Artificial Intelligence and The New Health Era

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ABSTRACT
Artificial Intelligence is representing a revolutionary technological development which is strongly reshaping the entire medical industry. Therefore, incumbents and new entrants are compelled to adapt their current business models in order to grasp the momentum to lead and pioneer in the quickly changing but likewise rapidly growing healthcare industry. This paper analyses business model changes and innovations by applying a uniquely created framework- The Integrated Pioneering Capabilities (IPC) Framework- to three selected global players in healthcare: Royal Philips, Alphabet Inc., and International Business Machines Corporation (IBM). Thereby both, existing capabilities within each firm and newly acquired and developed capabilities were outlined, with the latter complementing each respective company's capabilities repertoire and therefore strengthening their competitive advantage and enabling them to pioneer. Thereupon strategic actions conducted by each firm were stressed - including but not limited to strategic partnerships, collaborations, acquisitions and mergers- which are initiating eventual business model innovations or changes. Hence, at last, the application of the IPC framework enabled to determine whether AI developments in healthcare resulted in significant business model changes or simply led to continuous business model innovations, thereby demonstrating AI's imperative impact on the business models of incumbents and new entrants in the healthcare sector.

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1. INTRODUCTION

1.1 Introduction to Artificial Intelligence

The Medical Industry is experiencing a significant shift due to recent digitalization developments, driving businesses to adapt to the new technological advance, thus leading to unique opportunities for the entire healthcare sector.

One of the most dominant and influential developments is the progress of Artificial Intelligence, which is increasingly researched and implemented by well-established companies within the medical industry and new international conglomerates entering healthcare. Artificial Intelligence which is the machine's ability to continuously improve its performance without the need that humans have to explain exactly how to accomplish all the tasks it's given (Harvard Business Review, 2017), covers a broad range of technologies and applications, some of which are representing extensions of earlier techniques and others that are completely new (McKinsey, 2017).

Although AI is already well developed and applied within several other industries, the entrance in the medical sector is a novel approach, presenting a gap in the literature concerning AI's strong current and future impact on healthcare. AI implementation will be leading to business model changes for healthcare firms, driven by the need to adjust to the environmental developments. The application of a uniquely created framework-The Integrated Pioneering Capabilities (IPC) Framework- will be for that reason of high relevance within the following research, to fill the existing gap in the literature concerning AI's influence on healthcare companies and thereby also to show AI's impact on business models, both aimed to demonstrate AI's importance for healthcare.

Compared to the adoption within other industries, the health-sector is lagging behind to implement AI into existing business processes (McKinsey, 2017). Nevertheless, the importance of AI is demonstrated by a rapidly growing investment rate, which was estimated according to McKinsey to be between $26 billion to $39 billion within 2016. (McKinsey, 2017). High health-care spending, globally reaching 9.9% of GDP in 2014 (WHO, 2017), further underlines the tremendous interest to implement AI due to its cost saving ability. According to McKinsey, cost savings of AI-enabled initiatives would be $ 300 billion yearly in the US, therefore outlining its enormous potential to cut costs (McKinsey, 2017). Additionally, a study of Frost & Sullivan presented that the market for AI in healthcare is projected to reach $6.6 billion by 2021, while annual worldwide AI revenue will grow to $36.8 billion USD by 2021 according to the market intelligence firm Tractica, both exhibiting the rapid growth and profound importance of AI for healthcare (Medium, 2017).

AI has an unimaginable potential to improve and revolutionize the health-care industry, wherefore it is leading to new business opportunities for established and newly entering companies. The AI healthcare market is highly fragmented and characterized by diversified healthcare corporations increasingly developing AI capabilities, such as Phillips Healthcare, Johnson & Johnson, Pfizer etc., who are all in need to adapt to and catch up with new AI developments. Additionally, the market also includes large technology companies exploring AI applications in multiple industries, such as Google with its acquisition of DeepMind, IBM Watson with its new IBM Watson Health division, Microsoft, Apple and Samsung, who are all exploiting available big data and AI prowess for providing new healthcare services to its existing large customer base in the smartphone and wearables market. Key AI-based applications include intelligent diagnostics, which will significantly reduce misdiagnosis while also enabling the early detection of diseases such as cancer or cardiac diseases. Under the traditional diagnosis pathway, critical decisions were only based on the practitioner's ability to compare visuals of thousands of medical images. Today technologies like IBM's Watson are learning to determine patterns in imaging and text in electronic health record to provide precise diagnosis, thereby minimizing harmful misdiagnoses and customizing patient treatment (TMcapital, 2017). Additionally, further AI applications are drug discovery, whereby the drug development process which currently takes an average of 12 years (in the United States) will be significantly accelerated. Furthermore, another important AI application is treatment, including new developments concerning Robotics. Google partnered with Johnson and Johnson's (J&J) Ethicon, a medical device company, to further advance medical robotics. The newly created joint venture, Verb Surgical, leverages Ethicon's skills in surgical instrumentation and Google's capabilities across machine vision, imaging analysis and data analytics aiming to complement surgeon's abilities by using AI. (TMcapital, 2017).

The ability to compete in a fast-changing environment requires being agile in perceiving and generating opportunities to develop innovations (Afuah & Tucci, 2003) and improving the response to disruptions (Doz & Kosonen 2010). Therefore, established companies and new entering firms are both recognizing the need to adapt their business models in accordance with new AI developments. All companies are required to re-assess their existing business models with regard to the disruptive technological developments in healthcare, wherefore their business models need to change over time if companies strive to stay competitive in a continuously evolving industry (Doz & Kosonen, 2010; Teece, 2010). Therefore, the understanding and application of AI constitute a fundamental imperative for businesses and healthcare institutions to reinvent how healthcare is accessed and delivered (PwC, 2017).

Expectations for AI are sky high and corporate executives believe that AI will enable firms to move into new business, hence the industry experiences entries of new start-up companies and large multinational firms, shifting the existing equilibrium in healthcare (MIT Sloan, 2017). Well-known international software firms such as Google and IBM are entering the medical industry while leveraging on their existing knowledge of AI. International Business Machines Corporation, is shifting the industry with the application of IBM Watson within healthcare, IBM Watson Health. Google LLC is increasingly involved in the healthcare sector with acquisitions of and collaborations with start-up companies within the AI field. The $600 million acquisition of DeepMind in 2014, a firm with significant expertise in AI, is highly notable and enabling Google full integration and a strong competitive position within healthcare.

IBM Watson Health, Google (Deepmind) and Phillips Healthcare will be the focal point of the research paper and the conducted research will be centered around the following research question: ‘’ *How is Artificial Intelligence (AI) shaping the business models of incumbents and new entrants within the medical industry?’’* Thereby the following research objective(s) will be of particular interest:

- Researching AI's influence on the business models of the three selected companies (Application of IPC Framework)
    - i. Identifying Integrated Pioneering Capabilities
    - ii. Exploring strategic actions which are influencing the business models
    - iii. Determining barriers for business model reconfiguration/innovation
    - iv. Outlining specific AI applications of each company (used as a foundation for IPC's)

The following research paper will focus on the changing business models of 'Royal Philips', a well-established player within the medical industry, and technology giants 'IBM' and 'Google', both grasping the momentum to enter a shifting, but greatly promising and profitable market. Research will be provided about eventual business model changes or innovations by identifying Integrated Pioneering Capabilities, thereby looking at already existing and newly acquired/or developed capabilities in order to adapt to the new AI developments in healthcare. Therefore, three case studies for each respective firm will be conducted, whereby the uniquely created framework (IPC Framework) will be applied to determine AI's impact on the underlying business models.

2. THEORY

2.1 Artificial Intelligence (AI)

Artificial Intelligence - defined as the theory and development of computer systems able to perform tasks normally requiring human intelligence (Oxford University Press, 2018) - was coined and officially introduced by John McCarthy during the Dartmouth Summer Research Project on AI in 1956. The conference is considered to be the birth of AI as a field of science, but AI's origins date back even further to the work of Alan Tuning, who proposed for the first time the idea of a thinking machine with his publication of the Tuning test in 1950, accessing the possibility of machines to possess human intelligence. After its official introduction, the field of AI attracted high attention by leading experts and strong government funding, enabling further research and new developments. But during the 70s AI was experiencing first difficulties and critics, caused by high research investments and little results (BBC, 2018). Subsequently, interest in AI declined and AI did not make it into the spotlight until the victory of chess supercomputer Deep Blue by IBM, which was the first machine to defeat the then-defending world chess champion Garry Kasparov in a match in 1996 (Androidpit, 2017). Following the victory of Deep Blue, IBM's Watson defeated the two greatest 'Jeopardy!' champions in an exhibition match in 2011 and in 2016 a human professional player in the ancient Chinese game 'Go', an incredibly complex two-player board game with a seemingly infinite set of possible moves, was beaten by Google Deepmind's AI computer program Alpha Go (Medium, 2017).

2.2 Medical Industry- Developments

Today, big data, fast computers and advanced machine learning all are vital for the development of AI (Medium, 2017). Larger quantities of data, complemented by more sophisticated algorithms and sheer computing power have given AI increased force and capability (The Economist, 2018) and led to technological breakthroughs presenting new AI application opportunities in healthcare. Now the Healthcare AI market is among the AI industry's fastest growing sub-sectors and expected to grow at 39.4 % CAGR (compound annual growth rate) to over $10 billion in worldwide revenue by 2024 (TM capital, 2017), demonstrating its tremendous increasing role within the medical industry. Recent trends as the increasing number of elderly citizens, mounting healthcare expenditures, and a new data wave, are raising demographic pressures and resulting in workforce shortages, lack of access to quality and affordable healthcare and drastically increased health-care costs (PwC, 2017). An explosion in the amount of data for the health sector is visible in the past decade and the volume of data related to health was estimated to have reached over four zettabytes, which is approximately four trillion gigabytes (Medical Futurist, 2016). Staying current with and being able to access this data is beyond the scope of human capacities, underlining the importance of AI technologies to process the existing data which will enable new healthcare developments (PwC, 2017). A table with various trends in the healthcare industry is provided in the appendix (Appendix- Table 1), demonstrating the compelling need of AI for a vehemently improved healthcare industry.

2.3 Current Applications

AI is getting increasingly sophisticated at imitating human capabilities, but more efficiently, more quickly and less costly and is progressively partaking within our healthcare ecosystem (PwC, 2017). From insights and analytics, imaging and diagnostics, drug discovery to patient-specific treatment plans and virtual assistants, AI is poised to influence numerous fields of healthcare (PwC, 2017).

2.3.1 Intelligent Diagnostics

2.3.1.1 Early Detection

AI is increasingly applied to preventive care, i.e. early detection of diseases such as Alzheimer, Cancer and close monitoring of cardiac diseases at an early stage. Some clinicians are forecasting the spread of certain diseases by using AI technologies and try to anticipate which patients would be most likely to succumb (McKinsey, 2017). Supported by the acquired information, they are able to increase their understanding and offer preventive care to patients. The use of AI is enabling review and translation of mammograms 30 times faster with 99% accuracy, reducing the need for unnecessary biopsies as well as reducing the uncertainty and stress of misdiagnosis (PwC, 2017). AI is exceeding human capabilities, wherefore leading to benefits for clinicians with a reduction in workload and patients with better treatment possibilities. Additionally, AI enabled consumer wearables and other medical devices are helping doctors to improve the detection of potentially life-threatening diseases at early and therefore better treatable stages, again highlighting the vital importance of AI to detect and thereupon treat diseases.

2.3.1.2 Diagnosis

AI has the ability to process information much faster than any human can, thus presenting a great tool to increase efficiencies, as well as reducing misdiagnosis and medical errors (PwC, 2017). Additionally, AI enables quick and more accurate identification of disease indicators in medical images, like MRI, CT scans, ultrasound and x-rays, and therefore allows quick diagnostics reducing the time patients wait for a diagnosis from week to mere a few hours (Medium. 2017). In today's stringent healthcare compliance environment, practitioners are exposed to high pressure in events of misdiagnosis, which would subsequently lead to fatal mistreatments including high financial costs and negative psychological consequences for the patients. AI plans to close the diagnosis veracity gap within the medical industry by using algorithms that can make use of large data sets of patients while spotting patterns and relationships to arrive at clinical decisions. The more data is accessible for the technology, the smarter they become and the better will be the efficiency and accuracy for diagnosing diseases (TM capital, 2017). Additionally, it is anticipated that diagnostic outcomes could be potentially improved by 30% to 40% with clinical support from AI (TM capital, 2017). By significantly reducing the misdiagnosis rate, the AI technology will have the potential to decrease health care costs and reduce unnecessary testing and hospital stays, thereby initiating a new era in healthcare.

2.3.2 Treatment

Beyond scanning health records to assist clinicians to identify chronically ill individuals, AI can help to take a more comprehensive approach for the management of diseases, better coordinate care plans and help patients to better manage and comply with their long-term treatment programmes (PwC, 2017). New AI developments have a profound impact on improved

treatment possibilities since AI applications can sift through millions of pages of medical evidence, enabling them to provide diagnosis and treatment options in a few seconds. (McKinsey, 2017). Moreover, robotics is of high importance and are widely used for surgery, treatment of psychological conditions and supporting self-management of patients.

2.3.3 Drug Discovery

The extensive drug development and approval process are representing a significant cost within healthcare and according to Deloitte's recent estimation, R&D costs will reach $162 billion by 2020, illustrating a troubling challenge concerning the balancing efforts of the industry between reducing costs and growing innovation (TMcapital, 2017). According to the California Biomedical Research Association, currently, the drug development and approval process take on average 12 years for a drug to proceed from research to consumers. Only five in 5000 of the drugs starting pre-clinical testing ever make it to human testing and merely one of these is ever approved for human usage (TMcapital, 20117). On average, the development of a single new drug will cost a company $359 million, underlining the enormous potential of AI to reduce costs and accelerate the development process. Atomwise, a biotechnology company focusing on new drug discovery, found two drugs predicted by the utilization of AI which may strongly reduce Ebola infectivity. The analysis, which would have under usual circumstances taken months or years, could be completed within only one day, exhibiting the incredible potential of AI for reducing the time, money and effort needed for drug discovery and further development. (The Medical Futurist, 2017).

