Locally connected globally successful: Strategic analysis of Siemens Healthineers

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Medical technology companies have so far focused on the development of hardware, such as surgical devices, joint replacements, diagnostic equipment, infusion pumps and pacemakers. However, in order to have a progressive impact on healthcare in the future, there must also be a focus on the development of software, which is essential along with data collection and analysis. In many ways, the data collected by hardware is more valuable than the hardware itself, as it provides information that could be helpful in effectively addressing and remediating patient health issues. With the ability to use the data collected and establish approaches to problem solving based on it, medical technology companies are becoming more advanced and positioning themselves to be more forward-looking. (Ramani, Abrar, Anya, Blythe, & Rupesh; Schwartz, Stockton, & Monahan, 2017) The future of healthcare is expected to be driven by a ubiquitous, proactive, and integrated health and well-being system in which key and enabling technologies, for example, artificial intelligence, quantum computing, cloud storage, augmented and virtual reality, will play a major role. (Benjamin M., 2019; Kazmi, 2019a)

In the following, we will look at four major trends that medical technology is dealing with today.

6.1 Big Data

The healthcare sector is growing rapidly, and the need to manage patient care and develop innovative medicines has increased in equal measure. By 2020, the digital universe will reach 40 zettabytes of data. That's 5,200 GB of data for every person on the planet. Given the rate of growth, harnessing this data in real time is more challenging than ever. As these needs increase, newer technologies are being deployed in the industry. One big change that could take place in the future is the use of Big Data Analytics in healthcare. (Informa UK Limited, n.d.; Kazmi, 2019b; Rüping & Sander, 2019)

According to an International Data Corporation report sponsored by Seagate Technology, big data is expected to grow faster in healthcare than in sectors such as manufacturing, financial services or media. It is estimated that healthcare data will have an average annual growth rate of 36 percent through 2025. (Goepfert & Shirer, 2019.; Seagate Technology LLC, 2019)
Market research has shown that global big data in the healthcare market is expected to reach $34.27 billion by 2022 at a growth rate of 22.07 percent. Globally, the Big Data Analytics segment is expected to reach more than $68.03 billion by 2024, mainly due to continued investment in electronic health records, practice management tools, and workforce management solutions in North America. (Fernandez, 2019; Rüping & Sander, 2019)

6.2 Telehealth

One of the most notable medical technology trends of 2019 was the increasing prevalence of telemedicine and remote diagnosis of patients using telecommunication technology. The demand for telemedicine is increasing due to the fact that it is a convenient way to bridge the gap between doctors and patients. (Biel, Shukla, & Boozer Cruse, 2019; Meyer & Mahn, 2019)

It gives the patient freedom and flexibility while serving as a viable solution for the following patient needs (Benjamin M., 2019; Kazmi, 2019b):

- Regular clinical appointments with physicians
- Health support in the form of medication reminders
- Support for tracking health indicators such as blood pressure or blood glucose levels
- Advice on how to manage a persistent health problem on a daily basis

Siemens Healthineers offers a range of applications for this purpose. The eHealth Physician Portal and the eHealth Patient Portal improve collaboration between healthcare institutions and patients. In the process, web-based portals and applications facilitate various workflows in the healthcare sector. The patient portal allows patients to access their health data and records. It also allows them to upload their health information and decide on their permissions. This encourages their active participation in an increasingly paperless care process that does not require portable storage devices. Through the web-based physician portal, physicians can access medical data made available through the eHealth network. (Siemens Healthineers, 2019h)

6.3 Wearables

Health and fitness apps are not new, but they are expected to continue to grow in popularity. There are apps to monitor infant temperatures, check for heart irregularities, analyze electrolytes in sweat, and many others. These apps interact with smartphones, doctors and patients to give them an overview of their health. (Phaneuf, 2019; Zhang, 2019)

More and more physicians are recognizing the benefits of wearable technology. As a result, they are becoming more engaged with their patients' health monitoring. According to Accenture, 91% of healthcare providers want to make wearable patient monitoring part of their preventive health initiatives. (Accenture, 2017; Medtechwearbles, 2019; Ramani et al., 2019) Wherever eHealth solutions from Siemens Healthineers are used by healthcare providers, patients can connect their wearable devices and view their complete health data thanks to the interoperability of the application. (Siemens Healthineers, 2019c)

6.4 Artificial intelligence

Artificial intelligence is the ability of a machine to solve certain tasks that are combined with the mind of a human. This includes abilities for perception, reasoning as well as independent learning and thus the independent finding of solutions to problems. (Kreutzer & Sirrenberg, 2019) Machine learning is a subfield of artificial intelligence. These systems can learn from data through training. Machine learning allows systems to improve on their own over time and thus predict outcomes to specific tasks. (Bell, 2014)

