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Business Plan: Dental Monitoring

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Master in International Management

Supervisor:

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Iscte Business School

June, 2021



**BUSINESS
SCHOOL**

Department of Marketing, Operations and General Management

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Abstract:

There is huge potential for improvement of the healthcare industry through the use of emerging technologies. The problem, however, is, that due to heavy regulation there are just few technology- based solutions that are utilised and the dental market particularly is not yet digitalised. As a basis for the business model, the current state of the art of technology and the adaptiveness capacity in healthcare was analysed. The outcome demonstrates, that there is an immense need for patient- centred solutions and that digital transformation in healthcare often fails due to the complex implication. Furthermore, trends and challenges have been analysed, which reveal that the main challenge is a lack of societal acceptance for current data protection regulations. The main trends are Artificial Intelligence (AI) and wearable medical devices. The internal analysis comes up with strategy propositions to turn the market potential into an actual income stream, and design the service in a way, that is easy to use and avoids the challenges outlined above. Finally, the income statement underpins the business´ potential in the market with numbers, based on assumptions and findings. To get key insights and prove the businesses relevance, the business model was presented to 20 dental market experts, who filled out a survey to gather data and draw conclusions from it. The primary research uncovered that the trends detected are relevant and the market need for such a solution is identified. Generally, the results are in line with the business model´s solution and its expectations.

Resumo:

O recurso a tecnologias emergentes representa um enorme potencial de melhoria para o setor da saúde. No entanto, devido a questões burocráticas e à estrutura única da indústria, apenas algumas soluções tecnológicas estão de facto a ser aplicadas - o mercado odontológico, em particular, ainda não foi digitalizado. Como base para o modelo de negócio, foi analisado o atual estado da arte da tecnologia e a capacidade de adaptabilidade no setor. O resultado demonstra que há uma necessidade imensa de soluções centradas no paciente, e que a transformação digital na área de saúde muitas vezes falha devido a implicações complexas. Uma análise a tendências e desafios revelou que os principais entraves são sociais, refletindo uma falta de aceitação da sociedade perante os regulamentos de proteção de dados vigentes. As principais tendências são Inteligência Artificial e dispositivos médicos vestíveis. A análise interna traz propostas de estratégia para transformar o potencial de mercado num fluxo de receita, e projetar o serviço de uma forma fácil de usar e que mitigue os desafios supramencionados. Por fim, a declaração de rendimentos sustenta o potencial do negócio no mercado com números. Para obter os principais insights e comprovar a relevância da análise, o modelo estratégico foi apresentado a 20 especialistas do mercado odontológico, que responderam a um questionário. A pesquisa primária revelou que as tendências detetadas são relevantes e confirmou a necessidade do mercado para tais soluções. Os resultados obtidos estão em linha com a solução do modelo de negócios e as suas expectativas.

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List of abbreviation:

AC – Adaptive capacity

AWS – Amazon Web Services

ACA - Patient Protection and Affordable Care Act

CAGR – Compound Annual Growth Rate

CROCI – Cash Return on Capital Invested

DCF – Discounted Cash Flow

DM – Dental Monitoring

DT – Digital Transformation

EBIT - Earnings before Interest and taxes

EBITDA - Earnings before Interest, taxes, depreciation and amortization

EHR – Electronical Health Record

EMR – Electronical Medical Record

FIR – Fourth Industrial Revolution

HC – Healthcare

HIS – Health Information System

HIT – Health Information Technology

ICT - Information and Communication Technology

PHR - Personal Health Record

VR – Virtual reality

WACC- Weighted average cost of capital

1. Introduction

The COVID-19 pandemic has challenged the global health ecosystem and brought many healthcare systems close to the point of collapse. To deal with this overwhelming state of affairs, governments, healthcare systems and businesses were forced to re-think their approaches and restructure their processes. These challenges also created opportunities, for example, digital business concepts with innovative approaches, reducing the need for face-to-face consultations, became very popular. The pandemic acted as a catalyst for the digitalisation of the health care industry, which already realised the advantages of emerging technologies in the industry. Efforts to move towards digitalisation moved at a slow pace, due to regulations, high initial investment and socio-economic factors. Even if the industry is complex, the adaptive capacity is strong enough to stem the shift, which could improve the efficiency of healthcare, while creating better health outcome. The huge potential for improvements in healthcare through digital means is attracting the giants of big tech, such as Amazon and Apple, who are utilising their technological knowledge in order to change the way health-care providers work, which is causing a tectonic shift in the industry. Apple alone acquired more than 100 healthcare start-ups in the past decade, and they are already fighting for market share in this heavily changing market. The advantages of technology are slowly eclipsing the challenges that come with it, such as data protection and a lack of evidence of technology adding value. Through successful business models and greater protection of consumer rights, we can see a rising acceptance in our societies. Looking at technological advancements, wearable medical devices and the use of AI (Artificial Intelligence) stand out as their capacity for data collection can be used to improve the outcome of treatments significantly, especially in terms of prevention. The rising relevance of wearables can be seen in a market reaching a value of USD27 million by 2023, which corresponds to an annual rise of more than 50% (Reddy, 2021).

Due to a heavily regulated market and worsening reimbursement structures within Europe, one might think that the dental, but also orthodontic markets, are getting less attractive for investors, but they were wrong. The dental market, as a part of the whole health system, is on a rise. The demographic change has caused a shift in target groups towards the `best agers`, who are massively influenced by social media, being pressured to care about their aesthetics, while having the resources to pay for it (Yvonne Hasslinger, 2019). This shift offers great potential for the market. New technologies exist not just to improve the processes within a practice, but

also to improve the customer experience and form the basis of innovative products, such as clear aligner, which are devices which enable the customer to straighten their teeth without the need to wear visible braces. The clear aligner market has an expected CAGR (Compound Annual Growth Rate) of 19.7% from 2021 to 2028 is solid proof of the growth potential in dental markets (FORTUNE, 2021).

Approach and structure:

This Master's thesis will identify and validate a business model, that implements emerging technologies, in order to offer an innovative solution to customers, which has less errors and, improves efficiency, as well as offering higher qualitative results and a better customer experience. The overall purpose of this study is to investigate, if there is a business model that can serve as an example of how to disrupt a whole industry by digitalising dental practices around the globe, making exemplary use of existing technologies and proving that they can add value to businesses and customers. The empirical investigation of the digital health sector evaluates the current stage of digitalisation in the sector. To see- whether the healthcare system has the capability of successfully applying digital transformation approaches, the adaptive capacity will be analysed. Five underlying factors will be used to illustrate their influence and identify the changes needed to reach the adaptive capacity for digitalisation. The business model offers a solution for the dental market- within the health-care system. Therefore, a market overview will be provided- to get a rough idea of the dental market, its trends, the market potential and technological advancements, proven by numbers. The structure of the market is important to understand in order to know how it works, what a business model should look like to be successful and must be observed, since this industry is very unique. Furthermore, big players in the market will be identified, to identify which companies will be important for a shift in the industry. From the structure and adaptive capacity, one can already identify a few challenges, which will be described in more detail and expanded upon in the following chapter. Then importantly, the seven main trends in digital health care will be identified. From this foundation, the Master's thesis will focus and describe in detail the two most important trends as a basis for the business model and the solutions, which are wearable medical devices and AI. To round off the empirical investigation and highlight the current relevance of such solution, the influence of COVID-19 will be described, and the changes it has already brought and will bring for the future will be analysed.

The business model will be presented, based on research and assumptions. Firstly, the business will be introduced. Important factors, such as how the service will work, which solutions it offers and how it will solve their customers' problems will be outlined. Following this, there will be an explanation of why this business model can be so successful in the context of evaluating the market opportunity. Then, an external analysis will be done by applying the PESTL framework in order to find out- which external factors are influencing the business. An indispensable part of the external analysis is the competitor analysis, which will explore the cluster of existing competitors and their business' positions within this competitive environment. The external analysis will be closed with the application of Porter's five forces, a framework for analysing the company's competitive environment. They illustrate, how likely a shift in the market is through new entrants, but also how high the buyers' and suppliers' bargaining power is. Moving on to the internal analysis, the SWOT framework will be applied- to highlight strengths and weaknesses, but also threats and opportunities for the business. In the next stage, a customer profile will be created to identify the perfect customer to target, what added value is he or she looking for and/or what problem has to be solved. The partners of the business will be determined, as will their relationship to the business. At the end of the internal analysis, a possible strategy will be defined- for the business to work successfully. Importantly, the value proposition will point out the strengths of the solution and the business' competitive advantage. After the market potential has been analysed, the business' opportunity and growth potential will be taken into account. As a basis for marketing measures, the segmentation of the market will be set up, followed by a targeting that suits the customer profile stated before. A positioning in the market is important for customers to know, where they can classify the company, as well as to know, which quality and price requirements they have. The 7Ps will illustrate the business' marketing mix. A legal framework will be provided to further explain the company's legal status, and who is responsible and liable for the business operations. A fitting organisational structure is especially important for young and growing companies and will be proposed, followed by a change of management strategy, which is needed for young companies since they have to change and adapt at a high pace. The last part of the business case will give an outlook on the financial expectations. The income statement will provide a proper calculation of profit and loss of the company, based on assumptions.

- ◆ **How to design an innovative business model that implements current trends and successfully applies emerging technologies into a digital health business on the dental market**

An innovative business model comes up with a unique and relevant strategy. The strategy and aim of the company must be clear and be strictly followed. Even as an innovative player, the company does not need to be recognised globally, but everyone who hears about it must have a clear idea of the strategy and the improvements it can offer to its environment or industry. This strategy has to deliver a clear message with differentiation, such as “to be the cutting edge of dental treatment”. In terms of added value to the customer, it has to be patient-centred, as patients want to be actively involved in health process decisions. Furthermore, they want to claim a service anytime from anywhere, which should be given. Customers are placing great value on their experience, which makes it a necessity to offer a new approach for them to claim the service. Time saving and convenience is playing a large role in their perception of added value. Users in a B2B business are mostly interested in increasing efficiency, which can be reached through new approaches or technological advancements. A better clinical result, as well as reduced errors, will increase their work quality, thus resulting in an increase in customer satisfaction and an improved reputation, but also will create a competitive advantage. In the end, saving time and money is desirable and mostly occurs automatically by utilising innovative approaches.

Objectives:

The objective of this Master’s thesis is to build a knowledge base of the healthcare industry with a deep understanding of what is needed for a shift towards digitalisation, and also how to overcome any challenges. By uncovering trends, this thesis should give an outlook and focus on trends and technologies- that are capable of being implemented into a successful business model. Furthermore, the market potential has to be identified to see what service and/ or product should be chosen for the model. The business plan should consider two aspects. The first is finding a model- that is innovative and, applies current technologies in a way- that can be used beneficially, proving the successful application and change potential of emerging technologies in that market, whilst revolutionising the approach of dental practices and how customers claim dental services. The second aspect, is that the business model further finds their customers’ pain point, the right strategy to target them and creates a value proposition that makes the business profitable.

2. Digital Health

To understand the evolution- as well as vocabulary- of digital health, this Master's thesis is going to present a short epochal review of the research in digital health. It will introduce the three major stages of innovation that have been identified thus far. These three stages, especially the current one, are closely connected to the shift of consumer behaviour and development of the digital age.

2.1. History of Digital Health

The first Epoch:

The year 1998 was the starting point of the epoch of the digital health ecosystem, when the term “e-health” was first introduced. E-health can be described as the crossing point where healthcare and informatics business modelling are combined in order to provide health services- that are making use of data through new technologies. (Pagliari et al., 2005) In the early 2000's the services and products provided by digital health providers were embedded in the marketplace and reached acceptance by users. What really stands out in this epoch was the establishment of Electronic Health Records (EHR). EHR are a real-time dataset about health information of a patient, fed by authorised people such as medical staff in clinics or practices (Raghupathi & Kesh, 2009). The EHR was established to coordinate input of data, while enabling different stakeholders and sources to correlate under a national standard. EHR therefore is a fundamental part of e-health as it is the basis for an establishment of digital health standards, originated from electronic medical records (EMR). Those two programmes differ in the way they share and access information. While EHR can be shared throughout different medical institutions, EMR is only used in a single clinic or healthcare practice, mostly because of a lack of missing standardisation. The main reason for the rare use of HER- or perhaps it is more accurately described as the shift from EMR to HER- is that health providers are not willing to invest, as there seems to be no visible benefit to do so. The extension of EHR is the Personal Health Records (PHR), which includes the same or even more health- related information with the difference- that it is managed, fed and shared by an individual. While EHR is provider- centric, PHR is patient-centric and creates value for the patient, as they can decide on the input, have more transparency on their data and see the opportunity for prevention measures- which are used. One example of many of its applications is for the management of diabetes. The patient tends to take care of their health and the frequency of inputs to the PHR increases as the patient

is in charge and can influence his well-being (Graetz et al., 2019). This first epoch is mostly dominated by EMR, while the importance of patient- centred approaches was recognised, but not yet implemented. Value was mainly created on the provider side, rather than offering values to patients through the creation of a business model, which leads us to the second epoch(Stephanie & Sharma, 2020).

The Second Epoch:

The second epoch features those business models which create value for both parties, develop and use emerging technologies and build everything around the patient as the centre of investigation. This trend towards patient- centred solutions, is firstly needed to create possibilities for prevention, which drives people's willingness to use them, as they can create, organise and understand their data. Secondly, providers have a strong interest in raising PHR-s, because this data is more valuable, since it is more personal and more precise. With this shift, another topic rose in importance and has attracted the attention of market participants and thus the security and safety of this highly sensitive personal health data was highlighted. To ensure data security, countries had to implement standards regarding collection, usage, storage and transmission of data. Currently, technology companies are using contracts to ensure that they can use, analyse and share the customer's data. This protects them from lawsuits, rather than protecting customer's data. The use of medical devices, for instance, can have an immense impact on a customer's insurability. Therefore, those contracts have to face a shift towards a highly regulated usage, phrased in a way so that a customer has transparency and knows exactly, what his data can or will be used for including the opportunity to decide for or against it. (Perakslis & Coravos, 2019). During this epoch, infomediaries began to specialise, as the market got increasingly penetrated, and products or services must be more specialized. While some business models focus on gaining revenue through licensing, others provide health services linked to fitness, offering wearables or other tools to measure and track fitness developments. Furthermore, there are solutions being offered to analyse and make use of data, in terms of the creation of products or treatments.

The Third Epoch:

The development of the business models mentioned above, all based on IT services, starting from a device, use new technologies, and creates data which has to be stored, secured and analysed to provide individualised healthcare solutions, and has obviously led to healthcare data storage on the cloud. To drive profitability, increase scalability and simply reduce infrastructure

costs, cloud computing is an allrounder, which accelerates- rather than hinders the use of technologies and input of data.

Within this epoch, the infomediary can be seen as an additional player in the healthcare market, alongside the four main players: patients, providers, payers and vendors, and is linked to lower market entry levels on a health cloud. The infomediary plays a significant role in enabling business process integration in healthcare, developed in parallel to enhancement of technologies and digital health(European Conference on EHealth et al., 2007). A health infomediary brings together providers and patients and enables access to knowledge about illness and well-being shared by its participants. It can offer a range of services beyond sharing of information, such as advice, guidance and evaluation of health to improve patient outcomes (Permwonguswa et al., 2018). What has been recognised, is that the government plays a big role in digital health by not just participating as a payer, but also as regulator. Therefore, providers can gain a competitive advantage by establishing a relationship with the government and working together on a completely compatible and standardised digital healthcare system.

2.2. Digital transformation of healthcare

Digital transformation is known as a disrupter and has changed the structure of many industries. Digital disruption nowadays is well-known and has affected or even changed many industries, as the business model performance is closely connected to the use of new technologies, accelerated by the fourth industrial revolution. The way companies work can completely change through use of emerging technologies, but it can also create new business models. It allows new players to enter the market, as it lowers the entry barriers. Many companies are struggling with the adaption of their business model towards a digital strategy. Especially for older- established industries such as healthcare (HC), it can be difficult to change and adapt. Digital transformation is capable of changing HC entirely, starting with new business models, establishing a new way of value creation which will lead to- improved treatments and an introduction of prevention measures.

This Master's thesis is going to dig deeper into the digital transformation (DT) of healthcare, how it creates value and strives to revolutionise the sector with patient-centred solutions and offers huge possibilities to treat diseases more efficiently while increasing the quality of care (Kraus et al., 2021).The digitalisation of healthcare has therefore been clustered into five categories: HC vendors' operational efficiency, patient- centred strategies, managerial

implications and organisational factors, and staff practices and social aspects, as you can see in the following figure.

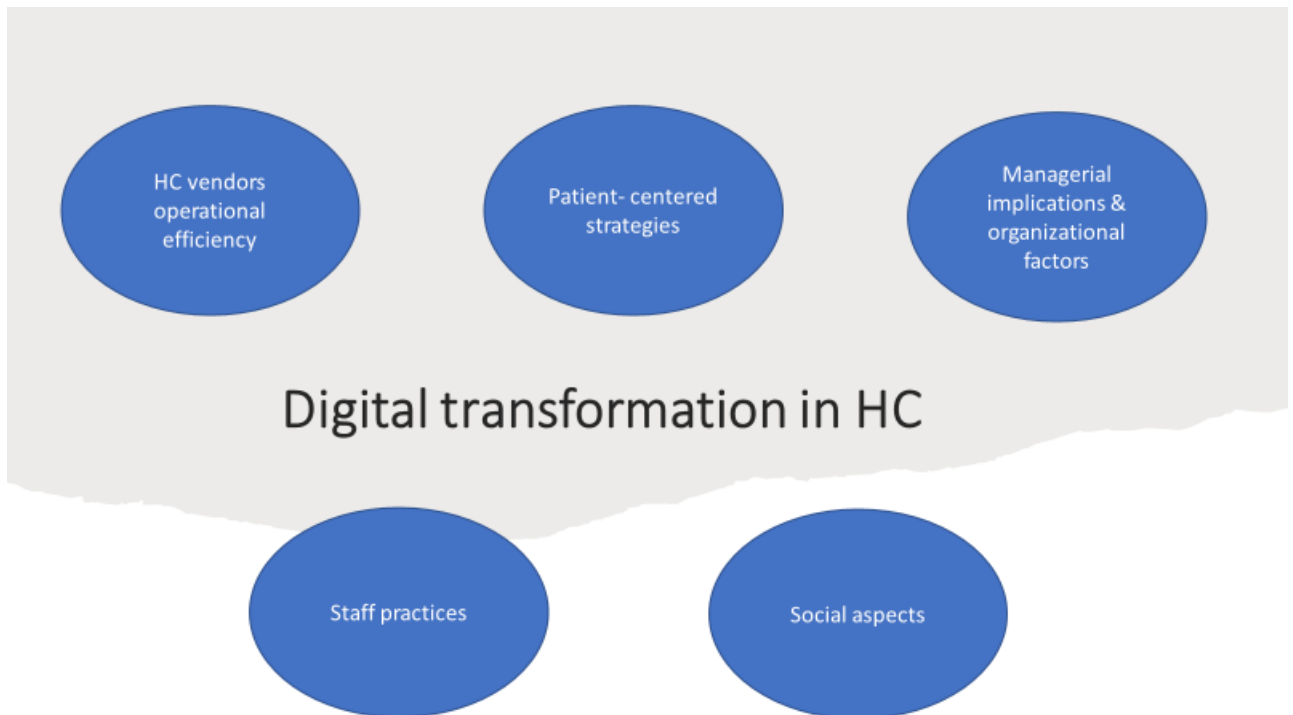


Figure 1: Digital transformation in HC (own illustration, in the style of Kraus et al.; 2021)

Starting with the first category, one can see that digital technologies help HC providers to first simplify administrative tasks, supported by platforms and devices which can easily update or access data and therefore optimise processes and make them more efficient. Furthermore, having access to analysed data, vendors can evaluate the patient's situation faster and better and therefore are able to provide more precise and tailored treatment approaches. Additionally, wearable devices can leverage individualised care and also enable clinics to cluster patients, so that they can prioritise patients, but also offer better treatments. Digital technologies are enabling fast communication between HC providers, which turns into reduced reaction times and increased quality of care. Value creation has changed by linking together all parties, supported by the new players- the infomediaries- mentioned earlier (Kraus et al., 2021).

The patient-centred approaches- described above are inevitable in healthcare nowadays, as patients are becoming actively involved in health process decisions. Firstly, HC is an industry- that can benefit from the participance of patients. Secondly, patients can easily take part in the value creation through sharing experiences and data, in order to feed the system and make HC become more innovative. Even though we already have opportunities for patients' value creation, the value is dependent on the frequency of input through measurements, reliability of

this data and if it is possible to detect patterns. Still, patient-centred approaches are the ones- which will accelerate HC and offer great potential for providers in terms of market exploitation, but also for patients in terms of well-being (Kraus et al., 2021).