2.4 Business Models & IPC Framework

2.4.1 Business Models (BM's)

A business model presents how strategy is implemented (Casadesus-Masanell & Ricart, 2010) and it expresses the rationale of how an organization is creating, delivering and capturing value (Magretta, 2002, Tikkanen, Lamberg, Parvinen & Kallunki, 2005; Davenport, Leibold & Voelpel, 2006). A sophisticated and well-suited business model can lead to increased market attractiveness, initiating an improvement of the value capture and resulting in a competitive advantage (Björkdahl, 2009). Additionally, a BM only develops over time (Morris et al., 2005; Sosna et al., 2010; Teece, 2010), wherefore progressive refinements are essential to create internal consistency and to improve the ability to adapt to its environment (Demil and Lecocq, 2010). Therefore, sustained value creation, requiring to successfully and continuously shape, adapt and renew the underlying business model (Osterwalder and Pigneur, 2010), will be of paramount importance for emerging industries as the health-care sector. Only through a sustainable BM, firms within the rapidly changing industry can survive or pioneer and acquire a strong competitive position in the respective market.

2.4.1.1 Business Model Elements (BME's)

Business models are composed of different elements which are merged together (Magretta, 2002; Morris, Schindehutte, & Allen, 2005; Zott, Amit, & Massa, 2011) and firms accordingly need to identify the main components which will generate value (Basile & Faraci, 2015). Osterwalder, Pigneur, and Tucci (2005) introduced a business model ontology, outlining elements and sub-elements of the business model, called building blocks. Key recurring elements within the building blocks are the value proposition, a statement convincing customers that products/services offered are superior compared to competitors, the value network, comprising a set of connections between organisations and/or individuals interacting with each other (i.a. including core customer segments, customer relationships, distribution channels etc.), and the revenue/cost model, providing financial information of a respective company (Bohnsack et al., 2014). Siggelkow (2002) stresses that the core characteristic of elements within building blocks is that consistent measurement across various companies concerning changes in these elements is possible, but that caution is needed since the approach also assumes that the same elements are equally central in all firms.

2.4.2 Business Model Reconfiguration (BMR)

Companies are required to continually develop and modify their existing business models, thereby recognising that business model reconfiguration is essential for success, not only to take advantage of new value opportunities, but also due to the accompanied reduction of risk of inertia to change- which is existing within the organisational culture of firms who have been successful with its business model over some time (Achtenhagen et al., 2013). A reduction in market share and therefore profitability, or in the worst scenario, business failure and bankruptcy, are possible consequences if a firm is unable to adapt its business model successfully in the face of unexpected and significant environmental breakthroughs, such as new AI developments reshaping the healthcare industry (Ganguly, Nilchiani, & Farr, 2009, Wirtz et al., 2010; Kotter, 2012). Therefore, Business Model Innovation (BMI) is of tremendous importance, providing firms with opportunities to gain competitive advantage (Morris et al., 2005) and promoting the development of unique ways concerning value creation for customers as a way to prevent competitor imitation (Zott et al., 2011). BMI's strategic potential thus lies in the identification of new sources for value creation (Zott et al., 2011), based on innovations of the different BM components and/or interactions occurring between these components (Demil and Lecocq, 2010; Morris et al., 2005). Two main dimensions of value creation from BMI are widely shared among researches, namely efficiency and novelty (Zott and Amit, 2008). Efficiency concentrates on cost reductions of existing transactions, i.e. cost leadership, while novelty rather points out new ways to conduct transactions, i.e. the product differentiation strategy (Zott and Amit, 2008). BMI can be employed by companies either for value creation based on one of these sources, or it could be used for a combination of different sources (Amit and Zott, 2001), in both cases strengthening the underlying business model.

2.4.2.1 Barriers and Enablers for BMR

Though business model change is inevitable and essential for survival, barriers exist challenging the successful adaption of firms towards a new industry landscape. A cognitive barrier can be experienced, stressing that firms need to overcome the dominant logic existing in the organizational culture because it could act as a filter which may limit the perception of new opportunities (Battistella et al., 2017). Moreover, another barrier is that existing processes need to be reconfigured, i.e. the existing status quo will be challenged and changed, thereby leading to high costs and risks associated with the implementation of a new business model (Battistella et al., 2017). Additional barriers are the challenge to identify the need to change timely, thereby ensuring to catch up with competitors or lead the industry (Wirtz et al., 2010). Considering the barriers mentioned, according to Smith, Binns, and Tushman (2010) complex business model renewal correspondingly implies a high importance of leadership, more concretely, in learning, building commitment and trust and dynamic decision making, thereby facilitating BMR. However, the ultimate success of a BM is dependent on several factors such as market conditions, technological infrastructure, organizational culture, existing competencies and assets, all contributing to sustained value creation, the ability to pioneer in a shifting medical industry.

2.4.3 Strategic Agility

Today, possessing a new and distinct set of capabilities are a necessary requisite for the ultimate survival and success of a company to respond to a shifting business environment (Battistella et al., 2017). Strategic agility- defined as the ability to reinvent or refocus the firm and its strategy (Fartash, Davoudi & Semnan, 2012) by adapting to unforeseen changes in the business environment- is of outstanding importance for sustained value creation. Furthermore, strategic agility is also excellently beneficial for BMI, since being strategically agile implicates to gain the ability to dynamically revise or even reinvent the company as well as its strategy, while also to think and to act differently, finally resulting in BMI's, as the business environment changes (Morgan & Page, 2008; Doz & Kosonen. 2008a; Fartash et al., 2012). Agility is a dynamic process of anticipating and adjusting to new market demands, thereby i.a. aiming to acquire a strong competitive position within a rapidly changing environment. Thus, considering its significance for identifying and implementing business model changes, it initiates the development of Integrated Pioneering Capabilities, thereby triggering the execution of the IPC framework.

2.4.4 Integrated Pioneering Capabilities Framework (IPC Framework)

According to Teece (2007) companies are compelled to be proactive in order to seize, shape and capitalise on new opportunities and to achieve this strategic agility, companies first need to identify their capabilities and prevent falling into the ''capability myopia'', i.e. a cognitive failure describes as not recognising the urgency for the development of new capabilities to create new value propositions (Battistella et al., 2017). The framework for sustained value creation, created by Achtenhagen et al. (2013), complemented with the main classes of capabilities conceptualized by Battistella et al. (2017), will be used as a theoretical foundation for the creation of a unique, integrated framework –The Integrated Pioneering Capabilities Framework (IPCF) – and applied to the challenges of incumbents and new entrants to adjust and succeed in the changing, AI-driven, medical industry. Integrated Pioneering Capabilities (IPC's) will be required by incumbents and new entrants to facilitate both survival and success within the new era in healthcare. Within the scope of the following research, 'Integrated Pioneering Capabilities' are defined as interconnected and difficult- to-replicate capabilities that will enable companies to change by shaping and adapting to the environment (Teece et al., 1997; Eisenhardt and Martin, 2000) and therefore being able to pioneer. Looking at the uniquely created framework (Figure 1), the business model changes in the medical industry are initiated by strategic agility, thereby orchestrating the creation of IPC's for a successful adaption to the new AI developments within the industry. Thereupon the development and acquisition of IPC's were identified, which are classified into the three main capability classes of Battistella et al. (2017), strategy innovation, resource capitalization and networking capabilities. Additionally, critical capabilities proposed by Achtenhagen et al. (2013) were incorporated into the capability classes as well, wherefore enabling an excellent synergy between the capability classes of Battistella and actual critical capabilities of Achtenhagen, both complemented by newly identified capabilities. A table with IPC's, including their respective definitions, is provided in the appendix to enlarge a more thorough repertoire of capabilities in existing academic literature (see Appendix-Table 2).

❶ **Strategy Innovation Capabilities**

Starting with strategy innovation capabilities, this class includes capabilities with a specific focus on being adaptive, innovative and absorptive (Wang & Ahmed, 2007), by continuously perceiving and proactively reacting to change (Hamel & Valikangas, 2003), while also overcoming limitations of perception (Day & Schoemaker, 2004; Winter, 2004) and becoming conscious of the change and realizing its effects on existing business (Hamel & Valikangas, 2003). According to Achtenhagen et al (2013), it also includes to identify and exploit new business opportunities. Therefore, applying it respectively to the healthcare industry, new AI enabled technologies are of compelling interest, facilitating strategy innovation by using the opportunity to enter a rapidly changing and growing market.

❷ **Resource Capitalisation Capabilities**

Considering the resource capitalization capability class, it includes abilities for a company to first acquire, then develop and deploy its resources, thereafter capitalizing on the new resources to ultimately achieve a competitive advantage relative to other firms (Lado & Wilson, 1994; Boonpattarakan, 2012). Looking again at the respective healthcare industry, new resources- primarily new human capital including new skills and advanced technological knowledge, but also financial resources in form of funds and investments- will be of high necessity to successfully implement AI into ongoing business operations. Hence companies aiming to successfully operate within the newly shaped landscape are driven to pursue Achtenhagen et al. (2013) proposal to use resources in a balanced way, i.e. acquiring new resources and allocating them effectively.

❸ **Networking Capabilities**

Finally, the networking capabilities class focuses on integration and connectivity- i.e. clear communication, top management support and collaborative culture- within an organization's internal system, while also considering external interest groups- i.e. specifically concentrating on stakeholder integration, (Battistella et al., 2017). To successfully implement AI into the business practices in the medical field, a supportive leadership and collaborative organizational culture will be essential, complemented by clear communication with customers, suppliers, and employees. Concluding, Achtenhagen et al. (2013) expressed that an important element for success in the changing industry is to achieve coherence between the stated capabilities, active leadership, corporate culture and employee commitment. Subsequently, the introduced IPC's from each respective class will facilitate the execution of *Strategic Actions* for new value creation with AI technology. According to Achtenhagen et al. (2013), strategic actions include, but are not limited to, new strategic partnerships, mergers and acquisitions, new AI departments and new expansion strategies to acquire new talent and knowledge for exploiting unique business opportunities. Additional new strategic actions are the acquisition of new resources to successfully implement AI technologies and the development of a new revenue and cost structure, altogether resulting in changes in existing *Business Models*. By combining the IPC's and strategizing actions for value creation, business models of respective firms can be shaped, adapted and even renewed, therefore making it possible to fully integrate into the changing landscape. Achtenhagen et al (2013) state that changes in the business model will encompass new products/services developed by AI technologies in the respective healthcare industry, new markets and customers which can be satisfied by the advances that AI is making possible, and further changes regarding the value network and cost structure, therefore strongly affecting various business model elements.

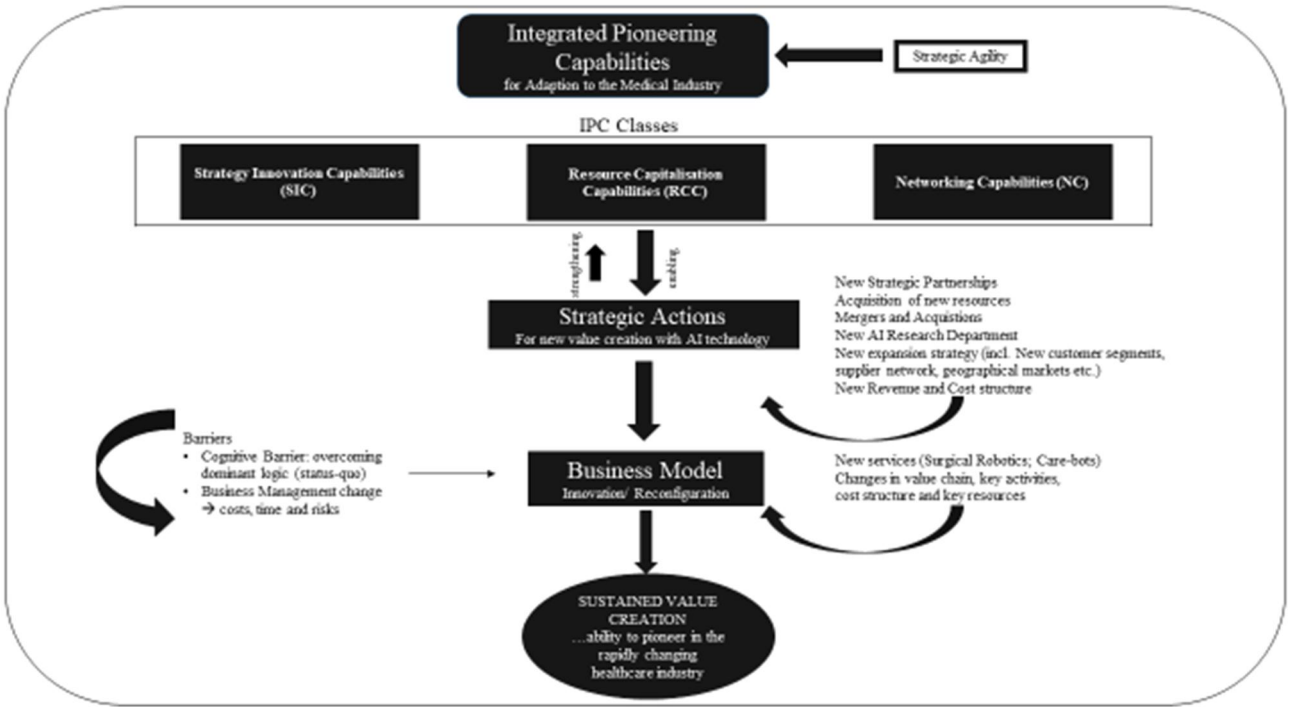

Figure 1- Integrated Pioneering Capabilities (IPC) Framework [created by Veysel Ümit, based on Achtenhagen et al. (2013) & Battistella et al. (2017)]

Although business model change will be inevitable for companies following the framework, they need to overcome existing barriers representing challenges and thereby interfering with the adaption process. Only with an innovative business model, initiated by IPC's and followed by the accompanied strategic actions, the fundamental purpose of achieving *Sustained Value Creation* can be achieved. In the end, sustained value creation is the instrumental factor, ipso facto, enabling firms following the framework to pioneer and lead the race within the new era in the healthcare industry.

3. METHODOLOGY

3.1.1 Research Design

Considering the design of the given research, I first stressed current healthcare trends and developments and studied four dominant AI application areas - early detection, diagnosis, treatment and drug discovery. Thereupon I aimed to provide a strong theoretical foundation comprised of business models, business model elements, reconfigurations, innovations and barriers and enablers, all critical for the application of a uniquely created theoretical framework- 'Integrated Pioneering Capabilities Framework (Figure 1). The framework created is based on Achtenhagen et al (2013) own theoretical framework of critical capabilities, complemented with the capability classes introduced by Battistella et al (2017) and used to identify business model changes in each respective case study. Table 2 (Appendix) provides a list of capabilities included in each class and their definitions and within the results section, firm-specific capabilities of the selected companies are identified and incorporated into the overall IPC framework. Within each case study, by comparing business activities initiated by the AI adoption process with existing capabilities in literature for successful adaption to a new environment, the most compelling existing capabilities (according to company annual reports) of the respective company were identified, complemented by newly acquired and/or developed capabilities (stressed by business paper publications and annual reports) to facilitate a smooth adaption to the reshaped, AI dominated, environment. Indicators for the assessment of the capabilities were, therefore, business activities of each firm (according to annual reports, company website, business paper publications etc.) which are either displaying existing capabilities in literature for adaption or leading to the creation of new Integrated Pioneering Capabilities through acquisitions or intra-firm capabilities developments through new research centers. Based on both, existing and newly acquired/developed capabilities, strategic actions were explored, which ultimately are influencing the underlying BM's of each firm. Hence, following the case studies, the research was concluded with a discussion by defining AI's particular impact for incumbents and new entrants in the medical industry, thereby identifying the need for either a radical business model change or an incremental business model innovation.

