oracle was chosen to standardize the systems by utilizing its services *Cloud ERP* (Enterprise Resource Planning), *Cloud EPM* (Enterprise Performance Management) and *Cloud HCM* (Human Capital Management) (Oracle 2020a). The systems were implemented in the frame of a "Big Bang"-approach, which means that the separate components were established in swift succession. Other companies involved in this modernization project have been the consultancy *Deloitte* and the IT-consulting company *InterRel* (Oracle 2020a).
In the same year, *EmblemHealth*, another US-American non-profit health company, worked together with Oracle to modernize its administration. Like Adventist Health, EmblemHealth had faced problems because it operates many hospitals with formerly various fragmented processes. Together with the US-American IT-service provider *Cognizant*, Oracle succeeded in harmonizing these processes in a time frame of 11 months and EmblemHealth expected to save 700,000 USD annually in addition to IT-savings due to the system change (Oracle 2020d).

In 2021, the US-American health insurance company *Blue Shield of California*, which had been using Oracle's cloud services for several years, announced that it will start a collaboration with *Google Cloud* in order to automatize payment procedures (Minemyer 2021b) (see *Section 2.2*). It remains unclear, what this new partnership means for Blue Shield's cooperation with Oracle. On its website, Blue Shield states that also other technological partners participate in the new project (Blue Shield of California 2021); on Oracle's website, the company emphasizes Blue Shield's satisfaction with its cloud services which, for instance, enabled a swift reaction in the Covid-19-pandemic due to the easy accessibility of all relevant data (Oracle 2020c).

In the same year, Henry McNamara, Oracle's senior vice president and general manager of *Oracle Health Sciences* took the view that the advancing digitalization of the health sector is a positive consequence of the Covid-19-pandemic. He praises the company's platform *Oracle Health Sciences Clinical One* which he describes as a "single source of truth" (Upton 2021). The platform is able to harmonize data from various sources like EHRs, apps and

wearables and also allows for clinical trial functions like randomization. McNamara sees high potential in this new way of conducting clinical trials because: "AI and ML not only process data faster than humans, they can point to patterns and trends that humans can't see and ideally lead to a more accurate and detailed view of how patients are responding in trials, which can lead to better outcomes in the long run" (Upton 2021).

Also in 2021, Oracle planned to build 14 new data centers, allegedly to be able to compete with *Amazon*, *Alphabet* and *Microsoft* in the cloud-business (Kerkmann 2021, Knitterscheidt and Kerkmann 2021). In the related announcement, the company states that no other enterprise is expanding in the area of cloud-computing that fast. However, Oracle only had a market share of 2% at this point of time (Kerkmann 2021). In 2008, Oracle's founder Larry Ellison had still referred to the then emerging discussion about cloud-computing as "complete gibberish" (Nunns 2015).

9.3 Electronic Health Records and Hospital Information Systems

The deal which Oracle closed with *Arlington Orthopedics* in 2016 (see above) also contained the implementation of Oracle-software in order to enable better access to patient data by standardizing EHRs (Banks-Louie 2016).

In 2020, Oracle started cooperating with the *Tony Blair Institute for Global Change* in order to implement cloud-based EHRs in Ghana and Rwanda (Oracle 2020g). The project also aims to help the countries in their fight against yellow fever, HPV and Covid-19 by helping to establish the respective vaccination programmes. For this purpose, the *Oracle Health Management System*, which is also used in the US-American Covid 19-vaccination campaign (see below), has been implemented. The Tony Blair Institute for Global Change is apparently negotiating with more than 30 further countries to implement the system (Oracle 2020g).

In 2021, the government of the Republic of Senegal closed a deal with Oracle in order to implement a digital health pass as one of the first African countries. The health pass was introduced in February 2021 and enabled citizens to travel freely again which had been prohibited before due to the spreading of SARS-Cov-2 (Oracle 2021e).

In the same year, the US-American health company *Kaiser Permanente* (see *Section 6.1*) worked together with Oracle to modernize its business processes. A renewal of the administration of the company's EHR-system has also been part of the deal (Oracle 2021b).

In the end of 2021, Oracle announced that it plans to acquire *Cerner*, one of the largest EHR-companies worldwide (see *Section 15*), for 28.3 billion USD. The deal, which is expected to be closed in 2022, is the second-biggest acquisition in the software industry after *IBM*'s acquisition of the cloud-enterprise *Red Hat* in 2018 and Oracle's founder Larry Ellison said that the deal aims for nothing less than the transformation of the health sector. While Oracle's stock price fell after the announcement, observers praised the acquisition for making the company the leading supplier for IT-systems in the health sector (Knitterscheidt and Kerkmann 2021).
In their announcement, the companies cited a study conducted by the *Mayo Clinics* (see *Sec-*

tions 2.2, 8.4) in 2020, which suggests that physicians spend 1-2 hours on EHRs and other desk work for every hour they spend with their patients, a burden which the companies aim to eliminate in the course of their cooperation (Oracle 2021d). A major change after the closing of the deal concerns the way how the hospital information systems of Cerner's customers will be accessed: In the future, Oracle's *Voice Digital Assistant* will be the major way to do so, enabling medical staff to spend less time on typing (Oracle 2021d). The Voice Digital Assistant is a direct competing product to the services provided by *Nuance* which has been acquired by *Microsoft* by now (see *Section 6*). Analysts stated that Oracle might profit from an increase in the demand for telemedicine by a increasingly technophilic population, which in turn will increase the demand for AI- and voice recognition solutions, in the highly competitive EHR-market (Makris 2022). However, the deal might also bring problems with it for Oracle because Cerner is struggling with the large-scale modernization of the EHR-system for the US-American Department of Defence (Donovan-Smith and Dreher 2021) (see *Section 2.3, 15*).
Besides the relevance of the deal for Oracle's position as supplier of EHRs for hospitals, the company was probably also interested in the health data accumulated by Cerner which was also part of the acquisition. On the one hand, the data enable the company to train its algorithms and ML-models and on the other hand, Oracle is also operating as a data broker which might be interested in monetizing the health data contained in Cerner's patient records (Christl 2017, Christl and Spiekermann 2016) (see above). While the latter also triggered criticism aimed at the responsible authorities who permitted the acquisition (Sherman 2022), most media coverage on the deal concentrated on potential improvements in healthcare and the development of the companies' stock prices (Knitterscheidt and Kerkmann 2021, Southwick 2021, Makris 2022).
Cerner's biggest business and clinic system had been based on Oracle-infrastructure already prior to the acquisition (Makris 2022), but for its cloud-infrastructure, the company had been relying on *Amazon Web Services* (Cerner 2020).

Only one day after the announcement of the Cerner-deal, Oracle made public that it will also acquire the AI- and automatisation-company *Federos* (Rutherford 2022).

Oracle also has its own *National Electronic Health Records Database* which was utilized by the Centers of Disease Control and Prevention (CDC) in its vaccination programme during the Covid 19-pandemic (see *Section 9.5*).

9.4 Innovation of Treatment

In 2018, the British non-profit company *Turning Point* started cooperating with Oracle and used its *Oracle Cloud CX*-service (Oracle 2020h, Post 2018). Turning Point offers support for drug addicts and people with psychological disorders and collaborates with Oracle to fight the long waiting times these people face, once they have decided to see a doctor. In order to do so, patient information, data on prescribed medications and former drug abuse as well as information on former interactions with the patient are saved in Oracle's cloud. This enables Turning Point's staff to access relevant information also when they are not in their office and on the way to meet a client. Appointment allocation is automated by *Oracle Field Service* to ensure a more efficient occupancy rate and clients are enabled to contact staff via

text messages. The *Oracle Live Experience Cloud* enables safe online-video-consultations according to the company and chatbots can be utilized for example to recommend relaxation techniques via *Oracle Digital Assistant*. The *Oracle Intelligent Advisor* recommends fitting programmes for patients based on their health data which renders an appointment with a general practitioner of the NHS in order to receive a referral unnecessary. Apparently, this procedure reduced the average waiting time for participation in a programme from four weeks to two days. Information on new treatment options as well as new compositions of the drugs, which are sold on the streets, are constantly updated via *Oracle Content Management* and thus accessible for all employees of Turning Point in the cloud (Oracle 2020h).

9.5 Logistics

Shortly before the start of the Covid-19-pandemic, the US-American healthcare provider *Prospect Medical* started to use *Oracle Cloud*. Besides standardizing its staff management, Prospect Medical also worked together with Oracle to facilitate material procurement, which apparently paid off especially in the beginning of the pandemic when extraordinarily much protection gear had to be ordered (Oracle 2021f).

Besides *Palantir* (see *Section 7.5*), also Oracle is involved in the vaccination programme of the *CDC* in the course of the Covid 19-pandemic in the United States. The CDC use the company's *Health Management System* which has been developed especially for this purpose (Oracle 2020f). The system uses Oracle's *National Electronic Health Records Database* which enables the authorities to observe how many citizens in a certain region have already been vaccinated in real time, a procedure which would not have been possible with the fragmented system of common EHRs in the United States. The database also allows to generate an anonymized data set for the governments for information-purposes. The *Oracle Public Health Management System* enables patients to report side effects of the vaccinations via smartphone or computer. Based on these reports statistics are generated and in emergencies, the system notifies medical staff automatically. Another tool, which has been developed by Oracle specifically for this purpose, is the *Provider Order Portal* that enables the organisation of the distribution of vaccinations (Oracle 2020f).

Since 2021, also Tasmania is cooperating with Oracle to organise its vaccination programme. The *Oracle Health Management System* is used to enable citizens to register for appointments online and authorities are not only enabled to send confirmations and reminders but also to see who has already been vaccinated in which location and with which vaccine (Oracle 2021g).

9.6 Other Activities

In 2012, the State of Oregon collaborated with Oracle in order to establish its project *Cover Oregon* which enables citizens and small enterprises to take out a health insurance on a digital insurance marketplace (Turner 2015). The project is operating within the *Obamacare*-framework and the state subsidizes citizens and enterprises who take out an insurance. When the website was due to go online in 2013, it was malfunctioning and in April 2014, it

became clear that it would be cheaper to establish a whole new system instead of repairing the old one which would have cost 78 million USD (Manning 2014). Subsequently, Oracle and the State of Oregon sued each other mutually. The case was settled when Oracle agreed to pay 100 million USD to the state of Oregon and to maintain and modernize the state's software and IT for further six years (Condon 2016).

In 2018, the Catholic non-profit health organisation *Providence St. Joseph Health* partnered with Oracle and used the company's cloud applications to modernize its administration structures. The organisation hoped to cut costs in its financial operations in order to be able to spend more money on healthcare for the underserved (PR Newswire 2018).

One year later, the US-American *Glenn Falls Hospital* used *Oracle HCM Cloud* to modernize its human resources-department (Oracle 2019).

In 2020, the State of New York used *Oracle Fusion Cloud Customer Experience (CX)* to implement a digital platform to disburden the health department and other state authorities during the Covid-19-pandemic (Keene 2020). The staff could access the platform via web-browsers from everywhere and citizens were enabled to contact them online via mail, chat or a web-portal or via their phones. For instance, the platform enabled them to register for social welfare online. Between the development of the concept and its implementations only four days passed. The State of New York recruited 4,000 employees to staff the call-centers, many of whom had been employed in departments not related to health and social benefits before (Keene 2020).