Moving onto the third cluster, obviously, Health information Technology (HIT) will play a significant role in business process improvements, in terms of organisational factors and managerial implications. DT is capable of minimising organisational factors, reaching for standardised organisations among HC institutions. This is especially important when looking at different levels of motivations for adoption of HIT, in regards to size, tax status and system interoperability, which makes unification more difficult and highlights the need for comprehensive motivation factors for the adoption of HIT. A barrier of successful DT in HC is the responsibility of the management to include medical staff in the process of co- development. Otherwise, DT can have a contrary impact on the individual HC entity. Furthermore, the differing levels of expertise throughout HC institutions must be taken into account(Kraus et al., 2021).

The impact on staff practices through DT or adoption of HIT is immense and is dependent on how workers react to a changing environment in terms of external limitation, but also that they are required to have flexibility and acceptance. In addition, the workforce might question their role within the system, as many tasks could be reallocated or done by computers, which could trigger fears around job losses or the need to do advanced training to keep up. Moreover, there is a continuous disruption of tasks, which requires an enormous flexibility of staff and management to motivate and lead them throughout this process(Kraus et al., 2021).

The discussion about socio- economic aspects has mostly come to the conclusion- that there is an inequitable distribution of healthcare. Technology adoption is obviously connected to investments in certain HC markets. Here we can see the U.S. HC market experiencing large investments in the past, linked to generally increasing technology investments, but also political initiatives and HC investment laws. Gaps in opportunities of HC market development in different geographical regions can be seen due to crowd funding initiatives as well. Moreover, low wage countries would rather spend money on staff than technology, as initial investment amortize at a slower pace compared to the Global North (Kraus et al., 2021).

2.3. The adaptiveness of the healthcare system

As digital transformation asks for lots of changes within the digital health system, all players have to adapt to given requirements, technologies and business model changes. More specifically, it requires the system to be robust to disturbance, as well as being capable of reacting to technological development, especially due to its pace, depth and impact on the whole system.

Therefore, it is necessary to have a look at the healthcare system's adaptive capacity (AC). The Fourth Industrial Revolution (FIR) will probably not exhaust the healthcare system's AC in the short term. Changes, such as the increasing usage of Information and Communication Technology (ICT) and devices by patients, but especially physicians, nurses will be caught by the system without the need for extreme amounts of shifts. However, human resources play a big role in the healthcare system because of their skills, knowledge and direct contact to patients. Therefore, they have a big influence in maintaining and improving a patient's health. In the long term, the system will need a much stronger AC, as patients and healthcare professionals will use a broader range of applications, such as implanted modules, but also other devices and platforms. Decision-making will take place based on technological input, which changes the way all participants work together. Looking at components of AC, Marek Ćwiklicki defined the following as relevant: human resources, ICT infrastructure, social capital, financial resources, governance and legal regulations, as illustrated in the following figure (Ćwiklicki et al., 2020)

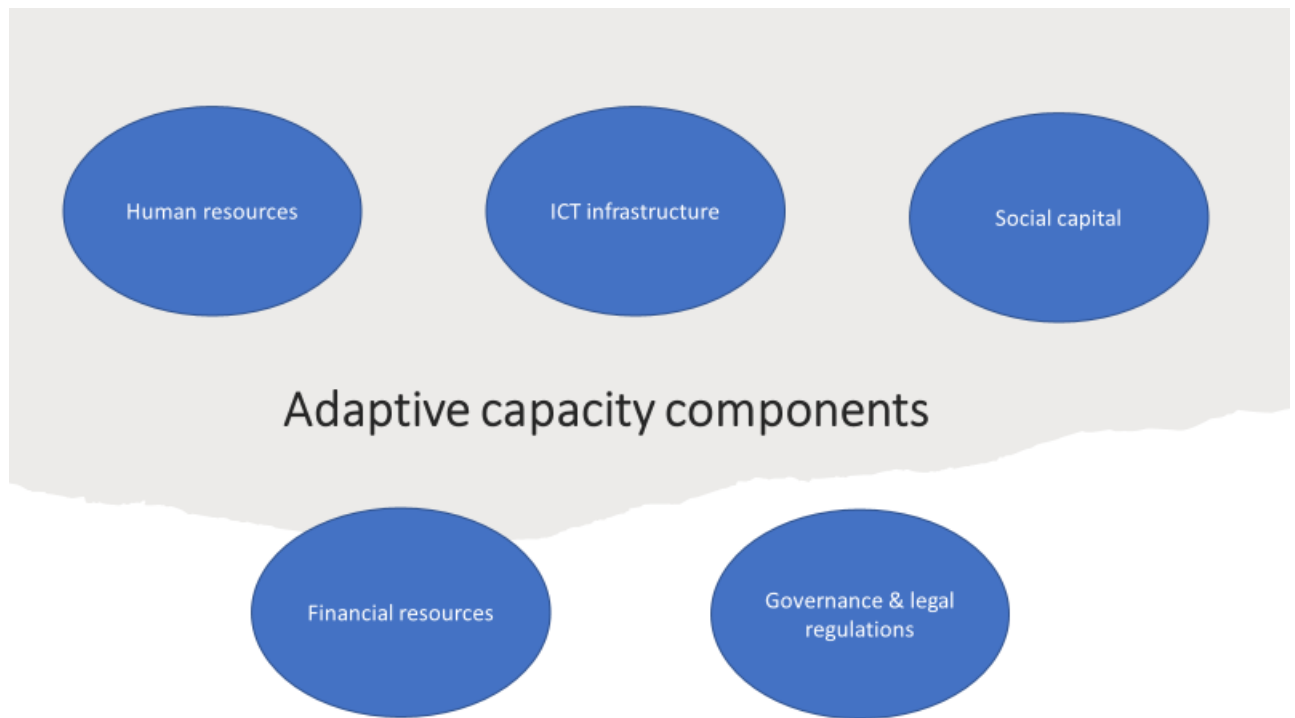


Figure 2: Adaptive capacity components (own illustration, in the style of Ćwiklicki et al., 2020)

Human resources are the ability and knowledge of people to apply new tools and devices in order to use the full range of Health 4.0 solutions. ICT infrastructure describes the ability to use all given technologies, which includes the availability of high-speed services, telecommunication lines, electricity and internet hosts in order to exchange data and make use of new devices. Furthermore, it should support the privacy of data to align with future governmental regulations and compatibility of electronic health records. Social capital talks about the willingness of patients to use new solutions, devices and cooperation, in terms of sharing of data. Financial resources obviously relate to monetary sources and wealth. As digital health solutions are very expensive, this factor is considered to be one of the most important ones, where we can see a lack of take up, especially in low- and middle- income countries. Furthermore, investors are scared to not see a return on their investments, as there still is uncertainty and there will potentially be a lack of efficiency during the implementation stage. Governance refers to all institutions, leadership, policies and all decision-making parties required to build a framework which is interoperable throughout the whole healthcare system. Legal regulations consist of intellectual property rights and data protection, but the most challenging part is the interaction between regional, national and international law(Ćwiklicki et al., 2020).

The following figure by Marek Ćwiklicki is based on experts who define all determinants on a scale ranging from not significant to very significant, and identifies all HC system elements, that are the most affected by AC factors, meaning those elements will need the highest AC- in order to adapt to Health 4.0 solutions (Ćwiklicki et al., 2020).

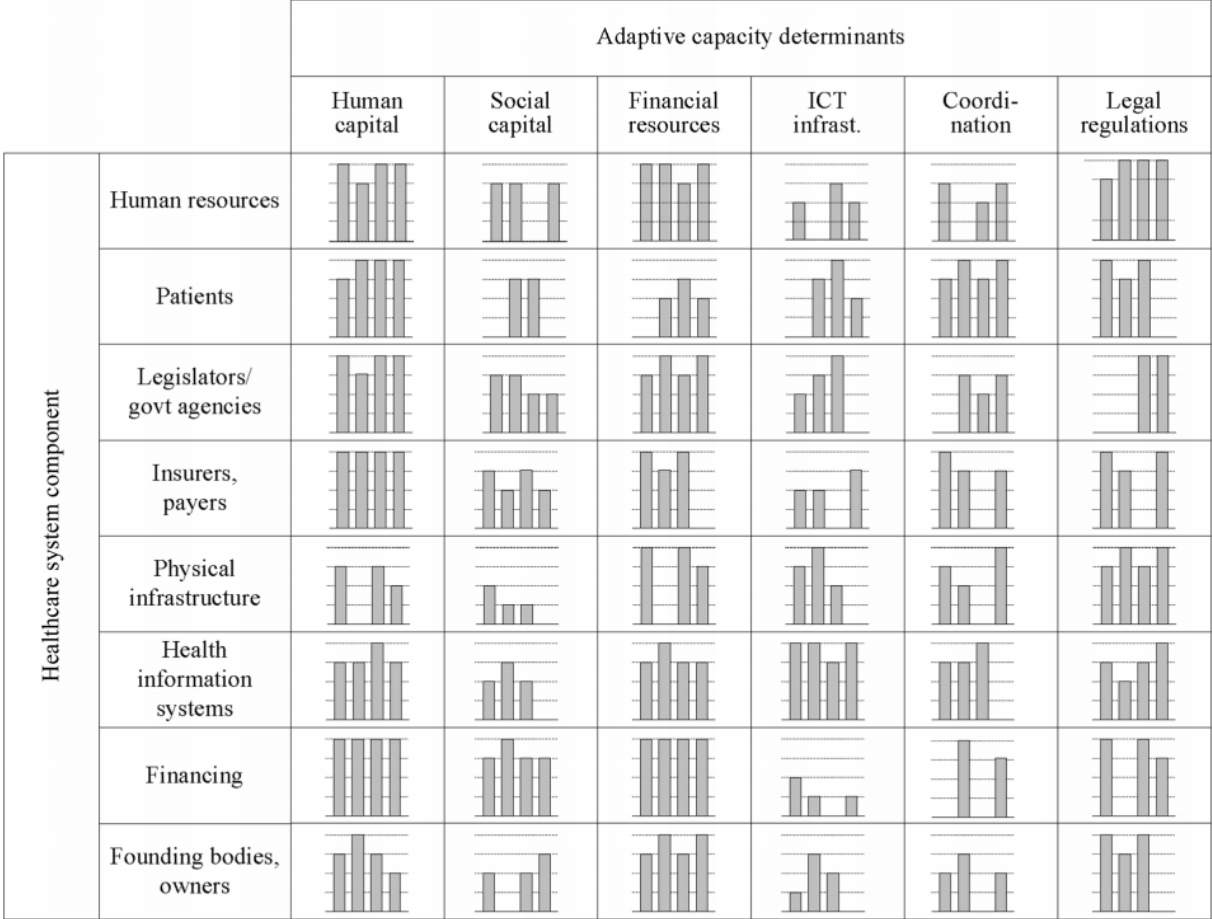


Figure 3: Adaptive capacity determinants(Ćwiklicki et al., 2020)

Another way of analysing the graph is to look at all AC determinants and point out the most important factors, which leads to the following findings. Human capital influences almost all parts of the HC system. Social capital meanwhile has a diverse influence; mostly it affects the financing, but it also has an effect on human resources and legislators. In contrast, financial resources have a big impact on the healthcare system as a whole, but especially on human resources, legislator and founding bodies, because they are directly impacted by monetary inflow. ICT infrastructure plays a major role for HIS. Coordination is seen as very relevant for patients, but also the HIS, while legal regulations are having a big impact on human resources, physical infrastructure, as well as financing. To sum up, the most significant AC determinants

are human capital, financial resources and legal regulations. This means that these three factors mainly define the success of Health 4.0 solutions.

3. Structure of the HC market / Big player

The structure of the health care industry is very unique as it is an insurance- based industry in many countries around the globe, where insurance companies cover payments for the treatments of patients, who have a contract with healthcare providers. The insurance covers- either wholly or partly- not only treatments, but also healthcare products or medicine prescribed by the healthcare provider. All participants, even the suppliers are heavily regulated by the government (Hansen & Baroody, 2020). The complexity and though regulations can cause issues with the system's ability to adapt to digital health, due to a lack of interoperability between key participants. Furthermore, big players in healthcare are trying to slow down the adoption of digital technologies, because they are afraid of losing their power to new market entrants. A provider's incentive to implement new digital health systems therefore is lacking because they do not want to share data with their competitors. This reason- along with technical concerns- as well as ongoing and high implementation costs is hindering providers' efforts to adopt digital health solutions. New technologies such as data collection technologies, information platforms, remote services and others have made space for new entrants and brought to light the need to change the system in terms of regulation. While traditional firms create value through selling products and delivering customer service or patents, providers of digital platforms can create and co-create value much faster and broader through different levels of stakeholders (Hermes et al., 2020).

Generally, the barriers for new entrants in Europe are relatively high, due to already established and efficient healthcare systems with strong healthcare providers. These high standards may scare off new entrants due to high entry costs, but the requirements to align with stringent regulations may also be off-putting (Market Line Industry Profile, 2020). Tech companies, such as Google, Apple and Amazon are resource-rich and have been making a lot of effort to become big players in the healthcare sector. It is useful to take a closer look at what tech giants did to enter the market. Amazon already offers a program for virtual health clinics and in- home visits, called Amazon Care, where patients can consult physicians or nurses through in-app visits. In 2019 Amazon acquired Health Navigator, who provides technologies and services to digital health companies, in order to support their care program. Furthermore, they are using the Amazon Web Service, their cloud service provider for data processing, and also collaborate with many healthcare providers who use AWS to store their data. In December 2019 AWS launched Amazon Transcribe Medical, which offers a solution for physicians to transform text

into medical records. This service, which can be integrated into devices or apps, is just available to cloud customers and therefore ties physicians to Amazon. Google already has 57 digital health start-ups in its portfolio and is, together with Microsoft and Tencent, responsible for most of the deals made with digital health start-ups, mainly focused on genomics, clinical research, insurance and benefits. Google Health has already hired more than 500 employees and is growing rapidly (Dyrda, 2020). Google is gaining expertise in this field by hiring people such as the former national coordinator of the Office of the National Coordinator for Health Information Technology Karen DeSalvo, who is now Chief Health Officer and who advises Google on providers, physicians and nurses, working within Alphabet's services (Dyrda, 2020). Apple is dominating the market of wearables, which offers health record applications and so collects huge amounts of health-related data (Dyrda, 2020). A Morgan Stanley analyst says that- it is likely that Apple will become the leader in consumer healthcare, predicting Apple's healthcare revenues between USD15 billion to USD313 billion by 2027 (Smith, 2020). Growth potential is especially seen especially in their wearables market, but also other ideas, such as converting AirPods into hearing aids could boost their healthcare revenue. Since 2018, Apple has had its own health clinic, where they offer free genetic screenings for Apple employees. Medical technology company Masimo sued Apple for stealing technology and infringing patents, including the technology used for the Apple Watch to measure blood oxygen levels. The company's revenues skyrocketed in 2020, also thanks to record- earnings in wearables and segments, such as Apple Health Records (Dyrda, 2020).

4. Market overview - Dental market

It is now the time to take a look at the dental market- as a part of the healthcare industry. Even though the dental market is just a small part, with public expenditure being around 3-8% of national health spending in Europe, it remains a market with stable demand, which could be seen during the pandemic. Furthermore, there are a lot of changes happening, which offer opportunities for investors, especially through disruptive business models. The dental market is special in terms of the fact that supply should always match the demand, as the market, especially in Global North countries, at some point becomes saturated. A contrary example would be the car industry, where people could buy more than they actually need. As in many other industries, the dental market is facing the challenges of demographic change at the moment. This means practices have to change their approaches in terms of customer focus and long- term treatments, which this Master´s thesis will come back to later. What is interesting is that even in Europe where people have the knowledge and money to prioritise oral health, over 50 % of the population- even more so in the population group of 60–65-year-olds-, suffer from periodontal disease, which is mostly attributed to poor oral hygiene. It is important to examine demographic changes more closely, as they have developed through a rapid rise in the proportion of older people in industrialised countries, and this will impact the demand structures of the dental market (Dr. Markus Heilbach, 2019). One can see, that the “best agers” (group of people 50+) are gaining importance, especially due to the need of long-term care, as teeth are generally getting worse with increasing age. What describes this consumer group is that they normally live in economically backed conditions, they are active and mentally fit (Yvonne Hasslinger, 2019). Due to their stable economic situation, they are more likely to invest in their oral health and appearance, making it an attractive consumer group in the market. Furthermore, they actively participate in the internet, which describes the willingness, but at least the capabilities of using digital health solutions, such as medical devices or self-pay services. The rising need of dental care among older people already led to an increased number of oral surgery and dental implants, which will continue in the long-term (Yvonne Hasslinger, 2019). What also has to be considered- is that there is a lack of access to dental care for people in nursing homes. This problem can be addressed through corporation agreements between dental practices and nursing facilities. In Germany around 30% of all nursing facilities have such an agreement, which illustrates the big potential of this market. This potential goes hand in hand with a much greater responsibility about taking care of those patients, in terms of different medications used, special treatment circumstances and- appropriate therapy planning and post

therapeutic care (“Mehr Kooperationsverträge Zwischen Zahnärzten Und Pflegeheimen,” 2019). Moreover, the demographic change tangents the service provider, who has to deal with an ageing workforce and a lack of skilled workers. This will lead to a need of dental technology and a change in dental products, adapting to their new focus group. The use of internet in this customer group, as mentioned earlier, shifts the procurement towards online portals, which paves the way for innovations and leads this paper towards the next important topic- the digital patient (Dr. Markus Heilbach, 2019).

The unstoppable rise of digital technologies, such as AI, virtual assistants or digital devices supports the expansion of digital infrastructure, enabling new approaches and techniques in dentistry, especially in terms of interaction between patients and practices. Medical devices that are gathering data, analysed through AI- based algorithms will draw new business models with great success potential, but also will offer improved patient care. Existing market players can profit from new materials and technologies, creating more innovative and efficient treatment options. These opportunities always come with the need for transformation, as the future patient comes with a different health awareness, is well-informed and makes their own decisions based on their research. Firstly, the patient is more likely to know what treatment he might need, as 43% (the figure is much higher for US citizens) search Google information about diseases and symptoms before going to the doctor (“Dr Google: Almost Half of Employees Prefer an Internet Diagnosis,” 2020). Secondly, choice is already an element as which dentist the customer chooses is based on internet research, comparing evaluations of different practices/ providers. Through videos and information on health websites, the patient can see- what treatments will look like, they can receive data through apps, smart devices or wearables and they will soon manage their own health records. Patients expect more detailed information about the treatment and cost plans. The future patient has much more market power, is more demanding and can choose the way they experience dental services. Dental care providers therefore need to be more transparent and in order to be successful, they need a more distinctive customer orientation than ever before. Moreover, patients are seeking for more flexibility. According to a survey 82% of patients in Flanders would want to communicate through digital channels with their healthcare provider, a figure which has probably increased since the pandemic hit in (“82% of Patients Want to Communicate via Digital Channels,” 2019). It can be assumed- that this number is transferrable to other European countries. How dental care providers can benefit from using technology is made clear by a an article saying, that two out of three people would consider changing the dentist, if they would use more advanced technology and 72% had a positive

experience at their last visit, when advanced technology was included(*The Need for Digital Dentistry Education*, 2019). An impressive number of 25% of people would visit their dentist more often, if they receive more education about technology. Combining the use of gathered data and AI, providers will easily be able to convince their customers to do a certain treatment, as they can predict the outcome very realistically. Also, financial planning and appointments can be supported by AI, which leads to more efficiency and accuracy. The dental market will have to shift towards more digitalisation, which shows great potential for dental care providers, who offer more technology- based solutions.

It is not only the interaction between provider and customer that can be improved through digital strategies, but also the procurement process, for example. By simply digitalising the procurement process, process costs can be reduced by around 40% and save half the time spent on this. As can be seen, the establishment of a digital strategy can not only increase the customer base, but also can lead to a gain in strategic advantage. However, 70% of companies feel unprepared for the challenges, that come with the implementation of digital dental care solutions (*The Need for Digital Dentistry Education*, 2019).

5. Challenges

With great opportunities come great challenges. The challenges in digital health mostly arise through digitisation and uptake of emerging technologies, as everything is new and there is a lack of literacy and regulation. As mentioned before, one of the main challenges is indisputably data protection, but the paper will explore all of the different challenges.

One of the biggest hurdles falls under the umbrella of societal factors. It is a factor that has to be considered, as new technology- and especially new healthcare solutions- driven by technology have yet to reach an acceptance in our societies. This acceptance has to be gained piece by piece, as our aging population in Europe asks for an adoption process. Everyone needs to understand and be willing to use new tools (Lennon et al., 2017). The uncertainty around policies and regulation plays a big role in people's acceptance. Another challenge is the need not just for local or regional regulations, but also international ones, which would bring together many different multinational health systems with all their complexity (Cummins & Schuller, 2020). As mentioned earlier, those emerging technologies are lacking in research or at least are at a low levels in literacy, which contributes to a slower acceptance rate, as people do not know what to expect exactly, especially in the long-term. The suitability of digital health solutions, especially the value creation for an end- user has to be proven to the public through educational initiatives (Flott et al., 2016). Providers and governments therefore have to find a way to convince the public of improved solutions for all through supporting them and including them in the process with the provision of increased transparency. The digital health trend towards remote consultation and treatments highlights the concerns of widening the socio- economic gap, as not everyone has the same opportunities of accessing those services (Ramsetty & Adams, 2020). Moreover, communication and social media platforms, as especially seen throughout the pandemic, can function as a platform to spread of false information (Laato et al., 2020). This is a big challenge, as the rise of conspiracy theories about the virus is immense and the influence- that such conspiracy theorists wield is immense. It is necessary to ask for industry and governmental support to inhibit such developments.