3.1.2 Research Setting

The given papers requirements for the selection of each case study company did include the following points. At least:

- One incumbent multinational healthcare company, representing a big player faced with the need to adapt to the AI developments
- One multinational new entrant with considerable healthcare operations (new healthcare division), exploiting the new opportunities in the quickly changing healthcare sector and aiming to pioneer

Hence the research will be centered on three major players within the medical industry, Royal Phillips, IBM, and Alphabet. The companies studied in this research are ideal for exploring challenges and changes experienced within the medical industry. Philips is representing an incumbent operating for decades within the sector, therefore possesses significant healthcare experience, but nevertheless is compelled to catch up with competitors and new entrants concerning the adoption of new AI technologies. IBM and Google, on the other hand, are both exemplary for new entrants with new AI dominated healthcare departments and are increasingly making use of their technology knowledge and substantial organizational resources, enabling them to pioneer in

the healthcare industry. The point of interest will be to study the challenges of an incumbent firm (Royal Phillips) to adapt to the new AI developments, while also considering activities of new entrants (IBM and Google) concerning AI implementation for healthcare. Therefore, a respective case study for each company is provided, by looking at how each firm is responding to AI and how AI developments are influencing their existing BM's.

3.1.3 Data Sources

Considering sources for the given research, mainly secondary data will be collected to explore AI applications and AI's impact on each company respectively. The choice to focus on secondary data was based on the overwhelming amount of existing data concerning AI for healthcare and AI driven healthcare operations of each respective firm, by publications of industry experts, leading consultants, and renowned business papers. Thus, the use of primary data was not of high necessity, added by the complexity to reach employees of the selected big multinational companies who also need to have all the information and knowledge about AI's impact on the business model of their company. Publicly available and private data from press reviews, websites, official company documents, business publications, and articles from newspapers, homepages, and other publications are used as the source for the whole research and are providing a sufficient and strong foundation of information to answer the constructed research question. To be more concrete, identified capabilities within the results section for each case are based on scientific articles and will be backed up with evidence provided from the publicly available information of companies on their company websites, executive reports and annual reports, complemented by business reports and economic newspaper articles. The data that will be used is of qualitative and quantitative nature, aiming to present the vital impact of AI on healthcare, whilst increasing the information base, and to diversify data in order to reduce biases (Patton, 2002; Yin, 2003).

3.1.4 Data Collection

The unit of analysis for each selected company was the entire business model concerning healthcare activities. Specifically, the research investigated Integrated Pioneering Capabilities required for the reconfiguration of existing business models, complemented by strategic actions influencing underlying BM's, both together enabling a successful adaption and the opportunity to pioneer in a shifting industry. Data was collected by using information provided on company websites and annual reports, thereupon complemented and reinforced by further supporting information from business paper publications. Hence the search strategy was focused on the AI implementation by each firm and specific search words for each firm did include i.a., AI healthcare, AI healthcare developments, AI healthcare application, AI adoption, AI capabilities and more. Thereby the databases of each firm were utilized, i.e. annual reports and company website information were primarily focused on.

To handle the research question, for each case:

1) A general company profile and overview concerning healthcare operations were provided
2) The Integrated Pioneering Framework was applied (including the identification of existing and newly acquired/developed capabilities, strategic actions, and business model barriers and finally the impact on underlying business models).

4. RESULTS (CASE STUDIES)

In the following case studies, Integrated Pioneering Capabilities to successfully operate and lead in the reshaped healthcare industry will be outlined, whereby the unique IPC Framework (Figure 1) will be applied for each respective company. First capabilities from each respective capability class will be explored, whereupon strategic actions and ultimately business model barriers and eventual changes will be researched. Additionally, each company's respective AI applications are explored and provided in a table (see Appendix Table 8-Section 6.4) - serving as a foundation for IPC's and strategic actions for business model reconfiguration.

4.1 Alphabet Inc.

Alphabet Inc. is an American multinational conglomerate created as the result of Google LLC's corporate restructuring in 2015. For simplicity within the following research, Alphabet will be referred as Google, the original technology company founded in 1998 and now representing one of the strongest and largest technology companies worldwide. Google LLC specializes in Internet-related services, including online advertising services, the search engine, software, hardware, cloud computing services et cetera. The companies' rapid growth facilitated a further expansion by developing new services and entering new markets such as the medical industry. Healthcare, combined with new AI developments, is representing an extraordinarily growing and profitable market, wherefore it became of eminent interest as it presents a promising opportunity for Google who always strives to enter new profitable markets. Google is betting that the future of healthcare is going to be AI, therefore strongly turning its focus to the shifting healthcare sector, convinced that AI can create a powerful new paradigm for the diagnosis, treatment, and detection of diseases (CB Insights, 2017).

4.1.1 Google DeepMind

DeepMind Technologies, a wholly-owned subsidiary of the Google conglomerate Alphabet Incorporated, founded in 2010, is claiming to be the world leader in artificial intelligence research and its application (DeepMind, 2018). Google's $500M+ acquisition of DeepMind in 2014 was reasoned to jump-start their own AI research, integrate AI into various Google products and services and most importantly, to facilitate an entrance into the medical industry. DeepMind utilizes machine learning AI armed with neuroscience insights to create strong general-purpose algorithms that are able to independently and continuously learn without the need to be taught (DeepMind, 2018). Concluding, DeepMind facilitated Google to enter a new rapidly changing healthcare market and provides an excellent opportunity to grasp the momentum and pioneer in the newly created landscape.

4.1.2 IPC Framework: Google DeepMind

4.1.2.1 Strategy Innovation Capabilities (I)

Starting with *Strategy Innovation Capabilities* a compelling capability already existing within the company is *Adaptive Capability.* Google is known for continuously searching new market opportunities and to leverage on its technology capabilities to exploit new market opportunities through offering new products and services and entering new partnerships. The acquisition of DeepMind is presenting an optimal example that Google acquired a company with high potential to be involved in a market with likewise high potential for growth and profitability. Furthermore, DeepMind's partnership with the NHS concerning the improvement of solutions for Acute Kidney Injuries (AKI's) is illustrating a concrete example of how Google identified and capitalized with DeepMinds AI technology on an emerging market opportunity to improve the early detection of AKI's (Boseley & Lewis, 2016). According to NHS professionals, more than a quarter of the 40,000 AKI deaths annually are entirely preventable, provided that better early detection would be existing (Suleyman, 2016) and hence DeepMind harnesses its capability to exploit a promising market

opportunity, which will result in early detection and better treatment of kidney malfunctions. Additionally, other capabilities already in possession of Google are *Experimentation, Anticipation* and *Innovation Capability,* since Google places high value on innovation to anticipate new market demands and opportunities to be able to adapt to and lead within new market ecosystems. Google DeepMind's partnership with the Moorfields Eye Hospital depicts an excellent example since the machine learning technology is used to experiment how it could help to analyze and understand eye scans to ultimately improve and make an earlier diagnosis for eye diseases. DeepMind is, therefore, experimenting with its innovative ML technology and anticipating to find new solutions by generating information to understand and thereupon prevent the three biggest serious eye diseases: glaucoma, diabetic retinopathy and age-related macular degeneration (Ram, A., 2018). Nevertheless, also new Integrated Pioneering Capabilities are formed with the acquisition of DeepMind, namely *Agility* and *Acuity*. DeepMinds acquisition enables Google to adapt to a heretofore unexplored market by Google and also provides the firm with an understanding of a new environment, making it possible to get knowledge of market players, market needs and changes in the market through AI. Nevertheless, a new capability that will be required for an effective interplay between Google and DeepMind is the *Grafting Capability*, since Google needs to know how to effectively gather information and incorporate knowledge and skills of DeepMind, while also understanding to provide DeepMind with the right resources, altogether enabling both to grow and succeed.

4.1.2.2 Resource Capitalization Capabilities (II)

Now considering *Resource Capitalization Capabilities*, *Technological Competencies,* represents a strong capability that both companies already possess, therefore enabling both to complement their technological skills and to leverage on them to pioneer in the healthcare industry. Google DeepMind's advanced ML technology represents a strong technological competency, which is harnessed within various business units and strategic partnerships. DeepMinds partnership with the NHS provides an example of how its ML technology is utilized within the healthcare industry, whereby DeepMind utilizes its ML technology to develop a software in partnership with NHS hospitals to improve early detection by alerting professional healthcare staff to patients who are at risk of risk of deterioration and death through kidney failure (Boseley & Lewis, 2016). The machine learning technology of DeepMind will significantly improve early detection, since the computer program is able to teach itself to find correlations and patterns in complex data, exceeding human capabilities and thereby resulting in better treatment and life savings connected to kidney malfunctions. Moreover, the DeepMind acquisition will enable the capability to *Gain and Release Resources* since new AI knowledge will be acquired and then shared across the company. Google DeepMind's AI technology will be for instance integrated into other services provided by Google, such as for the improvement of its search engine and AdWords services, enabling them to improve existing business practices and make AI the centerpiece of all operations. Additionally, *Strategic Unity* and *Teamwork* are representing capabilities that will be required to enlarge for a successful collaboration between Google and the professionals from DeepMind Technology. Although both companies are operating independently, they need to work together to a certain extent by sharing their existing knowledge and resources to achieve a common goal- the success of Alphabet Incorporated.

4.1.2.3 Networking Capabilities (III)

Finally considering *Networking Capabilities (III)*, *Collaboration Capability,* depicts a capability frequently visible at Google, since the company has multiple subsidiaries with whom they have successful long-term collaborations. The particular DeepMind for Google team will further reinforce the collaboration capability, ensuring that both- the parent company and the subsidiary- will strongly benefit from each other and strengthen their respective competitive position. Furthermore, DeepMinds acquisition provides new capabilities such as *Interconnectivity*, since projects implemented by DeepMind with its ML technology are interconnected and can be used for other purposes by mutually complementing and supporting each other. DeepMinds partnership with the Moorfields Eye Hospital to utilize machine learning for the improvement of eye disease diagnosis is highlighting an exemplary case, since the AI used in the process is stressed to be generalized. This means that it can be applied to other kind of images, wherefore other projects such as training the algorithm to analyze radiotherapy scans and mammograms by collaborating with the University College London Hospitals and the Imperial College London can be conducted (Ram, A., 2018). Additionally, DeepMind is generating *Communication Capability*, since only through DeepMinds communication concerning AI developments, Google acquires a clear understanding about AI and accompanied changes in the medical industry initiated by AI, which thereafter can be shared within the whole firm. Hence the DeepMind for Google team is designed to approach the challenge of clear communication and collaboration. Finally, *Stakeholder Integration* will be an important capability that needs to be developed, ensuring that all stakeholders of Google and DeepMind are involved in the adoption process and support the new AI technologies used both for the healthcare industry and Google's existing business practices. Only by creating understanding and support of all stakeholders concerning the need for AI, AI's essentials and the accompanied future changes, DeepMinds acquisition will be a true success and accomplish Google's ambitions to pioneer within various industries by adapting to and leveraging on AI technologies.

Table 1 Google DeepMind- Integrated Pioneering Capabilities

SIC (I)	RCC (II)	NC (III)
Adaptive Capability	Technological Competencies	Collaboration
Experimentation & Anticipation	Gain & Release Resources	Interconnectivity
Innovative Capability	Teamwork	Communication
Agility & Acuity	Strategic Unity	Stakeholder Integration
Grafting		

4.1.2.4 Strategic Actions (IV)

Considering strategic actions, Google concentrates on carefully selected strategic acquisitions such as the DeepMind acquisition, whereby aiming to add new revenue streams and capabilities to experiment with a new technology, to prepare for further value creation (Achtenhagen, 2013). Google's venture capital arm 'GV' –providing seed, venture and growth stage funding for start-up companies - has been the most active investor in healthcare AI start-ups with investments in nearly 60 healthcare-related companies since it raised its first fund in 2009 (D'Onfro, 2018). Two of five main portfolios of GV, namely 'Life Science & Health' and 'Data & AI', are representing investment areas – partly aimed to complement DeepMinds existing AI technology- and partly to build parallel, new subsidiaries working with AI to enable Google to join and lead within the rapidly changing healthcare industry. Furthermore, Google DeepMind places a high value on partnerships with leading hospitals as e.g. the Moorfields Eye Hospital in London, NHS hospitals, University College London hospitals and Imperial College London

hospitals, thereby mutually benefiting by helping professionals to improve patient care while generating new practical insights for DeepMinds AI technology. Moreover, DeepMind facilitates the acquisition of new resources for Google, primarily human capital, financial resources, and additional technological competencies, by integrating highly skilled professionals with advanced AI knowledge and also new revenue streams through the AI technologies that DeepMind is developing, into Google's existing services and products. Hence DeepMind introduces to Google new customer segments and a unique value proposition based on AI with a focus on differentiation, thereby enabling Google to set a landmark in the AI healthcare race.

4.1.2.5 Barriers & Business Model Change

Although the IPC's, accompanied by the strategic actions, will influence the existing business model of Google, first the company needs to overcome a cognitive barrier which slows down its adaption process to the reshaped healthcare industry. Top management needs to accept that DeepMind is introducing new knowledge and is the leading party concerning Google's entrance into the medical industry. DeepMinds 'DeepMind for Google' team is designed for tackling this barrier, facilitating the integration of both parties and allowing Google to understand the new AI technology and DeepMind to test and apply the technology to Google's existing services and business operations. However, Google DeepMind is operating as an entirely independent subsidiary, wherefore the cognitive barrier of challenging the dominant logic existing in Google is weakened, i.e. the status quo will not be strongly reshaped. Hence the acquisition of DeepMind is not presenting a radical business management change, but rather enables Google to capitalize on a significant new business opportunity which will drive the company to adjust their existing business model. Figure 2 (Appendix) provides an overview of the IPC's, accompanied by the strategic actions and how they together shape the existing business model. The IPC Framework- applied for Google DeepMind- clearly demonstrates that Google's existing business model will be driven to the need to adapt, but that the acquisition of DeepMind and the entrance to the healthcare industry will not lead to a radical business model change. Rather, Google will follow their existing business practice of continuously innovating their business model (BMI), facilitating the technology giant to incrementally change and adapt to the healthcare industry. Altogether, the innovative business model will result in sustained value creation and make sure that Google can pioneer through its numerous investments and wide-reaching partnerships in the healthcare industry.