In the same year, the non-profit health network *Northwell Health*, which operates many hospitals in the State of New York (see *Section 6.1*), partnered with Oracle, *Deloitte* and the German consultancy *Baker Tilly* in order to improve its personnel planning, which had become increasingly challenging in the course of the Covid-19-pandemic. For this purpose, Northwell utilized the Oracle services *Oracle Analytics* and *Oracle Fusion Cloud Human Capital Management* (Oracle 2021c).

Still in 2020, Oracle also closed a deal with the *US-American State Kansas* and the consultancy *Accenture* to modernize the state's platform for social transfers which will be operated via *Oracle Cloud Infrastructure* in the future (Government Technology 2020)

In 2021, the *Texas Children's Hospital* announced that it will modernize its administration processes with a transformation in the Oracle cloud. The new administration platform will be called *Voyager* and will focus on the standardization of processes and automatization of everyday-tasks (Texas Children's 2021, Oracle 2020b)

9.7 Summary

Oracle has been active in the health sector already for a long time, considerably longer than some of the GAFAM-companies. While the company had limited its activities mainly on supplying software for the modernization of administration procedures in the past, it seems that it has changed its strategy in recent years by trying to gain market shares in the cloud-sector and the market for EHRs, most notably with its acquisition of Cerner, which is expected to be closed in 2022. This reorientation in the health sector allows Oracle to manage

huge amounts of health data; data which are contained in Cerner's EHRs but also obtained from projects with organisations like Turning Point and the company's collaborations with vaccination campaigns in African countries. It remains to be seen whether Oracle, which is also highly active as a data broker outside the health sector, will try to monetize the obtained health data.

10 SAP

The SAP SE with headquarters in Walldorf, Germany, was founded in 1972 by five former *IBM*-employees (SAP w.y.d). The company focuses on the development of business administration software and solutions that are able to handle the whole business process including production, distribution, purchasing, inventory and human resource management. SAP is the third most valuable German brand after Mercedes Benz and BMW (Weidenbach 2021) and 99 of the 100 biggest companies are SAP-customers (SAP w.y.d). SAP has been active in the health sector, where it offers its business solutions to hospitals and benefits from its products' capabilities to be implemented in combination with solutions of other companies, already since the 1990s.

10.1 Health Apps and Smart Devices

SAP and *Deutsche Telekom* have been in charge of developing Germany's *Corona Warn App* which is based on an interface provided by *Alphabet* and *Apple* (see *Sections 2* and 3). The costs amounted to 20 million Euro of which SAP received 9.5 million Euro and Deutsche Telekom received 7.8 million Euro (Voss 2020). The development of the app was thus approximately ten times more expensive than in other countries like Switzerland (Dmitrienko et al. 2020). SAP and Telekom are also in charge of customer support which leads to additional costs (Voss 2020).

10.2 Data Analysis

In 2020, SAP developed its *Citizen Engagement Platform* together with *Qualtrics*, a US-American subsidiary of SAP which the company had acquired for 8 billion USD in 2018 (SAP News 2018). The platform aims to enable local authorities to make triage-decisions in the course of the Covid 19-pandemic. For this purpose, citizens answer questions concerning their symptoms, potential risk factors etc. on the platform and it is also analysed if particularly many people are accessing the service in a certain region in order to enable further steps like implementing a fever clinic in that region (Carlson 2020).
Apparently, the platform also includes features to enable supervising of citizens, who were tested positive for the virus, by requesting that they log in regularly from their quarantine location. According to SAP, it will be dependent on regional culture if this feature of the Citizen Engagement Platform is used (Carlson 2020).

In the same year, also the US-American health provider *Parkland Health and Hospital Sys-*

tem, which is based in Dallas, started a partnership with SAP to face the challenges caused by the Covid 19-pandemic (Kure 2021).
Via *SAP Hana* and *SAP Analytics Cloud*, a *COVID Command Center Dashboard* was implemented to find out faster, where infected people live in order to be able to send mobile test teams to them. Parkland also developed its own prediction model concerning the onset of the pandemic which turned out to be more accurate than the one used by state actors to inform citizens about the pandemic. Since Parkland's phone lines had been overloaded soon after the beginning of the pandemic, it implemented the *COVID symptom checker chatbot* based on *SAP Conversational AI* which is able to answer Covid 19-related questions in English and Spanish (Kure 2021). The *ER Greaseboard Dashboard*, which was used in Parkland's emergency rooms, was planned to be updated by new AI-features which, for example, aimed to predict the capacity of emergency rooms based on factors like weather and day of the week. Additional features of the dashboard include the identification of patients who are in need of a hospital bed but do not need to visit the emergency room, and the support of initiatives like the implementation of water stations on hot days (SAP 2021a).
The partnership with SAP also included improvements of Parkland's logistics (Kure 2021) (see *Section 10.5*).

10.3 Electronic Health Records and Hospital Information Systems

Already in the 1990s, the *Naemi Wilke Stift*, which operates a hospital and several further health facilities in the Lausitz, Germany, started implementing an integrated system of SAP-applications and the hospital information system (HIS) of the Telekom which is called *iMedOne* (see *Section 11.3*).

Since 1996, the *Kardinal Schwarzenberg Krankenhaus Schwarzach* in Austria uses the hospital information system *ISH Med* by *Siemens*, respectively *Cerner* (see *Section 15*), which is fully integrated into SAP. The hospital was a pilot customer for the new HIS and the first Austrian hospital to organize its medical processes and to base its own EHR on the system (Müller w.y.).
In 2007, the hospital engaged *T Systems* to support its nursing activities with digital solutions. T Systems is a subsidiary of *Deutsche Telekom* (see *Section 11*) which is a certificated "Gold Partner" of SAP (T-Systems Austria 2007).
Apparently since 2012, the hospital's EHR was also available on mobile devices via *SAP Electronic Medical Record (EMR)* (see below) which operates on *iPads* in the Kardinal Schwarzenberg hospital. Patient data are never stored on the devices but accessed in the HIS via wireless network. The *SAP Unwired Platform* also allows to access the EMRs via *Android*-devices by now. Senior Physician Dr. Rainer Pitzek praised the possibilities to explain image data or courses of surgery directly at the hospital bed (Müller w.y.).

Also since 1996, the HIS of the *Universitätsklinikum Homburg* was based on *SAP Healthcare*. Also in Homburg, *ISH Med* was used additionally. These modules are often used in combination whereby the focus of SAP Healthcare is on patient administration and finance and ISH Med is an extension for communication tasks and care planning (Bock 2015). Interestingly, ISH Med will soon belong to SAP's arch-rival *Oracle* once its acquisition of *Cerner* will be completed (*see Section 9*). It remains to be seen which consequences this

will have for hospitals that use the two modules in combination. In the Universitätsklinikum Homburg, a relational database of Oracle had apparently been used for SAP's enterprise resource planning already as of 2015 (Bock 2015).

On the conhIT 2012, an event for health IT in Berlin, which recently has been renamed *Digital Medical Expertise & Applications (DMEA)*, SAP, joined by several partner companies, presented its application *SAP Electronic Medical Record (EMR)*. The presentation took place on a joint exhibition stand with *T Systems* (see above) and T Systems will be in charge of the distribution of the application, its integration in the existing IT-structures of customers and of operating it in its own computer centres, while SAP will further develop the technological platform. Additional partners participating in this project were the medium-sized software developer *PlanOrg* from Jena, *Siemens* and *Agfa Healthcare* with its HIS *Orbis* (Ärztezeitung 2012). Formerly, Agfa Healthcare was the leader in the German market for HIS before it was acquired by the *Dedalus Healthcare Group* in 2020 (see *Section 13*).
SAP EMR was the first mobile patient record which enabled connections with all HIS, no matter if they had been developed by SAP or not, and all clinical backend-systems like laboratory, health imaging systems and hospital archives (Ärztezeitung 2012).

In 2013, the *ARCUS-Kliniken* in Pforzheim started using SAP EMR. PlanOrg was involved in the implementation process and the clinics, which are specialized on orthopaedics, use the service to enable physicians to access patient data on mobile devices (Morales 2013).

In 2015, the *Dernbacher Gruppe Katharina Kasper*, an organisation, which operates hospitals and retirement homes in three German states, partnered with Telekom and *SAP* to establish interlinks between the individual facilities. For this purpose, SAP- and Telekom-applications are connected by bidirectional intelligent interfaces to enable an integrated workflow. It was also planned to establish the *iMedOne Mobile*-app (Deutsche Telekom 2015b).

In 2020, SAP started a partnership with *Eskenazi Health*, a health provider which operates its own hospital in Indiana. SAP's solutions were used to connect Eskenazi's formerly separate systems for healthcare, government, public health and public safety. The aims of the collaboration were the storage of all relevant data in one central platform, the automatisation of processes, access by mobile devices and the implementation of a new interface which was easier to navigate. The established features were also used to optimize the management of the newly implemented EHR-system by *Epic Systems* (see *Section 14*). Eskenazi Health also hoped to be enabled to conduct its own studies with its new data management system and planned to address topics like homelessness and food deserts (SAP w.y.b).

In the end of 2020, SAP announced its *SAP Healthcare Initiative* which aimed at facilitating digitalization processes in German hospitals in combination with the *Hospital Future Act* (in German: *Krankenhauszukunftsgesetz (KZHG)*) which makes 4.3 billion Euro available for investments in hospital modernization. In its announcement, SAP referred to a study conducted by the *Bertelsmann Stiftung* in 2018, which came to the conclusion that the digitalization in Germany's health system is underdeveloped compared with similar countries, and added that the situation is worst in hospitals (SAP 2021c).
The technological base for SAP's initiative is its open development platform *Business Tech-*

nology Platform which was already used by ten business partners when the public announcement was made (SAP 2021). One of them was the medical engineering company *OPASCA* from Mannheim which developed a patient portal based on Business Technology Platform that enabled hospital check-ins similar to self check-in counters in airports. An application of *Healex*, a software developer from Cologne, searches through data from patients with similar diseases to detect patterns and to predict which treatment options will yield the best results (SAP 2021c). A spokeswoman of SAP emphasized that the company intended to strengthen partnerships with the initiative instead of competing with other companies. Concerning the Hospital Future Act, she praised the government for taking the opportunity imposed by the Covid 19-crisis and hoped that procedures like sorting and managing medication and anamnesis dialogues during hospital check-ins will soon profit from innovations fuelled by the new law (SAP 2021c).

The nephrology-unit of the *Charité*-hospital in Berlin works together with SAP to improve its own research- and documentation platform *TBase* which has been developed by the hospital's researchers already many years ago (SAP w.y.a). The aim of the partnership is to extend the platform and to make it accessible for other units of the hospital. SAP implemented digital patient records into the platform and enabled researchers to develop tools which are specifically designed for the clinic's needs. Patient data, which are entered into the platform, can be accessed by physicians and researchers in real-time and the platform was planned to be extended to the endocrinology-, rheumatology-, neurology-, cardiology-, paediatrics-, psychiatry- and gastroenterology-units of the hospital (SAP w.y.a).
A further extension of TBase is planned for the future. So far, doubts concerning the protection of patient data had prevented the Charité-researchers from storing the data in the cloud but according to responsible managers, this could change with an implementation of SAP's *HANA*-service. This would enable physicians at the Charité to treat patients all over the world. It was also planned to offer the TBase-platform free of charge for non-profit projects (SAP w.y.a).

10.4 Innovation of Treatment

While SAP's activities in the health sector described in the other sub-sections of this chapter also have indirect impacts on treatment processes, no activities of the company, which aim at innovation of treatment itself, could be found.