Moving on to the ethical factors- that can cause challenges in digital health, we can see that obviously, data protection is the biggest ethical challenge, especially with the involvement of nearly all the big tech companies, such as Google, Amazon, Apple and Facebook in the digital health landscape, as this increases the fear of a lack of data protection. Big tech companies are

very interested in this highly sensitive and personalised data. This fear was demonstrated recently, when WhatsApp announced its new terms of use, which allow them to transfer all personal data from WhatsApp to Facebook (*WhatsApp Terms Of Service*, 2021). Smart devices, such as the Apple Watch, were initially designed for other purposes, but are now being commonly used to gather health data and also, can not be defined as medical devices as such, which makes it even more difficult to regularise and apply data protection rules for medical devices (Cummins & Schuller, 2020).

Looking at the general perspective of connected health solutions, emerging technologies are often lacking in evidence of their added value, as little research exists, especially over long time periods, to prove the advantages of using them. This raises a safety concern, as one can not prove that new technologies deliver at least the same quality of outcome for the patient as before. Self-reported data should be employed with caution, as we do not know, how reliable and useful this data will be (Patrick et al., 2016). Another data issue pops up- when considering a connected healthcare system, as it is necessary to consider not just how data is protected when aggregated, but also when it is transferred between healthcare providers. To reach wide societal acceptance, as mentioned above, patients need to be engaged and- treated more like stakeholders, rather than just a data source in order to gain a real understanding of what security and privacy means for them, especially from the viewpoint of patients understanding about how their data will be used, which is not given yet (Cummins & Schuller, 2020).

AI's value in the digital health system is undisputed, but also comes with concerns regarding safety, fairness and explainability. One might state, that AI applies higher standards regarding safety and making mistakes, but the problem is, that there are no standards for verification or validation of AI- based outcomes. This means- that AI can be programmed without any regulations, especially regarding the outcomes, as the system mostly has limited trainings on real- world data, which makes it hard to successfully implement. Back to the point of explainability- providers are struggling to explain, why and how the system came to a certain solution (Panch et al., 2019). Nobody can really explain- clinicians or patients- how or why a decision has been made, while a doctor could easily explain to their patient, why they chose a certain medication or treatment. AI, therefore, needs to be more transparent, understandable and fair.

The current pandemic has highlighted the need of a change in our health systems, as many countries are being pushed to their limits. However, with all the new opportunities offered by

emerging technologies, many challenges also come. One of the biggest challenges is the safety and protection of sensitive health data. This area needs more governmental initiatives to establish regulations and policies. Furthermore, there are a lot of societal and ethical factors that have to be considered, which ask for more transparency and understanding from the patient side. In the end, there are a lot of challenges that come with digital health solutions, but the outcome for providers and patients can be immense, so it is necessary to find ways to solve these challenges.

6. Trends

Digital transformation in healthcare is completely re-shaping the way physicians interact with patients, how data is aggregated and shared between providers and how decisions are made. It has the potential to improve people's health with preventive solutions, create better and more individualised treatments, leads to less errors, and can optimise processes and lower costs. Furthermore, new solutions are putting patients in charge of their own health through apps, wearables and virtual reality in an exciting way. Seven key trends have been identified, that will accelerate digital transformation in 2021 (Reddy, 2021).

The ascendance of on-demand healthcare

The general trend of consumers to schedule their timetable according to their wishes and needs has now arrived in healthcare. Services have to be available anytime, from anywhere. Access to healthcare through mobile devices is now playing a big role, as more than 50% of website traffic in Q3 2020 was generated through mobile devices ("Percentage of Mobile Device Website Traffic Worldwide from 1st Quarter 2015 to 3rd Quarter 2020," 2020). Furthermore, as already stated in the chapter about the dental market, people tend to Google doctors before going and already book appointments online, demonstrating that the willingness to consult a doctor on- demand through a mobile device is high. This is promoted by companies such as Nomad Health, who- link doctors with medical facilities to make them become on- demand healthcare providers and even match physicians' talents, expertise and schedule much better than through standard approaches (Reddy, 2021).

Big data in healthcare

After discussing how to aggregate the data, this paper will now come on to the use and benefits of big data, under the premise that it has been analysed properly, so that use can be made out of it. Errors can be minimised, since software can flag inconsistencies between a patient's health status and drug prescription, which could result from medication error (Reddy, 2021). Preventative care can be used to reduce the number of patients that frequently visit emergency rooms, as they can account for 28% of patients in some places (Wynn & Writer, 2016). Staffing could be planned more efficiently through analysing patient traffic, which would prevent facilities from being under or overstaffed. Drug-makers could make use of big data to understand the market in terms of product iteration and budgets.

Virtual reality as new treatment method

A wide range of diseases ranging from simple pain, anxiety and post-traumatic stress disorder through to strokes can be treated through VR with a higher success rate, compared to prescription of opioids. From a healthcare professional's perspective, VR can be used to plan surgeries and it can be a way for medical students to simulate surgeries, so they can learn in a new, more cost-effective and exciting way (Reddy, 2021).

Predictive healthcare

As discussed earlier, predictive healthcare could make healthcare facilities more efficient in the way they schedule staff and processes. But predictive healthcare is able to do more than that. By analysing Google searches for diseases, it is possible to predict, which diseases are increasing in prevalence and thus we can prepare for this, which is a tool which can also be used to suffocate virus outbreaks and help prevent pandemics, such as we are experiencing at the moment (Reddy, 2021).

Blockchain

Blockchain has the capability to deal with the problem of safety in electronic health records. Through sharing information across a big network of computers, users can safely exchange financial information, while no bank is needed. Therefore, blockchain is able to improve the accuracy of medical records, avoid fragmentation and cut costs. This could revolutionise the way medical data is prepared and secured, as nowadays it is unstructured, shared through many EHR systems, is full of errors and very unsafe in terms of hacker attacks (Reddy, 2021).

The following figure describes the potential of applying those trends by numbers.

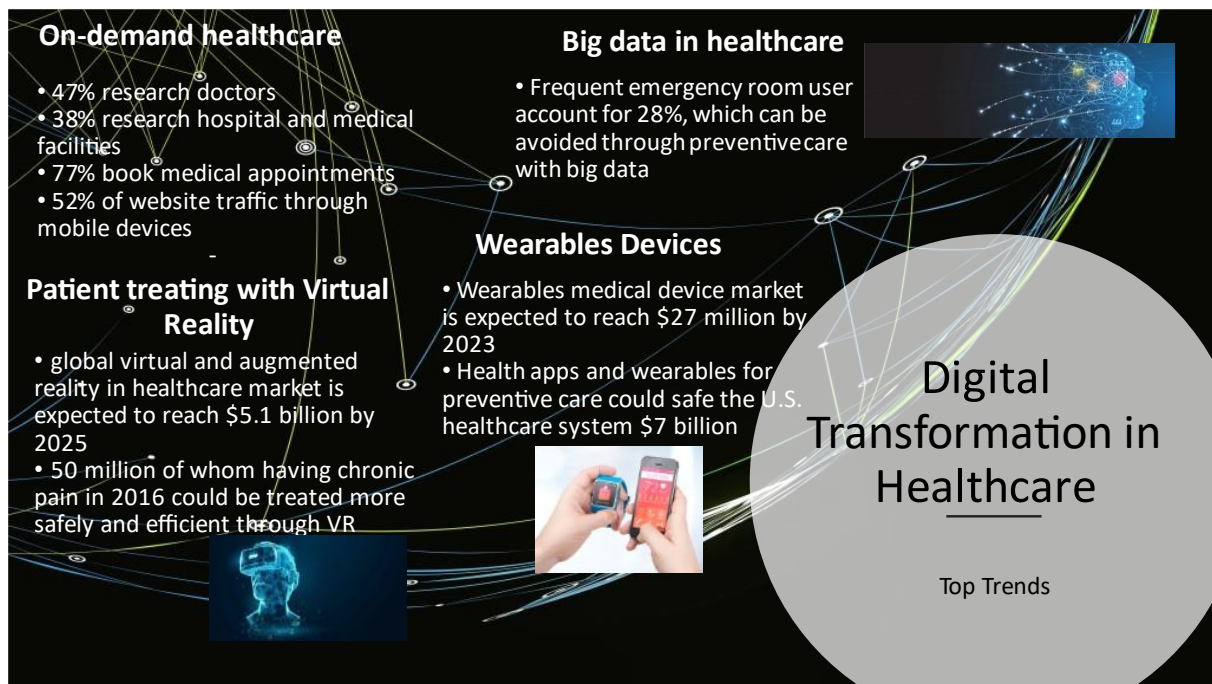


Figure 4: Digital Transformation in Healthcare (own illustration, in the style of Reddy, 2021)

6.1. Wearables Medical Devices

As mentioned earlier, wearables are becoming increasingly important for digital health sector, as their application and use is essential for the technological development of healthcare and could change the whole healthcare landscape. However, wearables, along with all other healthcare trends, require regulations and clinical approval. What distinguishes wearables from other technologies, especially data-collecting tools, is that the data is very personalised, collected in real time on a frequent basis. There is enormous potential for expansion of applications, such as fall detection, for disabilities like ankle- foot rehabilitation, cardiology and many more. The most commonly used wearables nowadays are heart rate sensors, exercise tracker, sweat meters (used to check blood sugar level for diabetics) and oximeters (monitor oxygen level in the blood for people with respiratory illnesses or asthma). With a focus on needs and feelings, wearables should be designed by working more closely with stakeholders, incorporating feedback loops, to see- how decisions influence the quality of wearables and in order to customise them. Future designers of wearables therefore have to give a higher priority to user input and make them more accessible and useful for user groups such as disabled or elderly. Today they are mainly used for young, sporty groups of people (Bause et al., 2020). While everyone talks about wearables in terms of smart watches, there are more types of

wearables to discover, such as smart clothing. By using computer chips to exchange electrical signals and data, smart clothes can connect to smartphones and are also able to measure blood flow, breathing rate or biological rhythm. Furthermore, wearables can be attached to the body. A Swiss company designed contact lenses- that are able to measure their intraocular pressure 24/7. This is used for glaucoma patients, as a change in pressure is the most important factor in diagnosing glaucoma and can be slowed down through continuous monitoring. Another innovative product is biopsy wearables. These are very special, as they can be either transplanted or even consumed by users. Firstly, they can be used to ascertain- if medication is ingested in real time, but they can also be used to permanently monitor blood sugar levels for diabetes patients (Lee & Lee, 2020). Furthermore, users could benefit from using medical health devices by obtaining a bonus from the insurance provider. Insurers or clinics could better assess patients risk, take preventive measures and save money (Reddy, 2021). People currently use wearables for different reasons; 37.15% is using wearables to measure general activity, followed by 23.96% to monitor heart rate, 23.96% to check the stress level, 11.81% to track sleeping, and 3.13% to measure blood pressure (Lee & Lee, 2020).

A further benefit of wearables is that they can support the trend of remote on demand healthcare, as individuals can receive health-related information at any time and can even connect to providers. The data that comes from these medical devices would enable more cost- effective and accurate treatment for patients than is possible with treating patients in the hospital. One important healthcare issue, the lack of healthcare workers and facilities- caused by an aging population- can be reduced through monitoring technology (Lee & Lee, 2020).

Generally, we have to divide users into two groups; medical personnel and the general public. While technology can assist medical personnel to take decisions, it enables users to take preventive actions. An important variable of the future success of wearables is technology acceptance and use intention. People who are oriented towards a healthy lifestyle are tending to learn and apply technologies and devices (Yilma, 2016).

In order to further develop digital healthcare, wearables have to collect data. The data collection can be either collated automatically, through use of sensors or manually by entering data. The collection of this kind of data is a special challenge, as they are the most confidential of all types of personal information. Users are concerned about what is collected, but especially how it is used. Even more concerning is the ownership of the data, since in most of the cases the owner is not the user, but the company that produces the wearable device, while the user only

can access their data in a summarised form. Meanwhile, the raw data can even be sold to third parties. Mostly, the data is stored in one database by the company, which is vulnerable if it becomes the victim of a hacking attack, as all customers' data can then potentially be exposed. Many users do not know a lot about the storage security of their data. They just trust the company and hope- that they comply with privacy and security regulations. This introduces the next issue, as often companies do not have to comply with the user's country regulations, since they produce the devices in other countries, where there are other regulations. Preventive security measures should be taken, such as authenticity controls, algorithms or encryption to ensure data security from wherever someone uses the device or accesses the system. In the healthcare context, the quality of data remains to be tested. There are significant differences between devices, when it comes to heart rate sensor measurements (Bent et al., 2020). Furthermore, something has to be designed to authorise certain people- such as care workers- to be able to access this personal information, if the user allows them to. Virus software is seen more often on mobile devices, since an increasing number are using mobile devices to access online banking or shopping, which makes it so interesting for hackers. The transfer between wearables and smartphones especially offers opportunities for malware to be implanted. A survey questionnaire found out, that 51.89% of respondents were not familiar with their device's security policies, especially since they are shown on such a small device, where it is even harder to properly read through them (Lee & Lee, 2020). 52.83% of people surveyed were not familiar with how their data is stored or transmitted. Surprisingly, 41.17% were not concerned about who could access their health data, which can be justified by 66.04% of respondents not considering confidentiality or anonymity as important (Lee & Lee, 2020).

Wearables will play a very important role in the future of digital health, as they are one of the best and most individualised data collectors. For prevention purposes, they will likely increase in importance, as they can collect personal health data on a daily basis and could therefore give us feedback on the personal health frequently. The main benefit of wearables is that they can personalise people's healthcare experience, influence their well-being and improve their personal health.

6.2. Artificial Intelligence

Artificial Intelligence has changed our everyday lives and is already applied in a lot of fields, sometimes without us even noticing. The way we buy products through online shopping platforms such as Amazon is based on suggestions by AI, the use of Amazon's Alexa, and

which advertisements we see, how we search for information, and spam-free emails are all a result of AI algorithms. AI has enabled many of the business innovations that have been created by big tech companies, but also many start-ups are jumping on the AI train in order to come up with disruptive business models that are capable of changing whole industries, including the healthcare industry (Basu et al., 2020).

AI is a computer science, which simulates human intelligence with the use of computer systems, that are able to perform tasks, which would normally require human intelligence. It includes applications for visual perception, speech recognition and even decision making. In the healthcare environment, it is usually fed with large data packages and then a machine-learning algorithm extracts information from the data, which is used to generate a useful output that solves an already defined problem in the medical system. AI's application in medical sciences include drug development, diagnosis of patients, treating patients remotely, matching symptoms with appropriate physicians, improving communication between patient and physician, transcription of notes, organisation images and- files and many more (Basu et al., 2020).

A field which can greatly benefit from AI is disease recognition through image analysis by a deep convolutional neural network (DNCC) model. A DNCC has been fed with 129,450 images which had to be classified into one of two categories, either keratinocyte carcinoma or seborrheic keratosis (Esteva et al., 2017). This DNCC achieved a performance equal to 21 board-certified dermatologists. This proved- how efficient AI systems can be trained through images, putting them on one level with dermatologists at classifying skin cancer in a fraction of the time. A physician spends years at college- and has to gather experience through giving thousands of patient diagnoses to get on this level. AI models can make clinics more efficient by diagnosing more patients in a shorter time. One especially beneficial use of AI is its utilisation in organisational purposes. AI is capable of matching a disease to the right physician, as mentioned earlier, and then could automatically schedule appointments, even across facilities. It could answer prescription related questions, find the most cost-effective drug and could even give information on drug availability or alternatives. The occasions where doctors are searching protocols or available clinical tools is another area, where AI could improve the workflow of a whole hospital or clinic. There are many assumptions being made on what a future with AI will look like. Often it has been discussed that AI will replace jobs in the healthcare industry. Nobody can predict the future, but it is likely that the people who understand the role of AI and know how to use it- will have an advantage. Successfully applying

AI needs programming knowledge. Therefore, the collaboration between physicians, who have the industry and patient knowledge, and data scientists is crucial for building a meaningful AI system (Basu et al., 2020). In recent times, AI has proven useful in the pandemic in terms of predicting where emerging hotspots might be, by analysing flight and traveller data and detecting contact between participants. Another very interesting area of application are treatments and therapies for cancer patients, who face high treatment failure rates- due to a lack of individualised therapies and medication (Reddy, 2021). AI is capable of taking a much closer look, so much so that it can spot details that no human eye could and thus can suggest an individualised treatment, reducing errors significantly. The cost and time-saving potential of AI can be seen in drug development. AI can shorten drug development from five years to just one using machine learning, which also cut costs significantly (“Why Big Pharma and Biotech Are Betting Big on AI,” 2018).

With opportunities comes challenges and probably the biggest limitation AI has is the availability of data, especially high-quality data. The lack of qualitative data is due to privacy and security issues. In terms of the privacy of patients’ data, this leads to a limited amount of data available, which leads to limited model training, resulting in a lack of knowledge around AI’s full potential. Another limitation is the fragmentation of data, especially in personal health records, as they often contain raw data, that has been entered manually and contains errors. Furthermore, data sharing between healthcare organisations is limited due to privacy concerns, which reduces the reliability of a model (Basu et al., 2020).

There are many best practice examples for the successful application of AI in digital health. This thesis will mainly focus on digital imaging, since this is needed for the business model. The following example describes and proves the successful application of AI in digital imaging; Beth Israel Deaconess Medical Center, located in Boston, developed an AI solution to faster diagnose blood diseases and is now capable of detecting them at a very early stage. The tool was built by feeding the machine with 25,000 images and then teaching them how to search for bacteria. The machine is now able to identify and predict harmful bacteria in blood samples with 95% accuracy (Daley, 2019).

AI is not just a passing trend in how to digitise the healthcare market, but it is a tool which will likely change all layers of healthcare, as it has massive potential for patients and healthcare providers

7. COVID-19

Digital Health has been discussed for many years already, but as already mentioned, the pace of adaption was very slow- due to a lack of regulatory adjustment, cultural barriers, administrative and reimbursement reasons, which made the systematic change of such a big industry very challenging. Since the outbreak of the pandemic, regulatory issues and security of data is under review. The pandemic came with an unexpected need for social distancing and required remote care for millions, and this has changed the digital health landscape and has elevated the discussion about digital health and therefore accelerated its development and adoption towards a more digitised healthcare system (Soliman & Zoghbi, 2020). Many countries' healthcare systems were lacking in preparedness for the pandemic in both Global North and Global South countries. Digital interventions can strengthen a healthcare system, as they can relieve facilities by helping people remotely without them overrunning facilities, if there is no emergency. Many Global South countries, such as Sri Lanka, encouraged people to get information and advice through the internet, but also encouraged them to use teleconsultation and schedule future appointments with doctors. To ensure enough digital capability, the government and Ministry of Health worked closely together with private telehealth companies. They also launched an app which would direct people to private sector telehealth providers. The use of digital tools had a major impact in keeping the numbers of COVID-19 patients low in Sri Lanka ("Digital Health and COVID-19," 2020). It can be seen, that especially low- and middle- income countries made big efforts in shifting their care models, while Global North countries could rely on their available infrastructure to deliver health services. Although Global North countries did not have such a big need to shift their care models, they did apply teleconsultations to take off pressure from their healthcare systems in order to focus on the people who really needed care, especially the patients in emergency care ("Digital Health and COVID-19," 2020). While telemedicine in healthcare can minimise inequality through lower barriers to access, there are disparities in broadband and access to the internet, which have to be addressed to ensure access to care for everyone.

The pandemic has definitely accelerated the deployment of digital health, as it has increased public awareness of what digital health tools are capable of. People were seeking a health component to complement their digital daily lives and found it in wearables and telemedicine. The World Health Organization pointed out in their global strategy for digital health; the use of technology should be affordable, safe, ethical, people- centred and evidence- based (*Global*

Strategy on Digital Health 2020–2025, 2020). Health authorities therefore need to expand and strengthen the implementation of digital healthcare to make it an incorporated part of the health system, not only during, but also beyond the pandemic. Nevertheless, it remains to be seen, if the changes applied in 2020 will be rolled forward, reversed or being partly adapted to the future of healthcare.

8. Business Case of an AI- based tele-dentistry company

8.1. Business description

Dental Monitoring (DM) is an AI- based tele-dentistry start-up- that is offering a service to remotely monitor orthodontic treatments. It is currently revolutionising the way dental and oral care is provided, by reinventing the patient’s experience. Applying AI- based solutions, DM is using technological opportunities to deliver a unique customer experience, meeting today’s customer needs. The bandwidth of solutions for practices goes from patient acquisition over remote follow up treatments to remote monitoring, in order to improve practice efficiency, treatment plans and offer closer treatment monitoring with less visits and costs. Through this technology- based approach, it is possible to work more precisely, reduce errors and increase the quality of outcome for the patient. Customers will have the opportunity to see a simulation of different appliances on their own teeth. DM enabled this smile prediction with help of an AI simulation- that uses a patient’s real teeth to predict their future smile, after successfully finishing the treatment. The following graph is a step-by-step- guide to how the solution is going to be applied in orthodontic treatments.