4.2 International Business Machines Corporation (IBM)

International Business Machines Corporation (IBM), founded in 1911, is a leading American multinational technology company with an industry-leading portfolio focused on i.a. cloud platform and cognitive solutions, consulting services and manufacturing of computer hardware, software, and middleware, all bolstered by being one of the world's leading research organizations (Bloomberg, 2018). IBM launched the Watson group in 2014, initiating a new era in computing with the introduction of IBM Watson- a cognitive computing platform with the ability to interact in natural language, process big data and continuously learn from interactions with computers and with people (Reuters, 2018). Watson is also intended to be an engine of transformation within IBM itself, guaranteeing the continuous adaption of the company to new technologies and environments (Lorenzetti, L., 2016). Hence IBM is respectively harnessing Watson for its entrance to the rapidly changing -but likewise significantly growing- healthcare market. Monumental market changes towards AI enabled technologies are consequently opening up excellent opportunities, resulting in the development of a new business unit focused on healthcare which is enabling IBM to pioneer by leveraging on their existing Watson AI technology.

4.2.1 IBM Watson Health (IBM WH)

IBM Watson Health is a new business unit, launched in 2015 and specifically designed for applying Watsons' AI technology to healthcare problems (Darrow, B., 2015). Watson Health works across the healthcare landscape, from payers and providers to government and life sciences, whereby it uses its AI technologies to create intelligent connections that shape new ways of working, drive value and accelerate breakthroughs (IBM, 2017). The healthcare division aims to provide clinicians and healthcare professionals with the latest AI technologies and expertise that they need to solve health challenges for people everywhere. Watson Health will create a single secure database, able to read patient's symptoms, followed by running through thousands of clinical studies, similar patient records and medical textbooks, to ultimately improve intelligent diagnostics, provide personalized treatment and to accelerate the drug development process (Lorenzetti, L., 2016). However, WH first needs a huge amount of complex data to be trained, which is not readily available nor easy to access (Darrow, B., 2018). IBM aggressively attempts to fill the data gap with acquisitions of data companies such as the $ 2.6 billion acquisition of Truven Health Analytics in 2016, a leading provider of cloud-based healthcare data (IBM, 2016). Additionally, IBM is further pursuing to integrate several health-related acquisitions to acquire more healthcare data. Explorys, including a 50 million people large data set and Merge Healthcare, a medical imaging company are additional acquisitions to support IBM Watson Health (Darrow, B., 2015). Moreover, WH also has ongoing partnerships with companies of various industries and is collaborating with Apple, to store and analyse data for ResearchKit (Apple's open source framework), with J&J to analyse existing scientific papers for new drug development and with the sports giant Under Armour to develop a cognitive coaching system for athletes (Lorenzetti, L., 2016).

4.2.2 IPC Framework: IBM Watson Health

4.2.2.1 Strategy Innovation Capabilities (I)

Seizing Opportunities Capability is depicting an already existing capability within IBM with enormous importance. IBM Watson Health is hereby an excellent example since the creation of the new business division displays that IBM realized its existing technological leverage with the Watson AI technology and the associated opportunity linked with Watson to enter and pioneer within the rapidly changing, AI-driven medical industry. Next, another significant existing capability is the *Reconfiguration Capability.* According to IBM (IBM Annual Report, 2017), IBM does not only strive to adapt their own business operations towards reshaped industries but rather also strongly focuses to create value for its client companies by enabling capabilities that transform their business, enabling them to transition from era to era. Watson Health is enabling leading pharmaceutical companies, (e.g. Pfizer, J&J), hospitals (e.g. MSK), technology companies (e.g. Apple Inc.) and even sportswear companies (Under Armour) to adjust to the respective- AI enforced- changes in their industries, thereby demonstrating its strong reconfiguration capability. Furthermore, also the Agility Capability is manifested within IBM since according to IBM (IBM Annual Report, 2017), the company aims to transform into an agile firm to drive innovation and help to drive productivity, which supports investments for participation in markets with great long-term opportunities. Watson Health is supporting and strengthening IBM's agility capability with the entrance into a market with significant long-term growth and profitability

prospects. Additionally, Watson Health is complementing IBM's existing capabilities with the *Innovative Capability.* IBM's Watson technology enables the creation of innovative business units exploiting its AI technology to target various healthcare solutions. IBM Watson for Drug Discovery is representing such an innovative AI-based program which significantly accelerates the development of drugs by helping researchers to identify novel drug targets and new indications for existing drugs (IBM, 2018). It analyses existing scientific knowledge and complex data, thereby detecting known and hidden connections that will result in new innovations and breakthroughs in drug discovery and development (IBM, 2018). However, IBM WH is not only developing new products and services, but is also strongly influencing and supporting the already existing change within the medical industry towards AI enabled technologies and therefore helping to reshape and develop an entire market with its innovative Watson technology.

4.2.2.2 Resource Capitalisation Capabilities (II)

Technological Competencies is an essential capability already strongly embedded in IBM. According to IBM (IBM Annual Report, 2017), the company's most valuable technological capabilities are including the following:

- IBM Watson Cloud: Cloud is facilitating the establishment of platforms through agility, standardization, and innovation.
- IBM Blockchain Solutions: Transforming business practices in areas such as banking and financial services, but also slowly integrated into healthcare.
- IBM Watson IoT: AI enabled solutions, assisting organizations to mine intelligence from connected devices (e.g. Healthcare Apps, Smartwatches.)

IBM WH is exploiting IBM's technological infrastructure and implementing the capabilities provided by the above-presented technologies into their own business operations. IBM Watson for Oncology, a business division from WH developed in partnership with the New York Memorial Sloan Kettering Cancer Center and aimed to provide top-tier treatment indifferent of patient's geographical location- is highlighting an example of WH's strong technological competencies and how WH is making use of other IBM technologies. Watson for Oncology has a brilliant ability to analyze and understand structured and unstructured data in clinical notes, reports, and intelligence from connected services –e.g. Healthcare Apps through the IoT technology (Medical Futurist, 2016). The analyzed data and researched solutions will be stored and shared through the Watson Cloud platform, facilitating access to new knowledge and solutions for healthcare professionals worldwide. Hence Watson for Oncology is harnessing the Watson Cloud and Watson IoT technological capabilities, to create industry-leading solutions and to reinforce the Watson AI technology. Moreover, *Strategic Unity* and *Teamwork* are stressing capabilities imperative for the success of WH. Due to the reason that WH won't be entirely independent of IBM, it will be crucial to ensure that knowledge is shared efficiently and that professionals can interact, communicate and collaborate together successfully while sharing overall an identical strategic objective- namely the prosperity of IBM.

4.2.2.3 Networking Capabilities (III)

Now concentrating at the last capability class, the *Coordination & Integration Capability* is highlighting another existing capability within IBM. IBM is actively involved in various industries and especially the Watson technology is applied in industries varying from financial services to healthcare. Within healthcare, the Watson technology is again integrated across various solution areas encompassing diagnostics, treatment, drug discovery and more. Moreover, the Watson for Oncology business unit does target enhanced standardization of cancer treatment across the whole industry, next to its purpose to improve and create treatment solutions. Watson is trained to incorporate the highly specific expertise of MSK oncologist's experts, thereby expanding and making solutions and new knowledge accessible to other doctors and ultimately generating a tremendously improved knowledge and skills standard (Lorenzetti, L., 2016). The particular partnership with the MSK for improved treatment and enhanced cancer treatment standard is also introducing another capability, namely *Collaboration.* Achieving both targets will require a strong collaboration between the MSK and IBM WHFO, whereby Watson will contribute the framework to learn, connect and store the data, while the MSK will provide its knowledge and thereby train and improve the computer system, enabling both to mutually benefit from each other and build a strong collaboration. Additionally, *Interconnectivity* depicting another capability within IBM WH and is best illustrated with the IBM Watson Health Imaging (WHI) division, which is approaching enhanced intelligent diagnostics by delivering AI based medical imaging solutions for radiologists, cardiologists and various other healthcare providers (IBM WHI, 2016). WHI aims to introduce solutions that are able to analyze and interconnect heretofore isolated structured and unstructured patient, population and medical research data, to significantly improve the detection of abnormalities (IBM WHI, 2016). Furthermore, *Customer Connectivity Capability* is representing a meaningful capability for IBM. According to the firm- the business strategy of IBM starts with its clients and IBM has established a reputation of trust and personal responsibility with its clients for centuries (IBM Annual Report, 2017). Although *Stakeholder Integration* will be of high importance for the success of Watson Health, it already has a wide-reaching network of partnerships which can be used for new collaborations and an effective entrance into the new industry.

Table 2 IBM-Watson Health- Integrated Pioneering Capabilities

SIC (I)	RCC (II)	NC (III)
Seizing Opportunities	Technological Competencies	Coordination & Integration
Reconfiguration	Strategic Unity	Collaboration
Innovative Capability	Teamwork	Interconnectivity
Agility		Customer Connectivity
		Stakeholder Integration

4.2.2.4 Strategic Actions

Watson Health follows Achtenhagen et al. (2013) principle by concentrating on focused and selected strategic acquisition and new strategic partnerships, together strengthening IBM's overall competitive position, while reinforcing their IPC's which are required to succeed in the changing healthcare industry. Next to the acquisition of healthcare startups and/or healthcare data companies (see Section 4.2.1), WH maintains a wide-reaching partnership network with leading clinics worldwide. The Cleveland Clinic Lerner College of Medicine, the New York Memorial Sloan Kettering Cancer Center and the Manipal Hospital's (India) – are all representing partnerships with some of the world's leading clinics and together realizing the powerful potential of AI and the interplay of technology and healthcare. WH for Drug Discovery is an exemplary business division within WH which has strong strategic collaborations. Toronto Western Hospital is harnessing the Watson technology to research Parkinson, whereby they already identified new drugs worthy of further study of which a dozen have never been linked to Parkinson before. Next, to this, IBM and Pfizer announced an official partnership in December 2016, whereby IBM's Drug

Discovery program will be utilized to help accelerate Pfizer's research concerning cancer treatment in immune-oncology (TM capital, 2016). With the creation of the Watson Health business division, IBM formed a unique department with strong industry-wide strategic partnerships focusing on AI for the medical industry which will introduce a new expansion strategy and strengthen the conglomerate's strong competitive position. Furthermore, WH is fundamentally influencing the transition of the healthcare sector towards AI enabled technologies, therefore strongly contributing to the disruption of the existing landscape. Consequently, IBM maintains a dominant role with its advanced AI technology in the evolving medical industry and devotes a tremendous amount for investments to further reinforce their position.

4.2.2.5 Barriers & Business Model Change

IBM needs to manage barriers within the corporate structure to tap the full potential of Watson's AI technology. Although the creation of Watson Health does not imply a radical change- since the Watson technology was already existing and is now exploited by the healthcare division to enter a new market- there will be nevertheless business management changes to be considered. Cost, time and risk are hereby factors that need to be carefully tackled, since the entrance in the medical industry is of high costs coupled with uncertainties concerning AI applications. After devoting more than $4 billion solely for acquisitions by Watson Health the business unit is pressured to demonstrate results and generate revenue and profits out of Watson in the growing medical industry. Hence another barrier is the high internal and external expectations associated with the Watson AI technology and its ability to lead to breakthrough healthcare developments. However, Watson Health will not result in radical business model changes within IBM, since the company already harnesses a dynamic, agile and innovative business model which is continuously adapting to changing industries and economic environments (IBM Annual Report, 2017). According to IBM (IBM Annual Report, 2017), the company's business model is built to achieve two fundamental objectives: I.) Supporting clients to transition into a new era by bringing together innovative technology and industry expertise - II.) Generating long-term value for shareholders. Both objectives are perfectly applicable to Watson Health, which aims to generate long-term profits with its Watson technology while helping to reshape and advance the entire healthcare sector. Figure 3 (Appendix) provides an overview of the IPC's and strategic actions influencing and complementing IBM's existing business model. The IPC Framework shows that the original business model objectives and main business principles will remain in place and that opposed to radical BM changes, Watson Health will simply strengthen and complement the existing BM with continued business model innovations, ensuring to acquire an industry-leading position and to ultimately achieve sustained value creation by leveraging on IBM's unique Watson AI technology.

4.3 Koninklijke Philips N.V. (Royal Philips)

Royal Philips, formerly known as Royal Philips Electronics (until May 2013), is a Dutch technology company founded in 1891 (Yahoo Finance, 2018). Philips initiated an official corporate restructuring in 2013, shifting its focus from once being a leading electronic conglomerate, into a highly specialized and innovative healthcare technology company pioneering in the reshaped healthcare industry. Consequently, Philips announced to establish two standalone firms, respectively focused on HealthTech and Lightning. The company restructured into three main divisions, including a stand-alone structure for Signify (formerly Philips Lightning), complemented by Philips Consumer Lifestyle and Philips Healthcare- together representing HealthTech (Philips Annual Report, 2017).

4.3.1 Philips Healthcare

Philips, armored with over 100 years of experience in healthcare, claims after its official restructuring to primarily focus on improving people's health and to facilitate enhanced outcomes across the health continuum from prevention, to diagnosis, treatment and finally home care (Bloomberg, 2018). Furthermore, by leveraging on its advanced technology coupled with deep clinical and consumer insights, the company is providing innovative products and services in diagnostic imaging, image-guided therapy, patient monitoring, health informatics and home and consumer healthcare (Philips, 2018). Overall Philips prioritizes four opportunity areas within healthcare (Philips, 2018).