10.5 Logistics

In April 2020, SAP developed a solution for the coordination of hospital beds in the beginning of the Covid 19-pandemic via its cloud services *SAP Cloud Platform*, *SAP Analytics Cloud* and *SAP Fiori* (Byczkowski 2020). The service was used by the *COVID 19-Koordinierungsstelle* of the Rhine-Neckar district which obtained a real-time overview over hospital bed-capacities in the region on one central platform this way. Accessing the bed management is possible via web-browser and various devices like desktop computers, laptops and smartphones are supported. Another difference to a common bed register like the one that is offered by the *Deutsche Interdisziplinäre Vereinigung für Intensiv- und Not-*

fallmedizin (DIVI) nationwide, is that SAP's solution distinguishes between many different kinds of beds (for example, depending on whether they include a ventilator) and also includes hospital beds outside of intensive care wards (Carlson 2020).

In the frame of SAP's partnership with *Parkland Health and Hospital System* (see above), also SAP's subsidiary *Qualtrics* (see above) offered its services to Parkland and developed the *Critical Inventory Tracker* which enables Parkland's employees to check how much inventory, for example protection gear, is still available in real time and via mobile devices. If critical inventory is scarce, a notification will be sent to the *Command Center Dashboard* (see above) (Kure 2021).

In the course of the Covid 19-pandemic, SAP also started operating a *Vaccine Collaboration Hub (VCH)* which enables to organize the whole distribution process of vaccines, from production to the doctor's office, on one single platform (Meitinger 2021). The platform is based on several cloud-based solutions by SAP like *Logistics Business Network*, *HANA* and *Analytics Cloud*. Additionally, *Qualtrics Vaccine Management + Citizen Experience* by SAP's subsidiary is integrated in order to enable the federal government and municipalities to find out more about the citizens' attitudes towards vaccinations. Based on this knowledge, new measures and campaigns can be implemented to increase the acceptance of citizens. The platform also supports the planning of vaccinations and to analyse potential side-effects. The government of Saxony used the VCH to order vaccines digitally, for distribution purposes and to manage capacities (Meitinger 2021). It remained unclear whether the VCH was implemented nationwide in Germany.

Since 2020, the South African drug manufacturer *Kiara Health* is collaborating with SAP to improve its distribution processes. After the transition to SAP-Solution had been completed, Kiara Health managed to increase the rate of on-time deliveries from 80-85% to 100% (SAP 2021b).

10.6 Other Activities

In 2021, the *Universitätsklinikum Bonn* started working together with SAP and its "Gold"-Partner *CubeServ* to improve its personnel planning. Tools like simulation-scenarios and continuous planning based on new insights were implemented and helped the hospital to increase its productivity in the field of personnel controlling by 30% (SAP 2022).

On its website, SAP lists current "Release Highlights" and planned innovations for the health sector. Among the current highlights were, as of October 2022, a cloud-based portal for patient applications, a waiting time forecast for outpatient care and emergency rooms, a beta version of an AI-based patient billing solution and a solution for improved administration of data sources. The planned innovations included extended self-service options for patients, a beta version of a new cloud-based hospital information system and facilitated big data analyses via improved connections with real time-data and imported data sources. In the forecast-section of its website, SAP announced a secure and patient-oriented health cloud (SAP w.y.c).

10.7 Summary

The examples of the health facilities operated by the Naemi Wilke Stift and the Austrian Kardinal Schwarzenberg Krankenhaus, which implemented solutions by Siemens, Deutsche Telekom and SAP already in the 1990s, show that relations of dependence between health providers and profit-oriented enterprises have existed already for a long time, a fact that sometimes tends to be forgotten in the discussion about Big Tech engagement in the health sector. SAP's activities in the health sector have a clear focus on the implementation of hospital information systems. In this field, a particular feature of SAP's solutions becomes apparent: their ability to integrate with systems and services from other companies like Deutsche Telekom (see also *Section 11* for more joint projects), Siemens and Cerner. The acquisition of the latter by Oracle raises the question how the company will interact with its rival in the future. The fact that many hospital information systems in Germany are based on SAP-applications also implies that solutions of other companies have to be compatible with SAP's applications to keep implementation efforts as low as possible. This might mean a considerable market power for SAP in this field. Like many of its competitors, SAP has reinforced its activities in the health sector since the outbreak of the Covid 19-pandemic and seems to plan to utilize the current momentum around the implementation of the Hospital Future Act for a further extension of activities in this field.

11 Deutsche Telekom

Deutsche Telekom is the parent enterprise of Europe's biggest telecommunication company, the 62th largest company in the world ranked by revenue (Fortune 2022a) and emerged from the privatisation of the *Deutsche Bundespost* in 1995 (Kesepohl 2019). In the aftermath of disclosures concerning *NSA*-activities in Germany by Edward Snowden, Deutsche Telekom started to take over important infrastructure tasks which had been fulfilled by international companies before (Reuters 2014), and nowadays, the enterprise is subdivided into six segments, of which one, *T-Systems*, is responsible for its activities in the health sector (T-Systems w.y.b). In the end of 2021, it became known to the public that the enterprise considers selling its deficient T-Systems-branch (Tagesschau 2021). However, according to KMA Online (2022), this would not include its health-unit.

11.1 Health Apps and Smart Devices

Deutsche Telekom has developed the *iMedOne Mobile*-App which enables hospital staff to access patient data and other features of Telekom's hospital information system *iMedOne* with mobile devices like *iPads* (Deutsche Telekom 2014b) (see *Section 11.3*).

Already in the very beginning of the Covid 19-pandemic, in March 2020, Deutsche Telekom developed a Covid-19-app together with its partner *BS Software Development*. At this point of time, it was not possible for citizens to use self-tests and also general practitioners had not begun to conduct tests in their practices so that it was only possible to conduct tests in test centres. The app enabled users to access their results online in the *Telekom Healthcare*

Cloud instead of having to enquire them on the phone which led to time savings of 4-8 hours on average. The service was offered free of charge for all participants and was implemented in ten laboratories in the first month of its existence (Borchers 2020).

Later in 2020, Deutsche Telekom partnered with *SAP* to develop Germany's *Corona Warn App* which is based on an interface made available by *Alphabet* and *Apple*. Deutsche Telekom is expected to receive 43 million Euro during the next years for operating the app including maintenance, security, network and hotlines (Voss 2020) (for more information on the Corona Warn App see *Section 10.1*).

In 2021, the *Krankenhaus Heinsberg* implemented an app which enables access to Deutsche Telekom's *m.Doc*-patient portal (Deutsche Telekom 2021b) (see *Section 11.3*).

The enterprise has also developed a *Medical Asset Tracking*-solution for hospitals together with *Sony Mobile Communications*. Medical devices and other inventory equipped with the tracker like endoscopes, ultrasound devices and hospital beds send their data via Wi-Fi connection into the cloud and are thus always traceable immediately (Deutsche Telekom w.y.c).

11.2 Data Analysis

In 2012, the Deutsche Telekom became active in the US-American health market when it closed a multi-year deal with *Presbyterian Healthcare Services (PHS)* to manage their data centre in New Mexico (Sverdlik 2012).

In 2015, the *Deutsches Herzzentrum Berlin* worked together with Deutsche Telekom and used the company's research portal *TrialComplete* to conduct the *Cardioproof*-study with participants all over Europe (Deutsche Telekom 2015a). The study deals with non-invasive imaging methods and besides the Deutsche Herzzentrum Berlin as coordinator, various international research institutions are participating. The Trial Connect platform enables researchers to save, assign and edit image data and is operated by Telekom's data centres in Frankfurt am Main. The platform is used based on a SaaS-contract and the system is fully scalable which means that it reacts flexibly on current needs for capacity and costs are calculated depending on the number of test persons and the duration of study (Deutsche Telekom 2015a).
Two years later, TrialComplete was also used by the *Deutsches Zentrum für Herz-Kreislauf-Forschung e.V. (DZHK)*. The DZHK had been founded in 2012 and used TrialComplete for several studies because the services allows for pseudonymization of data and enables to save image data centrally in standardized formats. The associated web-application can be accessed from everywhere without the need to install any additional software and it can be easily differentiated who is able to see which data enabling swift access to raw data and relevant results while at the same time the protection of sensitive health data is guaranteed (Deutsche Telekom 2021).
In 2021, the TrialComplete-platform has been used for a study of the *Nationales Forschungsnetzwerk der Universitätsmedizin (NUM)* which recorded medical image data of 11,000 participants from three cohorts to analyse potential long-terms impacts of Covid-19 (Deutsche Telekom 2021).

Another health institution using TrialComplete is the *Medizinische Hochschule Hannover* which is supported by funds of the *European Union* to conduct the *European Clinical Study of Regenerative Heart Valves (ESPOIR)* (Deutsche Telekom 2021e). The study investigates potential ways to implant heart valves of human donors, so-called homografts, instead of artificial heart valves to help children with congenital heart diseases. The multi-year study generated many terabytes of data in various different image formats from clinics in Moldavia, Italy, France, Belgium, Great Britain and the Netherlands. In order to generate results, these images had to be linked to the respective patient data which had also been stored in different formats. In addition, the need for pseudonymization impeded the correct assignment of data even further. According to Prof. Dr. Samir Sarikouch, study leader and senior physician at the Medzinische Hochschule Hannover, there had been no system which could solve these problems until TrialComplete was developed. TrialComplete transfers all image data in a standardized format (DICOM (see *Section 8.2*)) and its web-application can be accessed via client so that no additional programs or licences have to be acquired. The application itself is operated on T-Systems' own *Private Cloud*, which ensures its compliance with data protection regulations, and is fully scalable in order to guarantee the availability of additional capacities if the number of study participants increases (Deutsche Telekom 2021e).

In 2017, the health start up *Fuse-AI* from Hamburg started a partnership with Deutsche Telekom which aims at facilitating the detection of cancer by using artificial intelligence (Deutsche Telekom 2021d). For this purpose, the start up has developed an algorithm which analyses MRI scans, flags anomalies and gives an assessment whether the anomaly is rather benign or malicious. On the one hand, this analysis relies on high computing capacities but on the other hand, it would be inefficient to provide these capacities continuously. With *Open Telekom Cloud* it is possible to react flexibly on these fluctuating requirements. The cooperation started in the aftermath of Telekom's start up initiative *Techboots* which enables young entrepreneurs to apply for support by the Telekom (Deutsche Telekom 2021d).
Fuse AI is also active in other areas of the health sector and has, for instance, developed apps for the *Deutsche Gesellschaft für Psychiatrie und Psychotherapie, Psychosomatik und Nervenheilkunde (DGPPN)* and the *Klinikum der Universität München*. It also works together with *Radprax* which operates several medical care centers (MVZs) in North Rhine-Westphalia (Fuse AI w.y., Steffens 2018).

In 2021, Deutsche Telekom partnered with *apoplex medical technologies*, a developer of medical technology from Pirmasens, Germany, to develop a solution for the analysis of stroke risks in its cloud. Physicians are enabled to screen electrocardiograms, which have been saved in the cloud, for auricular fibrillation, which is considered to be the main risk for having a stroke. In Germany alone, 2 million citizens are estimated to suffer from auricular fibrillation which is often not detected because it often stays asymptomatic (Deutsche Telekom 2021a, Pharma Relations 2021).
The detection software of apoplex was already used by 200 clinics as of June 2021 and it was planned to transfer the first data into Telekom's cloud in August 2021. The software is also used in Italy and Spain and a further expansion in partnership with Telekom is planned. According to apoplex' managing director Albert Hirtz, Deutsche Telekom is an ideal partner for this project because their *Telekom Healthcare Cloud* fulfils all requirements of German and European data protection laws and can thus be used by physicians unhesi-

tatingly which is apparently not the case for US-American hyperscalers like *Google Cloud* and *AWS*. Additionally, Telekom's service is fully scalable (Deutsche Telekom 2021a).