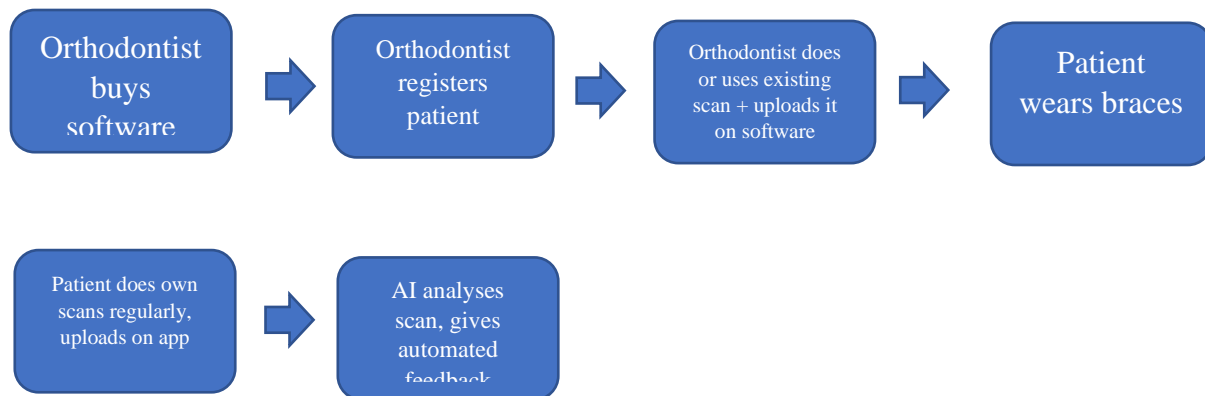


Figure 5: How it works- Application of DM’s solution (own illustration)

Firstly, the orthodontist buys the solution through subscription or a starter package- about which more will be discussed later on in the paper. The orthodontist then registers his patient on the software. If there is no recent mouth scan, the orthodontist has to do a proper mouth scan and uploads it to the software in order to have a basis scan for the treatment process. The AI can then compare and analyse the progress. In the next step, the patient then will be provided with different clear aligners, which they have to move on to during the treatment. Clear aligners are transparent orthodontic devices, an advancement of the classic dental braces, made of plastic.

The aligners will be produced on the basis of the scan and applied according to the treatment plan and the current progress. Before the treatment starts, the patient will have to download the app, where scans can be uploaded, communication with the orthodontist will take place and the treatment progress can be viewed. The patient receives a package with the clear aligners needed for the whole treatment, as well as the Scan Box, which is used to do the scans with the help of a smartphone used wherever the patient wants. The patient then wears the aligners and does the first scan themselves with the help of the Scan Box, which will have to be uploaded through the app. The AI then analyses the scan and gives automated feedback to the customer, and if requested, approved by the orthodontist. If everything goes well, this process will be repeated until the patient uses the last aligner and the promised result is achieved. If something does not go according to the plan, changes need to be made or the treatment plan changes, the patient can communicate through the provided channels within the app.

What problem does it solve? As we outlined earlier, the future patient has more market power, is more demanding and can choose the way they claim dental services, which is given by DM's solutions. The lack of digitalisation in dental practices can be counteracted by applying DM's solutions.

8.2. Market opportunity

An opportunity, often defined as a favourable juncture of circumstances might create a need for a new product or service and is therefore essential for businesses to survive or start-ups to establish themselves in a competitive environment (Krueger, 2005). By observing trends, one has to find out- whether there is a need for a certain product or service and how to satisfy the need by creating added value for the customer. Analysing the trends, it can be seen that customer behaviour has changed; they are now used to access a service at any time, from anywhere with nearly no limitations and at low costs. Empowering the patient and minimising unnecessary appointments through customer-centric solutions is thus not just an opportunity, but also approaches being a necessity. The founder's initial goal was to create an outside clinic experience to patients, only asking them to visit the clinic when needed (Glaser & Steinman, n.d.). The need for remote treatment became visible, especially in terms of responding to the current pandemic. The CEO, Philippe Salah, asked himself back in 2013, how to solve the problem of providing good quality care, even if the patient is not in the clinic (Aligner, n.d.). This trend, accelerated through the pandemic creates enormous future potential. The digitalisation of healthcare, namely tele- dentistry, is developing at a slow pace, and is calling

out for applications that benefit customers, raise efficiency, save costs, optimise resource consumption and increase clinical results, while ensuring data privacy and complying to regulations and policies. The product used for those treatments is mainly the clear aligner, which is expected to have a CAGR of 19.7% from 2021 to 2028, resulting in a high possible demand for this solution and definitely an immense opportunity (FORTUNE, 2021).

8.3. Business Model Canvas

<p>Key Partners</p> <ul style="list-style-type: none"> - Straumann Group <ul style="list-style-type: none"> ➢ Dental manufacturing and supply - Vitruvian Group <ul style="list-style-type: none"> ➢ Private equity fund - Loum <ul style="list-style-type: none"> ➢ Focus: Improving patient experience - Align Technology <ul style="list-style-type: none"> ➢ Manufacturer: Invisalign 	<p>Key Activities</p> <ul style="list-style-type: none"> - Platform maintenance and improvement - App maintenance - Improving products and service offer - Marketing - Customer support <p>Key Resources</p> <ul style="list-style-type: none"> - Machine learning technology - Human resources - Financial resources 	<p>Value Propositions</p> <ul style="list-style-type: none"> - Using advanced machine learning technology - New remote monitoring approach - Time/ cost-saving potential - Improved clinical outcome - Scan Box solves customer's need for digitalisation and flexibility in accessing the service - Unique customer experience 	<p>Customer Relationships</p> <ul style="list-style-type: none"> - Personal assistance <p>Channels</p> <ul style="list-style-type: none"> - Company's website - App for customers to access the service - Podcast - Webinar 	<p>Customer Segments</p> <ul style="list-style-type: none"> - Digital affine dentists - Aesthetics-driven customers - Orthodontic clinic chains with strong process orientation - Expanding dental clinics
<p>Cost Structure</p> <ul style="list-style-type: none"> - Platform maintenance - Human resources - Sales & Marketing - Production costs 		<p>Revenue Streams</p> <ul style="list-style-type: none"> - Sales subscription - Scan Box - Vision Licence - Smile License 		

Figure 6: Business Canvas Model (own illustration)

8.4. External analysis

8.4.1. PESTL analysis

Political & Legal factors

Healthcare is politically influenced mainly by changing public health insurance reimbursement schedules. Dental treatments are a special kind of healthcare treatment, since the reimbursement structure is different. Generally, but especially for adults, the reimbursement for dental treatments is relatively low, since those treatments are mostly considered aesthetic treatments, rather than necessary ones. This is even more the case when looking at orthodontic treatments for adults. Another political factor, linked to the reimbursement is the fees- that dentist or orthodontists are allowed to charge. This influences the attractiveness of the sector, since it decides on how much money they can make. Changes here can have a huge impact on the

industry and its providers and structure. It is therefore necessary to take a closer look at two major countries within Europe and their reimbursement structure and fees for dental care.

In France, general dental treatments are reimbursed in very much the same manner as that of other medical specialists, unlike other countries in Europe. The reimbursement rate for basic dental care is as high as 70%. Since those rates remained unchanged for decades, dentists would not be able to earn money. The system therefore allows many dentists to charge treatments above the standard tariffs, which are not reimbursed by the state. Additionally, for all non-routine treatments, such as crowns, prosthetics and orthodontics, dentists can freely decide on how much they charge, which is very attractive for dental care providers. Those extra, unreimbursed costs can only be fully reimbursed when patients take out supplementary insurance, and premiums are high. Since many households were not able to afford the dental care they needed, the government agreed on new arrangements with the dental profession and top-up insurers in 2018. In those arrangements dentists agreed on reducing their charges for non-routine treatments. Furthermore, the government increased the reimbursement tariffs for basic and preventive care. Lastly, health insurers agreed on including basic dental care in the scope of their standard policies. Governmental estimates state, that basic dental care which is fully reimbursed covers 46% of all work undertaken, 25% of intermediate work and 26% of non-reimbursable treatments (*Guide to French Health System*, 2021).

In Germany, all orthodontic treatments until age 18 are fully covered by public health insurance. However, this requires a certain severity of findings, which are rated according to the orthodontic indication groups. If, for example, a horizontal overbite of incisor teeth is more than 6mm, it can be fully reimbursed, but if it is just 5mm the treatment is considered a personal matter- that has to be financed by the patient. The public health insurance covers standard treatments, characterised as “suitable, economical and sufficient” at an average fee of €3.000. However, this amount mostly is exceeded, causing extra costs for the patients (KZBV, 2020). Anyone who thought- that private insurance companies would take over fees completely and without fuss- was mistaken. They always request the diagnostic documents, requiring them be assessed by a judge. Through this approach, they can put fees and the medical necessity in question and refuse to finance the treatment based on their legal analysis. Furthermore, one has the option to take out an additional dental insurance to supplement the private or statutory health insurance to get more dental treatments covered. One important factor for practitioners is how they calculate their bills, which is done on the basis of the German Dental Fee Schedule (GOZ). Dentists are allowed to charge only for services- required for necessary dental care, in

accordance with the guidelines of dental practice. Services beyond this may only be charged when performed upon the request of the payer. The fee can be multiplied by a factor of up to 3.5, depending on the materials used, required time and complexity of the treatment. Mostly the dentist provides the patient with an estimated cost outline for them to submit to the insurance provider, to see which costs are covered (Bundeszahnärztekammer, 2011).

Regulations can vary widely between countries. In the Netherlands, everything is completely regulated, and therefore relatively cheap for the customer. For dentists and orthodontists this means smaller profit margins. There have been dramatic changes in the average reimbursement rate in the U.S. throughout the years. In 2014, 67.1% of fees charged by dentists were reimbursed through third-party payers for D3310 (Endodontic therapy, anterior tooth), while it was as much as 71.9% in 2005. The reimbursement rate for D3320 (Endodontic therapy, bicuspid tooth) dropped from 74% in 2005 to 68.5% in 2014. For D3330 (Endodontic therapy, molar) reimbursement was 77.3% in 2005, compared to 72.7% in 2014 (Gupta et al., 2017).

In 2017 a new tax reform by the Republicans in Washington brought about big changes- for patients and healthcare industry companies alike, as it lowered the tax rate from 35% to 21% for US corporations (*Tax Reform Impact on Health Care and Life Sciences*, n.d.). This tax changes benefits life science manufacturers, as it makes the US market more competitive. Thanks to a one- time 15.5% transition tax on historical accumulated profits in cash and 8% on the rest, the new law could lead to a domestic investment of unrepatriated profits. Domestic research costs must be spread over five years (15years for offshore research) instead of immediately, starting in tax year 2022, which could lead to lower depreciation, thus resulting in higher profits. Taxes for orphan drug credit have been reduced from 32.5 % to 19.75%, which led to extended research on rare diseases (*Tax Reform Impact on Health Care and Life Sciences*, n.d.). The new bill could result in a reduction in premiums for consumers as insurers must comply with the ACA's medical loss ratio rules. These stipulate that at least 80% of individuals' premium income must be spent on medical expenses (*Tax Reform Impact on Health Care and Life Sciences*, n.d.).

Economic factors:

Healthcare providers will obviously be affected by many factors, such as inflation, interest rates or unemployment. These factors will directly influence, how people and companies are able to spend money. If unemployment increases, medical device manufacturers will struggle to find patients- that are able to pay their rates. Less people working leads to less people that qualify

for work benefits like healthcare. Those people then will be less likely to claim dental advice or service. Especially for the business model proposed, whose treatment methods are used by mainly adults, who, as was found out earlier, are paying for a large part, or even all of the treatment, disposable income plays a major role. This is also closely connected to general economic development. The better it is, the more money people are able and willing to spend on these kinds of treatments, since they are more aesthetic interventions- rather than essential ones.

Even if the healthcare industry is non- cyclical, meaning that demand is not reacting to changes as much as it would in other industries, interest rates can still have an impact. Capital is always needed, so if interests are rising, healthcare facilities cannot obtain capital in the same way as before. Since the interest rate in Europe was nearly zero throughout the last years, the healthcare industry was able to obtain much higher amounts of capital that they would have been able to obtain at other points where interest rates were higher.

Looking at inflation rates in Europe, especially regarding the current situation, where many experts predict an inflation is likely to happen, many players, especially in the healthcare industry, from insurers, providers, through to patients could suffer from it (Pearl, 2018). Normally the inflation rate is balanced through higher salaries or benefits. However, if inflation turns out to be higher than normal, this will have consequences, especially for US healthcare providers. Federal and state governments in the US control more than 50% of healthcare funding. Doctors and hospitals already get only 90% of the costs reimbursed, because they only increase their rates by 1-2% a year. Total healthcare costs are increasing by 3-4% each year, which means the healthcare providers, that provide care to the public sector are facing shrinking revenue year by year. As soon as they are asking higher prices, people would struggle paying for care (Pearl, 2018).

Social factors:

Every industry relies on understanding how demographics and the values and beliefs of the general public change over time. Healthcare providers, whether they operate in general healthcare, dental or orthodontic care should be aware of fears, cultural norms and the beliefs of people- when they treat them, but also when examining the way, they deliver care. For example, companies have to meet the requirements of claiming a service or product from everywhere, anytime through digital channels. Other social factors that will have a big impact on the orthodontic and dental market are aging societies. In Europe especially, the average age

of the population is rising, which is leading to a new boom of customers in their middle age, influenced by social media, who have the financial resources and willingness to invest in a new smile, while communicating and accessing services through digital channels. People are generally becoming more health-conscious, which means healthcare companies have to understand and analyse those trends and behaviours and use the results in their favour to establish a competitive advantage.

However, the main social factor that guide this business model in Europe is the awareness of dental aesthetics. This trend could be seen in the U.S. many years ago. The importance of the perfect smile with whitened and straightened teeth is extreme, since it is important for getting jobs and gaining acceptance in the society. Aesthetics became more important- due to a rising social pressure of having a perfect smile. The influence of social media, showing people with perfect teeth and an increasing amount of advertisement, accelerated the perceived need for those dental treatments. Furthermore, oral health has significantly improved, which shifts the focus to smaller corrections- that were not as important before.

Technological factors:

Technological factors play a very big role in healthcare, as they are disrupting the whole industry. Because of technological advancements, one can see improvements in treatments and prevention. Medical devices are offering a wide range of applications and providing individualised and enhance care. Technology allows healthcare to be delivered much faster and more accurately than ever before. Thanks to those advancements, healthcare can be accessed from the sofa, by anyone, and is cheaper. Technologically-enabled targeted monitoring leads to better results and commitment to patients, since they are now able to participate in the process, which makes everyone's life easier and can even be fun, which was inconceivable just a couple of years ago. Thanks to greater access to information, patients are better informed, which leads to increased prevention of diseases. All those technological factors completely re-shaped the way healthcare is delivered and accessed and will lead to an improved system that adds value to patients and providers.

8.4.2. Competitor Analysis

Since DM is a very unique start-up- that combines dental services with emerging technologies, it is hard to find other companies, who offer the same service. The competitive landscape is characterised by either companies which are offering emerging technologies- or companies who

offer dental products and services. Therefore, the following table was set up, which includes all of the main providers of the products and services mentioned above, although none of them can be considered a direct competitor.

Company	Location	Product offering	Strenghts	Payment	Category of Competitio n
Carestream Dental	Atlanta, Georgia	various scanner	High quality scanner	Price scanner	Tertiary
curve Dental	Provo, Utah	Dental Practice Management Software	Great customer reviews, personalised patient engagement, HIPAA compliance, 24/7 service	Price per business hour	Tertiary
Dentrix Ascend	American Fork, Utah	Dental Practice Management Software	Multiple add-ons, such as prescription, live chat, payment solutions, customise user permissions	Monthly subscription	Tertiary
Practice Web	El Dorado Hills, CA	Dental Practice Management Software	Paperless, no extra add-ons- all inclusive, boost case acceptance through3D chart treatment simulation, HIPAA, customise user permission	Mothly subscription	Tertiary

Eta Compute	Westlake Village,	Power embedded computing platform			Tertiary
Number AI	Oakland, CA	Automated customer interaction	No missed calls, immediate 24/7 response via text message		Tertiary

Table 1: Competitors (own illustration)

Carestream is a provider of dental supplies, mainly scanners, who has expertise in producing various mouth scanners. Those scanners could be an alternative to the Scan Box, offered by DM. Curve Dental is, together with Dentrix Ascend and Practice Web, one of their competitors who offer Dental Practice Management Software. Their product is the same, they just differ in price, add-ons, settings and design. Dentrix Ascend is the only one out of the three- that does not have HIPAA compliance. When it comes to the payment model Dentrix Ascend and Practice Web have monthly subscriptions, while Curve Dental’s payment model is based on price per business hour. These three companies are competing with DM’s Virtual Practice. Eta Compute is offering a power embedded computing platform, which supports machine learning intelligence in portable devices. This solution could also be used for medical treatments, especially with portable devices, such as mouth scanners, to even improve the quality of image analysis. Number AI developed an automated customer interaction, which enables small companies to significantly improve communication with their customers, competing with DM’s virtual consultant. They are all categorised as tertiary competitors, which can be defined as businesses that are tangentially related to yours and can be considered as future partners, when looking to expand the product catalogue.

Future competitors could be companies- that have access to this specific kind of data needed to establish an AI solution with the same or even better quality. This could be companies that are applying mouth scanners to patients or dental prosthesis providers. Those companies could gather enough images of tooth impressions needed. The images alone are not enough, since they have to be turned into valuable data, which means every image has to be classified in order for the AI to analyse them properly and determine, what it is supposed to look alike, which reduces the number of possible competitors. One company, that has both is Align Technology, the inventor of the clear aligners called Invisalign, as mentioned above, but who still can not be

considered a competitor yet, since they are not offering the same service or product, but instead are partnering with DM.

8.4.3. Porter's 5 Forces

Threat of new entrants:

There is always a threat of new competitors entering the market, gaining market share or even disrupting the industry. The seriousness of the threat here is closely linked to the barriers a certain industry has, such as high capital requirements, market regulations, governmental policies, access to distributors or customer loyalty for existing brands. In the dental industry the threat is considered low to medium. High medical regulations in terms of what is needed to make customers (practices) align with health regulations, but also the alignment with data regulations, such as HIPAA, to secure the data processing which comes with digital solutions, which work with a lot of highly sensitive data, thus making it difficult to enter the dental market. Furthermore, to enter the market with a digital business model requires large capital. Assuming the business wants to establish a properly working AI solution, it has to be fed with data, programmed and maintained by developers over a long period of time. As the dental industry is very unique and customers act different from the ones in other industries, the experience of existing players is hard to catch up. To create a competitive advantage therefore is a very challenging task for new entrants. The elasticity of demand is relatively low, meaning that customers' demand does not react as strongly to price changes as in other sectors, such as hygienist care with 0.6, compared to 0.2, on a scale from 0 to 1, in dental care. Findings also revealed- that there are significant economies of scale, which strengthens the barriers for new entrants (Le & Lo Sasso, 2020). Since the industry is not yet very developed in terms of digitalisation, there is quite some opportunity for disruption. As described in the competitor analysis, new entrants- who could compete with DM would have to bring a huge number of qualitative data and resources, and therefore the threat for new competitors is relatively low.

Bargaining power of suppliers:

The power of suppliers decides, whether they can increase prices or reduce quality with limited or no effect on demand. The decisive factor here is how dependent the demanders are on the suppliers, due to monopoly position, concentration of suppliers or lack of substitutes. Fewer suppliers decrease the industry's profitability potential. In the dental market, but especially in the orthodontist market, there might be quite a lot of suppliers, but as found out earlier, Aligner

Technology is the market leader for invisible braces- and is increasing in popularity in orthodontic practices, and thus their market power is extremely high, which means they have strong bargaining power as suppliers. The traditional suppliers of fixed braces are losing popularity, as the market has heavily shifted towards invisible ones. Looking at the technologies needed for this business model, there is limited access to qualified human resources, who are able to develop the necessary AI solutions, but at least they are expensive, which increases the bargaining power of suppliers. However, Aligner Technology's patent for clear aligners has expired, which means that the market will probably be flooded with new clear aligner producers. Due to this fact, any bargaining power will decrease, even if it can be considered medium to high at the moment.