1. Simplifying data and insight gathering
2. Driving improved treatment and outcomes
3. Removing excess costs
4. Providing patients and staff a better experience

According to Jeroen Tas, Chief Innovation & Strategy Officer at Philips, AI is already an integral part of the company's strategy and will be utilized to accomplish the above listed goals, thereby supporting doctors and hospitals with all relevant patient information to provide precise diagnosis, support personalised treatment and intervene early to avoid deterioration, ultimately helping people to live healthier lives and avoid chronic diseases (AI Business, 2017). Since early 2000, Philips has driven innovations in data science, analytics and most importantly, AI, to transform healthcare worldwide. Hence the introduction of HealthSuite Insights- an official AI platform of Philips - is no surprise. HealthSuite Insights provides precise, predictive and personalized insights from healthcare data through AI solutions and is an end-to-end data science platform which is uniquely created to enable data scientists and clinicians to develop breakthrough healthcare solutions by harnessing unrivaled expertise in health technology (Philips HealthSuite Insights, 2018). AI application within Philips' health continuum (see Figure 5- Appendix) has a vital role to achieve the firm's ultimate purpose: to make the world healthier and more sustainable through innovation, with the goal to improve the lives of three billion people yearly by 2025 (Philips Annual Report, 2017).

4.3.2 IPC Framework: Philips Healthcare

4.3.2.1 Strategy Innovation Capabilities (I)

Considering *the Strategy Innovation Capabilities* of Philips, *Absorptive Capability* is representing a particularly precious and already existing capability within the company. RP gathered thorough information and experience within healthcare with its long-lasting history in the industry and thereupon assimilated it within the corporate structure. Hence it resulted in recognizing the value of completely focusing on the healthcare industry, which led to the implementation of a stringent restructuring. Additionally, the corporate restructuring into a health technology company can also be excellently linked to the *Reconfiguration Capability*, since the company refocused solely on one industry and spun off its lighting division. The restructuring was expected to save about $129 million in 2015 and $258 million in 2016, demonstrating the enormous saving potential generated by the restructuring and facilitated by both the Absorptive Capability- by acquiring sufficient information about the reconfiguration and its consequences- and the Reconfiguration Capability- by being able to plan and implement a timely and effective restructuring (Lorenzetti, L., 2014), Furthermore the spin-off is justified by saying that it will result in the creation of *Agility Capability* for both, Signify and HealthTech. The lighting and the medical industry have been undergoing rapid changes and therefore it will enable both to benefit from improved operational agility to respond to the existing quick industry changes (Laurenzetti, L.,

2014). In addition, it will also further develop and reinforce the *Acuity Capability*, enabling both to have an improved holistic view and understanding of the particularly competitive environment, thus to quickly anticipate and adjust to environmental changes. The implemented corporate restructuring is also illustrating an existing, valuable capability for Philips, namely *Innovative Capability*. Philips claims to strive to excel and pioneer within new innovations and is, therefore, strengthening its existing capability with new AI enabled innovations in healthcare which will be of utmost importance with the official restructuring towards healthcare. The previously stated AI platform HealthSuite Insights is depicting an innovative technology infrastructure which is harnessed by numerous other projects. Phillips IntelliSpace Genomics is illustrating such an innovative project which leverages the AI platform to enable early detection and thus create new treatment possibilities (Philips Genomics, 2018). Finally, the overall refocus of Philips from an electronics corporation to a health technology company is enabled by the *Seizing Opportunities Capability*, since Philips identified the value, i.e. the huge opportunity, associated with focusing on the healthcare industry and decided to concentrate its talents, resources, and investments on entirely one dominant business division- Philips HealthTech.

4.3.2.2 Resource Capitalisation Capabilities (II)

Now looking at the second capabilities class, Philips is utilizing its existing *Connectivity Capability* by developing projects across its health continuum that are all well-connected, enabling separate units to efficiently cooperate and mutually benefit from each other through data and resource exchanges. Philips Oncology is hereby stressing an example, utilizing and exchanging data and knowledge from other disciplines (such as radiology, pathology, genomics, etc.) for cancer diagnostics, which are available through the digitalization of healthcare (Philips Oncology, 2018). Moreover, by addressing healthcare as a connected system, Philips unlocks efficiencies and drives further innovation that will help to create the *Alignment Capability* and *Strategic Unity Capability*. The connected business units are helping to achieve the quadruple aim of Philips, including to enhance the patient experience, improve health outcomes, lower healthcare costs and to improve the work life of healthcare professionals (Philips Annual Report, 2017). The listed goals will significantly contribute to achieving both strategic unity and alignment since the connected services across the entire continuum will be aligned concerning their vision and strategic purpose. Next, it is of paramount importance to consider the existing strong *Technological Competencies* of RP. Before demonstrating them, first the fundamental AI scheme-adaptive intelligence- needs to be explained. According to RP, efficiently using the power of AI requires to integrate it into clinical and hospital workflows and to implement AI in a way that gains the trust of healthcare professionals by building on their knowledge and experience. Philips calls this approach 'Adaptive Intelligence'- defined as utilizing AI, whilst developing integrated solutions that adapt to the needs of healthcare professionals and that are embedded into their workflows (Philips Executive Insights, 2018). Philips Illumeo- with its approach to augment clinician's skills to improve their imaging interactions- depicts an exemplary business unit which is harnessing adaptive intelligence to pull data from numerous hospital sources to create a holistic patient view, while providing diagnostic tools capable of adapting to the needs of physicians (Philips Illumeo, 2018). Illumeo's advanced adaptive intelligence technology incorporates an intelligent engine which is able to read and analyse image tags and to capture and transform patient data and images into actionable information, facilitating reliable protocols and empowering clinicians to make quick and informed decisions, wherefore it improves the detection of abnormalities and enables significantly improved accurate, precise and efficient diagnosis (Philips Illumeo, 2018).

4.3.2.3 Networking Capabilities (III)

Finally concentrating on the Networking Capabilities class, *Interconnectivity Capability* is a strongly visible capability existing across the health continuum of Philips. Philips is developing well-connected projects, which will not only result in the exchange of resources, but also enable the creation of connected networks, facilitating the quick proliferation of skills, knowledge, and understanding. Due to the fact that employees will be cooperating across their business units, knowledge will spread easily to various other business units. Moreover, the continued connectivity and cooperation across the continuum also enables the *Collaboration Capability* to flourish. Philips Oncology is representing a business unit which strives to establish a collaborative relationship between diagnostics and treatment. It aims multi-disciplinary collaboration, whereby information, knowledge, and skills from professionals in cancer diagnostics, genomics, radiology and several other fields will be used to jointly improve and create decisions within diagnostics and further treatment possibilities (Philips Oncology, 2018). *Coordination & Integration Capability* is another capability utilized and strengthened by the connected, collaborative business units within RP. Again, Philips Oncology can be used for illustration since it aims to integrate the best imaging and treatment capabilities, patient experience and lowest healthcare costs. (Philips Oncology, 2018). Moreover, Philips Illumeo is another example since its AI enabled technology for imaging assists clinicians in following best practice, thereby incrementally standardizing the workflow and thus reducing variability (Philips Illumeo, 2018). Nevertheless, two capabilities are important for the future success of Philips new strategic orientation, namely the *Communication Capability* and the *Stakeholder Integration Capability*. Philips is impelled to clearly communicate the motives of the restructuring and the accompanied future changes not only to employees of Philips, but also to all its stakeholders. Hence communication and the creation of a relationship built on trust will be of high necessity since all stakeholders need to understand and support the new path of Philips towards a leading health technology company.

Table 3- Philips Healthcare- Integrated Pioneering Capabilities

SIC (I)	RCC (II)	NC (III)
Adaptive Capability	Technological Competencies	Collaboration
Experimentation & Anticipation	Gain & Release Resources	Interconnectivity
Innovative Capability	Teamwork	Communication
Agility & Acuity	Strategic Unity	Stakeholder Integration
Grafting		

4.3.2.4 Strategic Actions

Now considering *Strategic Actions*, Philips is concentrating overall on three focus points (Figure 6- Appendix). The first focus point is *'Growth in core businesses'*, defined as aiming to capture new geographic growth opportunities and pivot to consultative customer partnerships, by utilizing and implementing its advanced adaptive intelligence technology to clients and partner organizations business operations all around the world (Philips Annual Report, 2017). Philips targets growth in its core business by continuing to drive innovative value-added and integrated solutions, which will be initiated by its connected health continuum relentless work towards new innovations and improved healthcare, to ultimately enable Philips to maintain its long-lasting, strong competitive position as an incumbent

company in healthcare. Second, Philips focuses on *'Growth in adjacencies'*-i.e. portfolio extensions and reinforcements through M&A's, organic investments and new strategic partnerships. According to Philips itself (Philips Annual Report, 2017), the company is increasingly teaming up with leading hospitals and health systems to understand their needs, provide integrated solutions and engage in multi-year cooperation's to create improvements concerning the quality of care delivery, healthcare cost productivity and overall patient outcomes. Hence Philips AI technology is reinforced by an extensive network of partnerships, including the Phoenix Children's Hospital, the Medical University of South Carolina and an 18-year strategic partnership with Mackenzie Health, altogether driving further innovation and enabling Philips to gather industry expertise to excel in the rapidly changing industry (Philips, 2018). Moreover, M&A's are of high importance for Philips, because with the large impact and new developments of AI and the accompanied new entrants, Philips as an incumbent is driven to acquire young technology firms to acquire AI knowledge and ensure that they are not falling behind. The $2.2 billion acquisition of Spectranetic's portfolio- which focuses on medical devices used in procedures in the cardiovascular system- and TomTec Imaging Systems- a provider of intelligent image analysis software particularly for diagnostic ultrasound- are representing two significant acquisitions made in 2017 to further strengthen the Diagnosis & Treatment businesses, thereby strengthening Philips' competitive position (Philips Annual Report, 2017). The last focus point is *'Customer and operational excellence'*, which is about continuing to lead the digital transformation by harnessing its adoptive intelligence technology and thereby improving customers experiences, the healthcare quality provided and organizational productivity.

4.3.2.5 Barriers & Business Model Change

Although CEO Frans van Houten claims that Philips managed to successfully implement its restructuring, there are ongoing barriers to achieve a full transformation towards healthcare. First, Philips needs to approach the cognitive barrier embedded within its employees of overcoming the existing status-quo and also the cognitive barrier concerning changing the wide public's view of Philips previous image of being an electronics conglomerate. Employees need to understand and thereupon accept the changes associated with the new dominant focus on health-technology. Nevertheless, since Philips is considered to be a long-lasting big player in the medical industry, the new dominant focus will not be entirely unfamiliar, since employees already have knowledge about the industry, enabling a smooth and easy transition. But also, the public needs to be aware that Philips changed from a leading electronics company to a health technology firm. Hence Philips is compelled to adjust their brand awareness, to create an understanding of the company and brand Royal Philips. Now looking at the impact of the restructuring on the BM, it can be stressed that the BM will only experience incremental changes. However, the new strategic actions of Philips Healthcare mentioned in the previous section do have direct consequences on the business model and the sustained value creation for the company. Altogether, the strategic actions will facilitate financial growth through new revenue growth, increased cash generation and improved return on invested capital, all strengthening the underlying business model and Philips competitive advantage (Philips Annual Report, 2017). Moreover, according to Philips (Philips Annual Report, 2017), the company is pioneering new business models which are designed to be specifically fitting for customer needs. Therefore Philips strives to enhance customers' business models to ultimately improve their own patient outcomes and productivity, thereby taking co-accountability for improved healthcare across the whole industry. Finally, with consideration of the applied IPC Framework (Figure 4-Appendix) it can be stated that Royal Philips will not experience radical BM changes, rather the company is harnessing its strategic agility capability by refocusing and innovating its underlying business model to adapt to the recent AI developments. Therefore, the firm will continue to establish a dynamic, innovative and robust business model which will enable them to maintain their undisputed status quo as a well-established big player in the medical industry.

4.4 Cross-Case Analysis

Now after careful application of the IPC Framework for each respective company, a brief comparison concerning similarities and differences will be provided. First and foremost, all companies have a striking similarity, namely the recent application of AI for healthcare. Google and IBM are both technology giants who saw a promising opportunity based on their existing strong technological capabilities and hence entered the medical industry, and Philips only recently concentrated on the AI application in healthcare initiated by its new restructuring into a health technology firm. All companies realized the powerful potential of AI and its inevitable future impact on healthcare and hence started their AI for healthcare endeavors. Google was tempted to enter the new AI driven healthcare market due to their strong technological foundations and followed their existing business practice of continuously searching for new market opportunities, demonstrated by acquiring DeepMind Technologies (*Adaptive Capability*). IBM Watson Health simply harnessed the existing advanced AI knowledge of the Watson Group for healthcare purposes, i.e. seized the opportunity which opened up with the new dominant role of AI in healthcare (*Seizing opportunities).* Philips, on the other hand, is a long-lasting incumbent in the medical industry who first acquired industry understanding, leading to the realization of the AI value in healthcare and the decision to fully concentrate towards health technology with a stringent restructuring. Therefore, Philips was required to adapt to the AI developments in healthcare, driving the company to add new AI capabilities to their already existing industry-specific knowledge to maintain their strong competitive position (*Absorptive Capability*). Adaptive Capability (Google), Seizing Opportunities (IBM) and Absorptive Capability (Philips), are illustrating distinct methods to enter healthcare and are the dominant capabilities initiating the AI adoption process.

Table 4- Initiating IPC's (for AI adoption)

Google	IBM	Philips
Adaptive Capability	Seizing Opportunities Capability	Absorptive Capability

Moreover, each firm had their own existing capabilities, which were strengthened and complemented in different ways. Google simply acquired AI capabilities with DeepMind's acquisition complementing their strong technological capabilities. IBM WH formed new capabilities through the application of Watson's AI technology in healthcare. Philips, however, had capabilities from before its restructuring of which some were maintained and strengthened, and added newly developed capabilities since its refocus on healthcare and AI. Intra-firm collaboration & strategic unity, stakeholder integration and support and organizational agility, all bolstered by strong technological competencies and high importance of innovation, were capabilities found in each firm for the adaption to healthcare.

Table 5- IPC's in all firms

SIC (I)	RCC (II)	NC (III)
Agility	Technological Capabilities	Collaboration
Innovative Capability	Strategic Unity	Stakeholder Integration

Furthermore, looking at the relationships between the capabilities, strategic actions, barriers, and business models, it needs to be stressed that the Integrated Pioneering Capabilities are laying the fundamental foundation for business model reconfigurations. Each firm has both, existing and newly acquired/developed capabilities, incorporating distinct capability classes, which are enabling subsequent strategic actions and together have a compound and, therefore, stronger impact on the underlying business models. To give a concrete example, the innovative capability present in each of the firms IPC repertoire, is subsequently enabling new strategic partnerships with industry experts, hospitals, institutions etc.,, and thereupon, both strengthening the research and implementation of the innovation and leading to adjustments of the underlying business model, such as a re-developed value proposition with a focus on AI-driven services or entirely new customer segments opened up through, for instance, exactly these new AI-driven services. Additionally, it also needs to be stressed that the IPC's and strategic actions are interconnected, i.e., although IPC's are enabling strategic actions, strategic actions are also strengthening these capabilities, therefore, intensifying the ultimate impact on the underlying business models. Again, using the example of the innovative capability, strategic partnerships with, e.g. leading hospitals, will, in the end, make the innovation more advanced and strongly contribute to its success, showing the interconnectivity between IPC's and strategic actions.