AI has been a hot topic in healthcare for several years. More and more processes are being automated and can use machine learning to analyze large and diverse data types faster and more finely. (Burkhart, 2017)

The benefits of AI are based on a number of recent developments that will enable medical devices to personalize an individual's care from initial diagnosis through ongoing treatment options. (Johner, 2019)

Over the course of 2018, we have seen a tremendous increase in the adoption of AI solutions in healthcare. This trend brings with it a host of benefits that are not limited to cost reductions. According to a Frost & Sullivan study, the AI healthcare market is expected to grow to an estimated $6.6 billion by 2021, with a growth rate of 40%. (Fernandez, 2019; Hosny, Parmar, Quackenbush, Schwartz, & Aerts, 2018)

With much patient information available in the cloud, physicians can use data to better understand diagnostic trends and data-driven solutions. AI can help physicians identify problems earlier, which in turn leads to better patient care.

AI related to medicine will help scientists analyze more data on tested drugs more quickly and efficiently, leading to faster time to market. AI will also be able to help employees work more efficiently and take over tedious tasks such as scheduling changes, data entry and programming. (Al-Siddiq, 2017; Kazmi, 2019b; Lindsey et al., 2018; Palmer, 2019)

AI is already transforming the healthcare value chain: Machines read diagnostic images, surgeons rely on robots, and medical devices communicate data in real time. It is enabling improvements in preventive and chronic care. (Lungren, Evans, Ranschaert, Morozov, & Algra, 2019; Maier & Schreiber, 2016)

While AI can create value within an industry, it is far from clear which companies will see profits or losses. For a better understanding of AI in medical technology, and at Siemens Healthineers in particular, we look below at the future prospects of its most successful division, diagnostic imaging.

Trend in diagnostic imaging

AI can help improve the analysis of medical images. Deep learning can be used to analyze computed tomography scans at different levels and better examine patients' affected organs. AI can help analyze cardiac images in a variety of ways. Scans can be performed at a high speed and accuracy. AI offers greater precision in detecting and tracking of lung abnormalities. It can assist physicians and radiologists in visualizing liver lesions. In addition, AI can also optimize the reading of mammograms. (Ajay Kohli, MD, Max Henderson, 2018; Axiomtek, n.d.; Bluemke, 2019)

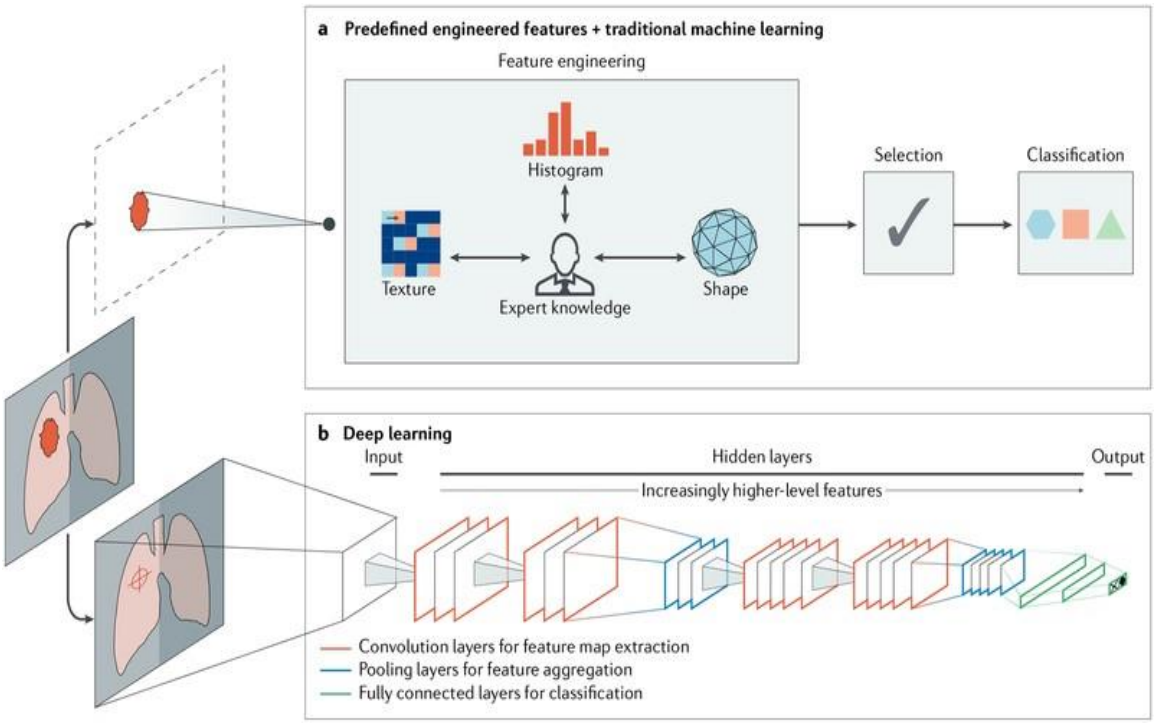

Figure 6-1 Artificial intelligence in radiology (Hosny et al., 2018)

Figure 6-1 outlines two methods of AI for a representative classification task, such as diagnosing a suspicious object as benign or malignant.