Bargaining power of buyers:

The buyer has high bargaining power if he can choose where to buy- and can switch between providers easily. This also requires the similarity and easy substitution of products or services. The buyers, who in this case are orthodontic practices, can choose between different dental practice management systems, but they cannot easily switch between them once they decide to use one. Secondly, they do not have that much bargaining power, as those systems are not perfect substitutes for one another, due to different features and approaches, as just a few offer remote monitoring. Brand loyalty does not really exist, since most of the monitoring solutions or practice management tools are new to the market and customers are going for the cheapest solution due to decreasing reimbursement rates. While the bargaining power of end customers is high in this market, the bargaining power of orthodontic practices is low, due to DM's unique solution.

Threat of substitute products:

Substitute products do not always have to be perfect substitutes for one another. Customers do not tend to switch to alternatives, even if features are missing, as long as they fulfil a similar need. This threat should therefore be analysed properly, not just looking at perfect substitutes. Other competitors might not have a perfectly working AI-solution, but if they can offer monitoring, not based on AI with a less convenient scanning approach, they offer the service for a lower price and would therefore be more attractive. This threat should be taken seriously. However, since DM's solution is very unique and adds a lot of value with its improved scanning method, increasing quality- while being affordable and offers significant cost savings, this threat can be considered low to medium.

Rivalry among existing competitors:

Rivalry among existing competitors investigates the number of existing competitors and their capability in terms of value adding, market share, product/service offer, influence/power and size. Another determinant that influences rivalry among existing competitors is the industry's growth potential and disadvantages when switching provider. When looking at the digital dental industry one can see that the number of players is increasing. Since the onset of the COVID-19 pandemic, the need for remote and digitalised solutions is needed more than ever before. Switching costs are relatively low, but the swapping of providers is still not very likely due to convenience and effort for re-training, which equalises itself. One factor that speaks against high level of rivalry is that the industry is growing and therefore the market share can be decreasing while remaining the customer base. Due to DM's start-up approach, offering a completely new service, there might be imitators- that want a piece of the pie. All in all, the rivalry among existing competitors can be considered medium.

8.4.4. SWOT analysis

Strengths:

- Remote orthodontic treatment.
- Unique monitoring approach.
- Accurate and promising treatment.
- Covering more than 50 clinical aspects.
- Great customer experience.
- Complete remote consultation, including videocalls, text and voice messages.
- Convenient treatment approach.
- Unique selling proposition for doctors and manufacturers of dental products and services.
- AI-based solutions, that enables maximisation of efficiency and growing digital practices.
- Automated feedback to patients including treatment advice.
- Realistic smile prediction.
- Automated screening reports.
- Cost-saving potential through a more efficient approach.

Weaknesses:

- Willingness of practitioners to apply remote telemedicine concepts.
- Long development phase.
- Create trust in AI vs. doctor's advice.
- AI-based solution needs enormous development investment.
- Applicable solution needs 20-40K patient images to work properly.
- Small customer base.
- Need to convince customers of cost-saving possibilities.
- Expensive product.
- Difficulties in usage of scanner.

Opportunities:

- Expected growth in demand for orthodontic products and services.
- Possibility of revolutionising the dental market.
- Ability to creating virtual practices around the world.
- Competitors lack in offering all-rounder-packages.
- Possible state funding for digital solutions.
- Possible premiums from health insurance companies for the use of DM solutions.
- Development lead, creating competitive advantage.
- Easy global scalability for increasing demand.
- Number of adults that want to straighten their teeth has risen by 40% in the past decade (Helfenbaum, 2017).

Threats:

- Competitors with better AI knowledge offer better solutions.
- Competitors offering cheaper solutions.
- Post-pandemic could see shift to standard approaches.
- Complexity and initial investment.

8.5. Internal Analysis

8.5.1. Customer profile

- Digital affine dentists.
- Aesthetics-driven dentists.
- Big orthodontic clinic chains with strong process orientation.
- Expanding clinics.

- Dentists with strong marketing, attracting patients, willing to spend without reimbursement.

After defining what characteristics our customers should bring, it is necessary to examine what value we deliver in order to attract those customers.

- We help them save time.
- We help them save money.
- We help them increase efficiency.
- We help them by offering a better customer experience.
- We help them grow a customer base.
- We help them in becoming more digitally fluent.
- We help them attain better clinical results.

The following calculation, made by an orthodontist, who is applying DM solutions, visualises the cost- saving potential this business model could provide to customers.

This specific customer pays a subscription fee, plus one Scan Box, resulting in a monthly payment of €199 per month.

How much value does the solution creates?

Customer has reviewing costs of €570 - €199 DM costs = €371 savings per patient.

Assuming he has 165 cases per year, this means the orthodontist gets an annual profit of €61,215 by using the solution.

There are additional ways a customer can provide value to us. First of all, it is important to attract the customers, by convincing them that they need these products and services and then making them pay for them. Additional values they could provide are the following:

- They refer me to further customers.
- They are capable of becoming advocates for us.
- They provide access to resources in order to grow the business.
- They provide me with valuable insights, which can turn into new opportunities.
- They do not require a lot of my time for making use of the support, and are easy to deal with.
- They let us use their logo for marketing purposes.
- They give us positive feedback and this encourages our team.

8.5.2. Partners

In 2018 DM partnered with the Straumann Group, a world leader in dental manufacturing and supply of implants, instruments, biomaterials and many more, in order to reach out to more dentists around the world. Together with Straumann Group they successfully developed and launched new products, such as the new Scan Box which made it easier and more accurate to capture intraoral pictures from patients. In 2019, DM gained another partner at its side with Vitruvian Partners, a private equity fund. With fund raising of USD 45 million, DM plans to accelerate its global expansion, especially in the US and Asian markets and strengthen its portfolio of solutions for the global market of general dentists (Alexe, 2019). More recently, DM acquired Loum, whose aim it is to improve the patients experience, which perfectly complements DM's expansive AI tools. Loum, founded in 2017 is designing a more playful version of the App through a gamification approach, which lightens the patient's journey, makes follow-up care more appealing, and accessible and is likely to be followed by engaging them. This complements available skills at DM and enhances the AI platform with new strategies plus it uses an innovative approach ("Dental Monitoring Strengthens Its Leading Position in AI-Powered Tele Dentistry by Acquiring Loum, a European Health Tech Start-Up," 2020). Beside those partnerships, DM is partnering with braces providers such as Align Technology and other clear aligner providers to ensure their solutions are applied.

8.6. Strategy

Considering that the industry's attractive profitability potential is a primary determinant, an important secondary determinant is the company's positioning within that market (Porter, 1985). Generic strategies are presenting four different approaches that help define a strategy, using the advantages the business model comes up with. This model presents two variables, namely source of competitive advantage, which is divided into cost and differentiation, as well as scope, which is further divided into narrow and broad. Taking the SWOT analysis as a base, we can point out strengths and weaknesses. With the use of Porter's generic strategies it is now possible to highlight and decide upon a strategy, which- makes use of the detected strengths and turns them into a competitive advantage.

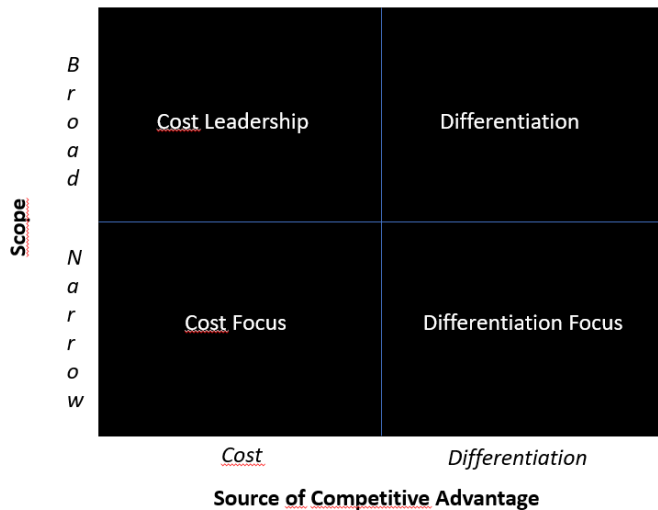


Figure 7: Porter's generic strategy (own illustration)

Looking at the scope, one can say that since the orthodontic market is admittedly a part of the dental industry, which again is a part of the healthcare industry, it can still be considered a broad market, instead of a niche market. In terms of competitive advantage, the business model clearly focuses on differentiation, as it has a very innovative approach, using emerging technologies. The differentiation strategy enables a competitive scope, supporting value creation on a very high level through delivery of quality service that is not just effective in terms of time saving, but also in terms of money.

8.7. Value proposition

Using advanced machine-learning technology, DM provides a completely new remote monitoring approach, that makes practices more efficient, provides time and cost saving potential, while increasing the patient's outcome. The developed AI- solution offers a very unique opportunity for practices to permanently monitor the treatment progress of their patients, while sending automated info or suggestions for improvements to patients per text message. The additional developed Scan Box gives patients the opportunity to scan their bite completely remotely, without the need for practice visits.

8.8. Growth potential and opportunity for the business

The opportunities for this business model in the market is immense. The global orthodontics market size- which was valued USD 4.06 billion in 2018 is predicted to almost double and reach USD 9.72 billion by 2026, boasting an annual 11.6% rise during this period (*Orthodontics*

Market Size, Share & Industry Analysis, By Product Type [Instruments and Supplies {Fixed (Brackets, Bands & Buccal Tubes, Archwires, and Others), and Removable (Aligners, Retainers, and Others)}], By End User (Hospitals, Dental Clinics, Others) and Regional Forecast, 2019-2026, 2019). The dental industry is facing a shift towards digitalisation, but especially since the onset of the pandemic the need for remote treatments has sharply increased, which brings about great opportunities. Furthermore, influenced by social media and other factors, more people- especially the middle-aged, are willing to spend money for the perfect smile. The business model is not just capable of dealing with the challenges of the current pandemic, but also will make practices more efficient in post-pandemic times. Furthermore, customers in general want to access services from everywhere with maximised convenience, which can be perfectly fulfilled by this business model.

8.9. Segmentation, Targeting and Positioning

Segmentation:

Demographic:

- Males and females.
- Medium to high income.
- Age: Generation X.
- Small orthodontic practices.
- Large orthodontic chains.

Geographic location:

- Companies around the globe.
- Focus on U.S., Canada and Europe.

Psychographic:

- Searching for more efficient solution.
- Ways to digitalise practice.
- Enjoy technical applications.

Behavioural:

- Seeking for benefits such as cost reduction, increase in productivity.
- Using digital tools to communicate with customers.

- Heavy users and- engaged customers using the application frequently and are purchasing add-ons.
- Customer loyalty, continually purchasing subscription.

The orthodontist market itself is segmented by product, end user and geography.

By products

- Instruments (around 5%).
- Supplies (around 95%).
 - o Fixed
 - Brackets.
 - Bands & Buccal Tubes.
 - Archwires.
 - Others.
 - o Removable
 - Aligners.
 - Retainers.
 - Others.

By End User

- Hospitals.
- Dental Clinics.
- Others.

By Geography

- U.S. and Canada USD 1.84 billion.
- Europe (U.K., Germany, France, Italy, Spain and the Rest of Europe).
- Asia Pacific (Japan and Rest of Asia Pacific).
- Rest of World.

(FORTUNE, 2019)

Targeting:

Based on the segmentation, we can now outline which segments are going to be targeted. DM is focussing on supplies. Even if the instruments market is predicted to grow rapidly, the supplies market makes up the greater share. Within the supplies market, DM mainly focuses on

removables in the form of aligners. In order to include the remaining supplies, the treatment also works with fixed brackets, while they are mostly used for treatments with children. With end users, the targeting clearly goes towards dental clinics, who not only have the biggest amount of end users, but are also the place with the highest potential. Geography-wise there are basically no limits, since the product and service can be used worldwide and is not specifically designed for one country or continent. Considering U.S. and Canada as being the biggest market with USD 1.84 billion, in 2018 this will be the focus, whilst not forgetting Europe and Asia (FORTUNE, 2019).

Moving on to demographics, we will explore who is a potential customer, breaking down practices into the two following categories:

Criteria size B2B:

A. Practice chains: 50+ employees – Smiles Dental, Apollo White Dentals, Integrated Dental Holdings, Floss Dental Clinic Chain and Aspen Dental Chain,

B. Standard size practices: 2-15 employees, basically every dental practice, that offers braces or aligner treatments

Since every dental chain or practice can be a potential customer, it is necessary to examine the number of dental practices around the world. The American Association of Orthodontists represents 18K+ orthodontists in the U.S. and Canada. In the U.S. alone, there are more than 200K active dentists (Statista, 2021), plus an additional 21K in Canada (Statista, 2013). In the European Union, around 278K practising dentists were counted in 2018 (Statista, 2020). There are no numbers available for dentists in Asia, but one can imagine the huge potential of the Asian market. Worldwide, the number of potential customers is immense.

Now the question is; how to target exactly those practices who are willing to invest in a digitised solution or remote monitoring. Google Ads is a good way of targeting them. Thinking about how they would search for those solutions, one has to figure out keywords, that they might use. This could be “digital practice”, “remote treatment” or “remote monitoring”. Investing in those keywords for Google Ads could boost clicks on the landing page, where the content has to be properly prepared for the researcher. The less clicks a potential customer needs to find the content or information they are looking for, the more they are willing to buy. Targeting by remarketing can also be very useful, since many people are checking for products, they are interested in buying in, but often get distracted or need more searches to be convinced to finally

invest. This is where to get them, as we know that those people were checking for exactly that product or service.

Positioning:

Going back to Porters generic forces, where the strategy was defined to be differentiation, now DM has to act as a market challenger, being placed at the desired position in the market. The purpose of a differentiator is to serve a huge market with a product or service different from others, that adds value to the customer and is special due to its features or innovativeness. DM fits within this positioning as it is a start-up who has a view to become a strong player in time and revolutionize the dental industry. With a properly working AI- based solution and a steadily growing market with huge potential, this business model is intended to achieve long term growth. If the price is considered to be on the Y axle and the quality on the X axle, the business would be placed at very high quality and medium price, as can be seen below.

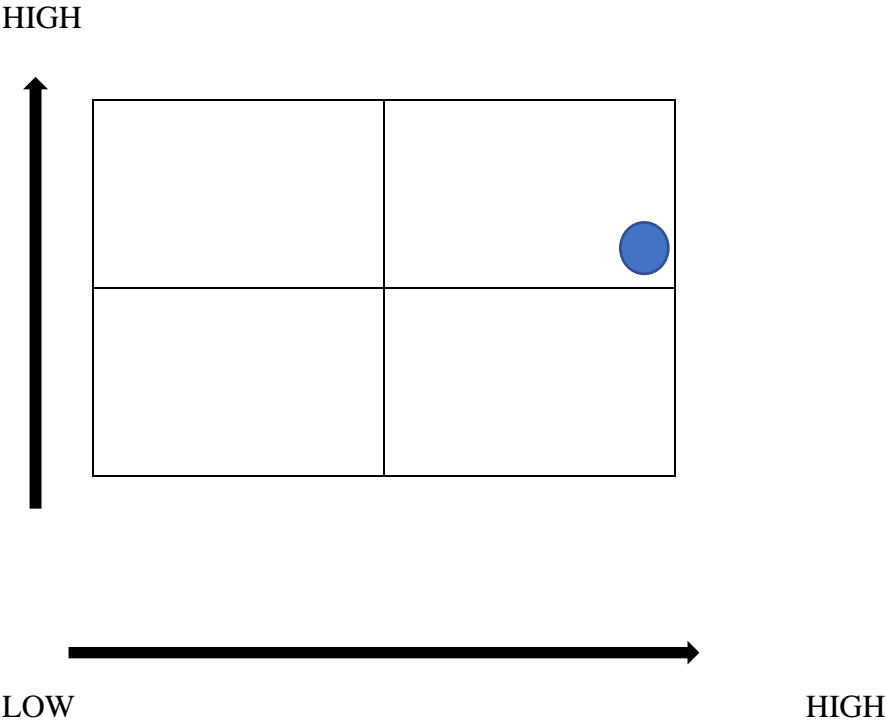


Figure 8: Positioning in the market (own illustration)

8.10. Marketing Mix – 7P’s

Since E. Jerome McCarthy invented the 4 P’s in 1960, they have been associated with the marketing mix and since then have always been a popular tool to determine a product or brand’s

offering. In this case the 4P model was extended to 7P-s to get a more detailed view of the marketing measures.

Product:

A product is the good or service a company offers to its customers, to fulfil the customer's needs, or even create a need. Type of product mainly determines the price, where to place it and how to promote it. Here the product will bring a differentiating service platform that allows remote monitoring for dental practices, offering a scanner to replace the need for practice visits. It is going to add value thanks to its exclusivity, cost-saving potential and digital approach. All features and characteristics will be contributing to serve the practice's productivity, customer engagement and improve the customer experience. The tool provides innovative AI-based monitoring, analysis of treatment process, automated feedback to customers, as well as messaging and video consultation. The full subscription package includes consulting, onboarding and training, the hardware to start the digital journey, including 15 Scan Boxes and three months access to the virtual practice, where you can assess and communicate with patients through video, phone call or messaging. Thanks to prediction of smile, the tool is capable of convincing patients to do this treatment easily. Scientific evidence of clinical results can prove the quality of the product.

Benefits:

- Minimise time spent on treatments.
- Important step towards virtual practice.
- Saves on treatment costs.
- Increases efficiency and reduces errors.
- Increases patient engagement and customer experience.

Price:

Price links the product's real and perceived value, but it must also take into consideration competitors' prices, seasonal discounts and supply costs. Furthermore, discounting must be considered when talking about the price, as this tactic sometimes draws in customers, but it also can lower the exclusivity of the product. The given price model is based on a monthly subscription, which will create a steady income and will make the business become profitable in the future. To ensure that there is a matching option for every type of customer, there will be different subscriptions prices with different features, plus starter packs to attract new customers.

For those who want to use the product without limitations, there will be a subscription- that offers unlimited use. DM is going to offer a price that is affordable, but due to the uniqueness of the product it will not be too cheap. Furthermore, the starter packages will have a huge discount and can be used for the first three months to attract new customers. Due to its time limitation, this will not have a negative effect on its exclusivity.

- Smile Mate: €199 /month.
- Vision Smile: €150 /month.
- Remote Monitoring: €11.99/ month.
- Scan Box: €49.
- Engagement & Conversion Pack: Smile Mate and Vision training, consulting and onboarding, three-month subscription to Vision and Smile Mate: €650.
- Remote Monitoring Pack: Consulting, onboarding and training, plus one-month unlimited upload of patient photos with 70% discount for all active treatments, plus hardware for 15 patients (Scan Boxes) €1,650.
- Full Virtual Practice Setup: consulting, onboarding and training, plus hardware for 15 patients (Scan Box), one-month unlimited upload of patients on photo with 70% discount for all active treatments, three-month subscription to Smile Mate, three-month subscription to Vision.

Place:

This is about determining- where a product should be sold- or how it should be delivered to the market. The product and service are offered online through the company's website, hosted by the Amazon Web Services company. The data will be accessed and safely secured on a cloud, so that no server is needed. Users can log into a domain, where they can access the service. An additional app will provide access for end users to do and upload the remote scans, plus it is where they can communicate with their orthodontist/ care provider. Of course, it will appear on social media, but the customers will mainly find all the necessary information through the company's website and obviously on Google searches.

Promotion:

Promotion is the way to get a message across, which therefore has to be delivered to the right people at the right place and in the right format. Basically, promotion nowadays is deeply connected with the place, as the message will likely be delivered online, where the product is placed as well. In order to attract potential customers, DM is providing podcasts where experts

will be invited to talk about digital approaches in the dental industry in general. Experts will join existing podcasts to talk about changes in the industry and obviously about how DM's solution can positively affect it. Through webinars with existing customers, DM can convince other potential clients to sign up. The user would speak about how to use the service, what benefits it has for them especially, and how much money they can actually save with the solution. This is one of the probably most convincing types of promotion. Furthermore, DM has a blog, where the progress can be shared, industry experts can give their opinion and customers can share their experiences. In health-related services, scientific marketing is a good approach to convince potential customers. Classical B2B marketing, but also B2C marketing by orthodontists can be beneficial. Social media influencers could increase the social pressure on people to have a perfect smile, which in turn would trigger the need for a dental treatment. Key opinion leaders could furthermore support and advertise the product and service. Due to their reputation and expertise, they can facilitate convincing customers. Universities that are specialised in health or dental care- can be places to scientifically prove the quality and value adding potential of the solution. The presence of the company through offices in every continent is important for their visibility and the trust that builds up through this. In each of them a direct sales force should constantly be trying to convince potential customers on site.

Physical evidence:

Physical evidence is often seen as a proof or confirmation of the existence of a brand, which can be done by a purchase. Such a proof can be unique packaging that links a product to the brand, brochures or even an invoice. This service can be claimed online, and it therefore has its evidence through the availability on the platform. Branding is provided through communication channels such as social media, where the brand and the service is visible. It is very important for the physical evidence that the starter package the customer receives when purchasing the product, is branded with DM and immediately establishes a link between the product and the brand.

People:

Everyone, who is directly or indirectly involved in the business can be counted on here, such as the ones selling the product, designing it, managing the team or the ones representing customers. Without those people the best product, innovation or appearance is useless. For any business, especially a start-up, it is important that people are connected to the brand and the idea and that they share the same vision. Everyone should be an ambassador for the company.