In the Netherlands, Deutsche Telekom collaborates with the Utrecht-based *Perined Foundation* in a project which aims to analyze data about the birth-process in order to improve perinatal care in the Netherlands (Health Dutch w.y.b).

Other research projects with participation of Deutsche Telekom include the study *Gesundheitsregion der Zukunft Nordbrandenburg - Fontane* conducted by *Charité*-hospital in Berlin (Charite 2018) and a study investigating the effects of the *M-sense*-app for headache patients conducted by Charité-hospital and the health insurance company *Barmer* (Schäffler 2017).

11.3 Electronic Health Records and Hospital Information Systems

As already mentioned in *Section 10*, the *Naemi Wilke Stift* started implementing an integrated system of *SAP*-applications and the HIS of the Telekom *iMedOne* in the 1990s (Deutsche Telekom 2014a).
The functioning of the system and a seamless transfer of data are guaranteed by Telekom's *Interface Manager for Healthcare*. The interface manager, which is also used by German police and ministries in modified versions, is a so called enterprise service bus-solution (ESB) which enables data transfer of systems that are originally not compatible with each other. At first, it receives data as integration server and subsequently, it transforms them into the desired target format which enables the medical staff to continue its work with the familiar applications (Deutsche Telekom 2014a).

In 2014, the *Sankt Katharinen-Krankenhaus* in Frankfurt am Main implemented Deutsche Telekom's *Interface Manager for Healthcare* (see above) which connects the hospital's subsystems like *SAP*'s patient management (see *Section 10*) and the hospital information system *iMedOne* (see above), the laboratory system and even the hospital's kitchen system. It also contains connectors which enable a connection with the data bases of *Oracle* (see *Section 9*). The interfaces can also be controlled with mobile devices via a smartphone-app (Deutsche Telekom 2014e).

In the same year, the *Knappschaftskrankenhaus Bottrop*, which had implemented *iMedOne* already in 2005, decided to intensify its partnership with the Deutsche Telekom by additionally implementing *iMedOne Mobile* which enables medical staff to access and to edit digital patient data from everywhere via their mobile devices making the time-consuming entering of data into paper files and the burdensome transport of bulky ward round carts redundant. Each access is recorded in order to prevent misuse of patient data, schooling for staff took only 20 minutes and the easy handling of the system allegedly lead to high acceptance by the hospital's employees (Deutsche Telekom 2014b).
One year later, also the *Agaplesion Diakonieklinikum* in Rotenburg implemented *iMedOne Mobile* to complement its HIS. In this hospital, *Apple*'s *iPads* are used to record and control the courses of treatment directly at the hospital beds. The cameras implemented in the devices can be used to take pictures of wounds which are instantly added to the hospital's EHRs. Thus, all patient data are instantly available for all relevant medical staff members and assignment errors are prevented. Additionally, it is possible for nursing staff to receive

authorisations from doctors via the app which enables them to act swiftly without having to meet the attending physician in person first. Also here, each access is automatically protocoled so that it is always transparent who changed which data at which point of time (Deutsche Telekom w.y.b).

As mentioned in *Section 10.3*, the *Dernbacher Gruppe Katharina Kasper* partnered with Telekom and *SAP* to connect its facilities with each other. There had already been a multi-year collaboration between the Dernbacher Gruppe Katharina Kasper and Telekom before the developments in 2015 (Deutsche Telekom 2015b).

Also in 2015, the *Gemeinschaftskrankenhaus Bonn* started a partnership with Deutsche Telekom. The hospital aimed to abandon its old paper records system completely and to introduce a modern system of electronic health records instead. For this purpose, the hospital acquired 200 *iPad mini*-devices and installed Telekom's *iMedOne Mobile* on them. The software also offers medical advice for the attending physicians, recommends medications for patients and contains a security check for prescribed medications. Each ward in the hospital disposes over six devices, three for physicians and three for nursing staff. The staff always carry the devices with them and pass them on at the end of their shift which enables continuous access and editing possibilities of patient health records in real time (Gemeinschaftskrankenhaus Bonn 2015).

In 2019, the *Klinikum Esslingen* decided to transfer its *SAP*-applications on Telekom's virtual servers to optimize operating procedures and harmonize its server landscape. The clinic stated that Telekom's servers enable dealing with peak loads without the need to install any new hardware. The transfer of the data to the servers could be completed within two days during active operation (Deutsche Telekom 2019b).

In 2021, the *Krankenhaus Heinsberg* implemented the *m.Doc*-patient portal which was developed by T-Systems in collaboration with its partner *m.doc GmbH*, a software developing company which is based in Cologne (Deutsche Telekom 2021b). The *m.Doc-Smart Health Platform* enables patients to arrange appointments with physicians online and to access location plans and further information on their hospital visit. The complete service operates on the *Telekom Healthcare Cloud* on servers in Germany and patients as well as medical staff can get access via web-browsers or the associated mobile app. The appointment-tool is integrated into the hospital's HIS *iMedOne*, which had been implemented already several years ago, so that arranged appointments are integrated automatically in the physicians' timetables. The hospital has also implemented the mobile app *iMedOne Mobile* (see above), which is, for example, used for wound documentation and performance recordings for billing with health insurance companies (Deutsche Telekom 2021b).

In the same year, the *Ostseeklinik Schönberg-Holm* introduced the HIS *REHA.Complete* which has been developed by *T-Systems Austria*. On behalf of the clinic, the HIS does not operate on Telekom's cloud but on servers owned by the clinic itself (Deutsche Telekom 2021f). All devices, which are authenticated in the clinic's intranet, can be used for access. REHA.Complete is able to accompany every step during the patients' visits starting from the moment of hospitalization and ending with the billing process with the respective health insurance company. Medical, therapeutical and organizational data are stored in a central EHR which means that every member of the staff is able to access all patient data at any

point in time. The HIS also uses entered data to make proposals for the final report and potential follow-up treatments (Deutsche Telekom 2021f).

In March 2022, the Deutsche Telekom employed Gottfried Ludewig, who assumes the overall responsibility for the company's health department since then. Ludwig had been the head of digitization in the German Ministry of Health under the former minister Jens Spahn before (Deutsche Telekom 2022b).

The Deutsche Telekom is one of the partner companies of the *gematik* (see *Section 8.3*). The Telekom developed the *Security Module Card-Typ B (SMC-B)* which serves as electronic authenticity certificate for health providers (*Elektronischer Praxisausweis*) and enables them to access the Telematikinfrastruktur (TI) (gematik Fachportal w.y.). Also the so called *E-Heilberufeausweis (eHBA)*, which enables physicians to prove their personal identity and enables them to access certain features of the TI, is developed by the Telekom (Deutsche Telekom w.y.a).

The enterprise also offers its own *Mobile Patient Record*, which is optimized for use on *iPads* and *iPhones* and contains functions like scanning of patient wristbands, storage of image data and a dictation function (T-Systems w.y.c). There is also a special version of the app which can be connected with *Cerner*'s HIS *i.s.h. med* (see *Section 15*) which, in turn, docks to *SAP*'s solution *IS-H*. The HIS had initially been developed by SAP, *T-Systems Austria* and the *Gesellschaft für Systemforschung und Dienstleistungen im Gesundheitswesen (GSD)* in the 1990s. In 2009, *Siemens Medical Solutions* acquired the GSD and T-Systems' shares of the HIS (Siemens Healthineers 2009) but in 2015, Siemens Medical Solutions, and thus the HIS, was in turn acquired by Cerner (see *Section 15*).

As of October 2022, Telekom's HIS *iMedOne* was used in 250 clinics and 100 of them operated the system via Telekom's cloud services. Additionally, the enterprise had participated in 750 *SAP*-implementations (Deutsche Telekom 2022a)

11.4 Innovation of Treatment

The Deutsche Telekom has developed a monitoring platform which health insurance companies can offer their customers and which includes, for instance, therapy support for back pain patients and for the prevention of diabetes. Health insurance companies can offer the platform as SaaS-solution which means that they will not face any investment costs. The aim of the platform is to encourage users to monitor their health behaviour in order to improve their health, prevent diseases and to reduce health costs. It is possible to enter data manually but the platform also enables the import of data from other devices, for example of fitness trackers by *Fitbit* (see *Section 2.1*) and the blood glucose meter *GlucoDock* (Deutsche Telekom w.y.d).

11.5 Logistics

The Deutsche Telekom's activities in hospitals, which are described in detail in *Section 11.2*, often have interconnections with the field of logistics.

In 2019, the *Universitätsklinikum Mainz* implemented an Internet of Things (IOT)-device named *Healthcare Service Button* in cooperation with Deutsche Telekom (T-Systems w.y.a, Deutsche Telekom 2019a). While procedures like ordering medical devices for patients, for example a vacuum pump to accelerate wound healing, had meant an enormous bureaucratic burden for medical staff in the past, it is now possible to order the respective device with one push on the service button. A mail with the order is automatically sent to the hospital's equipment stores and use of the device is documented digitally. After the treatment has ended, another push on the button is sufficient to start the return procedure. This way, the nursing staff saves approximately 20-30 minutes per device-lending procedure and mistakes due to the need for manual documentation are prevented. *T-Systems Multimedia Solutions (MMS)* developed an associated mobile app which can be used via *Android* and *iOS* and works as a connector between the device and the cloud. It enables the staff to scan the barcodes on both the service button and the medical device to establish a connection between them and the automated dispatch of e-mails and documentation begin once the app has been started and the button has been pushed. The Healthcare Service Button contains its own battery-powered electricity-supply and connectivity via *NarrowBand IoT*, the network standard for IoT-devices, which means that it works independent from the availability of WLAN access (T-Systems w.y.a, Deutsche Telekom 2019a).

In the Netherlands, the Deutsche Telekom is collaborating with the *Regionale Ambulancevoorzieningen (RAV'en)*. The Deutsche Telekom offers information systems which enable a faster establishment of contact to relatives in emergencies and improvements of the exchange of information between different units, for instance if helicopter pilots are included in an operation (Health Dutch w.y.a).

11.6 Other Activities

In 2002, the *Universitätsklinikum Hamburg-Eppendorf* started to source out several human resources management tasks to *Telekom Healthcare Solutions (THS)*. Telekom's solution for the management of these tasks is based on the *SAP ERP HCM*-software and besides the creation of salary statements for 11,000 employees of the Universitätsklinikum, THS is also responsible for printing and sending the statements directly to the employees. Furthermore, the company also implemented a digital personnel file which is accessible for supervisors everywhere (Deutsche Telekom 2014d).
Four years later, also the *St. Joseph Krankenhaus* in Berlin decided to use the SAP ERP HCM-based outsourcing solution of THS. In cooperation with *Drakos*, a software development company from Hanau, THS also implemented *ID Expert*, a card-based solution, which is tied completely to the SAP-system and enables to control the access to medical devices. The companies also planned to regulate access to hospital buildings and digital signatures with the solution (Deutsche Telekom 2014c).