The method **a** in the figure is based on technical features extracted based on expert knowledge. Examples of these features in cancer characterization include tumor volume, shape, texture, intensity, and location. The most robust features are selected and fed into machine learning classifiers and classified. (Hosny et al., 2018; Miotto, Wang, Wang, Jiang, & Dudley, 2018)

Method **b** uses Deep Learning. It consists of several layers in which feature extraction, selection and final classifications are performed simultaneously during training. In layers, abstract shapes such as lines and shadows can thus be recognized, as well as entire organs and objects in deeper layers. (Hosny et al., 2018; Miotto et al., 2018)

Tangible benefits of AI support: chest radiographs

Siemens Healthineers developed and introduced a new product for radiology this year. This is called AI-Rad Companion Chest CT and is artificial intelligence-based software. It was recently awarded the CE mark, which means that it can now be marketed as a medical device in Europe. (Siemens Healthineers, 2019a)

AI-Rad Companion Chest CT helps radiologists analyze CT images of the thorax, i.e., the chest area, more quickly and accurately and document the results in the shortest possible time with the help of automatic measurements. One hoped-for benefit of this AI program is that cardiopulmonary disease, for example, is better detected and incidental findings are less likely to be missed. In fact, up to two-thirds of incidental findings, such as vascular calcifications or arterial dilatations, go unmentioned in radiology reports. This could be largely avoided through automated image analysis and reporting. AI-Rad Companion Chest CT is the first AI-based application on the new AI-Rad Companion platform and is vendor-independent, meaning the software can analyze image data from many CT system manufacturers. (Diagnostic & Interventional Cardiology, 2019; Verdict Media Limited, 2019)

Siemens Healthineers plans to expand this platform so that more and more efficient algorithms are available for additional organs. This will enable the company to consistently expand its portfolio of effective solutions for AI-based clinical decision support. The algorithms in the software are trained with extensive data sets and annotated by qualified clinical specialists. These are designed to evaluate and extract primary indications and additional clinical information from CT chest images. (Siemens Healthineers, 2019d)

Its capabilities include segmentation, measurement, and highlighting of important anatomical structures, all of which support quantitative and qualitative analysis.

Using CT images of the thorax, the software can differentiate between the various structures of the chest, highlight them individually, and automatically mark and measure possible anomalies. This applies equally to organs such as the heart and lungs, aorta and vertebral bodies. The software automatically converts the findings into a quantitative report that can be accessed via the image viewing system used by the radiologist in everyday clinical practice. In some circumstances, the intelligent assistant also alerts the physician to possible abnormalities that would otherwise have been missed because they were not the focus of the original examination, for example, incidental discoveries of pathological dilations of the aorta (aneurysms). (Healthineers, 2019; WEKA FACHMEDIEN GmbH, 2019) The cloud-based product presents its results in the form of a quantitative report that will be automatically available in the image archiving and communication system. This will reduce the time required to manually document results. AI-Rad Companion Chest CT integrates seamlessly into existing

clinical workflows. It is vendor-independent, as mentioned earlier. The software has been tested and validated for CT scanners from Siemens Healthineers, GE Healthcare and Philips. AI-Rad Companion Chest CT is designed to enable radiologists to make a quick and accurate diagnosis. (Healthineers, 2019; Siemens Healthineers, 2019a)

Intel's OpenVINO toolkit for intelligent image recognition

Intel Corporation is engaged in the design, manufacture and sale of computer products and technologies. It offers computing, networking, data storage and communications platforms. (Cable News Network. Turner Broadcasting System, 2019)

Intel is also involved in the field of artificial intelligence and offers processors, tools and frameworks for Deep Learning. Training platforms, already trained models from Tensorflow or Apache MXNet and deployment environments for companies are designed and offered. Developers can quickly integrate various trained neural network models into the toolkit via a unified application programming interface (API). The OpenVINO Toolkit, short for Open Visual Inference and Neural Network Optimization, offers developers ease of execution and real-time applications. It is open-source software, thereby providing users with flexibility and openness to develop innovative AI solutions. (Intel Corporation, 2018a)