It is important to pass the passion, values and vision to the ones joining the team, once the company is growing. The same importance should be given to the customers, so the business must know them as a person, what they need, how a solution would benefit them and it is necessary to constantly review and adapt to their changing needs, as well as to adopt technological developments or trends. The relationship of the sales people to the customers is of high importance not just create relationships with clients but also to maintain them.

Processes:

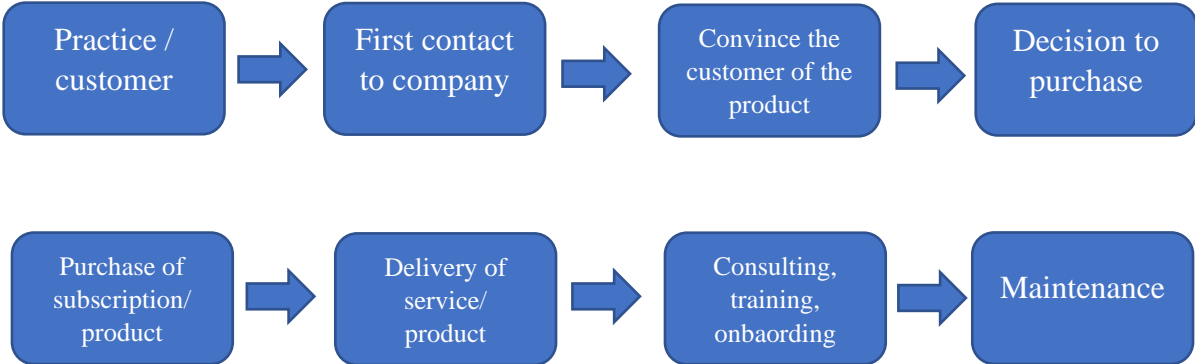


Figure 9: Processes (own illustration)

8.11. Legal Framework

DM is registered as a simplified joint- stock company in the Paris Trade and Companies Register in France. This company form is one of the most popular ones in France and is similar to a limited liability company under U.S. law, which is based on the common law, rather than the civil law. It is mostly used for small to medium sized enterprises. A simplified joint- stock company can only have one shareholder, whose liability is limited to his contribution, which here is €15,149,30. In the case of collective decision- making, the sole proprietor exercises the power transmitted to the shareholders. The structure can be freely determined. The only obligation is- that it has to be represented by the president towards third parties, who can either be a legal entity or an individual, which is the case here.

8.12. Organisational structure

When the business success is looked at as a skeleton, the organisational structure of a business can be considered the backbone. It can have a massive impact on achieving goals and on

employees' motivation. There is no right organisational structure, it heavily depends on the company's culture, values and mission. It is so important since it defines, who reports to whom, who has the responsibility for what and who takes decisions ("5 Different Types of Organisational Structure Explained," 2020).

At DM's main location in France, one can see a functional organisational structure being applied. This approach groups people by its function. The clear advantage is the high degree of specialisation, since they can learn from each other and solve problems together. It gives a clear structure with responsibilities and fuels growing together as a team. Individuals can grow, identify and establish their skills. Another advantage for the fast-growing team at DM is the easy scalability, which promotes growth. A disadvantage is, that it might create barriers between departments communication and knowledge transfer. Work can get repetitive and boring, leading to demotivation and loss of enthusiasm. Since DM has various locations around the world with some small offices, this structure cannot be applied everywhere.

8.13. Change Management

One might wonder why you need change management in a start-up, using the newest technology and who can easily adapt to new situations or a changing environment? Nowadays a common phrase is "change is the only constant". A fast-growing start-up like DM is one who has to be prepared for massive changes in many areas. The number of employees may reach more than 250, which brings the need for constant rearrangement of staff, changes in responsibilities, functions or even the forementioned organisational structure. With time, products can change, or new ones can be launched, which results in changes of the focus, market, marketing and so on. It is important to be prepared for this. There are five stages for change management, which are the awareness of the need for a change, the desire to support and participate in the change, the knowledge of how to change, the ability to implement required skills, behaviours and the reinforcement to sustain the change (Hiatt, 2006) Not being prepared for a change can harm any business, no matter how successful it might be, and therefore is essential for DM to be ready to change at any time.

8.14. Financial plan

The financial plan will provide information on investment and possible financial strategies, as well as an outlook over the next five years, starting in year 2021. The assumptions are rising

exponentially on a big scale, but are justified by the aforementioned expected CAGR of 19.7% from 2021 to 2028 for clear aligners (FORTUNE, 2021). Additionally, the global orthodontics market is expected to double within the next five years (Emergen Research, 2021). Therefore, the following numbers can be reached without a big increase in market share. The underlying prices can be found within the chapter marketing mix, the 7P-s.

8.14.1. Financial expectations

This immense market potential and the uniqueness of this innovative solution leads to the following assumptions. The numbers of patients monitored- which is the basic service and therefore is considered the main income stream- are expected to grow exponentially, reaching a high in 2025 of half a million customers who are actively monitored.

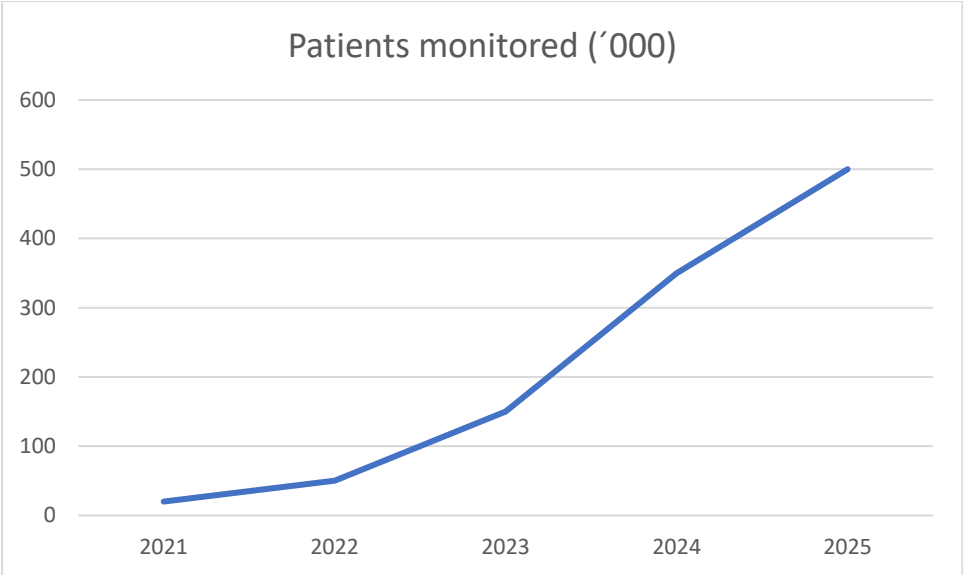


Figure 10: Patients monitored per month (own illustration)

The patients monitored are obviously linked to the number of active dentists on the platform. This number is assumed to reach 15k by 2025. Since add-ons are offered in form of Vision Smile Simulator and the Smile Mate licence, DM is expecting a high number of active dentists to use those licences reaching 11k by 2025, which results in 73.3% of dentists using those licences. This number will increase, once the practitioners are realising the value, added through those licences, for their productivity, customer experience, satisfaction, case acceptance and cost-saving potential.

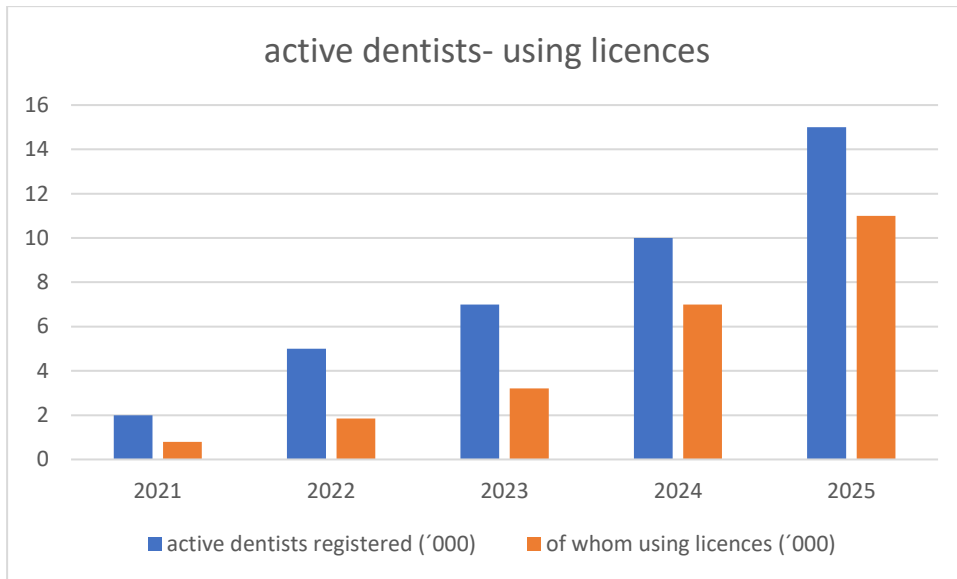


Figure 11: Active dentists- using licences (own illustration)

The total sales are assumed to have the following numbers, divided into the category's subscription, Scan Box, as well as Vision and Smile Mate licence, which are reflected in more detail in the income statement.

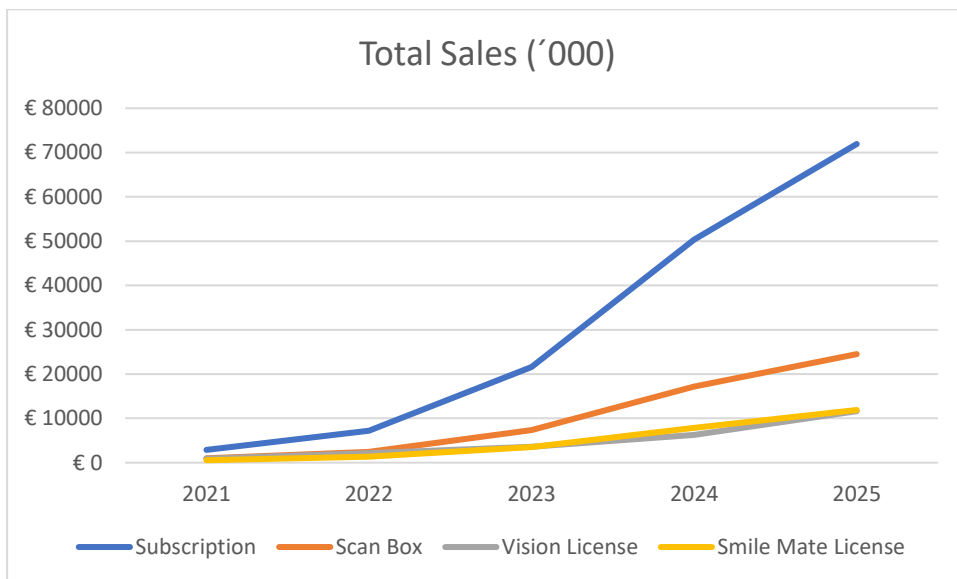


Figure 12: Total sales (own illustration)

8.14.2. Income Statement

The sales are divided into the sub-categories mentioned above, while a discount was granted on the sum of all sales. This comes from the starter packages offered to new customer, as well as for bigger dental chains, that request a higher number of subscriptions and licenses. For the

sales subscription it was assumed to sell 20K, considering the monthly price of €11.99, multiplied by 12. Therefore, €2.878 million will be the revenue made from sales subscriptions. Considering the predicted exponential growth, it was assumed that 50K will be sold in year two, 150K in year three, 350K in year four and 500K in year five. As every sold subscription means a new treatment or new patient, sales of the Scan Box are equal to the subscription. A Scan Box costs €49, which results in an accumulated revenue from Scan Boxes of €980,000 in year one, calculated from 20K Boxes, multiplied by €49. Years two to five of Scan Boxes sold lean on the sales of years two to five in subscription. It was further assumed that 300 Smile Mate licences will be sold in year one, which, at an annual price of €199 would result in revenue of €716,000. Considering the predicted exponential growth, it was assumed- that 650 will be sold in year two, 1.2K in year three, 2K in year four and 4.5K in year five. For the Vision licence it was assumed that in year one, 500 customers would buy the licence, which would result in €894,000 revenue at a price of €149 per licence, for year two it was assumed that 1.2K would be sold, 3.2K in year three, 5K in year four and 6.5K in year five. It has been mentioned earlier, that starter packages with discounts are provided, which explains the discount of 10% on the whole sales. The cost of goods sold must be conducted from this. For the production costs, one Scan Box costs €20 to produce, which results in total production costs of €400K in year one, as 20K have been produced. The maintenance costs for the platform, meaning the provision, the costs for storage on the cloud for each patient, general improvements, including consultation and eradication of errors, are assumed to be at €3 million in year one, rising slightly at a rate of 5% year by year. The sales minus the costs of goods are resulting in a positive gross profit in year one already, as can be seen in the Table 2 income statement. Continuing with the operating expenses, we can see the first item salary. This calculates 80 IT developers with an annual salary of €75K each; 120 people- working in administration with an annual salary of €50K each; and 30 management employees with an annual salary of €100K each. Those numbers accumulate to €15 million in year one. For the following years, an increase in the number of employees by 25, with an average annual salary of 60k, was assumed. Furthermore, 3% annual salary increase were applied. Office expenses, such as office supplies and equipment were assumed to account for €2 million in year one, rising slightly by an annual rate of 5%. Rent has been calculated as follows; approximately 250 employees are working for DM. For one employee, the average space needed is 15sqm, which amounts in 3,750sqm total. In the central business district of Paris, the second-hand rent (€/sq m/year) is €645. This accumulates to €2.5 million for year one (Delphine, 2021). It was mapped that in year four the company would move to a bigger office building, due to expansion. The costs for sales and marketing, which were assumed relatively

stable throughout the first three years, starting at €2 million, were predicted to more than double from year four, when the break- even point will be reached, and marketing expenses will be increased in order to attract more customers. Lease rentals, which could be the fleet needed for the salesforce is assumed to be as high as €500K in year one, increasing by an annual rate of 5%. IT costs, such as ERP, Office 365, and Salesforce licenses are assumed to cost the company €500K in year one, rising by annual 10%, due to an increasing number of employees and therefore an increase in the amount of licences needed. Costs for legal and tax advice or auditing are summed up in costs for advice at €500K in year one, rising by annual 5%. Others were planned to amount to €800k. In year one, total operational expenses were as high as €20.8million, leading to an Earnings before Interest, taxes, depreciation and amortization (EBITDA) of €-21,879million, which will turn positive in year four only. Depreciation, a bank loan, which is assumed to be €20million, with an interest of 6%, leads to annual €1.2million depreciation. Without an amortization, we get to an EBIT of - €23,089 in year one, which also turns positive in year four. From the EBIT, one has to deduct taxes, which amount to 28% considering the company to be a simplified joint stock company, registered in Paris, leading to the net income, which is - €23,079 million in year one, and will turn positive in year four and reaches the top at €32,645 million in year five.

For The Year Ending	Year 1	Year 2	Year 3	Year 4	Year 5
Sales					
Sales subscription	2,878	7,194	21,582	50,358	71,940
Scan Box	980	2,450	7,350	17,150	24,500
Vision License	894	2,146	3,576	6,258	11,622
Smile Mate License	716	1,552	2,866	4,776	10,746
Discount- 10%	547	1,334	3,537	7,854	11,881
Total net sales	4,921	12,008	31,837	70,688	106,927
Cost of Goods Sold					
Production cost	400	1,000	3,000	7,000	10,000
Maintenance Costs	3,000	3,150	3,308	3,473	3,647
Gross profit	1,521	7,858	25,529	60,215	93,280
Operating Expenses					
Salary	15,000	16,950	18,960	21,027	23,157
Office expenses	2,000	2,100	2,205	2,315	2,431
Rent	2,500	2,500	2,500	3,000	3,000
Sales & Marketing	2,000	2,000	2,000	5,000	7,000
Lease rentals	500	525	551	579	607
IT costs	500	550	605	666	732
Cost for advice	500	525	551	579	607
Others	800	950	1,120	1,280	1,500
Total Operating Expenses	23,800	26,100	28,492	34,446	39,034
EBITDA	-22,279	-18,242	-2,963	25,769	54,246
Depreciation					
Amortization					
EBIT	-22,279	-18,242	-2,963	25,769	54,246
Interest	1,200	1,200	1,200	1,200	1,200
Taxes 28%	0	0	0	7,215	15,189
Net income	-23,479	-19,442	-4,163	17,354	37,857
CROCI	-34.28%	-28.06%	-4.56%	39.65%	83.46%

Table 2: Income statement (own illustration)

As can be seen in the income statement, the break-even point is reached in year four of the calculation. This is the case, because it just illustrates the years 2021 to 2025. From starting the business and developing an AI-solution, a lot of capital and resources were required, resulting in big deficits in the first years. The investment totals to €65 million, which comes from an

assumed €20 million bank loan, plus the €45 million investment raised by a fund in 2019, as described in chapter partners. The bank loan is assumed to be at an annual interest rate of 6% (Steve Nicastro & Lane, 2021). To put into perspective the investment and the net income earned, the Cash Return on Capital Invested (CROCI) was applied. It calculates a rate from EBITDA through total equity value, here in form of the total investment, which is considered the total equity.

8.15. Financial valuation

Financial valuation is very important in order to define a value, that actually confirms the potential of a business model. However, in a start-up this is not that easy, because revenues are not yet at a level, that proves a realistic value. Therefore, it is important, to first define the stage, the company is at the moment. In the following graph, you can see the business- lifecycle, which defines common stages for start-ups. It can be seen, how the weight between the approaches- discounted cash flow (DCF) and market comparables typically is (FundsUp, 2020). DM is situated somewhere between the early growth- and growth stage.

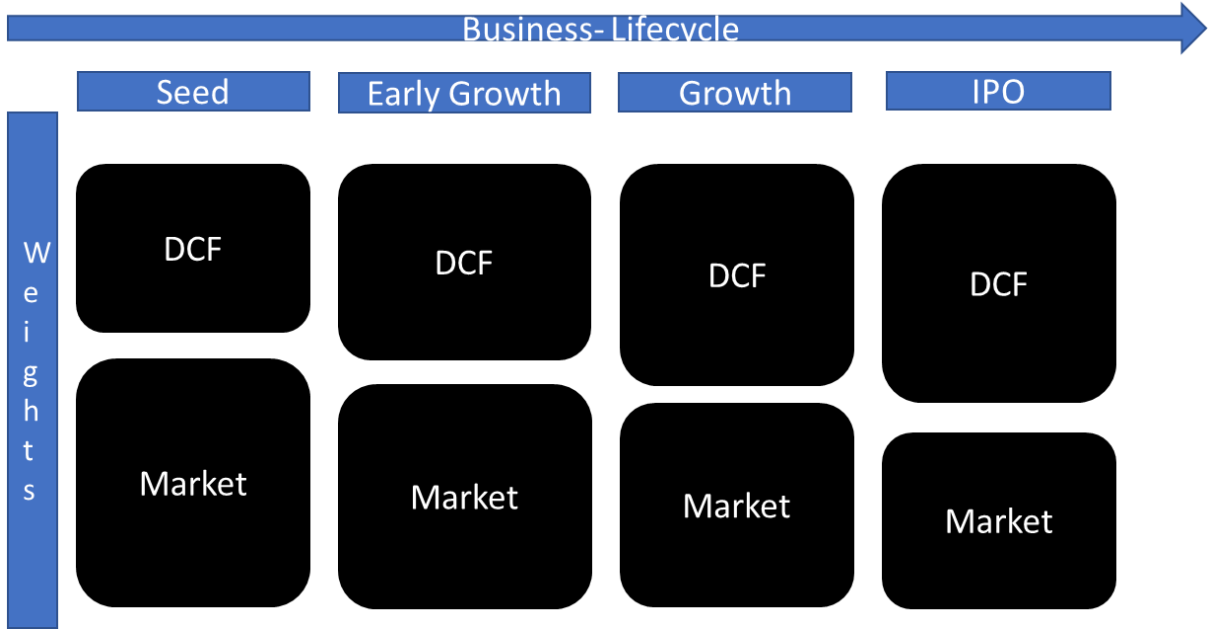


Figure 13: Business- Lifecycle (own illustration)

Those two methods are the most common ones, when it comes to early-stage valuation. The comparable analysis is to compare the business with other similar businesses by looking at multiples such as EBITDA, sales or equity. In this case, there are not that many comparable companies, especially with a set value, so this method would not work here. The DCF method

is considered the soundest method, since it includes many more factors and is therefore more likely to get a higher value confirmed by investors (Fundsup, 2020). It is forward-looking, instead of considering historical results, based on the cash flow, which is a more suitable approach for this company. To start a DCF analysis, the cash flow calculation is needed, which can be seen in the following graph. All numbers are based on the income statement. The €20 million as capital expenditure is the bank loan, which will be claimed in year one.