In 2013, the Deutsche Telekom started a collaboration with the *Hausärztliche Vertragsgemeinschaft AG (HÄVG)*, a subsidiary of *Deutscher Hausärzteverband e.V.*. As part of the deal, the Deutsche Telekom acquired 25% of the *HÄVG Rechenzentrum GmbH*. The new company, which was founded through the merger, is based in Cologne and became market leader in the area of billing for selective contracts in the health sector (Deutsche

Telekom 2013).

In 2015, the Deutsche Telekom closed a deal concerning the use of its entertainment programme *Entertainment for Hospitals* with several German hospitals. Entertainment for Hospitals enables patients to watch TV on flat screens, listen to the radio and audio books, access the internet, to make phone calls and to play video games. Already in the same year, the service was available at 3,000 hospital beds (Deutsche Telekom 2015c).

In 2018, the Deutsche Telekom became the first German enterprise to use *Nuance Voice Biometrics* in order to authenticate its customers. Instead of entering a password, customers speak a sentence ("At Telekom, my voice is my password") and the tool recognizes the voice of the respective customer. In 2021, Nuance was acquired by Microsoft (Mascellino 2022) (see *Section 6.2*).

In 2020, the research and consultancy company *ISG* named Deutsche Telekom as a leading enterprise in the areas of *Payer Digital Transformation Services* and *Provider Digital Transformation Services* in its *ISG Provider Lens*-report (Deutsche Telekom 2021c).
In the same year, Mark Düsener, chief of Telekom's health department, promoted an acceleration of digitalisation processes in the German health system at the *Digital Medical Expertise & Applications (DMEA)* (see *Section 10.3*), an exhibition for digital health-related topics in Berlin. In the same comment, Düsener emphasized that Europe has to be careful not to become too dependent on US-American tech companies in this regard and named the dependency on *Alphabet* and *Apple* while implementing the *Corona Warn-App* as an example (Düsener 2020).

In April 2022, Deutsche Telekom presented its new *cyber-security-package* for hospitals on the DMEA. The financing of the project is supported by funds in the frame of the *Hospital Future Act* (see *Section 10.3*) which provides 4.3 billion Euro for the modernization of hospitals of which 15% have to be invested in improvements of the information security management. In 2021, a study with participation of the *Universität der Bundeswehr* in Munich revealed that one third of German hospitals showed weaknesses in the area of cyber-security (Becker 2022).
The Deutsche Telekom stated that it is one of very few German enterprises which offers suitable solutions for ten of eleven objects of funding explicated in the KHZG and, furthermore, fulfils all data protection requirements (Becker 2022).

The enterprise also offers a solution to facilitate billing procedures for care providers and payers: *De-Pay* enables automated billing and is compatible with other care provider solutions like *LEOS-Heilmittel* and *De-Touro* which was designed for the billing of patient transports. De-Pay is a complement of the *ZHP.X3*-platform which is operated by the Telekom-subsidiary *HMM Deutschland* and enables health insurance companies to interact with care providers (who have to be connected with the platform's counterpart *LEOS*). Applications, authorizations and payments can all be conducted via the platform which is already used by 40 health insurance companies and about 10,000 care providers enabling about 25 million insured persons to profit from the solution according to the Deutsche Telekom as of October 2022 (Deutsche Telekom 2022c).

On the website of its sub-unit *Health Dutch*, the Telekom advertises its *LMS*-software which is described as centre-piece of its software solutions for research on pathologies (Telekom

Healthcare w.y.b).
In the course of its *Healthcare Academy*, which takes place in the Netherlands, Deutsche Telekom offers training courses on information and communication technology in the field of research on pathologies (Telekom Healthcare w.y.a).

11.7 Summary

The Deutsche Telekom has been active in the health sector already for many years and has become an important partner company most notably for hospitals. Its hospital information system *iMedOne* operates as infrastructure for a great variety of processes in German hospitals, its Interface Manager for Healthcare allows for the merging of data from previously incompatible data and many clinics use Telekom's solutions in combination with applications by SAP. But the enterprise has succeeded in establishing itself as a major player also in other areas of the health sector: Its research platform TrialComplete is used as infrastructure for international studies and the Telekom collaborates with the German government in projects of high significance like the implementation of the *Elektronische Patientenakte* and the *Corona Warn-App*. However, besides few exceptions, the activities of the Deutsche Telekom are clearly focused on the European health market, where its supposed compliance with European data protection regulations in combination with widespread distrust in its US-American competitors might be a big competitive advantage for the enterprise.

12 CompuGroup Medical

CompuGroup Medical (CGM) is a publicly traded health software enterprise with headquarters in Koblenz, Germany. The company was founded in 1987 and belongs to the market leaders in the area of health software by now. In 2021, the company employed 8,500 workers in 20 countries. Its revenues surpassed 1 billion Euro and its software solutions were used by 1.6 million users in 56 countries (CompuGroup Medical 2022b).

In 2007, CGM planned to acquire *i-Solutions*, a medium-sized developer of hospital information systems located in Mannheim, Germany. However, in the end, the Australian corporate group *IBA* managed to close the deal. *Cerner* (see *Section 15*) had also been bidding on i-Solutions, which in later years belonged to various corporate groups until the Swedish stock corporation *Trill Impact* took over the majority stake and merged it with *Meona*, a developer of clinical IT solutions, under the name *Mesalvo*. At this point of time, i-Solutions operated HIS in 102 German hospitals (Mau 2018, kma Online 2022a).

In the field of HIS, the Czech Republic was among the first countries, in which the company became active. In 2009, the *CompuGroup Medical Czech Republic* was established as a merger of several subsidiaries of the company (CompuGroup Medical w.y.a)

In 2011, the CGM reinforced its activities in Scandinavia by acquiring the health software provider *Lorensbergs Holding* including all subsidiaries (Digital Health Portal 2011a).
In the same year, the CGM acquired *Parametrix*, the market leader for hospital information systems in Switzerland (Digital Health Portal 2011b).

In 2012, the CGM acquired the Italian health software company *Effepieffe srl* to strengthen its position on the Italian health market. It had entered the market for health information systems in Italy in 2006 and was market leader in the field of primary care with a market share of 40% in 2012 (Digital Health Portal 2012a).
In the same year, CGM merged two of its subsidiaries in the Turkish health market and planned to become the leading provider of health information systems in the Gulf region and the Middle East (Digital Health Portal 2012b).
In 2013, CGM was among the companies which were in charge of implementing a nationwide EHR-system in Poland (Digital Health Portal 2013).

In 2014, CGM started a partnership with the *Hochschule Koblenz* and the German insurance company *Debeka* to establish a new study programme at the *RheinAhrCampus* in Remagen in which students specialise on software engineering in the health sector. Students complete practice phases in both companies in the course of their studies and receive a training allowance throughout their studies (Hochschule Koblenz 2014).

In 2016, the company planned to acquire *Agfa Healthcare*, which was the market leader in the German market for hospital information systems at the time, but in the end CGM failed to close the deal, apparently because the pension provisions at Agfa Healthcare were considered to be too high (Mau 2018). Four years later, CGM's competitor *Dedalus Healthcare Group* acquired large parts of Agfa's healthcare section (Przegendza 2020) (see *Section 13*).

In 2017, CGM acquired two Belgian providers of software solutions for dentists (Mau 2018).

In 2020, the company acquired parts of the portfolio of its US-American competitor *Cerner* (see *Section 15)* in Spain and in Germany for about 250 million USD (Collins 2020a). The deal included two HIS, which were implemented in German hospitals, *medico* and *Soarian Integrated Care*, as well as *Selene*, a HIS which was implemented in 65 Spanish hospitals at this point of time. Especially the acquisition of medico, which was used by 250 German hospitals back then, meant a considerable increase for CGM's market share in Germany and made the company the number 2 in the market for HIS after the *Dedalus Healthcare Group* (Collins 2020a, kma Online 2022a) (see *Section 13*).
Additionally, Cerner also sold its *Soarian Health Archive* to CGM, a platform designed for storing health data. Cerner itself had acquired medico and Soarian only five years earlier from *Siemens* (Collins 2020a) but then decided to focus on its core markets according to its Global President Emil Peters (CompuGroup Medical 2020).

In June 2021, CGM announced its plans to acquire the *VISUS Health IT GmbH* which develops software for health providers and has its office on the *Gesundheitscampus Bochum*. According to Thomas Simon from CGM, VISUS has become an important actor in the IT-infrastructure of German hospitals during the last 20 years and apparently, there is hardly a hospital left in Germany which does not rely on its *JiveX*-solutions for data management in its day-to-day running (Visus Health IT 2021).

In the same year, the *gematik*, who is in charge of the implementation of a standardized EHR-system in Germany (see *Sections 8.3, 11.3*) permitted CGM to participate in field tests for the implementation of the EHR-connectors in medical practices. The company's *KoCo-Box MED+*, which functions in combination with its information systems *CGM ALBIS* and

CGM M1 PRO, was tested in 30 medical practices of general practitioners for filling in and retrieving data from EHRs (CompuGroup Medical 2021). KMA Online (2022) named the company an important player for the set up of Germany's *Telematikinfrastruktur*.

Also in 2021, the German start up *Nia Health* collaborated with CGM. Nia Health had received a founder's grant of the *Charité Hospital* in Berlin (see *Sections 10.3, 11.2*) and operates an app which supports people who suffer from neurodermatitis. The company claims that its app is able to detect the causes of surges and, thus, helps to prevent them in the future. The partnership of the companies enables physicians to recommend the app directly through their doctor information systems if they are operated by CGM (Nia Health 2021). The costs for the app, which amount to 599.40 Euro per year, can then be reimbursed by most health insurance companies in Germany (Nia Health w.y.).

Unlike its main competitors in the market for health information systems, CGM makes the largest share of its revenues not in hospitals but in doctor's offices. While revenues in this field amounted to 467 million Euro in 2020, revenues with HIS only amounted to 187 million Euro (Apotheke Adhoc 2021).

In the end of 2021, CGM was victim of a ransomware attack which affected the company's intranet and phone-support. The company emphasized that most customer systems worked as usual and were considered to be safe to use. There were also no hints that customer data might have been accessed by unauthorized parties. No further information concerning the attack was disclosed (Borchers 2021).

In 2022, CGM announced on its website that in 2021 alone, 5,000 physicians decided to implement its *Clickdoc*-calendar in their medical practises to manage patient appointments. While established customers are able to integrate the calendar into their doctor management systems for free, additional functions like online-scheduling of appointments and patient reminders each cost an extra 49 Euro per month (CompuGroup Medical 2022a).

Also in 2022, Angela Mazza Teufer became member of CGM's board of directors. Previously, Mazza Teufer had worked in leading positions for *Oracle* (see *Section 9*) and *SAP* (see *Section 10*) (CompuGroup Medical 2022c). In the same year, Michael Franz, who was in charge of global communication at CGM, left the company and was hired by *m.Doc*, a company from Cologne which offers a digital patient portal (see *Section 11.3*), where he became chief product officer (kma Online 2022b).

Together with its subsidiary *intermedix*, CGM offers solutions for marketing campaigns in the health sector. The aim is to reach physicians, pharmacists and patients with the companies' messages in the right moment, namely while patients are treated or advised and while medications are prescribed. In order to do so, data from day-to-day running in medical practises and pharmacies are used. It is not disclosed which data exactly are utilized. In medical practices, messages of pharmaceutical companies can be displayed on the doctors' screens during the prescription process and messages on customer displays in pharmacies are used to stimulate impulse purchases. According to CGM, 65,000 general practitioners, 14,000 pharmacies and nearly one million patients in these pharmacies can be targeted this way every day in Germany (Intermedix w.y.).