However, barriers need to be considered for a real impact on the business model, which, if neglected or underestimated, can lead to stagnation and therefore an increased gap to the AI adoption process of competitors. The cognitive barrier of understanding the change in status quo, i.e. overcoming the dominant logic, originated through the AI adoption, is representing a pressing concern in the entire healthcare sector, and is also existent in each of the analyzed companies. All firms need to ensure that everyone within the company understand and accept the AI-dominated strategic direction and associated necessary changes, i.e. the importance of AI for the future of their firms and the consequences in the case of late or no realization at all, hampering necessary adjustments in business models and thereby leading to possible business failure or strongly weakened market positions. Only if barriers associated with the new focus on AI, are approached and overcome, the BM's can be adjusted through continued business model innovations or radical business model changes towards AI in healthcare.

Finally considering BMC's through AI's developments for each respective firm, it could be observed that none of the companies are experiencing a radical business model change. All of the selected firms have dynamic and agile BM's and place high value on continued BMI. Hence new AI developments will drive them to adapt their BM and consider reconfigurations instead of radical changes. The IPC Framework of each firm (see Appendix- section 6.2) further illustrates IPC's and accompanied strategic actions, leading all of the firms to continued BMI and consequently to sustained value creation.

5. DISCUSSION

After extensive research concerning AI's impact on healthcare, the erstwhile constructed research question of how AI is shaping the BM's of incumbents and new entrants in the medical industry will be addressed. Although the researched sample was limited to three companies, the results clearly demonstrated that both incumbents such as Philips and also new entrants, such as IBM and Google, were experiencing business model reconfigurations. Hence, as the applied IPC framework demonstrated, all firms, be it incumbents or new entrants, are driven to continuously shape, adapt and renew their BM's as stressed by Osterwalder and Pigneur (2010) since BM's are in any case only developing over time. Therefore, the need for reconfigurations is an important, but foreseen and calculated, factor for adaption to environmental changes- in this case the new AI developments. Moreover, looking at previously defined Business Model Elements (BME's), according to the followed IPC framework, key elements within the building blocks introduced by Osterwalder et al. (2005) as the value proposition, value network, and revenue/cost model are all strongly shaped and reinforced through AI. The new AI developments and thereby originated IPC's and strategic actions, are influencing the underlying BM's and therefore the business model elements, thus leading to the creation of novel value networks comprised of new customer segments, relationship etc., new revenue models initiated by the profitability prospects of AI applications in healthcare; and also, to a new, unique value proposition, whereby AI is representing the centrepiece for healthcare operations of healthcare firms. However, there are also distinct factors to consider for new entrants and incumbents. AI is forcing incumbent firms without knowledge of AI technologies heretofore to vehemently invest in AI research and acquire the missing AI capabilities. The need to reshape is compelling due to entrants of both big multinational companies and a tremendous amount of start-up firms increasingly entering the medical industry, all with significant technological capabilities and, in the case for multinational new entrants, substantial resources. Hence the reason for adapting to the AI-driven healthcare market is not merely because of new promising opportunities, but rather due to the need to catch up with competitors and new entrants who are implementing AI and realizing its future potential. Moreover, the risk of inertia to change, pointed out by Achtenhagen et al. (2013), also needs to be considered by incumbents and is representing a difficulty not to be underestimated. Well-established companies such as Philips or Siemens, have been successful with their BM's over some time and hence need to understand, accept and implement the required change of status quo. Failure to realize the change on time, or failure to understand the need for change at all, could result in devastating consequences ranging from weakened market position and the accompanied creation of a new equilibrium, to the failure of guaranteeing corporate survival.

Considering new multinational companies entering the medical industry, there is no direct need to adapt to the new AI dominant healthcare market for reasons as survival and maintaining their competitive position, rather the primary reason to enter is based on the main premise to harness a new market opportunity and thereby generate further growth and profitability. New multinationals are simply sensing opportunities and thereupon seizing on opportunities whereby they are executing an investment to capitalize on the emerging market opportunity facilitated by AI in the now technology dominated healthcare sector. Hence the new AI developments are presenting an excellent opportunity to leverage on their existing enormous resources and exploit a rapidly growing market with the potential to quickly acquire a strong market position. Multinationals such as IBM and Google are recognizing the significant opportunity and making use of their strong existing technologies (including AI technologies), enabling them to set the pace in the AI race and therefore to influence the emerging change by being co-responsible for the growing need and refocus on AI in healthcare. Nevertheless, new entrants are faced with market uncertainties due to lack of experience, exacerbating their new healthcare operations and driving them to high initial investments in the form of acquisitions of healthcare related firms and to high management efforts related to the creation of partnerships with experienced healthcare players.

Altogether both incumbents and new entrants are faced with the need for continuous BMI originated by the AI advances in

healthcare. Incorporating the aforementioned results, firms are exposed to the new AI developments disrupting the existing healthcare industry, wherefore they develop and/or acquire new IPC's specifically aimed to implement an efficient AI adoption and thereby be able to pioneer. However, as proven by the results of the case studies, AI does not lead to radical business model changes, in lieu thereof, each firm aims to continuously improve and innovate their BM to catch up with the latest AI developments, to slowly familiarize all involved employees with AI and the associated changed and thus, to implement it incrementally into their overall business operations. Therefore, BMI is of high necessity in order to gain a competitive advantage in the industry, which in turn needs and is empowered by the strategic agility capability of firms to successfully implement continued innovations and pioneer in the industry. After all, only strategically agile firms will succeed with continued BMI's since according to Fartash et al. (2012) agility provides the ability to revise or even reinvent the BM of a company. Hence agility will be an instrumental factor, because it incorporates to anticipate new developments just such as AI and thus to adjust to the new market conditions. This brings us to the point of considering strategic agilities initiating role for the IPC framework and its associated particular value for answering the research question. All firms are compelled to be proactive and agile in order to capitalize on novel market opportunities and therefore need to identify their existing and newly acquired Integrated Pioneering Capabilities. Hence strategic agility is a prerequisite that needs to be embedded within all firms to be able to detect market changes and understand the need to act. Strategic agility is, therefore, initiating the process of first identifying existing capabilities and thereupon complementing these with newly developed or acquired IPC's. Thereafter respective firms will perform specifically suited strategic actions, together with the IPC's leading to either a radical business model change (BMC) or continuous business model innovation (BMI).

Summing up, AI's impact on BM's of incumbents and new entrants is conditional on first exploring existing and new IPC's, strategic actions and BM barriers which will altogether result in continuous innovations of underlying BM's. Only by progressively considering each respective dimension of the developed IPC framework, the real impact of and need for change through AI in healthcare can be determined and thus firms will be provided with the chance to decide on further actions to implement either a necessary radical change or, as proven to be the case in healthcare, incremental innovation.

6. ACADEMIC RELEVANCE

The given research paper studied the utilization and development of Integrated Pioneering Capabilities needed for the adaption to a quickly evolving industry landscape and their impact on business models. Even though literature already exists concerning capabilities for companies experiencing environmental changes, none of the researchers focused on the AI for healthcare developments and the accompanied changes in the healthcare industry (BMI's, BMR's etc.). Furthermore, neither was a complete framework integrating various capabilities, capability classes, strategic actions, business model barriers and business model changes/innovations available yet. Due to this gap, a unique framework was created integrating all the aforementioned dimensions, enabling a holistic view towards the impact on business models of AI. Building on and using existing literature from Achtenhagen et al. (2013) and Battistella et al. (2017) as the foundation for the framework, a set of existing capabilities and newly acquired or formed capabilities were identified for each selected firm and concretely allocated to three capability classes. Moreover, the research aimed to connect the identified capabilities and capability classes with strategic actions, thereby showing their combined impact on either business model changes or innovations, since heretofore each dimension was approached isolated without their aggregated impact on underlying BM's. Concluding, neither a concrete classification of capabilities nor a single interconnected framework demonstrating eventual BMC's and enabling companies to pioneer was available in the literature; therefore, leading to the creation of a unique, integrated framework- The Integrated Pioneering Capabilities Framework- underlining the given papers significant contribution to existing literature.

7. MANAGERIAL IMPLICATIONS

Considering managerial implications, the designed IPC Framework is suggested to be applied by managers within the healthcare industry to assess the impact of a strong environmental change and to assist subsequent decision making for eventual adjustments of BM's. Managers can determine whether the influencing factor, in this case, AI, will present either a radical change and therefore lead to BMC's or an incremental change leading to continuous BMI. Building on the decision, managers can target to acquire further capabilities and approach specific strategic actions to enable innovations or changes in BM's. Furthermore, it is suggested that managers use the unique framework to identify existing capabilities of their respective firm and thereupon complement these by either developing or acquiring new capabilities. Furthermore, it is recommended for managers to carefully evaluate which type of strategic actions best fits their situation; i.e., for instance, evaluating the need for strategic partnerships or mergers and acquisitions; as each decision has different benefits and risks to be considered. Additionally, managers should be highly selective by choosing specific capabilities and need to recognize their added value and need for the innovation or change process.

8. LIMITATIONS

Finally considering limitations, only a limited number of case studies are used as a foundation for applying the IPC framework to determine eventual BM changes, wherefore the robustness of the research is limited, making it difficult to draw generalized conclusions. Only three companies were researched in total, demonstrating an obvious limitation due to the reason that a larger sample would result in the benefit of exploring industry-wide impacts on BM's. Moreover, each company makes use of and develops different capabilities aimed to suit their own business operations. Thus, again it is irrational for generalization attempts since capabilities are strongly varying and dependent on firm's activities. Moreover, identified IPC's are not exhaustive, which means that each firm could have other capabilities unmentioned by the conducted research. The research paper was limited to capabilities from Achtenhagen et al. (2013) and capability classes from Battistella et al. (2017) as a foundation for capabilities provided in existing literature. Both the theoretical foundation and associated analyzed results were limited to available secondary data, exhibiting another limitation with the non-consideration of primary data which is weakening the respective results of each case study company. Furthermore, the research was also limited concerning the identification of strategic actions of each company since each firm harnesses numerous strategic activities in form of partnerships, acquisitions, mergers, and alliances. Finally, the research paper limited its results to global big players in the medical industry – incumbents such as Philips- and new entrants- such as IBM and Google- with the intentions that these firms are a reliable basis to represent the changing medical industry. However, it illustrates a strong limitation since the research focused only on big multinational firms as new entrants and therefore did not include the excessive number of start-up companies entering the healthcare industry.

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10. APPENDIX

10.1 Medical Industry- Developments

Table 1- The Need for AI in healthcare

The Need for AI in healthcare	
Growing and aging populations	- Alongside an increasing number of people suffering from chronic conditions
Escalating healthcare costs	- US healthcare spending increased 5.8 % to $ 3.2 trillion (2015) - EU spends around 10% of its GDP on healthcare
Operational inefficiencies	- Institute of Medicine estimated that the US healthcare system wastes $750 billion annually (two main sources of waste: unnecessary services and inefficient care delivery)
Staff Shortage	- WHO estimation: Global deficit of 12.9 mil. skilled healthcare professionals (by 2035)
Big Data	- Vehemently increasing volume of healthcare data (four trillion gigabytes)

10.2 IPC Table

Table 2- Integrated Pioneering Capabilities

Strategy Innovation Capabilities	
Adaptive Capability	Ability to identify and capitalize on emerging market opportunities (Wang &Ahmed, 2007)
Agility	Ability to adapt simultaneously too many different business environments (Stalk et al., 1992).
Autonomy	Ability to encourage and tolerate risky, ambiguous and unsuccessful radical ideas (Chang et al., 2012)
Experimentation	Ability to probe, experiment with, test and commercialize radical ideas and concepts, across R&D, manufacturing and marketing disciplines (Chang et al., 2012)
Grafting	Ability to acquire and to import from others to transform oneself (Doz & Kosonen, 2010)
Innovative Capability	Ability to develop new products and/or markets, by aligning strategic innovative orientation with innovative behaviors and processes (Wang & Ahmed, 2007).
Reconfiguration Capability	Ability to change asset structure in an ever-changing environment (Protogerou, 2005).
Absorptive Capability	Ability to recognize the value of new, external information, assimilate it, and apply it to commercial ends (Wang & Ahmed, 2007).
Acuity	Ability to see the competitive environment clearly and thus to anticipate and respond to customers' evolving needs and wants (Stalk et al., 1992).
Anticipating	Ability to refine foresight tools to explore future usage concepts (Doz& Kosonen, 2010; Rohrbeck et al., 2015; Battistella & Pillon, 2016).
Seizing Opportunities	Identification and calibration of technological and market opportunities, the judicious selection of technologies and product attributes, the design of business models, and the commitment of (financial) resources to investment opportunities (Teece, 2007).
Sensing Opportunities	Constantly scanning, exploring and searching across different technologies and markets (Teece, 2007).

Resource Capitalisation Capabilities	
Cultural Capability	Ability to foster awareness and internalization of the mission, vision and core values (Kaplan & Norton, 2010).
Gain and Release Resources	Ability to gain and release new resources. Includes acquiring new knowledge (human capital) whereby managers acquire/develop and then build new thinking within the firm (Eisenhardt & Martin, 2000).
Leadership	Ability to acquire and embed leadership throughout the organization (Ulrich & Smallwoord, 2004).
Organisational Competencies	Ability to develop supportive organisational culture (employee commitment)
Strategic Unity	Ability to articulate and share a strategic point of view (Ulrich & Smallwood, 2004).
Talent	Ability to attract, motivate and retain competent people with required skills (Ulrich &Smallwood, 2004).
Technological Competencies	Ability to generate, assimilate, transform and exploit acquired knowledge (Kaplan & Norton, 2004).
Teamwork	Ensuring that knowledge and resources are shared and all stakeholders positively interact (Kaplan & Norton, 2004).
Alignment	Ability to align goals and incentives at all levels (Kaplan & Norton, 2004).
Connectivity	Ability to create systems connected with each other, enabling the sharing of resources- incl. human, financial and organizational capital.