GE Healthcare is a provider of medical imaging equipment and other healthcare technologies and worked with Intel. In the process, the company tested and further expanded their deep learning solution offerings. (Intel Corporation, 2019)

GE's CT imaging specialists had developed and trained their new AI-based model with the Python programming language and open-source software (OSS), using the TensorFlow and Keras libraries for Deep Learning. Working with some of Intel's AI optimization experts, they used Intel's Deployment Toolkit to optimize its solutions and test the performance of the result. (Intel Corporation, 2019)

Intel further cooperated with Philips and used servers consisting of scalable Intel Xeon processors. Philips' goal is to offer AI-based services to its end customers without significantly increasing the cost of the customers' systems and without making changes to the deployed hardware. The companies tested two healthcare use cases for Deep Learning models. First, they examined X-ray images of bones to look at bone aging processes, and second, CT scans of the lungs for lung segmentation. (Philips,2019; Intel Corporation, 2019)
With the OpenVINO toolkit and other optimizations, as well as the efficient multicore processing of Intel Xeon processors, Philips was able to achieve a 37.7-fold speed improvement for the lung segmentation model over baseline measurements. (Philips,2019; Intel Corporation, 2019)

Siemens Healthineers AI software: competing against OpenVINO

The OpenVINO Toolkit is an OSS, while Siemens Healthineers AI Rad Companion CT is proprietary software. The advantages and disadvantages of these software models are explained below. With an OSS, the source code is available to anyone free of charge for modification and extension. The goal of an OSS is to generally encourage software developers to collaborate openly. With a proprietary software however, the source code can be changed only by the organization/company and/or the owner. Thus, usage rights of this software can be restricted and distributed through licenses. For a better overview, the advantages and disadvantages of the software models are described in bullet point form in Table 2. (Ballhausen, 2019; Kazmeyer, 2019; Picincu & Weedmark, 2019)

Table 6-1 Advantages and disadvantages of proprietary and open-source software (Kazmeyer, 2019; Picincu & Weedmark, 2019)

Advantages proprietary software:	**Advantages Open Source Software:**
• Designed for a limited group of end users with limited capabilities • OSS often have missing drivers • Indepedence through own software	• It is free of charge • Less prone to errors • You can customize the software to your business requirements
Disadvantages proprietary software:	**Disadvantages Open Source Software:**
• Licenses and maintenance are expensive • It is developed only for a specific purpose • Low degree of adaptability readiness • Security problems are detected more slowly	• Vulnerable to malicious users • Not user friendly like commercial versions • Successful operations require training/education • Compatibility issues may occur

Looking at the advantages and disadvantages of both models, it can be seen that there is no clearly more advantageous solution. More time is needed to compare the performance of both software types in order to make more accurate statements. A coexistence like macOS and Windows is also possible.

6.5 Evaluation of digitalization at Siemens Healthineers

Digitization is changing medical technology like no other industry. It can be seen that established companies, such as Siemens Healthineers, are getting competition from companies that are primarily active in other industries. In addition to Intel, Nvidia, known for its

graphics cards, also got involved with the Nvidia DIGITS project. This also involves deep learning models for medical imaging. Nvidia is also offering its platform for free. (NVIDIA Corporation, 2019) This confirms the claim that the trend is toward an open innovation process in which companies from different industries, such as Intel and Philips, cooperate with each other.

Siemens Healthineer's Strategy 2025 aims to offer technology-enabled services alongside AI and Big Data. In this regard, the company is positioning itself solidly with eHealth Solution. With the eHealth Communication Tool, Siemens Healthineers enables healthcare workers to communicate with each other across institutions and share expert knowledge. (Siemens Healthineers, 2019h) A conceivable extension of this tool would be to enable direct communication between physicians and individuals. This would allow Siemens Healthineers to expand its telehealth activities. On the other hand, the company is leaving untapped potential in the wearables trend. Siemens Healthineers offers mobile apps for physicians - such as Visual Care. (Siemens Healthineers, 2019e) In the app, progress and health conditions can be easily documented. Proprietary apps for smartwatches and other fitness trackers could yield additional synergies. For example, fitness activities could be transmitted directly to Visual Care and evaluated by physicians.

Siemens Healthineers has set out its strategy to expand its market leadership to 2025 and beyond in order to grow faster and generate higher returns. The company has prepared itself well to take advantage of the paradigm shift of digitalization and the structural growth opportunities in healthcare. Its success is evident in its financials. (Alexander, McGill, Tarasova, Ferreira, & Zurkiya, 2019; Siemens Healthineers, 2019d)