CGM also offers information systems for physiotherapy facilities, midwives and health in-

surance companies (CompuGroup Medical w.y.b).

In March 2022, CGM's market capitalization was 3.8 billion Euro (CompuGroup Medical 2022b).

Summary

While competitors of CGM in the field of health information systems have a clear focus on offering their products to hospitals (see *Sections 13*, *14* and *15*) CGM has established itself as a central player in medical practices especially in Europe. The company has achieved significant growth in recent years by several acquisitions, probably most notably of Cerner's hospital information systems in Spain and Germany, although it was not able to complete all of its acquisition plans. Further sources of revenue for CGM in the health sector are the company's partnership program with health app developers and its advertising solutions for pharma companies.

13 Dedalus Healthcare Group

Quasar Spa, the predecessor company of the Dedalus Healthcare Group AG, was founded by Giorgio Moretti in Florence in 1982 (Clinicum 2020). At first, the company had developed IT-solutions for health and financial markets before it merged with *Datamat* and abandoned its activities in the health sector in favour of developing services for defence- and space industries. In 2005, the company changed its focus again and since then, it has acquired about 75 health- and IT-companies, which have been merged into the Dedalus Healthcare Group making it one of the largest suppliers of hospital information systems worldwide. Since its acquisition of *Agfa* in 2020, Dedalus' new headquarters are located in Bonn and the company operates several additional sites in Germany, Austria and Switzerland (Dölfs 2016, Clinicum 2020). In 2022, the company managed more than 330 electronic health records from more than 6,100 clinics (Dedalus 2022a). Its self-declared goal is market leadership in the field of healthcare IT solutions in Europe (Dölfs 2016).

In 2000, Dedalus acquired *Bull Italia* and the Italian healthcare company *Milennium* in order to gain a foothold in the Italian health sector by offering an electronic medical record system for general practitioners (Dedalus w.y.b).

In 2010, the private equity investment funds *Mandarin Capital Partners*, which is based in Luxembourg, invested in Dedalus and offered the company the possibility to expand further. After the investment, Mandarin Capital Partners held nearly 20% of Dedalus' shares and further investments were planned for the near future (Reuters 2010). According to Dedalus (w.y.), Mandarin held 27% of Dedalus' shares between 2011 and 2013.

Since 2011, Dedalus is also active in countries in the Middle East, North Africa, Latin America and China (Dedalus w.y.b).

In 2012, Dedalus started collaborating with the software developing company *Tribe29* from Munich. Tribe 29's software *checkmk* is used by Dedalus to monitor its IT-solutions (checkmk w.y.).

In 2016, Dedalus acquired the Bologna-based pathology software company *NoemaLife* which made Dedalus market leader in the Italian health sector (Dedalus w.y.b). NoemaLife had developed the laboratory information system (LIS) *DNLab* and *HALIA*, a software which links the LIS to laboratory instruments (Dedalus w.y.a).

Still in 2016, *Ardian*, Europe's largest private equity company, took over Dedalus' majority stake with 60% of the shares (Villegas 2016). Ardian had been founded by the French insurance company *Axa* (see *Section 6.4*) in 1996 but became independent in 2013 (Ardian 2013) and has invested in several health companies including *CMG*, an operator of medical centres in Florida (Ardian w.y.), and the French laboratory medicine company *Groupe Bio7* (Ardian 2018).

In 2017, Dedalus acquired *Netika*, the French market leader in the area of laboratory software. One year later, the company acquired two further French companies, *DL Santé*, which had developed medical technological solutions, and the IT-developer *Infologic*. In 2019, Dedalus acquired the IT-company *Softech* and *Web100T*, a French company which had developed web-based applications for both public and private health facilities (Green 2019).

In 2020, Dedalus acquired large parts of *Agfa*'s healthcare unit (see *Section 12*) for 975 million Euro. The acquisition made Dedalus market leader for HIS in Germany. Before, the company had not been represented in the German market at all (Dölfs 2016). The deal includes all healthcare activities of Agfa in Germany, Austria, Switzerland, France and Brazil. Agfa's activities in the field of medical imaging software, which the company offers in Northern America and other international markets, was not part of the deal. Leading employees of Agfa said that the deal will not change much for the company's customers and that Agfa's staff will continue to work on their projects (Przegendza 2020). The deal with Dedalus was praised since both companies had been active in complementary markets before. Giorgio Moretti named the importance of the DACH region in the European health market as main reason for the acquisition (Przegendza 2020). In the context of the Agfa-acquisition, Dedalus' headquarters were moved to Bonn (Dölfs 2016).

In 2021, Dedalus continued its strategy of acquiring other companies in the field of health IT services. This year, it took over *Dosing GmbH*, a software provider in the field of medication safety (Dosing GmbH 2021), *Dobco Medical Systems*, which had offered software for diagnostics (Dedalus 2021b), *ix.mid GmbH*, which had developed a laboratory communication service (ix.mid 2021), and the *OSM AG*, a software developer in the field of healthcare, which had been a market leader for LIS and had collaborated with Dedalus already since 2006. According to Andrea Fiumicelli, CEO of Dedalus, the latter acquisition once more emphasized the great importance of the DACH-region for his company (Dedalus 2021a).
In the same year, Dedalus also acquired *Swiftqueue*, a cloud service provider, which also operated a patient portal, that enabled users to schedule appointments and to view lab results, and self check-in solutions for hospital patients (Dedalus 2021c).
Still in 2021, the company also acquired the health provider-software of the US-American IT-giant *DXC Technology* for 450 million USD (Dölfs 2016).

In 2022, CEO Andrea Fiumicelli predicted that Dedalus' revenue would exceed the billion-mark in the end of the year. In 2019, Dedalus had a revenue of about 210 million Euro, in 2021, revenues amounted to approximately 760 million Euro. To reach his ambitious

goals, Fiumicelli planned to acquire even more companies in order to expand the company's technology portfolio. According to him, Germany is the individual market with the highest relevance for Dedalus. This statement might also be connected to the passed *Hospital Future Act* which encourages health IT investments in the German hospital market (Dölfs 2016) (see *Sections 10.3, 11.6*).

In the same year, the company took a majority stake of the *Care-Bridge GmbH* which offers cloud-solutions for the hospital discharge process and had been a subsidiary of the German *Asklepios Gruppe*, an operator of private clinics with headquarters in Hamburg, before (Dedalus 2022c). Additionally, Dedalus acquired the *CSG-GmbH* which had focused on the field of medicine controlling (Dedalus 2022b).

Also in 2022, Dedalus began cooperating with the software company *Diamant Software* which operates a solution that enables to implement AI-based automatization processes in accounting. As part of their partnership, the companies implemented Diamant's software in Dedalus' HIS *Orbit*. German hospitals, which are already using this new solution, include *Karl Jaspers Klinik* in Bad Zwischenahn and several hospitals of the *Artemed Gruppe* (Scarabis 2022).

According to information on the company's website as of October 2022, Dedalus manages more than 3 billion lab results, more than 330 million EHRs from over 6,100 different clinics, 28 million inpatient admissions and 32 million emergency admissions annually (Dedalus 2022a). Alone in Germany, Dedalus offers laboratory diagnostics in 550 clinics making it the market leader also in this field. Apparently, the company tries to go beyond its exclusive focus on HIS and tries to extend its portfolio of solutions for hospitals. For this purpose, the company recently also acquired several companies from areas like data analysis and artificial intelligence (Dölfs 2022).
Dedalus is the company with the highest capacities in the field of research and development in the sector in Europe. From 2020 to 2022, it has nearly doubled the number of its employees to more than 6,000 of whom more than 2,000 are working in the field of research and development (Dedalus 2021c).

In May 2022, however, media reports revealed that Dedalus itself is apparently up for sale. The majority stake holder Ardian (see above), which holds 75% of Dedalus' shares by now, seems to plan the start of an auction process together with the investment banks *Morgan Stanley* and *USB*. According to the article, the market value of the shares might reach 3 billion Euro (Dölfs 2016, Ruhkamp 2022). In 2020, Winfried Post, Dedalus' DACH-region chief, still had emphasized that Ardian's engagement with the company would be long-term and that its vision would be to develop Dedalus to become one of the three biggest health IT-companies in the world together with *Epic Systems* and *Cerner* (Dölfs 2016) (see *Sections 14* and *15*).

Summary

All things considered, Dedalus seems to be the ideal-typical example of a Big Tech company which plays a major role in the German health sector since the Agfa-deal in 2020 and whose engagement is nevertheless unknown to large parts of the public. The company has shifted its focus from the Italian market first to the French health sector and in recent years to the DACH-region and here most notably, Germany, where it even succeeded in reaching

the market leadership in the field of hospital information systems. The company's recent focus on the German market might hint at the importance that health IT enterprises attach to the Hospital Future Act. Ardian's role as majority stake holder of the company shows the influence of private equity funds in the health market and their aims might have to be considered when companies like Dedalus are granted access to billions of lab results annually in German hospitals. The fact, that Dedalus might be sold already in the near future after following an aggressive acquisition strategy in the recent past itself and gaining importance in the German HIS-market only in 2020, indicates the dynamics and volatility of European HIS-markets.

14 Epic Systems

Epic Systems was founded in Wisconsin in 1979 under the name Human Services Computing. The foundation investment was only 70,000 USD. The company founder Judy Faulkner, who is a computer programmer herself and is known as most successful female tech company founder in the world, is still Epic's CEO (Jennings 2021). She is famous for blocking all attempts of investments from third-parties to keep control over the company and in turn, Epic also differs from most of its competitors because it has never acquired another company, produces all of its software itself and never considered to relocate its headquarters or production units (Forbes 2021, Cobb and Sauser 2014). The company's motto is "Do good. Work hard. Make money." (Jennings 2021). Faulkner has signed the *Giving Pledge* which means that 99% of her assets will be donated to a private charitable organization. Epic has been active in the health sector from the beginning of its company history and is one of the biggest vendors of electronic health records in the world. While Epic's software is often described merely as an EHR-system, it has in fact extended to other functionalities already years ago and also includes "admission, discharge, pharmacy, specialty care...,billing, insurance benefits, referrals and more" (Eisen 2008b)

In 1983, the company developed an appointment software called *Cadence*. In the same year, the company's name was changed from Human Services Computing to Epic Systems. In 1987, Epic introduced *Resolute*, a software which linked appointment planning with a billing system. In 1992, the company invented *EpicCare*, its first electronic health record system based on *Microsoft Windows* (Eisen 2008a).
In 2000, Epic implemented *MyChart* into its system. It is an online portal which enables patients themselves to access key information in their health records and was later complemented by *MyChart Bedside* which makes information available on mobile devices in hospital beds of participating clinics like the *Geisinger Hospital* (see *Section 3.1*). At the time, in which MyChart was introduced, Epic Systems employed only 400 workers (Eisen 2008a).
One year later, Epic implemented *Hyperspace* which improved the interface of already existing Epic-applications (Eisen 2008a).

In 2003, *Kaiser Permanente* (see *Sections 6.1, 9.2*), the largest non-state health provider in the United States, started to implement applications of Epic Systems in its facilities and invested 1.8 billion USD into the project. Also *IBM* (see *Section 8*) and *Cerner* (see *Section 15*) had applied for the deal (Eisen 2008a, Cobb and Sauser 2014).

In 2006, *Epic Europe* was launched in the Netherlands (Eisen 2008a). Apparently, the company had been active in the Netherlands already before when it partnered with *Philips Medical Systems* to develop solutions for medium-sized hospitals. However, the partnership was terminated in 2006 without any success, making Epic's first international pursuit a failure (Eisen 2014). Nevertheless, Epic chose health facilities the Netherlands for further implementations in Europe and received high approval rates among its customers (Heath 2015). As of 2022, the company also operated branches in Bristol, Dubai, Dhahran, Helsinki, Melbourne, Singapore, Trondheim and Soborg. According to a former employee, Epic has not been active on the big Chinese health market yet, because it fears that its intellectual property might be stolen (Eisen 2014).

In 2008, Epic's Chief Administrations Officer, Stephen Dickmann said that the implementation of Epic's applications is not feasible for every health provider and that in particular small hospitals would often not be able to afford to become Epic-customers (Eisen 2008b). In the United States, the company in general has the reputation to be expensive but to enable seamless implementations without unforeseen problems in return (however, this does not always seem to be the case with customers in other countries, see below).

As of 2008, the company did not create business plans because "such memorized strategizing quickly becomes outdated" and did not spend any money on marketing (Eisen 2008b, Cobb and Sauser 2014).

Also in 2008, Epic Systems was implemented in the *Mohammed Bin Rashid Academic Medical Center* in Dubai (The U.S.-U.A.E. Business Council 2016).

In 2009, Judy Faulkner was a member of Barack Obama's *Health IT Policy Committee* which aimed to accelerate digitalization processes in the health sector. In the frame of this cooperation, she also participated in the working group that developed the criteria which EHR-companies have to fulfil concerning interoperability criteria (Cobb and Sauser 2014, Caldwell 2015).

Also in 2009, the US-government issued the *Recovery Act* which aimed to end the financial crisis which had begun two years earlier. In the health sector, hospitals were supported by the act in particular. The *Health Information Technology for Economic and Clinical Health (HITECH) Act*, which is a part of the Recovery Act, guaranteed them 30 billion USD that could be used to digitalize their processes and to introduce electronic health records (Cobb and Sauser 2014). According to Barack Obama, this should enable the hospitals to "cut waste, eliminate red tape, and reduce the need to repeat expensive medical tests." (Caldwell 2015). The increased demand for EHR-systems, in turn, also helped Epic Systems to continue its growth path (see below) since there were only few vendors of comprehensive EHR-systems for hospitals at the time.
According to a study by the New England Journal of Medicine, only 1.5% of the hospitals in the United States had implemented a comprehensive EHR-System and 7.5% had implemented a basic EHR-System in 2008. In 2014, five years after the recovery act, 75.5% of the hospitals stated that they operate at least a basic system in their facilities (Boulton 2016). But there was also criticism because the act had not paid enough attention to interoperability and the ability to transfer data between hospitals and between health providers and patients (Cobb and Sauser 2014). This topic has developed to be a heavily disputed issue in the

United States by now with Epic, on the one side, being rather opposed to higher degrees of transferability and many other tech companies like *Cerner*, *Microsoft* and *Apple* on the other side (Jennings 2021) (see *Sections 3.3, 6.3, 15*). A report of the *RAND Corporation* from 2014 named Epic a "roadblock to interoperability" (Caldwell 2015). Additionally, it was criticized that hospitals implementing EHR-systems apparently had to sign contracts which prohibited them from revealing exact terms and conditions. Another obstacle for more interoperability in the US-health sector is the prohibition for the government to support a health system with unique healthcare identification numbers (Caldwell 2015).

In 2012, Epic started implementing its system in Finland under the project name *Apotti*. In Finland, a unique approach is pursued and "Apotti is the first system in the world to combine social and health care records into one electronic record" (Apotti w.y.). The end of the implementation phase has been expected for 2021. (Apotti w.y.)

In 2014, Epic was among the first companies to use *Apple*'s *Health Kit* to develop its own applications (see *Section 3.1*). Among them were *Haiku*, which enables the synchronisation of health data with mobile devices like *iPads*, and *Canto* which enables medical staff to perform tasks, for which they had needed computers before, like accessing patient data and taking notes, via their mobile devices. In 2019, there were rumours that Apple might plan to acquire Epic in the near future (Gurdus 2019b). However, the rumours were quickly dismissed by Judy Faulkner who also emphasized that Epic's customers did not pay much attention to media reports referring to the matter ("They all said they laughed") (Farr 2019d). While Epic used Apple's Health Kit to create applications, it also offers a solution for app developers itself: *App Orchard* makes Epic-interfaces available to enable developers to create their own applications for the Epic-System. As of 2018, about 100 apps had already been developed (Gawande 2018).

Contrary to criticism against Epic for blocking interoperability (see above), the KLAS ranking 2014 ranked the company highest in "user satisfaction with health information exchange". Concerning the depth of exchanged data, however, its main competitor *Cerner* ranked higher (Leventhal 2014).

Also in 2014, Epic reinforced its activities in Europe by implementing its EHR-system for the first time in a hospital in the United Kingdom, the *Cambridge University Hospitals (CUH)*. The deal included the implementation in all facilities of the hospital, which had been hardly digitalized at all before, and the implementation costs amounted to 200 million GBP. All facilities started operating Epic's EHR at the same time following the company's typical "big bang approach" (Allen 2019). Unlike with experiences in the United States, where implementations allegedly succeed seamless in most cases (see above), the CUH faced many problems in the aftermath of the implementation. For instance, the whole system collapsed for four hours and during this time, all ambulances had to be redirected to other hospitals. Also six months after the implementation, the *Care Quality Commission*, which inspected the CUH, was not satisfied with the developments, blaming Epic for making it "difficult for staff to follow required guidelines" and being responsible for wrong prescriptions of medication. One year after the implementation, the hospital's chief executive had to resign because "patient safety and welfare was placed at risk" (Hertzum and Ellingsen 2019).
Two years after the implementation, most problems seemed to have been resolved and the commission emphasized that many of its concerns had been addressed by several modifica-

tions of the electronic health record in the meantime. The CUH now saves 460,000 GBP annually measured in saved working time (Hertzum and Ellingsen 2019).

In 2015, *Mass General Brigham*, a group of renowned hospitals in Boston, began to implement Epic-applications in its hospitals. The costs were planned to be 1.2 billion USD. In 2018, however, it became clear that the estimates had been too low and that costs had already amounted to 1.6 billion USD. The costs for the software itself only accounted for 100 million USD, the rest of the cost resulted from lost revenues due to less patient treatments in the implementation phase, costs for support with handling the new programs and other cost items associated with the implementation (Gawande 2018).

Similar to *Alphabet*, also Epic Systems applied for the development of a new EHR-system for the US-American *Department of Defence* but in the end, *Cerner*, *Leidos* and *Accenture* closed the deal (see *Sections 2.3, 8.3, 15*).

Also in 2015, Epic reacted on criticism on blocking interoperability by waiving the fees for transferring data to hospitals which operate EHR-systems by other vendors. While data transfer had also been possible before, Epic had charged a fee for this service per patient and year. Epic, in turn, also blamed authorities for blocking interoperability by not offering certificates with which it could be established if third-parties asking for patient data are trustworthy (Caldwell 2015).

In 2016, Epic was already active in seven European countries (Allen 2019) and in May 2016, also the Danish *Herlev and Gentofte Hospital (HGH)* started operating an EHR-system by Epic with implementations in all hospitals in two out of five of the country's health regions to follow. Health records in the affected hospitals had been partly digitalized already before but there had also still been much usage of paper records and the systems were prone to crashes (Hertzum and Ellingsen 2019, Allen 2019). A first attempt to introduce EHRs in the regions had failed in 2008. In 2013, a new tendering began, in which Epic succeeded against the Danish software company *Systematic* which focuses on developing solutions in the field of national defence but had already implemented EHR in West-Denmark in 2002. The costs for all implementations combined amounted to 375 million Euro making it Denmark's biggest IT-investment so far. The last implementation took place in the end of 2017 (Hertzum and Ellingsen 2019).
Similar to the implementation in the CUH in the United Kingdom (see above), the HGH faced many problems after the go-live and apparently, two patients suffered injuries as a consequence of the faulty implementation. The *Danish Patient Safety Board* claimed that the implementation might have caused death or injuries but could not confirm that this really had been the case (Allen 2019). Technical problems caused faulty transmissions of reports and new-born babies were hard to identify because they appeared in the health records without their mothers' social security numbers. Gert Galster, one of the physicians, who were in charge of the implementation, even recalled that "Many who were there are still traumatized by having seen battle-hardened doctors and nurses weeping openly for days" (Allen 2019). The issues might have become worse due to insufficient training of medical staff and only one of 149 respondents of a survey conducted one month after the go-live felt prepared for using the system. Critical tests were delayed and known errors not fixed until the implementation took place. An important functional test was delayed until five months after the implementation and then revealed 196 errors. Additional problems arose

from translation errors, which, for instance, left physicians with the curious decision to either amputate the left or the "correct" leg, and differences in the hospital culture between the United States and Denmark: While it previously had been possible for Danish nurses to prescribe medication in emergencies, Epic did not offer this choice, complicating processes even further (Allen 2019). While there were also physicians, who praised certain aspect of Epic Systems, only 27% of the hospital staff were satisfied with it four years after the implementation. It remained unclear on which base the optimistic forecasts in the business case had been established and despite recent increases, productivity had not reached the baseline level 18 months after the implementation (Hertzum and Ellingsen 2019).
In 2018, Systematic (see above) succeeded against Epic in a tendering for the implementation of EHRs in the remaining Danish health regions. Apparently, also the "Epic-regions" would prefer transferring their systems to Systematic by now but the burdensome implications with high costs cause lock in-mechanisms making Epic "too big to fail" (Allen 2019). According to Jonathan Schlusser of the Danish GP organization, Epic had offered to install its system in doctor's offices free of charge, a fact that was denied by the company, but the organization had refused: "You couldn't give us enough money to install Epic." (Allen 2019).
Also Norway planned to implement Epic Systems in a health region (Hertzum and Ellingsen 2019). Differently from the UK and Denmark, it is planned to also include general practitioners, nursing homes and home-care services. Initially, the start of the project had been planned for 2021 but by now, the first implementations have been rescheduled to take place in 2022. Apparently as a reaction to the problems in Denmark, the authorities in Norway did not publish any information on expected benefits regarding efficiency and costs but rather concentrated on promoting better treatment quality and facilitated interactions between different health facilities (Hertzum and Ellingsen 2019).

Also in 2016, Epic started being active in Lebanon when it implemented its software in the *American University of Beirut Medical Center* (American University of Beirut 2016).

By 2016, all fifteen hospitals, which received the highest research funds from the *National Institutes of Health* in the United States, were Epic-customers and nearly two thirds of the medical students were trained in health facilities who had implemented a system by Epic. The clinics using Epic also included the top facilities for academia like *Cleveland Clinic* and facilities of the *Mayo Clinic* (see *Sections 2.2, 8.4, 9.3*) (Boulton 2016).
In 2018, the Mayo Clinic completed the implementation process in the frame of the so called *Plummer Project*. All 90 hospitals and clinics of the non-profit organisation are now using Epic which means that everyone at Mayo is able to access relevant patient data no matter in which facility the patient has been treated first (Madson 2018).

In 2017, Epic introduced its new *Share Everywhere*-feature which enables physicians, who are not employed by hospitals with Epic-implementations, to access patient data. However, this can only be done once and it is not possible for them to edit the data. Instead, it is possible for them to send a note to the respective treating physician in the hospital with Epic-implementation. Share Everywhere is a component of *MyChart* (see above).