Networking Capabilities	
Collaboration	Ability to work across boundaries, thereby ensuring efficiency and leverage (Ulrich & Smallwood, 2004)
Coordination & Integration Capability	Ability to effectively integrate and standardize business processes, while also adopting latest management techniques and systematically implementing the business plan (Protogerou, 2005).
Customer Connectivity	Ability to build lasting relationships characterized by the trust with specific customers (Ulrich & Smallwood, 2004).
Communication Capability	Ability to communicate underlying assumptions and future changes, thereby ensuring understandings of the contexts and developing a common ground (Doz & Kosonen, 2010).
Integration	Ability to integrate and align the organizational connectedness and ambidexterity of radical innovation with the mainstream business (Chang et al., 2012).
Interconnectivity	Ability to create networks connected with each other, facilitating the quick proliferation of skills, knowledge, and understanding.
Stakeholder Integration	Ability to establish collaborative relationships based on trust with a wide variety of stakeholders, especially those with noneconomic goals (Sharma & Vredenburg, 1998).

10.3 Applied IPC Framework

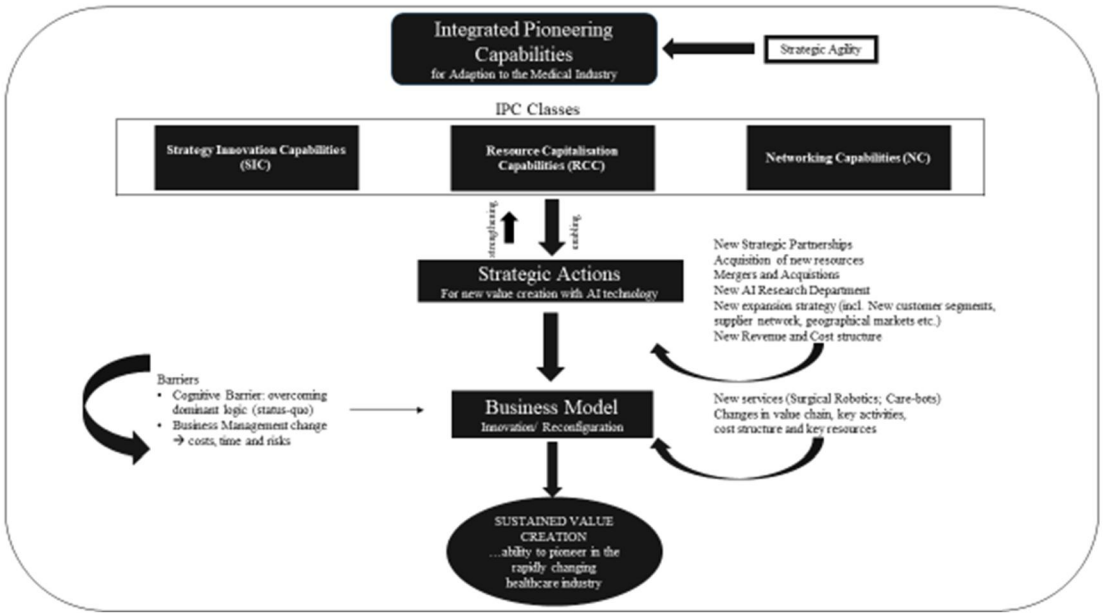

Figure 1- Integrated Pioneering Capabilities Framework [created by Veysel Ümit; based on Achtenhagen et al. (2013) & Battistella et al. (2017)]

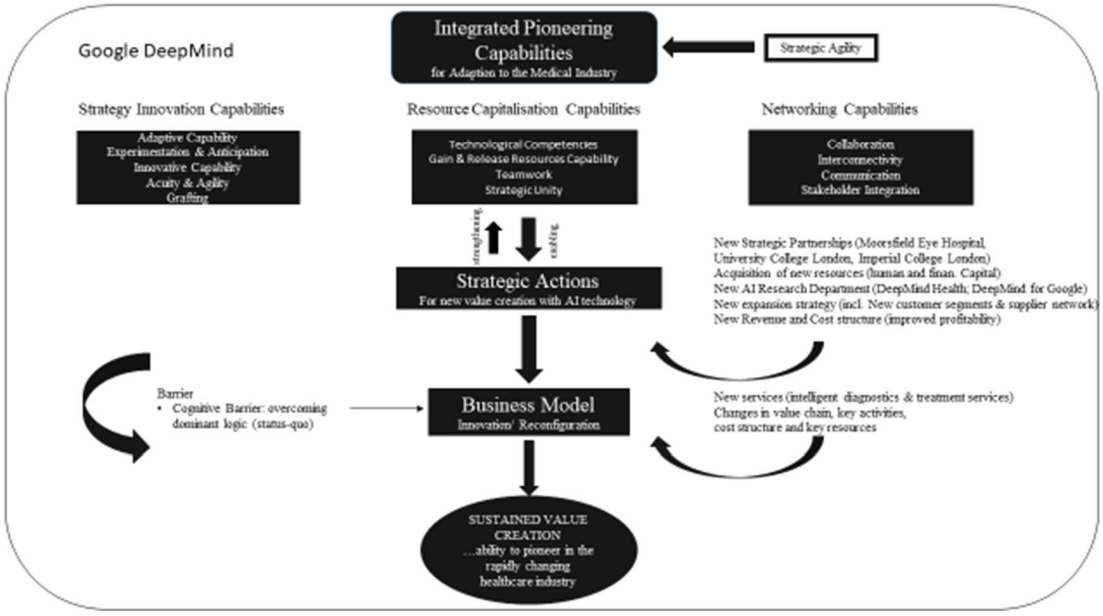

Figure 2- Integrated Pioneering Capabilities Framework (Google DeepMind)

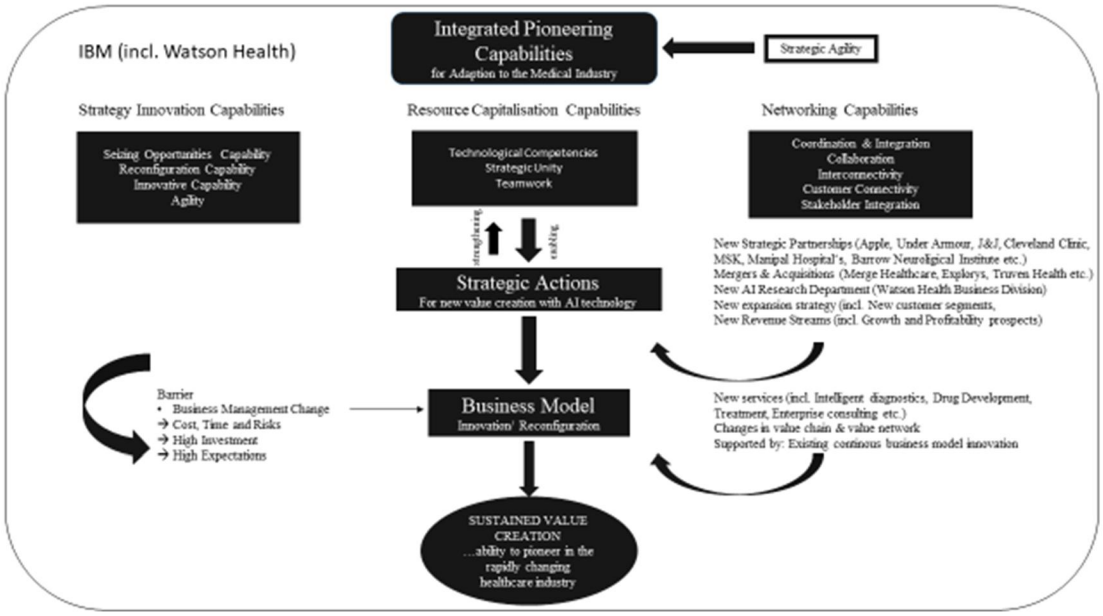

Figure 3- Integrated Pioneering Capabilities Framework (IBM- Watson Health)

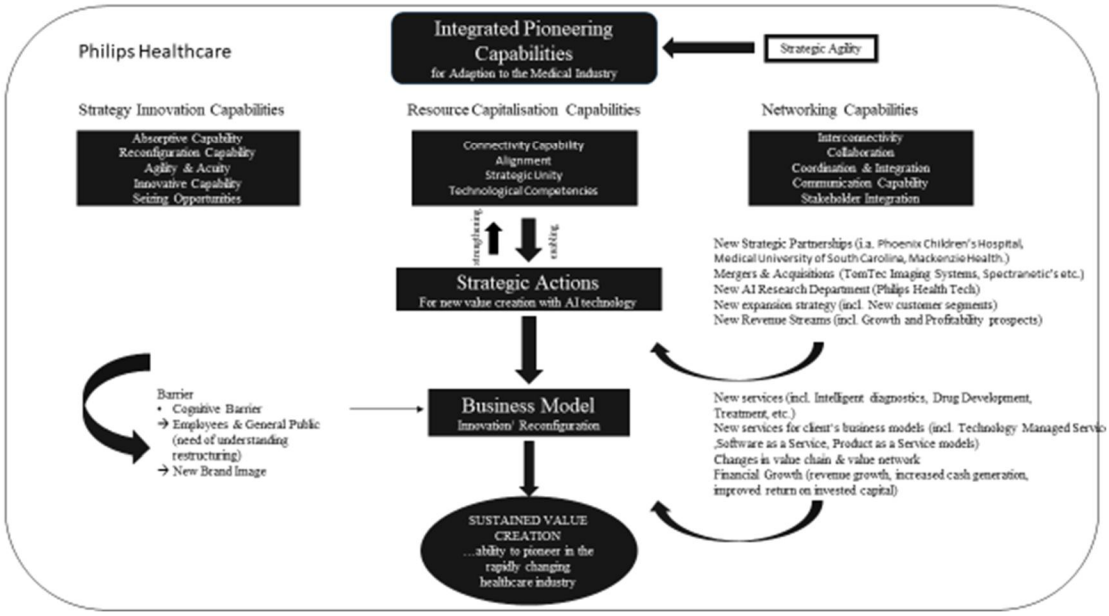

Figure 4- Integrated Pioneering Capabilities Framework (Philips Healthcare)

10.4 Integrated Pioneering Capabilities (for each respective company)

Table 3-IPC's of Google DeepMind

SIC (I)	RCC (II)	NC (III)
Adaptive Capability	Technological Competencies	Collaboration
Experimentation & Anticipation	Gain & Release Resources	Interconnectivity
Innovative Capability	Teamwork	Communication
Agility & Acuity	Strategic Unity	Stakeholder Integration
Grafting		

Table 4- IPC's of IBM Watson Health

SIC (I)	RCC (II)	NC (III)
Seizing Opportunities	Technological Competencies	Coordination & Integration
Reconfiguration	Strategic Unity	Collaboration
Innovative Capability	Teamwork	Interconnectivity
Agility		Customer Connectivity
		Stakeholder Integration

Table 5- IPC's of Philips Healthcare

SIC (I)	RCC (II)	NC (III)
Absorptive Capability	Connectivity Capability	Interconnectivity
Reconfiguration Capability	Alignment	Collaboration
Agility	Strategic Unity	Coordination & Integration
Acuity	Technological Competencies	Communication Capability
Innovative Capability		Stakeholder Integration
Seizing Opportunities		

Table 6- IPC's present in all companies

SIC (I)	RCC (II)	NC (III)
Agility	Technological Capabilities	Collaboration
Innovative Capability	Strategic Unity	Stakeholder Integration

Table 7- Initiating IPC's (for AI adoption)

Google	IBM	Philips
Adaptive Capability	Seizing Opportunities Capability	Absorptive Capability

10.5 AI Applications

Table 8- AI Applications

Alphabet Inc.	AI Application
Google DeepMind	• **Early Detection** - NHS Partnership for Acute Kidney Injury - DeepMind's ML technology is developing a software alerting healthcare professionals to patients at risk of deterioration and death through kidney failure ➔ Improving early detection, enabling prevention of AKI death (> 25% entirely preventable) • **Diagnosis** - Partnership with Moorfields Eye Hospital for Eye Diseases - ML technology applied for finding patterns and correlations more quickly to improve earlier diagnosis - AI algorithm trained to learn to analyze signs of the most serious eye diseases: glaucoma, diabetic retinopathy, and age-related macular degeneration ➔ Enabling clinicians to make earlier and better diagnosis (can prevent 98% of severe visual loss) • **Treatment** - Identifying treatment plans for cancer - First researching tumor identification (by improving intelligent diagnostics) ➔ Improved ID will enable the creation of customized treatment leading to life-saving possibilities
International Business Machines Corp.	AI Application
IBM Watson Health	• **Treatment** - *IBM Watson for Oncology*- in partnership with New York Memorial Sloan Kettering Cancer Center (MSK) - Watson combining data from patient file records with clinical expertise, external research & big data for identification of personalized patient treatment - Watson trained to incorporate the expertise of MSK oncologist's experts ➔ Enhancing top-tier cancer treatment by enabling healthcare professionals to provide elite treatment by harnessing the expertise of MSK oncologists • **Intelligent Diagnostics** - *IBM Watson Health Imaging*: approaching enhanced ID by delivering AI based-medical imaging solutions for radiologists, cardiologists, and other healthcare providers - Analysing and interconnecting heretofore isolated structured and

	unstructured patient, population and medical research data ➔ Improving detection of abnormalities • **Drug Discovery** - *IBM Watson for Drug Discovery:* aiming to accelerate drug development by identifying novel drug targets and new indications for existing drugs (IBM, 2018).

Royal Philips	AI Application
Philips Healthcare	• **Intelligent Diagnostics & Treatment** - *Philips IntelliSpace Genomics*: application suite for pathologists, oncologists & researchers- leverages on HealthSuite Insights ML technology to discover hidden systematic structures in the data and generate hypotheses aimed for improved clinical trial matching & treatment ➔ Accurate predictions of potential future ailments- early detection & quick treatment possibilities (AI Business, 2017). - *Philips Oncology*: integrating best imaging and treatment capabilities, patient experience and low healthcare costs ➔ Personalised oncology/ Patient-specific treatment (first-time-right decision-making imaging & supporting decision-making tools) • **Intelligent Diagnostics** - *Philips Illumeo*: imaging and informatics technology, developed in partnerships with radiologists, augmenting clinicians 'skills and redefining imaging interactions - Assists clinicians in following best practice (standardizing workflow and reducing variability throughout imaging diagnostics) ➔ Improves detection of abnormalities and enables accurate, precise diagnosis

10.6 Key AI-Subfields

10.6.1 Machine Learning (ML)

Machine Learning involves the development of a computational approach which is enabling the user to automatically understand and make sense out of the data. It leverages the insight that learning is a dynamic process which is not made possible by pre-defined rules, rather through experiences and examples. A machine can gather information and is increasingly getting more intelligent, similar to a human being (TM capital, 2017). But dissimilar to a human, a machine is not susceptible to sleep deprivation, distractions, information overload and short-term memory loss, making the technology more powerful than human capabilities (TM Capital, 2017). ML involves multilevel probabilistic analysis, enabling computer systems to simulate and expand on the standard way of how the human mind processes data (Pearl, 2018). Programs are trained to recognize and respond to patterns in large amounts of data, such as identifying abnormalities in medical images. It is also increasingly used for analyzing rigorous amounts of molecular information while researching potential new drugs, a process which as previously explained is highly time-consuming and financially costly (BBC, 2016). Therefore, ML could soon be indispensable to healthcare, driving the industry towards revolutionary opportunities.