Cash Flow Calculation					
	Calendar Year Ending December 31 ('000)				
	Year 1	Year 2	Year 3	Year 4	Year 5
EBIT	-22.28 €	-18.24 €	-2.96 €	25.77 €	54.25 €
Amortisation	-	-	-	-	-
EBITDA	-22.28 €	-18.24 €	-2.96 €	25.77 €	54.25 €
Provision for Taxes	0.00	0.00	0.00	-7.22	-15.19
Net Income	-22.28 €	-18.24 €	-2.96 €	18.55 €	39.06 €
Capital Expenditures	(20.0)	0.0	0.0	0.0	0.0
Cash Flow	-42.28 €	-18.24 €	-2.96 €	18.55 €	39.06 €

Figure 14: Cash Flow Calculation (own illustration)

After having the cash flow calculation, a discount rate or weighted average cost of capital (WACC) has to be set. This rate is used to determine the present value of future cash flows. The following formula has been applied: $\text{Discount rate} = ((\text{Value of equity}) / \text{overall capital}) * \text{cost of equity} + ((\text{value of debt}) / \text{overall capital}) * \text{cost of debt} * (1 - \text{tax rate})$. $\text{Discount rate} = (105/125) * 0.0504 + (20/125) * (-0.2592) * (1 - 28\%) = 0.041539 * 100 = 4.153\%$ (Campbell, 2019). The cost of equity was calculated through: $(\text{Value of equity} / \text{overall capital}) * \text{return}$, which was assumed to be at 6%. $\text{Cost of equity} = (105/125) * 6\% = 0.0504$. The cost of debt was calculated with the following formula: $(\text{Value of debt} / \text{overall capital}) * \text{interest on debt} * (1 - \text{tax})$, while the interest on debt was assumed to be at 6%. $\text{Cost of debt} = (20/125) * 6\% * (1 - 28\%) = -0.006912$ (Campbell, 2019). Further assumptions, that have been made can be seen in the overall capital, from which there are €20million from the bank loan in debt, as well as assets worth €60 million for the platform/machine learning system and €45 million from investments, mentioned earlier. This sums up to €125 million overall capital, of which €20 million are debts and €105 million are equity.

With the discount rate, we are now able to determine the total enterprise value by offsetting it against the sum of the present values of an investment according to the respective cash inflows and outflows, adding the EBITDA multiple factors, multiplied by the EBIT of year

five. The EBITDA multiple was chosen to be at 7.5x, while the calculation has also been made with 8.0x and 8.5x, all relatively low EBITDA multiples for a start-up. The calculation also provides different discount rates, starting from the earlier calculated 4.153%, adding 1% two times.

		Total Enterprise Value		
		Terminal EBITDA Multiple		
		7.5x	8.0x	8.5x
Discount	4.2%	336.91 €	358.16 €	379.41 €
Rate	5.2%	316.15 €	336.21 €	356.27 €
(WACC)	6.2%	296.73 €	315.68 €	334.64 €

Figure 15: DCF Analysis: EBITDA Multiple Method

We chose to use the discount rate, calculated earlier and applying a 7.5x EBITDA multiple, so that we have a moderate, but realistic value, which is likely to be paid by investors. This leads to a total enterprise value of **€336.91 million**.

9. Methodology / Business Model Validation

The aim of this research was to find a business model that perfectly implements emerging technologies, in order to offer an innovative solution to customers, that has less errors, improves efficiency, as well as offering high-quality results and increased customer satisfaction. After finding a business model that fulfils this, the target customer was defined, as well as a value proposition, channels and suggested strategies for the business. The next step is to validate the findings, to see if the right trends were detected, the market potential is realistic, the solution can be applied, whether it creates added value and to finally confirm that potential customers would apply the solution and thereby validate the business model.

Participants:

A total of 23 experts from the dental industry participated in the survey. In order to get broad validation, three groups of experts were chosen to evaluate the solution from several angles. Of the 23 experts participating, four are managing directors of dental companies, such as Permidental, CDI Dental, Labocast 3D and David Reaney and Associates Dental Practice, which are dental clinics or prosthesis providers. Those experts are working closely together with practitioners, such as dentists, orthodontists or suppliers and therefore have a good overview of the market, its potential and trends. Furthermore, 11 of the participants are dentists and eight are orthodontists. In order to get a broad opinion from experts working in the European market, participants from different countries were chosen, such as France, Spain, U.K., Germany, Sweden and the Netherlands.

Design and procedure:

Before conducting the survey, the findings, such as trends, challenges, market structure and opportunities, as well as the business model with its internal and external factors, value proposition, structure, strategy and partners were presented to the participants. The collection of answers was carried out by an online survey, which all participants had to fill out within a timeframe of two weeks. Participants were asked to answer the questions in the survey, based on the input of the presentation, their experience and market insights. The survey was designed with the following structure. First, a general assessment of the business perspective of the dental/ orthodontic market was requested. In the next step, common trends were introduced, from where participants could choose and prove, that the focus trends were analysed correctly. The purpose of the following question was to evaluate the impact of the challenges that come

with changes in reimbursement schemes. After evaluating trends and challenges, the survey leads the participants towards the digitalisation in dentistry. Questions were designed to ascertain the participants' perception of digitalisation's impact on orthodontic appliances, service and treatment approaches, as well as on the industry's efficiency. Further questions deal with the underlying product of the business model, the clear aligners. To see- whether this product's potential is as high as stated in the findings, participants were asked about its importance for them, if they see the importance of them growing and how they would define the potential of clear aligners versus conventional appliances within the next five years. In order to see if specialised orthodontists and also general practitioners can apply this solution, which in the second case would lead to a much greater market potential, the participants had to provide their opinion on the future segmentation. The next question was to identify how realistic the marketing measures set out in the business model are. Therefore, the participants were asked if patient marketing for "the perfect smile" is creating false or unfulfillable expectations. To evaluate how open-minded experts are to technologies such as AI and if they will be applied advantageously for remote monitoring, the participants' appraisal was questioned. In order to better analyse their opinion, they could classify how likely it is for them that AI will be applied for this purpose, with a choice of responses ranging from "very unlikely", to "only for limited aspects", to "fast growing due to cost pressure and increasing engagement of patients", or "will become the standard". To prove that technology can enable better clinical results with less errors, the participants were asked to classify whether there is potential for improvements through technology and how big that potential is. The last question was to figure out if they would use such an AI tool, if certain improvements in care could be demonstrated.

An online questionnaire from Google Forms was used to gather the answers.

Data analysis and resulting adjustments:

For the data analysis, the answers to each question will be looked at. Firstly, the response will be compared to the findings/perceptions that this thesis contends for. If there is a deviation, the impact on the business model will be analysed, defined and eventually adjustments will be made. As a validation for the business model's relevance in the market, it was expected that at least 75% of the participants would have to answer the last question- which asked if they would apply the solution- with YES.

The business perspective for the dental/orthodontic market was considered high. The participants agreed, with 73.9% stating improving or highly improving perspectives. An

increasing business perspective is a plus for the business model’s market potential. However, the impact on the success of the business model is not extremely high, since the solution can be applied on the existing market and there are a huge number of potential customers in the existing market, as stated in the chapter on segmentation, targeting and positioning, that can be convinced. The following graph shows the responses of the participants, where one participant considered a worsening, five a neutral and 17 who thought there would be an improving business perspective.

What business perspectives do you expect for the dental/ orthodontic market within the next 5 years?
 23 responses

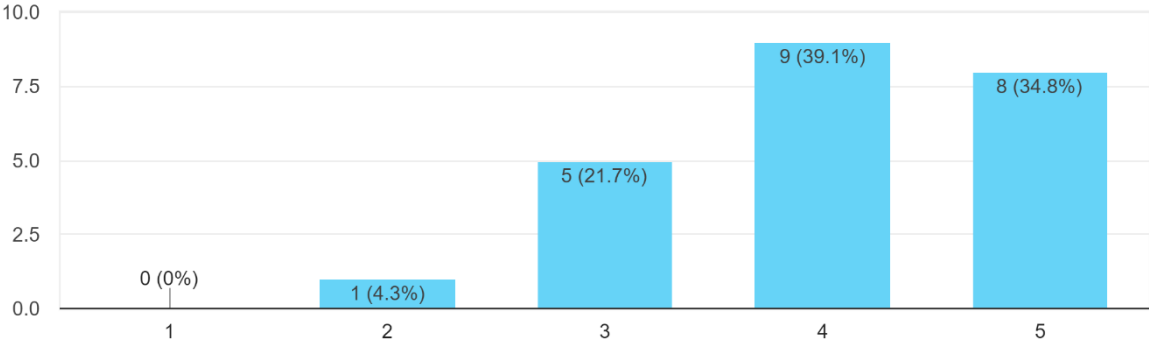


Figure 16: Survey- Question 2 (own illustration)

The major trends analysed in the literature review were AI and wearables. The trends derived from this for the dental market applied within the business model were remote monitoring, a focus on patient experience and smile prediction. Those trends were confirmed by the participants. Another trend that became visible is the chairside 3D printing, as can be seen in the following graph. This proves- that the trends analysed are seen by market participants and the business model deals with the implementation of current trends. That there are other trends, such as 3D printing, not considered in the business model, which proves a trend towards application of technology in the dental market.

Which major trends do you expect for the dental/ orthodontic market within the next 5 years?

23 responses

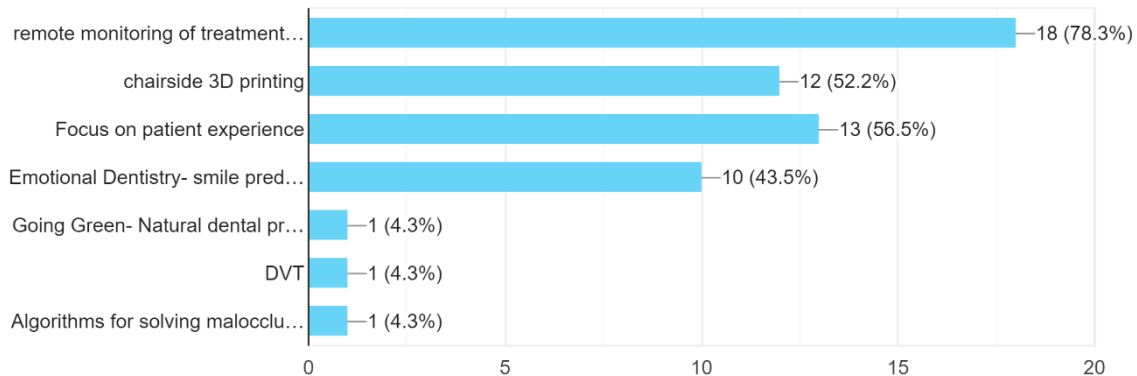


Figure 17: Survey- Question 2 (own illustration)

Changes in health-related reimbursement schemes were considered a political factor that have an impact on profits and the market's attractiveness for dental care providers. However, the participants did not consider it having such a big impact, since it has changed so many times already, while the standard was kept high. One participant stated that it will enlarge the gap between patients with good oral health and those who do not care, which can be considered a social issue. Dr. Rodriguez, a Spanish dentist said, that the Spanish public health system does not provide an adequate dental health service, so most patients have to pay for their treatments already. Even though they expect the reimbursement schemes to worsen, they consider the impact low, since they were not good before either. Dr. Miara, a French orthodontist stated, that the government increased its support to cover at least very basic treatments, while profit potential for basic treatments has been cut by the government. Since the aligner treatment is an aesthetic, and from a medical standpoint it is considered an unnecessary treatment, thus it has little impact on this business model. Dr. Schekelmann, a German dentist said, that the offer for supplementary insurance is increasing, which is beneficial for those treatments because they become more affordable. The overall impact of changes in reimbursement schemes on the business model though is relatively low, since practitioners will not stop working in this field and customers using the solution are mainly not backed by insurance, so they cannot claim reimbursements, as described in the chapter focusing on PESTL analysis.

The impact of digitisation in dentistry on orthodontic appliances was considered high. Participants confirmed that. Two participants saw the impact as consistent, the rest evaluated it

high to very high, while no one responded that the impact is low. This proves that that the business model triggers the right points by digitising orthodontic appliances.

How would you evaluate the impact of digitalization in dentistry on orthodontic appliances?
23 responses

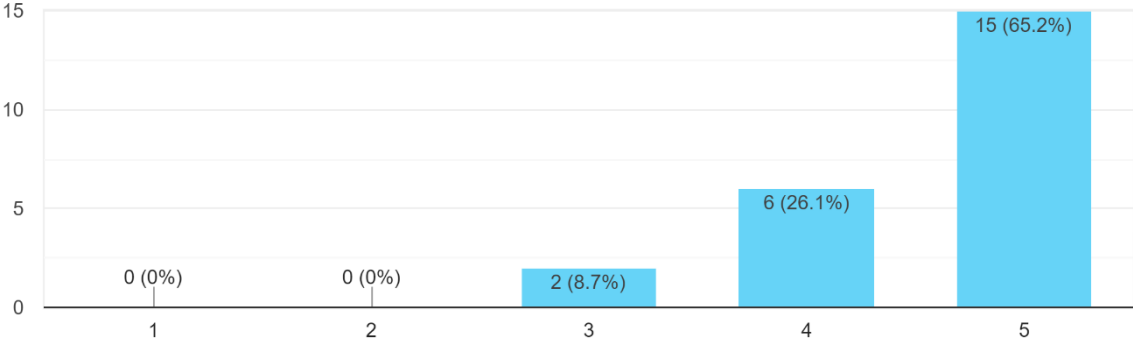


Figure 18: Survey- Question 4 (own illustration)

The impact of digitalisation on services and treatment approaches, was considered high. More than 50% of participants confirmed a very high impact, while just 4.3% stated it would have just a small impact. This result shows that services and treatment approaches will likely change through digitalisation.

How would you evaluate the impact of digitalization in the dental industry on services and treatment approaches?
23 responses

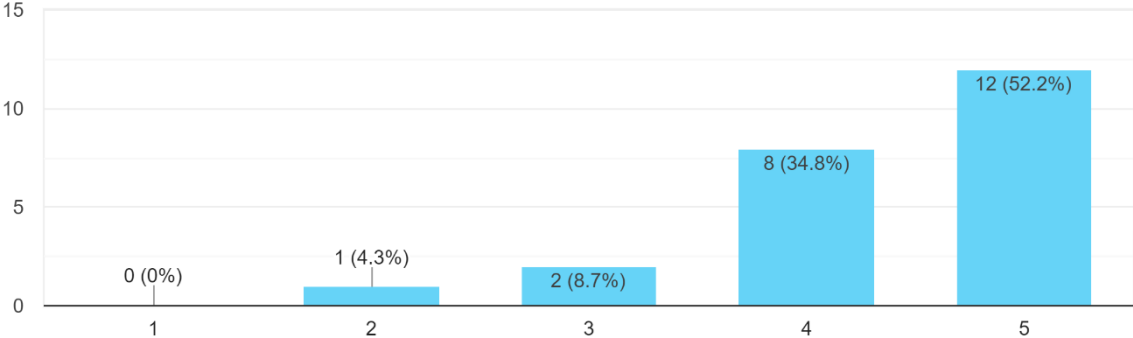


Figure 19: Survey- Question 5 (own illustration)

Regarding the impact of digitalisation on efficiency, this thesis found that efficiency can be heavily increased through digital approaches, since the solution offers a high potential to reduce face-to-face visits, while improving clinical results; 87% of all participants agreed to that, saying the impact is high or very high.

How would you evaluate the impact of digitalization in the dental industry on efficiency?
23 responses

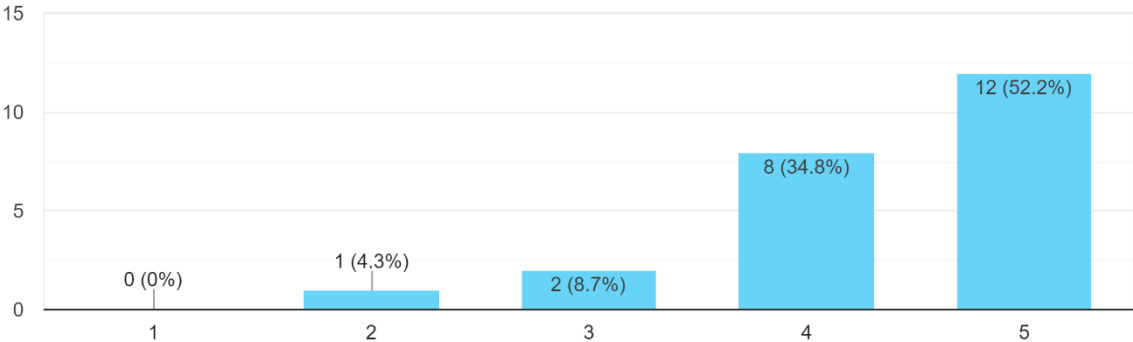


Figure 20: Survey- Question 6 (own illustration)

The next question was aiming to discover if aligners are important for practitioners today. This answer does not have such a big impact on the analysis, as it was more an introductory question to establish what practitioners think about clear aligners now and if the importance of them will change in the future. It is interesting to see that the responses were very different. Most of the participants (30.4%) however, answered that they are already very important for them today, but it can also be seen that for 21.7% it is less important, and 13% said it is not important at all for them today.

How important are clear aligners for you today?

23 responses

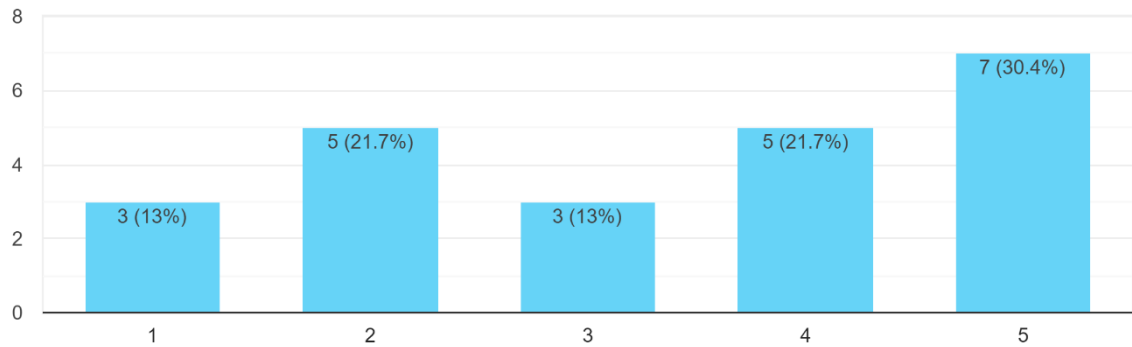


Figure 21: Survey- Question 7 (own illustration)

Going on to the future importance of aligner, this thesis found out that the CAGR of clear aligners is predicted to be 19.7% until 2028, which shows a clear trend of an increasing importance for practitioners in the future (FORTUNE, 2021). What is interesting is that even if just 30.4% of participants consider aligners very important for them today, 82.6% of the participants answered that they will become more important for them in the future, which proves the predictions and shows the importance for aligners in the coming years.

Will clear aligners become more important for you in the future?

23 responses

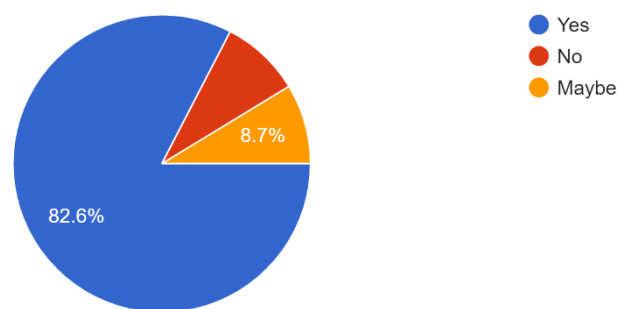


Figure 22: Survey- Question 8 (own illustration)

The next question aimed to find out- what experts think about the potential for clear aligners compared to conventional appliances within the next years. It was considered very high, even with nearly no conventional appliances, especially considering that the treatments for aesthetic

reasons are mainly requested by people above the age of 18. But it was not expected that they will completely replace conventional appliances, since they are much cheaper. The findings show that opinions differ in this point. Some say that conventional appliances are still the better option, since the clinical results are better compared to clear aligners. In that case, the potential would remain immense, since adults would prefer invisible aligners anyway, as they are removable and invisible. During the presentation and discussion with the experts, Dr. Schekelmann, a German dentist said, that for her, clear aligners are the better option even for the health of your teeth, since conventional braces have to be attached with some kind of glue, which harms the teeth. Also, the teeth cannot be brushed properly during the whole treatment, which can take up to one year. This could also be seen in the responses, where 73.9% considered the potential high, while 21.7% said they will nearly replace conventional appliances.