Also in 2017, *Mackenzie Health* was the first Canadian health provider to implement Epic Systems in its facilities (Mackenzie Health 2017).

One year later, Epic implemented its applications in *Johns Hopkins Aramco Healthcare* which marked the company's first implementation in Saudi-Arabia (Epic Systems 2018).

In 2019, Epic announced its Big Data initiative *Cosmos*. As part of the project, the company, which had not been known for participating in the field of health research before, made deidentified patient records available for research institutions. The data set includes representative longitudinal health data and contains information about 162 million patients. The data set has been the source for various publications in academic journals and the company's *Epic Research*-team has analysed the data to deal with topics like Covid 19-breakthrough cases for vaccinated people and fire arm injuries (Jennings 2021, Epic Cosmos w.y.).

In 2020, Epic announced that it will no longer rely on *Google Cloud*-services (see *Section 2*) and will start using *Amazon Web Services* (see *Section 5*) and *Microsoft Azure* (see *Section 6*) instead. Shortly before, also Epic's main competitor in the United States *Cerner* decided against a collaboration with Alphabet and started to use Amazon Web Services (see *Section 15*) (Farr 2020k). Epic also operates its own cloud service (Eisen 2014).

In the same year, Epic started working together with *Lyft* in order to make the organisation of patient transports easier for hospitals. Lyft is the main competitor of *Uber* in the United States but has not offered its service in other countries so far. The collaboration enables medical staff to schedule Lyft rides directly from the patient's EHR without having to install any additional applications. Uber has also become active in the health sector with its subdivision *Uber Health* and a partnership with Epic's rival *Cerner* which is similar to the Epic-Lyft-collaboration (Landi 2020d).

Still in 2020, the US-American health provider *Eskenazi Health* implemented Epic's EHR System and combined the implementation with a partnership with *SAP* to yield optimal results (see *Section 10.3*) (SAP w.y.b)

In 2021, the health provider *AdventHealth* from Florida planned to implement Epic solutions in 37 of its hospitals. The expected costs of the implementation amounted to 650 million USD excluding costs for continuous maintenance work (Jennings 2021).

Also in 2021, Epic Systems was implemented in three Australian hospitals (Epic Systems 2021).

In the course of the Covid 19-pandemic, Epic faced a revolt of its employees, when it gave them the order to return to their offices. 89% of the employees were dissatisfied with the way in which Epic handled the pandemic. While, on the one hand, the company is known for its flat hierarchies and a campus "like a city out of a fantasy novel" (Atlas Obscura w.y.) with many amenities, there are also reports about high workloads, a "hypercompetitive" (Jennings 2021) working climate and similarities to the structures of a cult. Nevertheless, Epic seems to stay an attractive employer and according to a former employee, it is "easier to get into medical school than Epic" (Eisen 2008b, Boulton 2016, Jennings 2021)

Epic experienced rapid growth since the turn of the millennium. In 2000, its revenues had amounted to 47 million USD and in 2020, they were 3.3 billion USD . In 2000, Epic had employed 396 workers and by now, more than 10,000 people are working for the company. The company also offered software worth 500 million USD free of charge in 2020 to support health facilities in the course of the pandemic (Boulton 2016, Jennings 2021).

In 2021, the company had 564 customers which operated about 2,400 hospitals worldwide. The dominance of Epic was strong particularly in the United States where the company's customers represented two thirds of the country's population, its main competitors being *Cerner* and *Meditech* (Jennings 2021). According to a KLAS Global Performance Report from 2015, Epic did however not perform as strong in other regions of the world (Heath 2015).

Summary

Epic Systems has been a major player in the US American hospital landscape for decades and has succeeded to strengthen its dominant position in the market despite much criticism. The company differs from its competitors in terms of general company strategy (no acquisitions, no investments) and also concerning its negative attitude on facilitated health data transfers, but it is plausible that there are also strategic considerations at play on both sides of the discussion. A closer look at the implementations of Epic Systems in different facilities reveals surprisingly heterogeneous results with successful implementations in the United States and also the Netherlands and significant problems in other facilities in the United States, the United Kingdom and especially Denmark. This suggests that implementation success is highly dependent on external conditions and also reflects studies which generated mixed results concerning the impacts of EHRs despite theoretical benefits (Cobb and Sauser 2014). It remains to be seen how Epic Systems will react on the new EHR-offerings of companies like Alphabet and Apple and, particularly in the United States, on the pressure to guarantee more health data interoperability.

15 Cerner

Cerner was founded in Kansas City, Missouri in 1979 and has been focussing on IT-solutions for health providers since its foundation (Cerner 2019). The company is mainly known for operating EHR-systems in hospitals and is the main competitor of Epic Systems in the United States. In 2021, Epic had a market share of 31% and Cerner had a market share of 25% in the US-market for EHR-systems (Drees 2021b). Besides its home market, Cerner also operated EHR-systems in more than 30 other countries including Germany as of 2019 (Cerner 2019, Collins 2020a). In 2021, it became known to the public that *Oracle* (see *Section 9*) will acquire Cerner for 28.3 billion USD (Knitterscheidt and Kerkmann 2021).

In 1982, the *St. John Medical Center* in Tulsa, Oklahoma was the first hospital to implement a Cerner-solution. The clinical IT-application *PathNet* had been advertised with the slogan "As fast as humanly possible is sometimes too slow" (Cerner 2019). Three years later, PathNet was also implemented in health facilities in the UK and Canada (Cerner 2019).

Unlike its main competitor in the United States, *Epic Systems* (see *Section 15*), which pursued a strict no investments strategy from the beginning, Cerner decided to go public already in 1986 (Cerner 2019).

In 2003, Cerner tried to close a 1.8 billion USD-deal with the US-American health provider *Kaiser Permanente* but in the end Epic succeeded in the negotiations which has been considered as the company's "breakout moment" (Cobb and Sauser 2014) (see *Section 14*).

In 2006, Cerner began operating its first health clinic on the company's *World Headquarters Campus* in Kansas City. The clinic had been built to offer care for Cerner-employees and their families and as of 2019, three further clinics on the company's facilities in different locations in Kansas City have been built (Cerner 2019).

One year later, Cerner planned to acquire *i-Solutions*, a medium-sized developer of hospital information systems from Mannheim, Germany. Also the *CompuGroup Medical* was interested in the acquisition but in the end, the Australian corporate group *IBA* managed to close the deal (Mau 2018) (see *Section 12*).

In 2015, Cerner acquired *Siemens*' health IT-unit *Siemens Medical Solutions* for 1.2 billion Euro. The deal also included three hospital information systems which had been developed by Siemens, *ISH-Med*, *Soarian* and *Medico*, and the deal made Cerner the second largest provider of HIS in Germany. However, some observers took the view that Cerner would probably resell the German-branches of its newly acquired HIS soon and that the real intention of the deal had been the acquisition of a competitor in the important US-American market (Mau 2016). As of 2016, ISH-Med was by far the market leader for HIS used by German university hospitals (Mau 2016).

In the same year, Cerner's revenue was projected to amount to 4.4 billion USD, a revenue twice as high as the one of its main competitor Epic Systems (Boulton 2016).

Still in 2015, Cerner partnered with the IT-company *Leidos* and the consultancy *Accenture* to apply for the development of a new EHR-system for the US-American *Department of Defence*. In the end, the group succeeded to close the deal being worth 9 billion USD. Also, companies like *Alphabet* and *Epic Systems*, which had partnered with *IBM* had been among the applicants (Boulton 2016, Terry 2016, Tech Monitor 2015) (see *Sections 2.3*, *8.3* and *14*).
However, Cerner was facing many problems in the aftermath of the implementation in several pilot facilities and veterans relying on the health services of the Department of Defence criticised the new system harshly. For instance, cancer diagnoses were delayed by months, medications for post traumatic stress disorder could not be prescribed on time and other medications were accidentally double-dosed after the implementation of the new system (Donovan-Smith and Dreher 2021).

Like Epic Systems, Cerner is a partner of *Apple*'s *Health Records*-project, which was launched in 2018 (see *Section 3.3*). Health Records is an application which enables users to access various health data concerning vaccinations, medications and allergies with their smartphone (Spiegel Online 2018).

In 2018, more than 500 hospitals in Germany operated an EHR-system by Cerner (Mau 2018).

In 2019, Cerner named *Amazon Web Services* its "preferred cloud provider" (Cerner 2019). The company had been searching for a partner being able to store its enormous amount of health data. Google had offered Cerner "tens of millions of dollars in incentives" (Farr 2020k) but Cerner still decided for Amazon. The company's decision might have been caused by the then ongoing discussions about the data scandal in the frame of Google's partnership with *Ascension* for *Project Nightingale* (see *Section2.2*) (Farr 2020k). Cerner

and Amazon had already collaborated in earlier years (Farr and Novet 2017).

In the controversial debate about more health data interoperability in the United States, Cerner supports the *Carin Alliance* which is in favour of better access for patients to their health data. While other Big Tech companies like *Microsoft* (see *Section 6*) and *Apple* (see *Section 3*) are also members of the alliance, Cerner's rival Epic Systems is hesitant about allowing for facilitated access (Farr 2020g).

Cerner collaborates with *Uber Health* and implemented Uber's services into its platform to arrange patient transfers (Landi 2020d).

In 2020, the *CompuGroup Medical* acquired huge parts of Cerner's portfolio in Germany and Spain for 250 million Euro (see *Section 12*) (kma Online 2022a, Collins 2020a). Apparently, the saturated market for hospital information systems in combination with low investments in the digitalization of the health sector had led to Cerner's decision to cut back on its activities in Germany (kma Online 2022a). A spokesperson of the company said that the plan was to "align around Cerner's core global assets" (CompuGroup Medical 2020). However, the hospital information systems *ish.med* and *Soarian Clinicals* were still owned by Cerner and used in about 250 hospitals in Germany (kma Online 2022a).
According to KMA Online (2022), the announcement of the *Hospital Future Act* (see *Sections 10.3, 11.6, 13*) has led to a further reassessment of the situation and Cerner's German headquarter emphasized that Cerner will reinforce its activities in Germany. The company had also advertised forty new positions in Germany with more to come in the future.

In 2021, *Oracle* announced its plans to acquire Cerner (see *Section 9*) for 28.3 billion USD (Knitterscheidt and Kerkmann 2021). The deal was closed in June 2022 (Oracle 2022). Cerner's system had already been operating on Oracle's database before, enabling a seamless transition and facilitated implementation of new components like Oracle's *Voice Digital Assistant*. According to Oracle, Cerner's established customers will benefit from extended Cloud-, AI- and machine learning-capabilities in the future (Makris 2022). However, there were also concerns of data protectionists due to Oracle's activities as a data broker (Sherman 2022) (see *Section 9.3*). For Instance, Cerner had advertised its *Cerner Real World Data*, a longitudinal data set with person-centric health information. The data are de-identified but it is not guaranteed that re-identification by Oracle (or its customers) is precluded (Sherman 2022).

Summary

Cerner is Epic System's main competitor in the HIS-market in the United States and after its acquisition of Siemens' health IT-unit, the company also belonged to the market leaders in Germany until it sold huge parts of its German business to CompuGroup Medical. It remains to be seen how the takeover of Oracle will impact Cerner's future activities and if the implementation of the Hospital Future Act will lead to a reinforcement of the company's activities in Germany.

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