10.6.2 Robotics

Robotics are embodying machines that can understand, continuously learn and reason, thereby helping patients and clinicians to better understand information and specifically to diagnose and design effective treatment plans for the latter. An excellent opportunity exists for AI to transform surgical robotics, making it capable of performing semi-automated surgeries with increasing efficiency, thereby increasing the standard of successful medical procedures (TM capital, 2017). When combined with ML, Robotics will optimize and ameliorate the safety, effectiveness, and consistency of successful performances concerning surgical techniques. Moreover, Robotics is representing one of the hottest new markets in the technology industry and according to the International Data Corporation (IDC, 2017), it is vehemently growing at a 17% compound rate with an estimated worth of $188 billion by 2020. Markets and Markets (2017) estimates that robotics specifically for the medical industry will grow up to $11.4 billion by 2020. Recent changes are already leading to a power shift around the operating table due to the fact that Robotics are increasingly used for minimally invasive surgeries, thereby relieving surgeons from work overload and pressure and simultaneously increasing the efficiency of operations. Nevertheless, all future benefits taken into account, both researchers and clinicians agree that the human touch will remain a key component and of paramount importance of the healthcare experience.

10.6.3 Algorithmic AI

Algorithmic AI is comprising the use of human-created algorithms which is used as the basis for treatment recommendations and data analysis, thereby revealing that not all new AI solutions emerging in the health sector are relying on independent computer intelligence (Pearl, 2018). Algorithmic AI applications are the most commonly used in healthcare, representing evidence-based approaches which are specifically programmed by experts and therefore dependent on professional knowledge of researchers and clinicians. Humans essentially are gathering data and inserting it into algorithms, whereupon computers are simply extracting the information and apply it to problems. Taking the example of cancer treatment, harnessing consensus algorithms from industry experts, along with data entered by oncologists into medical records, i.e. patient's age, genetics, cancer staging and associated medical problems, a computer can review dozens, or sometimes up to hundreds, of generated treatment alternatives and recommend the most appropriate and efficient combination of chemotherapy drugs for a patient (Pearl, 2018). The utilization within cancer treatment is hereby exemplifying the magnificent potential that algorithmic AI is generating for improved treatment options.

10.7 AI Application (Previously included in Results)

10.7.1 Google DeepMind

10.7.1.1 AI Application: Early Detection

The partnership with the NHS started in July 2015, when leading kidney specialists approached DeepMind about Acute Kidney Injury (AKI), ranging from minor loss of kidney function to dialysis, transplant and also death (Suleyman, 2016). According to NHS professionals, more than a quarter of the 40,000 AKI deaths annually are entirely preventable, provided that better early detection would be existing (Suleyman, 2016). Therefore, Google DeepMind is developing with its world-class machine learning technology a software in partnership with NHS hospitals to improve early detection, by alerting professional healthcare staff to patients who are at risk of deterioration and death through kidney failure (Boseley & Lewis, 2016). The machine learning technology of DeepMind will significantly improve early detection, since the computer program is able to teach itself to find correlations and patterns in complex data, exceeding human capabilities and thereby resulting in better treatment and life savings connected to kidney malfunctions.

10.7.1.2 AI Application: Diagnosis

DeepMind also uses it machine learning technology to improve diagnosis, hereby specifically concentrating on eye diseases by working with clinicians at the world-renowned Moorfields Eye Hospital in London. DeepMind's technology will again rapidly find patterns and correlations, though now aimed at investigating how machine learning can help to analyze and understand eye scans, ultimately to improve and make an earlier diagnosis. London-based DeepMind is training its AI algorithm by crunching data from thousands of 3D retinal scans, to detect signs of eye diseases more quickly and also efficiently than human professionals. The images provide rich data with millions of pixels of information, thereby enabling the algorithm to learn to analyze the data for signs of the three biggest serious eye diseases: glaucoma, diabetic retinopathy and age-related macular degeneration (Ram, A., 2018). Consequently, machine learning will enable clinicians to make earlier and better diagnosis, resulting in exorbitantly positive consequences for eye diseases, since according to Suleyman (2016), Cofounder of DeepMind, early detection and treatment can prevent 98% of severe visual loss (Ram, A., 2018). According to Dr. Dominic King, clinical lead for DeepMind Health, the artificial intelligence used in the process is stressed to be generalised, which means that it can be applied to other kinds of images, wherefore other projects such as training the algorithm to analyse radiotherapy scans and mammograms by collaborating with the University College London Hospitals and the Imperial College London can be conducted.

10.7.1.3 AI Application: Treatment

Next, to Google DeepMind's intelligent diagnostics AI applications, the British company has been researching different ways to identify and create treatments plans for cancer. First, the company is researching tumor identification, i.e. using intelligent diagnostics to improve detection and diagnosis, by training algorithms on an existing set of images of breast cancer. The created algorithms are able to detect tumors with 92% accuracy, exhibiting its enormous potential for further treatment possibilities. Only with early detection and correct diagnoses, both enabled by machine learning technologies, better and specifically customized treatment can be provided for patients, leading to life-saving possibilities. Moreover, DeepMind is also working on other cancers as e.g. neck and head cancer, whereby the work in this area is specifically related to treatment design. The company applies AI to speed up the mapping process for determining where radiotherapy should be applied. The current process takes almost four hours, whereas DeepMinds ML technology can reduce it to less than one hour (CB Insights, 2018), demonstrating a huge potential to reduce time and effort.

10.7.2 IBM Watson Health

10.7.2.1 AI Application: Treatment

IBM Watson for Oncology (IBM WFO) - IBM's new innovative healthcare program originally developed in partnership with the New York Memorial Sloan Kettering Cancer Center (MSK) - enables to provide healthcare professionals with evidence-based treatment options. Watson for Oncology has a brilliant ability to analyze and understand structured and also unstructured data in clinical notes and reports, which are critically important for the selection of a treatment pathway (Medical Futurist, 2016). Thereupon Watson combines the data from patient file records with clinical expertise, external research, and big data available, eventually identifying personalized treatment plans for patients. The original purpose of the program designed with the MSK was targeted towards enhancing the standard of cancer treatment. Watson is trained to incorporate the highly specific expertise of MSK oncologist's experts, thereby expanding the knowledge to other doctors and ultimately generating a tremendously improved knowledge and skills standard (Lorenzetti, L., 2016). Watson will contribute to the partnership the framework to learn, connect and store the data, while the MSK will provide its knowledge and thereby train and improve the computer system. Any healthcare professional- assuming to license the program- will be ultimately able to provide elite cancer treatment- by accessing and harnessing the expertise of MSK oncologists (Lorenzetti, L., 2016). WFO simply ensures that patients are provided with top-tier treatment, indifferent of their geographical location- ipso factor illustrating a significant solution for patients who live in areas without world-class medical services.

10.7.2.2 AI Application: Drug Discovery

IBM Watson for Drug Discovery (IBM FDD) - another innovative AI-based program- is aiming to accelerate the development of drugs by helping researchers to identify novel drug targets and new indications for existing drugs (IBM, 2018). Watson for Drug Discovery analyses existing scientific knowledge and complex data with the purpose to detect known and hidden connections that can support to increase the likelihood of drug development breakthroughs (IBM, 2018). The program facilitates the synthesizing of massive datasets, aimed to unearth insights at a scale beyond what is manually possible. Additionally, it utilizes its machine learning abilities to evaluate and learn through reasoning algorithms, thereby generating novel evidence-based hypothesis. In December 2016, IBM and Pfizer announced an official partnership whereby IBM's Drug Discovery program will be utilized to help accelerate Pfizer's research concerning cancer treatment in immune-oncology (TM capital, 2016). The collaboration will target s.l. cancer therapies and support the discovery of new drug targets and the identification of novel gene sets. Furthermore, Watson for Drug Discovery is in life sciences currently used to approach diseases such as ALS and Parkinson. Toronto Western is representing the first Canadian hospital using Watson to research Parkinson (IBM, 2018). Researchers of the hospital first identified 620 drug candidates for potential Parkinson treatment, while 21 of the identified drugs are evaluated to be worthy of further study of which 12 have never been linked before to Parkinson (IBM, 2018). Considering Drug Discovery for ALS, the Barrow Neurological Institute successfully used Watson for Drug Discovery to research unexplored proteins and genes that are potentially associated with the ALS disease (IBM, 2018). All three collaborations are strongly highlighting IBM Watson's magnificent potential for drug discovery and development, ultimately benefiting all parties- from pharmaceutical companies to individual patients.

10.7.2.3 AI Application: Intelligent Diagnostics

IBM Watson Health Imaging (IBM WHI) is approaching enhanced intelligent diagnosis and detection of diseases by delivering cognitive- AI based- medical imaging solutions for radiologists, cardiologists and other healthcare providers (IBM WHI, 2016). Technological advancements in imaging precision have led to an exponential growth of the daily volume of medical health data. Watson Health Imaging is representing a pioneering business segment which aims to introduce solutions that are able to analyze and interconnect heretofore isolated structured and unstructured patient, population and medical research data, thereby significantly improving the detection of abnormalities and malfunctions (IBM WHI, 2016). The Watson Health Medical Imaging Collaborative, officially introduced by IBM in 2016, is a global initiative -encompassing more than fifteen pioneering health systems, medical centers, imaging technology companies and ambulatory radiology providers- and aiming to facilitate the use of cognitive imaging into daily practice to help doctors approach eye, brain and heart diseases; diabetes; and breast, lung and several other cancers (IBM Medical Imaging, 2017). Merge Healthcare- a leading company part of the IBM portfolio- specializes in providing enterprise imaging, interoperability solutions and clinical systems that seek to advance healthcare with improved intelligent diagnostics. Merge's AI-based imaging solutions enable to manage, share and store billions of patient medical images, therefore simplifying and enhancing the detection of diseases (IBM Medical Imaging, 2017).

10.7.3 Philips Healthcare

10.7.3.1 AI Application: Intelligent Diagnostics & Treatment

Genomics- the branch of molecular biology concerned with the structure, function, and mapping of genomes- is one of the key areas for AI application in Philips Healthcare. Philips IntelliSpace Genomics (PISG) is an application suite for pathologists, oncologists and researchers, which leverages on HealthSuite Insights machine learning technology to discover hidden systematic structures in the data and to generate and validate hypothesis aimed for improved clinical trial matching and treatment. PISG with its AI technology connects the genomic fingerprint of individual patients with other sources of information, e.g. radiology results, clinical data, family history, population management data, multi-omics molecular data etc., to enable the detection of patterns and trends that may prevent the disease and help to create new treatment possibilities. According to Tas, AI's application to genomics will enable Philips to scan an overwhelming amount of genomics data to find patterns in large groups of patients and combining it with a patient's personal genomics data will enable to provide accurate predictions of potential future ailments, thereby facilitating early detection and quick treatment possibilities (AI Business, 2017).

RP is also strongly impacting healthcare in oncology with its adaptive intelligence technology. Philips Oncology aims to integrate the best imaging and treatment capabilities, patient experience and lowest health-care cost. It concentrates on personalized oncology, which means to provide first time right decision-making imaging, complemented by fast supporting decision-making tools, both together enabling patient-specific treatment. Hence Philips Oncology developed a three-step approach, starting with confident diagnosis- i.e. harnessing adaptive intelligence to accurately and precisely characterize a patient's disease, supported by multi-disciplinary collaboration. Information embedded from disciplines in cancer diagnostics and genomics are linked to jointly improve decisions within the diagnostic phase, but also diagnostic data from other fields are supporting improved diagnosis (such as radiology, pathology etc.) which are available through the digitalization of healthcare. Subsequently, the second approach is focused on personalized treatment, whereby patient-specific cancer is targeted by utilizing imaging based or integrated therapy, enabling the integration of diagnostics and treatment. Finally, Philips Oncology

places a high value on efficient delivery- i.e. to optimize workflows with the purpose to drive down healthcare costs, improve healthcare outcomes while creating a positive patient experience. Altogether, Philips Oncology significantly improves diagnostics and treatment, by striving to establish a collaborative relationship between both fields, therefore leading to better patient outcomes.

10.7.3.2 AI Application: Intelligent Diagnostics

Philips Illumeo is an imaging and informatics technology developed in partnership with radiologists, representing a new paradigm of clinically intelligent software augmenting clinicians' skills and capabilities, thereby redefining their current imaging interactions. Ilumeo is harnessing adaptive intelligence to pull data from numerous hospital sources to create a holistic patient view while providing diagnostic tools capable of adapting to the needs of physicians. The AI enabled technology incorporates an intelligent engine which is able to read and analyze image tags and an image recognition system, facilitating robust and reliable protocols, therefore significantly improving detection and diagnosis. It provides radiologists with individual patient information such as patient problem lists, lab results, prior radiology reports, imaging orders or scanned documents created by health information systems. Additionally, it assists clinicians in following the best practice, thereby incrementally standardizing the workflow and thus reducing variability throughout imaging diagnostics. Altogether Illuemo's advanced adaptive intelligence technology, including AI-enabled solutions, captures and transform patient data and images into rich, actionable information, thereby empowering clinicians to make quick and informed decisions, wherefore it ultimately improves the detection of abnormalities and enables accurate, precise and efficient diagnosis within multiple clinical domains with one standard for diagnosis.

10.8 Royal Philips

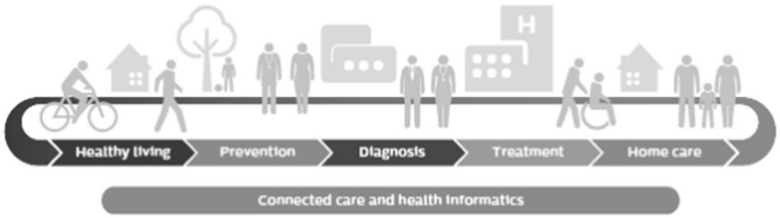

Figure 5- Health Continuum of Royal Philips

Figure 6- Strategic Actions of Royal Philips