What is the potential of clear aligners vs. conventional appliances within the next 5 years?
23 responses

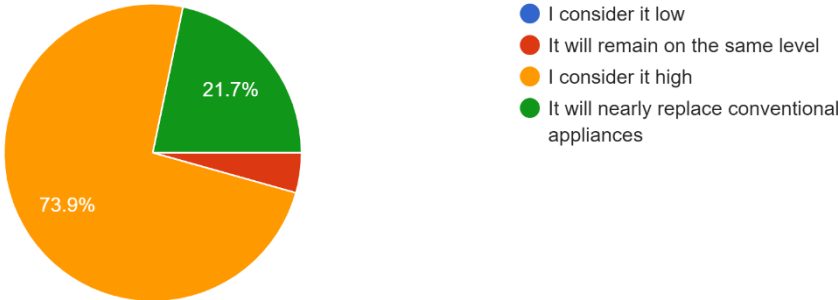


Figure 23: Survey- Question 9 (own illustration)

Since the business model’s solution makes the treatment process so much easier- and does not ask for the highest expertise anymore, it was assumed, that straightening teeth will not be done by specialised orthodontists only. General practitioners like dentists are able to offer this service without the need of being specialised. Even direct patient marketing can be used to provide this service without the need for a practitioner. While it was not assumed that this business will be taken over by general practitioners or through direct patient marketing, it was expected that especially general practitioners will participate in this business, since they can create a further income stream easily. Almost half of the respondents would ascribe 20% of the business to general practitioners and 10% to direct patient marketing. Surprisingly, 8.7% said- that the business would be divided equally between the three groups. Dr. David Reaney, who owns a dental practice in the U.K. with six dentists said, that highest proportion will be by trained

general practitioners, which is a very interesting point of view, since they would have an advantage over general practitioners without training and would even be more trustworthy for patients, which makes his statement likely to occur. All in all, it proves, that through such solutions, the circle of people- that are able to offer this service is opening up, which shows the potential for, and the attractiveness of this solution.

How much of this business will be done by specialized orthodontists/ general practioners/ direct to patient marketing?

23 responses

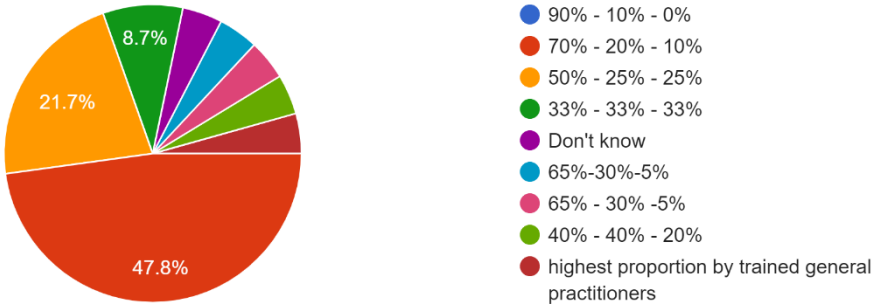


Figure 24: Survey- Question 10 (own illustration)

The following question was asked to establish whether marketing measures have to be adapted, and to enquire if patient marketing is creating false or unfulfillable expectations. Since patient marketing for these kinds of treatments is very promising and potential patients are attracted by promises for the “perfect smile”, the outcome was very important so it could be established if marketing has to be adapted in a way that it just promotes realistic outcomes. Of the participants, 30.4% rate it neutral, 52.2% said it often creates wrong expectations and 8.7% said it occurs very often. After seeing this result, the marketing approach was adapted in a way so as not promise too much, and inform customers about the possibility that the outcome might differ to their expectations. Additionally, the Smile Prediction, which uses the original teeth of the patient to predict the outcome reduces the risk of false expectations tremendously.

Is patient marketing for "the perfect smile" creating wrong or unfulfillable expectations?

23 responses

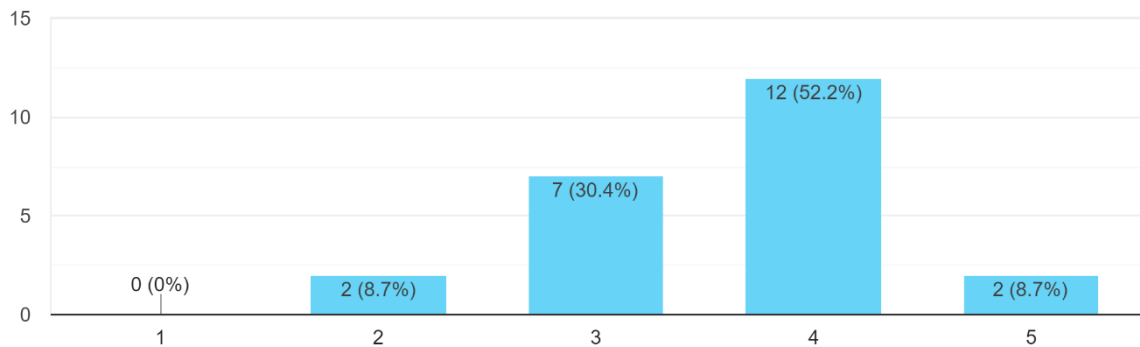


Figure 25: Survey- Question 11 (own illustration)

It was expected that dental care will take advantage of recent and future AI developments to enable remote dental monitoring for orthodontic treatments, mainly because of cost pressure and increasing patient-centred approaches. Therefore, it was expected to become the standard. Of the participants 56.6% agreed that it will be fast-growing due to cost pressures and the increasing engagement of patients, and 26.1% said it will become the standard. However, 17.4% also said dental care will only take advantage of AI developments for very limited aspects of dental care. With 82.6% of participants agreeing on the thesis' expectations, this proves the importance of AI solutions to enable remote dental monitoring, but the 17.4% of respondents who disagreed also shows that not everyone is fully convinced and like every adaption, it will take time to reach full acceptance.

To what extent will dental care take advantage of recent and future AI developments in order to enable remote dental monitoring for orthodontic treatments?

23 responses

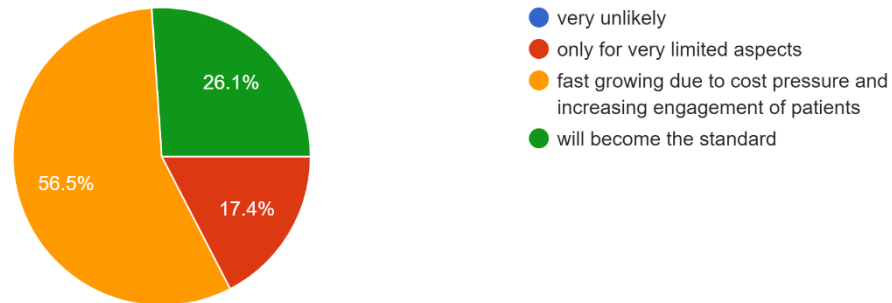


Figure 26: Survey- Question 12 (own illustration)

The Master’s thesis stated that through the use of AI, one can reduce errors, analyse scans more precisely and clinical outcomes can be significantly improved. To convince practitioners about the advantages of AI solutions in terms of efficiency and/or cost-saving potential might be doable, but to actually get confirmation of better clinical results through the use of AI was expected to be challenging, especially considering the fact that many practitioners fear being replaced by AI. Surprisingly, 43.5% of the participants trust AI diagnostic tools to be offer significant improvements for oral health, with 34.8% saying it will become the standard.

Would you expect Intra Oral Scanning or other visual screening methods, using AI diagnostic tools to compare the oral status between visits, to improve oral health?

23 responses

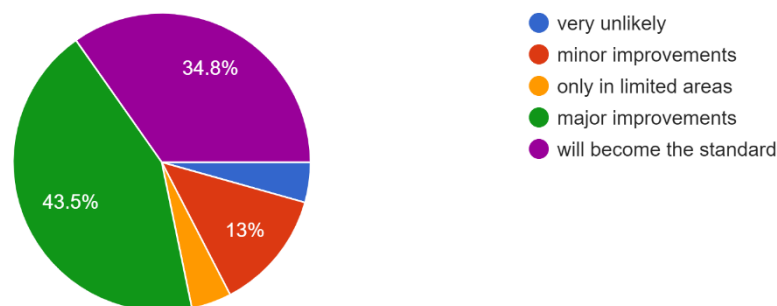


Figure 27: Survey- Question 13 (own illustration)

Finally, the last question was to validate the business model. The participants were asked, if they would apply such a solution, to see whether there actually is potential for this business

model to be successful and if potential customers would claim such a service. It was important that at least three quarters answer “yes” in order to prove that. As can be seen in the following graph, 82.6% would claim such a service.

Would you use a scientifically verifiable AI tool for orthodontic treatments, that enables remote treatment monitoring and controlling, reduces you...hes, as well as automated updates to the patient?
23 responses

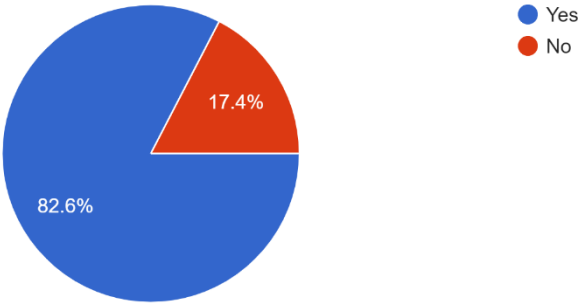


Figure 28: Survey- Question 14 (own illustration)

10. Conclusion

This Master's thesis aimed to identify and design an innovative business model which implements current trends and successfully applies emerging technologies to the dental market. The business model can be considered innovative, since the strategy is very unique, and is striving for innovativeness and change in the industry with help of technology. The clear message is differentiation through an innovative approach, which offers a unique solution for the market. The aim of the company is to revolutionise the working approach of dental practices by significantly reducing the number of face-to-face visits, while saving on costs and tremendously improving customer experience. When designing the solution, the model was careful to offer a solution which is patient-centred by allowing them to access the service at any time and from anywhere, but also ensuring that the patient can easily communicate with and consult their practitioner through the video or call function. The way the patient can access services is very innovative and provides an extraordinary customer experience. In terms of added value, this solution brings the aforementioned value for the patient, but also the practitioners benefit from the solution, since it offers easier ways to communicate with and convince customers, asks for less effort to complete a treatment, reduces costs, saves time and even brings better clinical results, with less errors. It not only adds value, but also completely changes processes, working approaches and is able to digitalise practices, not just for the treatments but also for organisational aspects. The beneficial use of the technology is without doubt, proving that, at least for some aspects, the technology is advanced enough to be applied successfully, though it begs for high initial development. The business model definitely found the customers need. The right strategy to target customers has been adapted after analysing experts' responses and the business' profitability potential has been illustrated in the income statement.

Digital transformation in healthcare is going at a slower pace than expected. The healthcare industry is an industry which is heavily regulated and therefore adaptations cannot be made as fast as one would imagine, considering the improvements made possible through new technologies. Another reason for obstruction is that the high initial investment takes time to amortise, while the implementation phase is energy- draining and difficult. Human resources are playing a big role in successful DT, since they are the link between the facility with their processes, approaches, and applications used and the patient. In the long term, they will be asked a stronger AC due to a much broader range of applications, which requires training and

the ability to use technology properly. It is not just human resources which are important, also other factors like ICT infrastructure, social capital, financial resources, governance and legal regulations will ask for a very strong AC to digitise the healthcare sector. Even if a strong AC is needed, the potential for increasing efficiency is immense, as is the potential to earn money by redesigning healthcare. That is why big players like Amazon and Apple have entered the market, offering lots of solutions using their technologically know-how and vast resources. With their fresh minds and innovative approach, they are able to speed up the digitalisation of healthcare, since they are new in the industry and do not need to make a shift. The main challenges that have been identified are societal acceptance, data protection, as well as a lack of technological evidence for value creation, and standards and regulations. Societal acceptance takes time, but also a low level in digital literacy contributes to a slower acceptance rate, as people do not know what to expect. The business model aligns with HIPAA standards, which creates acceptance and trust. The lack of evidence was counteracted with a survey that proves the value creation of the solution, but also an example calculation which shows the cost-saving potential of a customer that is applying the solution. Standards and regulations will have to be established in more detail by governments in the future. It is important to always align with those institutions to create trust, but especially for data protection; it has to be secured so that customers feel their data is safe with the company. The trend section found that AI and wearable medical devices are being the main trends in healthcare today. Of course, other trends are visible too, but the potential for AI is immense since it could have an impact on almost every layer of future healthcare, while wearables are especially strong when it comes to prevention and data collection. Combining those two trends, and using initial data to set up the AI and further collecting data from the wearables, is the perfect combination for a successful and applicable solution. The impact of the pandemic is uncontested, and due to the need for remote consultation and social distancing, digital approaches have moved into focus. Witnessing the collapse of health systems, the urgency of the situation forced governments and institutions to adapt their approaches with at a rapid pace, which is beneficial for the increased DT and will also leave its mark well into the future.

The external analysis within the business model revealed the influence of, political and legal factors on the business, mainly due to changes in reimbursement schedules. However, the business's potential in the market is so big, that it has no disadvantage at the moment. The competitor analysis showed, that due to the unique solution, it combines competitors' offers and therefore is, at least at the moment, not in direct competition, which could change, if

companies with enough resources and relevant data offered a similar solution. Therefore, the business has to constantly develop and extend the lead in its field. The bargaining power of suppliers, however, is high and should therefore be viewed with caution, as it creates dependency. The internal analysis uncovered many strengths and opportunities, that have been mentioned already, which can be used to its own advantage. However, threats like competitors offering cheaper or better solutions and challenges with convincing customers of the cost-saving potential for a relatively expensive solution must be kept in mind. A calculation about the cost-saving potential showed that a single dentist from the UK gained an annual profit of €61,215 with 165 cases by applying the solution. The strategy chosen for this business model is differentiation, since it differentiates from competitors by providing a unique service in a broad market. The value proposition is given by the use of an advanced machine learning technology that allows practices to constantly monitor the treatment progress of their patients without the need for practice visits. The global orthodontics market as an underlying market is predicted to almost double from 2018 to 2026, with an annual 11.6% rise during this period, which describes the growth potential as a player in this market (*Orthodontics Market Size, Share & Industry Analysis, By Product Type [Instruments and Supplies {Fixed (Brackets, Bands & Buccal Tubes, Archwires, and Others), and Removable (Aligners, Retainers, and Others)}], By End User (Hospitals, Dental Clinics, Others) and Regional Forecast, 2019-2026*, 2019). The clear aligner market, which is the underlying product, is expected to face a CAGR of 19.7% from 2021 to 2028, which further proves the high demand for this solution (FORTUNE, 2021). Also the shift towards “best agers” who have the resources to pay for such treatments, influenced by social media to have their teeth straightened and having the “perfect smile” is contributing to the growth potential of this business model. The targeting will focus on dental clinics, since they are the biggest segment of end- users with the highest potential. Geographically the focus will be on Europe, the U.S. and Canada, while the service can be provided around the globe, which might open up a focus on other areas in the future. The potential customers base is huge and to get them on the landing page, Google Ads will be used, as well as webinars and articles in trade journals to introduce the solution and its benefits. A blog will share the progress, current developments and guest contributions of industry experts. Scientific marketing will be used for scientific evidence of the service. Since the dental market is a relatively small one, it is possible to raise awareness in the short-term. High quality at a price slightly above the average will define the positioning. As for the organisational structure, the functional organisational structure was chosen, since it promotes a high degree of specialisation and provides clear structures and responsibilities, which is important for start-

ups to be successful. The income statement reveals that almost €5 million in revenue would be made in year one, while the net income is - €23.5 million. This is because of the high initial investment needed to develop the AI-based solution and the high operating expenses required to run the business and maintain the platform. In year four, the break-even point will be reached and the investment starts paying off. The last year of the calculation showed almost €40 million in net income. The CROCI, starting at -34.28% will also turn positive in year four, reaching its peak in year five at 83.46%.

Overall, 23 experts from six different countries in Europe participated in the survey, which was conducted to confirm the literature review's findings and validate the business model. The survey was built piece by piece, starting with the literature review, leading to the business model's strategy, approach and underlying product towards the final question, where the participants had to answer if they would use such the solution. First, the participants were asked how they see the general business' perspective on the orthodontic market. The responses illustrated- according to expectations- that there is a huge potential for the whole market within the next five years. The major trends analysed in the literature review were AI and wearables, which were used to establish a remote monitoring of treatments, with a focus on patient experience, as well as offering smile prediction. The participants voted remote monitoring as their top trend, followed by focus on patient experience and chairside 3D printing. Smile prediction was in fourth place. Other trends given were not chosen, proving the business model's correct choice of trends. As stated in the external analysis within the business model, the reimbursement structure as a political factor can have an impact on the business. Since the participants were from different countries, the answers differed. Spanish participants said that the National Health System does not provide an adequate dental health service, so most patients already have to pay for their treatments today. Even though they expect the reimbursement schemes to worsen, they consider the impact low, since they were not good before either. French participants stated, that the government supports to cover at least very basic treatments and profit potential for basic treatments has been cut by the government. Since the aligner treatment is an aesthetic, from a medical standpoint unnecessary treatment it has little impact on this business model. Germany is covering more dental treatments than other European countries. Miss Schekelmann, a German dentist said, that the offer for supplementary insurance is increasing, which is beneficial for those treatments because they become more affordable. Dr. Pigg, a Swedish dentist, answered that he expects changes which will widen the gap between people with good oral health and those who do not care. All in all, the opinions of people differ

on that point. They mainly expect the reimbursement schemes to improve for patients, which causes negative changes for practitioners for basic treatments, while the impact on this business model is considered relatively low, since the changes won't have a big impact on the purchasing decision of the patients. The impact of digitalisation on orthodontic appliances, service and treatment approaches and efficiency was overall considered high to very high which was the expected result. When it comes to the importance of aligners for survey participants today, surprisingly it is not as important for them today, but 82.6% said that it will become important for them in the future, which again proves the great potential of aligner treatments. The survey further revealed that the percentage of unspecialised practitioners offering aligner treatments is increasing, showing that the earning potential for general practitioners is high, if they try to get a piece off the cake. Regarding the potential of clear aligners versus conventional products, the responses uncovered that clear aligners have more potential than expected, with some survey participants saying that they have advantages against conventional aligners from a medical standpoint, since they are better for the oral health, contrary to the research results. The marketing measures had to be adapted, due to a relatively high percentage of participants saying- that patient marketing is creating false or unfulfillable expectations. From a technological point of view, participants agreed that dental care will take advantage of recent and future AI development due to cost pressures and increasing engagement of patients, while providing major improvements for comparing the oral status between visits. Finally, 82.6% of the participants said, they would apply such a solution and therefore proved that the business model is offering a required solution for the market, with great potential for improvements in clinical outcomes and earning potential. The response was in line with the expectations and findings throughout the literature review and the business model.

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12. Annexes

Digitalisation in Dentistry

Validation for a business model in teledentistry within orthodontics *Required

1. Please fill out your name and country of practice *

2. What business perspectives do you expect for the dental/ orthodontic market within the next 5 years?

Mark only one oval.

	1	2	3	4	5	
worsening	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	improving

3. Which major trends do you expect for the dental/orthodontic market within the next five years?

Tick all that apply.

- remote monitoring of treatment progress + analysis of changes chairside 3D
- printing
- Focus on patient experience
- Emotional Dentistry- smile prediction
- Going Green- Natural dental products Other:

4. Do you expect changes in health- related reimbursement schemes and which impact would they have?

-
5. How would you evaluate the impact of digitalization in dentistry on orthodontic appliances?

Mark only one oval.

	1	2	3	4	5	
very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	very high

6. How would you evaluate the impact of digitalization in the dental industry on services and treatment approaches?

Mark only one oval.

	1	2	3	4	5	
very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	very high

7. How would you evaluate the impact of digitalization in the dental industry on efficiency?

Mark only one oval.

8. How important are clear aligners for you today? *Mark only one oval.*

	1	2	3	4	5	
not very important	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	very important

very low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	very high
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9. Will clear aligners become more important for you in the future?

Mark only one oval.

- Yes
- No
- Maybe

10. What is the potential of clear aligners vs. conventional appliances within the next 5 years?

Mark only one oval.

- I consider it low
- It will remain on the same level
- I consider it high
- It will nearly replace conventional appliances

11. How much of this business will be done by specialized orthodontists/ general practitioners/ direct to patient marketing?

Mark only one oval.

- 90% - 10% - 0%
- 70% - 20% - 10%
- 50% - 25% - 25%
- 33% - 33% - 33%
- Other:

12. Is patient marketing for "the perfect smile" creating wrong or unfulfillable expectations?

Mark only one oval.

	1	2	3	4	5	
never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	very often

13. To what extent will dental care take advantage of recent and future AI developments in order to enable remote dental monitoring for orthodontic treatments?

Mark only one oval.

very unlikely only for very limited aspects fast growing due to cost pressure

and increasing engagement of patients will become the standard

Other:

14. Would you expect Intra Oral Scanning or other visual screening methods, using AI diagnostic tools to compare the oral status between visits, to improve oral health?

Mark only one oval.

very unlikely minor

improvements only in

limited areas major

improvements will

become the standard

Other:

15. Would you use a scientifically verifiable AI tool for orthodontic treatments, that enables remote treatment monitoring and controlling, reduces your number of patient's face-to-face visits significantly, while analysing the course of treatment and giving suggestions about possible treatment approaches, as well as automated updates to the patient?

Mark only one oval.

Yes

No

Other:
