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Manuel-Christopher Parg, BSc (WU)

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Statutory declaration

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Wien, 21.06.2016 Manuel-Christopher Parg

Abstract

English

Worldwide currently exists a variety of challenges in the health system and in health care, with which the international healthcare industry has to fight with everyday. Specifically, the increased rate of new diabetes cases and the increasing number of all forms of cardiovascular disease has not been solved these days, whereby only a small number of preventive measures exist to stop the current trend. Together with the new emerging technologies on the subject of mobile health (mHealth) it is increasingly becoming important to explore the possibilities of these new approaches and to integrate them into existing health systems in a preventive manner to maximize the benefits from their applications. The mobile platforms, which can be seen as an essential building block of mHealth, are one of the factors that can determine the success or failure of the current ideas and therefore have to be analyzed comprehensively. The present thesis explores a selection of potential market constellations in the field of preventive and mobile healthcare platforms in a quantitative manner, whereby the theoretical understanding behind the approaches, which was acquired by means of a comprehensive analysis of the existing literature, and the research project PRECIOUS are important parts.

Deutsch

Weltweit existiert aktuell eine Vielzahl an Herausforderungen im Gesundheitswesen und in der Gesundheitsvorsorge, mit welchen die internationale Gesundheits-Branche tagtäglich zu kämpfen hat. Speziell die erhöhte Rate an Diabetes-Neuerkrankungen und die steigende Anzahl jeglicher Formen kardiovaskulärer Erkrankungen sind bis heute nicht gelöst, wobei zur Zeit nur eine geringe Zahl an Präventivmaßnahmen bestehen, um den aktuellen Trend zu stoppen. Zusammen mit den neu aufkommenden Technologien rund um das Thema mobile health (mHealth) wird es immer wichtiger, die Möglichkeiten dieser neuen Ansätze zu erforschen und diese in bestehende Gesundheitssysteme in präventiver Weise zu integrieren, um den Nutzen aus ihrer Anwendung zu maximieren. Die mobilen Plattformen, die als essentieller Baustein von mHealth gesehen werden können, sind einer der Faktoren die über Erfolg bzw. Misserfolg der aktuellen Ideen entscheiden können und deshalb umfassend analysiert werden müssen. Die vorliegende Arbeit erforscht auf quantitative Weise eine Auswahl an möglichen Marktkonstellationen im Bereich der präventiven und mobilen Gesundheitsvorsorge-Plattformen, wobei das theoretische Verständnis hinter den Ansätzen, welches mittels einer umfassenden Literaturanalyse angeeignet wurde, und das Forschungsprojekt PRECIOUS einen wichtigen Bestandteil darstellen.

Contents

List of Figures

List of Tables

1 Introduction

1.1. Motivation & Problem

The global healthcare sector is faced with multiple challenges nowadays, whereby especially the World Health Organization (WHO) and further other healthcare research institutes have been analyzing the challenges for years and are trying to find efficient instruments to minimize the problems which emerge from these global healthcare challenges. The whole healthcare sector is still faced with multiple challenges in 2016 which are of demographic, operational, regulatory, innovation and financial nature and have to be controlled in a more appropriate way than they are now or even be solved within the next years [1].

The aging population is only a small brick of the demographic issues, but is nevertheless a well-known challenge which doesn`t only influence the healthcare sector [1]. Since the people all around the world are getting older from year to year, especially the group of older people is getting larger each year and because of the advanced age of these humans, a number of problems emerge. In 2015 the world population of humans aged 60 years and older was just 12 %, but until 2050 this age group will amount 22 % of the whole world population [2].

Additionally, the number of chronic disease is an emerging issue when focusing on demographic healthcare challenges [1]. The numbers of any form of cardiovascular disease (heart disease and strokes) and diabetes have been raising in the last years. In 2012 these three types of disease made up 27.8 % of global deaths which is a shocking high number [3]. Already 8.5 % of humans in an adult age (above 18 years) have had diabetes in 2014, whereby 90 % of them suffered from diabetes type 2 [4]. Especially the high numbers of overweight people and of those who are already obese are main reasons for this trend. According to the statistics of the WHO in 2014 worldwide 1.9 billion humans in an adult age (above 18 years) had a body mass index (BMI) greater or equal to 25, which means that they were overweight [5]. Next to this number further 600 million had a BMI greater or equal to 30, which means that they were obese. If these numbers are set to the world population, a percentage of 39 % of humans aged 18 years or above were overweight and 13 % were obese [5] [6]. Additionally the overweight or the obesity can lead to musculoskeletal disorders or some types of cancer which can lead to death in a critical state [5]. A higher proportion of the intake of unhealthy food, like food with a high fat percentage or a high sugar percentage is one of the main reasons for this dramatic increase of overweight and obesity in the last decade [5].

Also the idleness regarding the physical activity is another main factor which leads to these effects. Some humans have no chance to exit their unhealthy lifestyle because of the increasingly sedentary workplaces in some jobs and the human-inactivity-form of transportation nowadays [5].

Further, global healthcare challenges of demographic nature are the access to healthcare and the consumer engagement [1]. Since there are still many people without any healthcare or any type of medical institution on-site, it is and it will be difficult to solve health problems in such regions. The comprehensive provision of such countries has to be the main focus to fight against these challenges. But also the consumer's engagement has raised through the digitalized globe [1]. Nowadays, people are better informed and have higher expectations on healthcare, because they know or can at least inform themselves about actions or initiatives which may be possible in other countries with similar life standards. Of course such informed humans will expect or even request such situations in their own region or at least in their own country. Going beyond this, employees of companies in some countries expect an employer-sponsored health plan from their employers which leads to a premium-healthcare that is funded by their own employers [1]. Of course such demands have also great benefits for those employers because they have a higher number of healthy staff and the number of staff illness and thus the staff outage can be reduced.

The healthcare infrastructure in some countries is one of the major healthcare issues when focusing on the operational view [1]. A major measure, which is often used when discussing this topic, is the number of hospital beds per x citizen. A lot of countries show a lack of hospitals beds, but especially the less-developed countries, in which the higher proportion of people lives on the country-side, show a high deficit regarding hospital beds [7]. Statistics show that the issues won´t improve as much as necessary in the next years, since studies show that the number of hospital beds per 1000 citizen will nearly stay stable from 2014 to 2019 [7].

Alternative medical care delivery and a more efficient way of providing healthcare are other main challenges of operational nature [1]. The decentralization of healthcare and the according healthcare institutions are approaches which are pursued in many regions to introduce alternative delivery mechanisms and consequently reduce costs for large healthcare centers to provide healthcare in a more (financial) efficient way.

Telehealth approaches, with which a patient can directly communicate with a nurse or a doctor via video chat, or any other form of home care approaches, where the patient is remotely monitored and stays at home during his health check, can support such initiatives to create a better and a more direct healthcare for the customer and in parallel reduce the costs for the whole healthcare system.

Similar to the issue of hospital beds there also exists a measure of available doctors per x citizen. It seems clear that it makes no sense to have a high number of beds where patients can be treated, while the healthcare staff who actually treats these patients is far too little. The statistics show that there exists a global lack in the number of doctors analog to the number of hospital beds [7]. Especially because of the fact that the absolute number of doctors will stay stable within the next few years and the world´s population will raise, the healthcare industry has to develop measures to deal with this issue.

A digitalized world brings many advantages with it, but also the possible risks and frauds need to be considered. Especially the regulatory view of the global healthcare addresses these issues which arise from a digital and more complex healthcare [1]. Next to the patient's safety regarding the comprehensive studies to reduce the safety risk of the intake of any medications, also the emerging frauds and abuses through a digitalized healthcare sector like cyber security need to be analyzed. The countermeasures to reduce the amount of non-digital and digital safety risks should be stronger anchored in the general healthcare regulations and in the according laws.

The innovative perspective of the global healthcare challenges has its main focus on the advances since the major aim of the medicine was the more professional and more developed medical treatment of patients [1]. Until now the research and development in the healthcare sector were crucial factors which need to be considered by every institution or company which provides any healthcare for patients, whereby foremost the pharmaceutical companies are driving this progress nowadays. Innovations need a great number of new ideas and approaches and since the digitalized world is involved in many business sectors, also the healthcare sector can´t circumvent or even escape this process. New approaches, like the connected health approach, in which new technologies like mobile devices are connected to or integrated into existing healthcare processes, have a high meaning regarding the innovation of the whole business sector. This part of healthcare innovation will be a main focus within this master's thesis since many consulting companies and statistics ascribe a high importance to these approaches regarding the estimated market potential [8] [9] [10].

Last but not least the financial view of the worldwide healthcare challenges is essential for the whole market since the healthcare sector is major part of many national economies from the financial perspective [1]. The gross domestic product (GDP) is a monetary measure for the value of all final goods and services produced in a period, whereby usually the period is a calendar year and can thus show the financial impact of the healthcare industry in a country within one year. Statistics of the WHO show the healthcare spending in relation to the GDP of a single country, whereby the statistic of each year is published three years later, so for example in the WHO statistical report of 2015 [12] the statistical data of 2012 was published.

	Global expenditure on health as % of gross domestic product (GDP) in 2000	**Global expenditure on health as % of gross domestic product (GDP) in 2012**
Low income	2.9	5.1
High income	9.6	11.6
Global	7.7	8.6

Table 1: Total expenditure on health as % of gross domestic product in 2000 and in 2012 [11] [12]

The above statistics are based on real data which was provided by single countries. The data shows that the healthcare spending has raised in relation to the GDP from 2000 to 2012, whereby in 2012 this proportion has already declined a little bit compared to the years before, but the reassurance to the proportion of 2000 is not achieved at all. Especially the high income countries show a higher healthcare spending, because through customer empowerment patients have higher expectations in the healthcare system and to meet this demand, higher public and private investments are necessary.

Next to the statistics of the WHO, the American business consulting company McKinsey & Company has created a forecast for all Organisation for Economic Co-operation and Development (OECD) countries until 2100 [13] [14] to show the dramatically rise of the healthcare spending in relation to the GDP with the title “If the next 100 years looks like the last 50 years, then we`re in trouble”.

Total expenditure on health as % of gross domestic product (GDP)					
Selected OECD countries	**2005**	**2030**	**2050**	**2080**	**2100**
USA	15.3	24.9	36.7	65.6	96.8
France	10.7	18.0	26.6	47.6	70.2
Germany	10.7	17.4	25.6	45.9	67.7
Austria	10.2	16.6	24.4	43.8	64.5
UK	8.3	13.5	19.9	35.6	52.5

Table 2: Total expenditure on health as % of gross domestic product (GDP) [13] [14]

The above table is just an estimation but should still show the dramatic situation in the next 85 years if the health spending rose in the same extent like it was rising in the last years. Overall the analysis of McKinsey & Company shows that the healthcare spending will probably amount about 30 % of the median OECD GDP by 2070 [14].

The healthcare spending is dependent on the costs which are necessary for the healthcare system and since the costs are rising within the next years the global healthcare spending will also rise. An article [15] in the Forbes magazine shows that the costs of the American healthcare system rise faster than the inflation. To show this effect the health care inflation of the US American economy was compared with the consumer price index of the US American economy for the years 2005 to 2015. In 10 of these 11 years the health care inflation was higher than the consumer price index which leads to the result that the health care costs are rising higher than the classical consumer costs from year to year.

The major cost drivers in the healthcare sector are actually based on the global healthcare challenges which were described before. According to the analysis of McKinsey & Company the major four cost drivers can be identified [14]:

- Aging population [14]

The worldwide population is getting older and already by 2020 the number of people aged 60 years and older will outnumber children younger than 5 years [2]. It can be assumed that more people will need healthcare because of the higher number of old people in the future.

- Medical procedure costs [14]

Though the progress in the whole medical research and development the costs will rise in the next years because the medical tests and the necessary studies will be more expensive.

- Resource constraints [14]

A great number of doctors and other medical staff will be missing because the number of this staff will nearly stagnate in the next years whereby in parallel the world´s population will rise. The costs of the healthcare system will rise too because medical specialists will work in urban areas, will be rare on the country-side and hence the treatments on the country-side will cost more because they need to get there. To deal with this issue, medical specialists have to be motivated through a higher wage to work also in non-developed countries or on the country-side to balance the lack of doctors through the regions [1].

- Patient empowerment [14]

Through the information variety nowadays patients will be more informed and will hence expect and demand a better quality of healthcare which leads to a rise of the overall costs.

1.2. Contribution

The primary goal of this thesis is to get a quantitative understanding of Value Networks on the preventive mobile health platform market. Those internet-based market structures are assisted by the current technological trends like the emerging market of smart devices, whereby such digital devices have got some technological boundaries, which need to be recognized and handled within the whole exploration. Since the whole topic is very complex and pretty new there are a number of important parts which need to be considered and hence have to be analyzed in detail. The basic ideas of mobile health, the PRECIOUS project and the already existing research work around the involved topics of Value Networks model frameworks, two-sided markets and quantification mechanisms for Value Networks should support the thesis in getting a sophisticated and clear view of the whole topic.

Equipped with all the knowledge and experience which was developed in the thesis, two different Value Networks were designed and a quantification followed by an analysis of these Value Networks on the preventive mobile health platform market is made to show how possible market constellations and relationships between single business actors can look like in reality. Subsequent to the analysis, effective treatment recommendations for the involved business actors are derived to improve their position on the respective market. The different Value Networks offer the possibility for specific business actors to be included or excluded in a Value Network to widen or narrow the analysis. A systematic approach to understand the possible variations and the limits of such concepts will be a major part of the thesis together with the specifics of the market constitution.

1.3. Structure

At the beginning of the work, in Section 1, the currently existing challenges of the global health sector are discussed and afterwards, in Section 2, the topic of Value Networks and mobile health (mHealth) in general is analyzed, in order to recognize which aspects are essential for the thesis. In a next step, in Section 3, a literature review of Value Network frameworks, two-sided markets and the quantification of Value Networks is made to deepen the necessary understanding. Subsequently, in Section 4, the PRECIOUS project is introduced and the major contents and concepts within the project are described, to get a sophisticated focus on which elements are important within a preventive mobile health platform market.

In the further course of the thesis in Section 5, with the aid of a selected Value Network framework, two possible variants of the preventive and electronic healthcare platform market are conceptualized and analyzed in detail, whereby on the one hand a privately-funded approach and on the other hand an approach financed by public money is chosen. The thesis is completed in Section 6 by a summary and in Section 7 with further questions which have to be considered in the future. Section 8 and Section 9 are already the appendix of the thesis, whereby in Section 8 the used literature is listed and in Section 9 the extended calculations are included.

2 Fundamentals

2.1. Business models, Value chains, Value Networks

2.1.1. Business models vs. Value Networks

Until today there exists no general definition of the term business model [16], because each person who designs or works with a business model of a company includes or excludes specific parts of the organization because he/she wants to model the organization from a specific perspective. To model something means to make an abstraction of the reality and this abstraction step will be executed by every human in another way, which leads to different forms and different complexity levels of business models. Osterwalder and Pigneur's book [17] tried to analyze, which bricks have to be the building blocks of a business model in the modern world and therefore Osterwalder introduced the "canvas" business model approach, which is a concept for how a definition of a business model should look like.

Osterwalder introduced the following definition so that other people, who work with his "canvas" approach, can get an understanding of his idea of a business model: "A business model describes the basic principle, according to which an organization creates, conveys and captures value." [17]

The corresponding business model approach "canvas" is based on this definition and has overall nine important parts which define a business model [17]:

- Customer Segments
- Value Propositions
- Channels
- Customer Relationships
- Revenue Streams
- Key Resources
- Key Activities
- Key Partnership
- Cost Structure

The focus of the approach is to see the whole business environment from the perspective of the chosen company and, with the nine building blocks above, Osterwalder tried to capture the four most important areas of a company: customers, supply, infrastructure and financial survivability [17].

A general issue of many of the existing business model designs or definition approaches is, that they have a rigid focus on the respective company and sometimes even ignore the relationships to the companies around the focal company. The approach of Osterwalder tries to identify the partnerships which the company has, but to understand the real impacts of those relationships the whole analysis has to be set up even broader. If a company wants to be successful nowadays it has to develop a new form of business models where the creation and capturing of value have to occur within a so-called Value Network [18]. A detailed analysis of those Value Networks and the corresponding Value Network approaches will be made in the next chapters.

2.1.2. Value chains vs. Value Networks

The value chain is more and more becoming a less useful approach because many of the products and services turn into digital goods and services and the classical value chain is not dealing with such new and more complex situations [18]. Next to this also the cooperation between single companies has more and more evolved in the last years and gets more important from day to day. The value chain has a very clear focus on simply producing a product along a supply chain and all process steps are aligned in such a way to produce a useful product that is of value for somebody. The whole focus of a value chain is hence placed on the companies involved in such value creating processes.

The Value Network approach takes a step forward regarding the cooperation of companies because this concept sees the creation of value only via the co-creation of value of different companies. Additionally the value itself is in the central focus and all activities need to be aligned to maximize the value. Therefore it is important to have an overall view, not only on the own company, the own business performance and the outcome at the end of the year, but also on the competitors who help maximizing the value of a product or service within the Value Network. [18]

To give an answer on how value is created in a Value Network it is essential to understand the dynamic nature of such approaches. Every single company involved and its contribution to the creation of value need to be carved out very well. Furthermore, the performed activities of the own business strategy and the resulting effects need to be considered in an appropriate way, whereby also the possible responding actions of the competitors need to be observed and analyzed.

2.2. Digitalized health - Terms & Definitions

The digitalized world has reached the healthcare sector some years ago and a few new terms emerged together with the new technologies and approaches. In this section the definitions of the most important terms for this master's thesis will be analyzed to get a clear understanding of each term, whereby especially the focus will be on digital health, electronic health, connected health and mobile health. Although the presented definitions are all focused on the integration of information and communication technology, the single definitions distinguish themselves.

According to Arthur D. Little, "Digital health" represents "The convergence of digital technologies (especially information and communication technologies and data analytics) with elements and decision making structures of the traditional care value chain. The overall objective is to improve the wellbeing of patients, and/or to reduce costs of services." [19] The main aim of digital health is hence the integration of technology into existing structures and existing business approaches.

"Electronic health" or short "eHealth" is according to the WHO defined as [20]:
"The transfer of health resources and healthcare by electronic means, encompassing three main areas:

- The delivery of health information, for health professionals and health consumers, through the internet and telecommunications
- Using the power of IT and e-commerce to improve public health services, e.g. through the education and training of health workers
- The use of e-commerce and e-business practices in health systems management"

The term "eHealth" is broadly similar to the term "Digital health". In many applications they are used as synonyms, but when you're just comparing the definitions of Arthur D. Little and the WHO, the terms seem a little bit different in their perspective. Both have a clear focus on the patients, whereby the term "Digital health" also focuses on the reduced costs through the application of it, whereas the term "eHealth" has no aim of reducing any costs through its use and tries to focus on the health professionals.

The term “connected health” as defined by Accenture has neither a clear focus on the patient nor a focus on the reduced costs since Accenture defined: “connected health is an approach to healthcare delivery that leverages the systematic application of healthcare information technologies to facilitate the accessing and sharing of information, as well as to allow subsequent analysis of health data across healthcare systems” [21]

The term “mobile health” or short “mHealth” is in the main focus of this master’s thesis and will therefore be analyzed in detail. There exist several different definitions of mHealth:

“In fact, mHealth is the building block that enables Digital Health solutions to enfold their full potential by using mobile communication technologies and concepts.” [18]

“Medical and public health practice supported by mobile devices (mobile phones, smart phones, and tablets), patient monitoring devices, personal digital assistants (PDAs), and other wireless devices. Utilizing a mobile phone´s voice and short messaging service (SMS) and more complex functionalities and applications including general packet radio service (GPRS), third and fourth generation mobile telecommunications (3G and 4G systems), global positioning system (GPS), and Bluetooth technology.” [22]

“Mobile health (mhealth) is the utilization of mobile technologies to provide health related solutions across the patient journey.” [23]

“Medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices” [24]

“The provision of healthcare or health-related information through the use of mobile devices (typically mobile phones, but also other specialized medical mobile devices, like wireless monitors).” [25]

mHealth is a major part of dealing with a number of existing healthcare problems worldwide and may be an approach to reduce new diseases. Since so many people nowadays are concerned with overweight and obesity problems, especially the number of diabetes patients rises from year to year [4].

According to the research2guidance's mHealth App Developer Economics reports of 2014 and 2015 [26] [27] the mobile health approach could be a solution to deal with this dramatic high numbers. In this report diabetes and obesity were ranked as first and second, regarding the disease which may have the highest business potential on the mHealth market, whereby especially diabetes, as the most relevant disease, was far away from the other mentioned diseases. Hence, the expectations on the mobile health market to dramatically reduce the existing number of diabetes diseases are high. [26] [27]

Summing up, it seems clear that mHealth is an important term concerning the digitalized healthcare market. All definitions include the term mobile in any form, so it seems clear that the term has nothing to do with any stationary device or application. Several technologies are available on the market which may support the application of mHealth. Although the mobile devices in mHealth will be any type of helping device for a patient / end consumer or any type of medical staff, this roles are not stated within the definitions. Most of the time the focus of mHealth is, like the definitions show, on the used technologies. Deloitte categorized possible mHealth solutions by their grade of complexity:

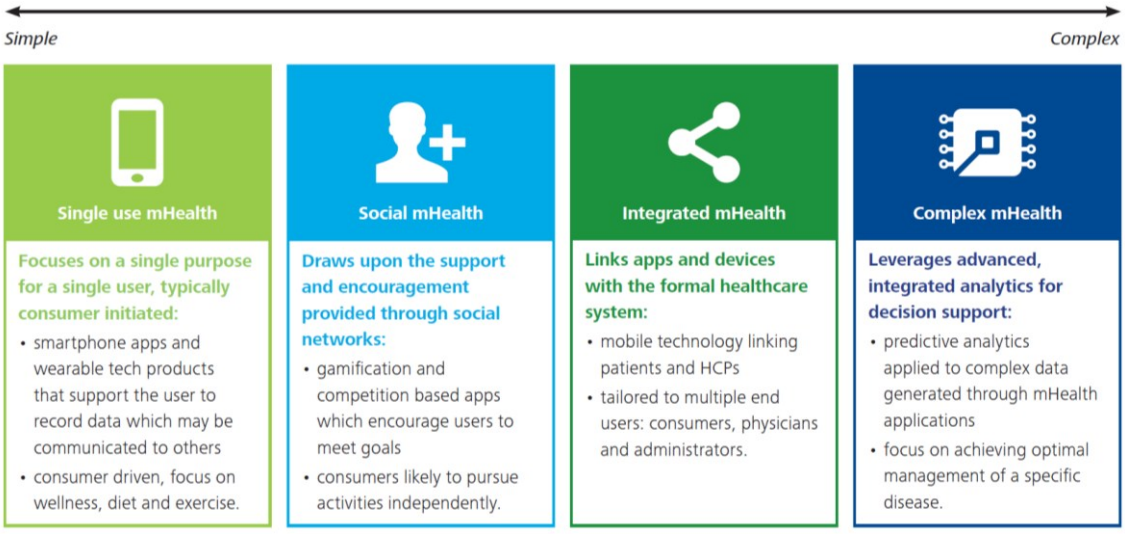

Figure 1: Four dimensions of effective mHealth [22]

Nowadays many mHealth applications of the "Single use mHealth" exist. Some of those applications already include some elements of the more complex category "Social mHealth" in which the main aim is the comparison to other users. The last two stages of complexity "Integrated mHealth" and "Complex mHealth" have not yet emerged since the whole mHealth approach is a new, not fully developed approach which nevertheless shows a great market potential for the next years [8] [9] [10].

When not looking on a specific definition of mHealth, but rather trying to figure out the promises of mHealth, the following two statements can be found [28]:

- Better patient healthcare and patient security
- Sustainable cost reduction for the government

The main aims are thus the well-being of the customer and the reduction of the healthcare costs for the government. A representative of the US Health and Human Services Secretary once said that mHealth is “the biggest technology breakthrough of our time [being used] to address our greatest national challenge” [25].

Many consulting companies and market research institutes ascribe mHealth a very large market potential [8] [9] [10] while a study conducted by McKinsey & Company in 2014 shows that nowadays a small number of health patients are interested in using a mobile app for interacting with their healthcare system:

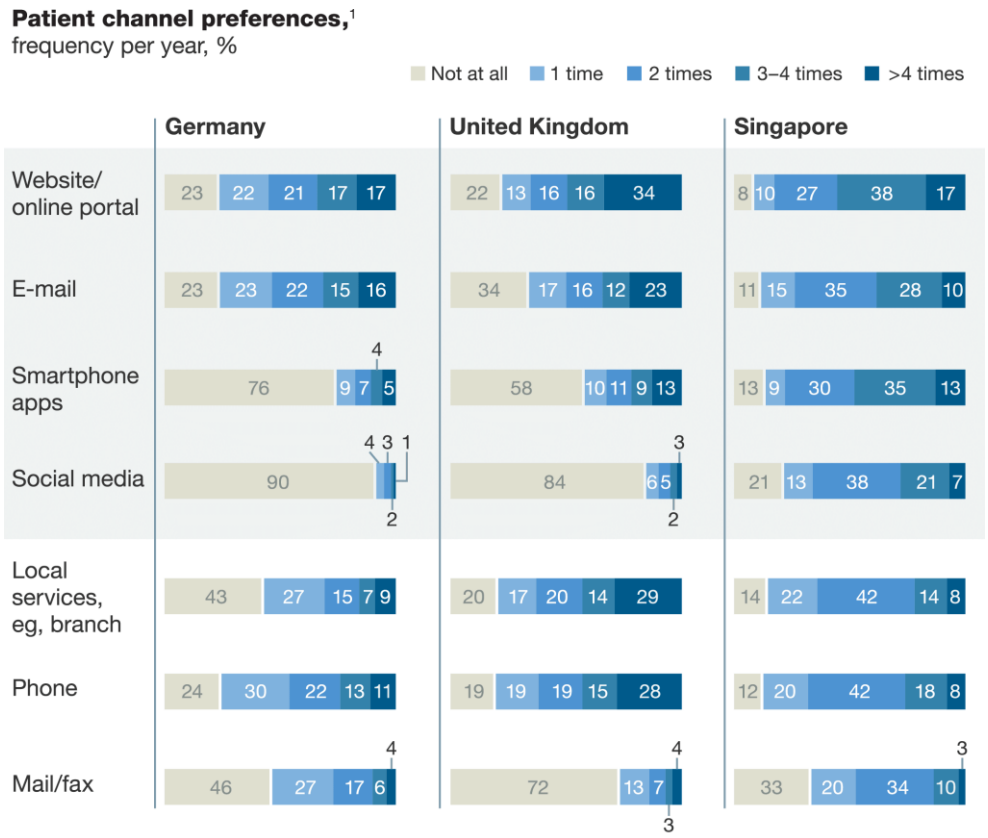

Figure 2: Patient channel preferences [29]

The study was carried out in 2014 and focused on the usage in 2013. It actually says nothing about the usage or potential in the future, but it shows that all involved companies and institutions have to exert themselves to reach a greater number of patients using any mHealth application to achieve the forecasts for the next years.

2.3. Challenges of mHealth

In the mobile health (mHealth) industry there are many different challenges which need to be considered when designing a mobile health system. In an abbreviated form, the challenges were categorized into five classes to get a better understanding of the possible barriers.

2.3.1. Financial / Economic

- The healthcare and the IT market have not enough experience in building mHealth systems and thus difficulties in building credible business cases [21]
- Inadequate funding for solution vendors [30]
- High costs of the implementation and the operating of IT systems [21] [31]
- Financial constraints on organizational investment in IT [21]
- Lack of coherent strategies linking healthcare IT investments to desired health outcomes [21]
- Lack of an investment climate, exacerbated by the financial crisis [21]

2.3.2. Technological

- Lack of interoperability between mHealth solutions [21] [30] [31] [32]
- Lack of commitment to standards that enable interoperability [30] [21]
- Involvement of big data like a new IT approach which leads to problems [32]
- Lack of technical expertise to manage IT systems in the mHealth market [21]

2.3.3. Structural / Organizational

- Lack of impetus or trust between organizations to share data with each other [21]
- Lack of transparency regarding the utilization of data collected by such applications [31]
- Regional differences in accessing ICT services, limited access in deprived areas [31]
- Liability of mHealth systems [31]
- Low cohesion between companies in the mHealth sector [30]
- Research and innovation in mHealth [32]
- Reimbursement models [30] [32]
- Balancing central leadership and local flexibility [21]
- Fragmentation and lack of coordination in healthcare delivery [21]
- Infrastructural constraints (e.g. variances in network bandwidth) [21]
- Lack of structured clinical data for secondary uses [21]

- Lack of legal clarity for health and wellbeing mobile applications [31]
- mHealth role in healthcare systems and equal access [32]
- Access of web entrepreneurs to the mHealth market [32]
- mHealth role in healthcare systems [33]
- Creation of policies and frameworks [33]
- Scalability hindrances [30]

2.3.4. Clinics and end users

- Physician reluctance to embrace new technology resulting from concerns about ease of use, changes to working practices, loss of productivity, income disruption, information overload and legal liability [21]
- Lack of awareness of clinical benefits [21] [30]
- Physician concerns about data security, privacy and confidentiality [21]
- Limited large-scale evidence of the cost-effectiveness of tools and services [31]
- Patient safety and transparency of information [32]
- Data protection, including security of health data [32]
- Creation of incentives [33]

2.3.5. Patients and public

- Concerns about privacy and security of personal health information [21] [32]
- Legislation that, while intending to protect people's privacy, often restricts appropriate sharing and use of data [21]
- Encouraging patients to play a role in managing their own healthcare [21]
- Lack of awareness of and confidence in mHealth solutions among patients, citizens and healthcare professionals [21] [30] [31] [33]
- Creation of incentives [33]

As many of the above challenges as possible need to be considered in an appropriate way to guarantee a successful mobile health system in the long-term. In my opinion the challenges which are only dependent on the business strategy of the provider of a mobile health system can be brought under control in a simple way, whereas the challenges where multiple other stakeholders of the healthcare system are involved are for sure much more complicated and need a lot of compromises, which leads to the conclusion that those - most of the time more complex - challenges have to be analyzed in detail.

2.4. Benefits of mHealth

Mobile Health (mHealth) is a complex topic and the different possible approaches need to be considered before the implementation of a mHealth system is made. When such a system is implemented correctly, the following benefits can emerge:

Convenience	A mHealth system is a very convenient tool for a patient because he/she can interact with the medical expert in a very simple way without physically presence. [34]
Continuous interaction	The interaction between the patient and the medical expert can be done at any time and can work non-contemporaneous because of the virtual environment, whereas in a real environment both sides have to be physically present at the same time. [34]
Mobile platforms are increasingly ubiquitous	Different types of mobile platforms and mobile devices are distributed all around the globe. Through the meanwhile high number of such platforms and devices the interaction has become even more attractive. [34]
Efficient processing system	The faster and more efficient transport of information eases the administration burden. [21]
Improved patient safety and emergency care	The fast access of information leads to a faster treatment possibility. [21]
Improved patient experience	The patient can access his own information from anywhere at any time and can track his own health state. [21]
Cost savings	The improved efficiency in handling information and the higher quality of information decreases the errors and the redundancies and thus also the costs. [21] [33] [35]
Accelerate clinical research and performance	Through data analytics it is possible to aggregate data in an appropriate way and derive measures for optimizing treatments by analyzing successful treatments in the past. [21]
Patient centered care	The patient is the main object within the process and thus the coordination is easier between different clinical institutions. [21]
Increased public health monitoring and disease management	Analysis of existing patients, their treatments and the consequent experience can lead to great experience about disease. [21]

Table 3: Possible benefits of mHealth

2.5. Hardware devices on the mHealth market

The base of the mHealth market is the hardware devices and the corresponding software applications which run on those devices. Like the term mobile health already says, it is all about mobile hardware devices. In a survey of research2guidance [26] they tried to figure out which mobile hardware devices have the highest business potential on the mHealth market:

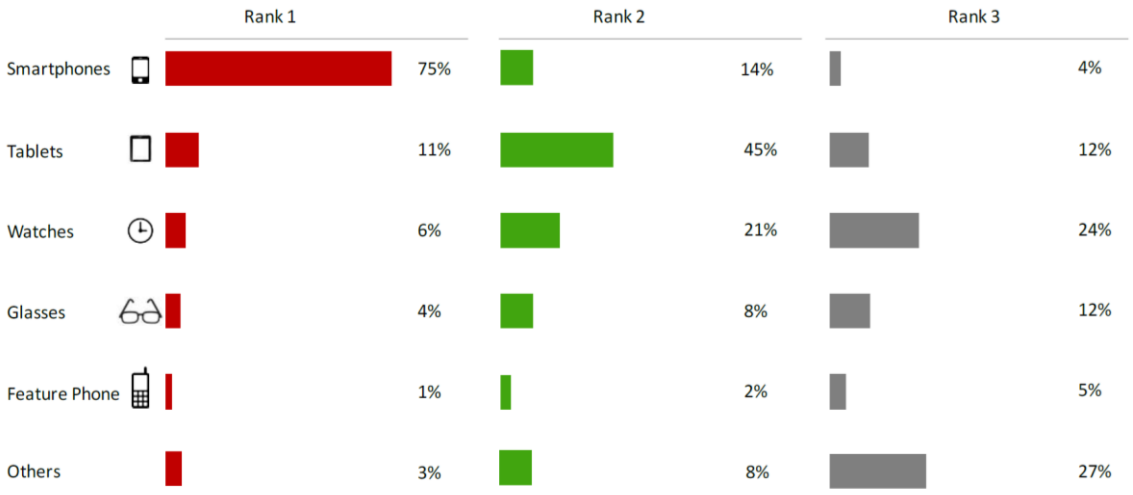

Figure 3: Devices with the highest business potential for mHealth market [26]

The well-known smartphones made it to the hardware device type which is assumed to have the best market potential on the mHealth market. Although the smartphone hype emerged in 2007 with the Apple iPhone there are already many different statistics available, regarding the penetration level of smartphones, which show high numbers up to nearly 90 % for some regions, which means that nearly 90 % of the population uses a smartphone, which is an amazing high number [36]. On the second place the survey participants voted for tablets, from which also a large market of different devices exists nowadays. These two device types are part of the “big four” according to Accenture [37]. The “big four” are those electronic devices that have up-to-date the largest consumer purchase intent. Next to the smartphones and tablets, which are currently in the lead of this ranking, also laptop computers and high-definition TVs have a large consumer purchasing intent [37]. Thus the previous named devices are, according to Accenture, currently the top four of the purchasing intent of end customers and are therefore called the “big four”. Of course the ranking will change over the next years since new electronic devices will emerge and every device type which has a high purchasing volume now will come to a saturation level one day.

Next to smartphones and tablets, also watches and glasses made it under the top four of the study of research2guidance [26]. The study assumes that those watches and glasses are not the common products used in the daily business today, but rather engineered watches and glasses which have special functionalities and can connect with other devices for communication reasons. The study actually means watches and glasses which are well-known as smart watches or smart glasses on the market and are part of the overall term “wearables”, which is a comparative modern term for all electric devices humans can wear, whereby the device has to have the functionality to communicate with other electronic devices. Especially for the mobile health market those devices are crucial because they can monitor and analyze the current state of the end customer, whereby smartphones and tablets will be more or less only used for displaying the gathered information in detail on screens. Based on the hype cycle of Gartner the company, Bionic.ly created a hype cycle too [38] whereby their special focus was on the digital health market. The “digital health hype cycle” showed on its peak, which represents the technology with the highest expectations of the respective market, the term “wearable tech”, which is simply an abbreviation of the term “wearable technology” and is thus an alternative term for the wearables described before. Especially the hype cycle of Bionic.ly shows that the analysis of wearables is very important when trying to understand the mHealth hardware device market. Of course also wearables bring, like every product or service, different advantages and disadvantages with them, which are listed below, to get a clear understanding where the strengths and weaknesses are.

Advantages of wearables in the mHealth market [39]:

- Improved healthcare services
- Training and collaboration opportunities
- Cost reduction through faster reaction
- Sustained motivation through improvements
- Broad data collection
- Cheap prices and thus affordable services

Disadvantages of wearables in the mHealth market [39]:

- Unaddressed regulatory and policy issues
- Technical difficulties
- Poor data quality because of missing experience
- Possible unwillingness of continuous tracking
- Impractically & unfashionable devices
- “No need” argument

While there are already many different studies available for smartphones and tablets it is not exactly clear yet, in which intent wearables will muscle on the mobile device market in the future, because the beginning of this business was not easy and after a good market start and a hope for even higher sales in the following years the market demand declined in the subsequent years [40]. Apple tried to give an impulse to the market by introducing his Apple Watch, but it has to be observed and analyzed in the next years in which extent this stimulation will have success.

According to a study of Accenture [41] end consumers are already interested in topics and offerings, where wearables are the only type of mobile device for providing the requested functionalities. Especially new offerings like health or fitness monitoring are interesting for end customers which leads to the conclusion that the market of wearables must have a high market potential in the future, whereas the pure interest in any type of mobile devices is not directly comparable to the actual purchasing intent which is much more important for the market and the operating companies. The positive purchase intent of wearables can be observed in a study of Deloitte where different electronic devices were compared to figure out which devices will be purchased by end customers in 2016 [40].

Deloitte analyzed, which market development the wearables will take on the mobile device market in the next years and came to the deduction that it is not yet clear yet which sales volume the wearables will reach on the mobile device market in the future. Nevertheless it is already clear that the whole market has achieved a small recovery after a poor startup which can be observed through the sales between 2013 and 2015. [40]

Another important factor for the market potential of a mobile device in general is the usability. A huge number of mobile devices has been introduced on the market but only some of them have had success while others failed because of the customers' expectations in functionality and usability. A study of Accenture [37] shows that 33 % of the end customers, who can imagine to buy a smart device, assume usability as an important factor of the purchase decision. Due to the fact that most of the mobile devices of the new generation offer great functionalities, the technology behind them is very complex. Many customers already desire an easier use and the corresponding figures speak for themselves: People using wearable health mobile devices were asked about their satisfaction with the products and from a technological perspective 24 % said that their devices were too complicated [37].

Overall 83 % of customers using a smart mobile device had difficulties in using their device, which is an amazing high number and has to be quickly improved by the product development teams of such products to persist in the future [37].

To summarize the hardware device situation on the mHealth market, there are three important types of mobile devices which have to be considered when developing a mHealth strategy: smartphones, tablets and wearables. In 2015 already 9 % of all US American consumers had access to all those three device types which can be used to access a mobile health application, whereas a mHealth application would never be designed in such a way that the interaction between the end customer and three different mobile device types would be necessary [42]. It is more likely that an end user only needs to have access to one of the recommended devices and when looking on the US American end customers in 2015, 70 % already had access to a smartphone, 51% to a tablet and 14 % to any type of wearables [42].

2.6. Software applications (apps) on the mHealth market

On the mHealth market the software applications which are used by the customers are mobile apps which can be installed and used on mobile devices like smartphones, tablets, wearables, etc. The consulting company Accenture names the emerging market of mobile apps the “appification of everything” because consumers like to have apps for nearly every use case [41].

The mHealth App Developer Economics of 2015 report of research2guidance [27] shows that there are many different distribution channels available for distributing mHealth apps. Since there exist many different business cases for using a mHealth app, the distribution channels show alternative ways of distributing such apps. According to the report of research2guidance [27] the top three distribution channels are: app stores, physicians and hospitals. Apps which are distributed in closed business areas, e.g. hospitals, are only useful inside those closed areas since they are designed for the internal communication between the healthcare staff or the communication between patients of a specific healthcare institution with the healthcare staff of this specific healthcare institution. The app in such a business case can´t be used in other healthcare institution environments and also not by patients which are not part of the concerned healthcare institution.

Thus it makes sense that the acceptance of such distribution channels is very low from the patients' perspective, which is shown through the leading rank of the app stores like the distribution channel with the largest business potential, because the app stores are typically more focused on the patients than on closed business environments such as physicians or hospitals [27]. The app store, as the main distribution channel, will be analyzed in detail in the following paragraphs.

The importance of a single app store is often shown via the number of apps existing in this particular store. Hence, that measure is also used in this master thesis to identify the most important stores, whereby especially two app stores show a large gap to the other existing stores. The Apple App Store and the Google Play Store are the only stores that have more than 1.5 million available apps by July 2015, whereby the Google Play Store is in the lead with about 1.6 million, closely followed by the app store of Apple with about 1.5 million by July 2015 [43]. Next to those two leading platforms the Windows Phone Store and the Amazon Appstore are fighting for the third place and, dependent on which statistic is considered, one of those two platforms is on position three and each of those two stores has got about 340k to 400k mobile apps available for download [43] [44]. According to these facts it seems clear why a huge number of app developing companies or even single app developers are focusing on publishing their apps on one or even on both of the two leading platforms, the Apple App Store and the Google Play Store.

Although the overall number of apps is still raising, the number of downloads is declining in some regions, because a saturation level of apps has already been reached and there exists only a small number of newly published apps which offer new features [45]. Despite the fact that the number of downloads declines, the value of the app market still rises, whereby specially in the European Union there will be a change of the revenue models for the app economy [45]. According to a study of Gigaom Research in 2014 [46] the basis of each business model will be the concept of in-app-revenues, where users can download the app itself for free and can activate additional features within the app by paying real money. To ease the use and to reduce the user´s overview of such payment transactions the user has to enter his credit card data only once - for example when he uses the app for the first time - and can afterwards make purchases continuously.

It is very interesting to understand which factors influence the success of the two leading app platforms which were named before and why the other competing platforms have not yet had the possibility to close the gap to them. Of course the hardware compatibility is a major factor since there exists a high number of smartphones or similar mobile devices like tablets or wearables with whom different apps of the leading app stores are compatible.

In contrast, there exists only a small number of devices which are compatible with the apps of those app stores which are far behind the leading platforms. Therefore the central question is: Why do people rather choose devices which have a large number of compatible apps? The answer seems easy, since the variety is larger and thus more attractive, but the number of apps has raised historically which leads to the following question: Why do app developers rather choose the leading app stores for publishing their apps? Those two mentioned questions are a chicken-and-egg problem, which is why some researchers tried to figure out which factors are really influencing app developers to publish their apps on specific platforms.

In the publication of Kim, et al. [47] two different mechanisms, the dedication-based and the constraint-based, were identified to analyze the factors which can influence an app developer choosing a specific app store. The dedication-based mechanism can simply be described as a mechanism in which the app developer feels happy and enjoys the different benefits which emerge from the relationship to the app store provider, whereby the constraint-based can be understood as an extension of the first mechanism since the app developers try to continue the already existing relationship and are constraint to stay in that relationship, because if they cancel it they would lose all efforts and expenditures made in the past. The dedication-based mechanisms according to Kim, et al. [47] include the subsequent factors, whereby some of them were also defined by Cuadrado and Duenas in their paper [48] about success factors of mobile app stores:

- Benefit-sharing attractiveness [47] [48]

Nowadays each app store shares the revenue, which is created by the sales of apps, with the app developing company or a single app developer who published the app. The common revenue share proportion is 70/30, which means that the developer earns 70 % of the sales revenue while the app store provider gets 30 %. If this proportion would be declined in such a way that the developer earned less than 70 % of the sales revenue he might change to another competing platform.

- Market demand [47]

The leading platforms, the Apple App Store and the Google Play Store, benefit from their large use bases which were created in the past. Also the app developers, publishing their apps on those platforms, benefit from the existing huge number of users which leads to the conclusion that an app platform with a large user base is much more attractive for an app developer because the market demand for new apps is higher than in an app platform with a small user base.

- Perceived usefulness of development tools [47] [48]

Useful development tools, such as software development kits (SDK) which support the app developers, are a crucial factor for an app developer regarding the selection of the app platform in which apps can be developed with this development tools.

- Perceived usefulness of online forums [47]

Supporting tools, like online forums, are important for an app developer if he needs help. When an app store has a high number of apps most of the time the existing online support is much better than for app stores with a small number of apps, since solution approaches for identified problems and obstacles may already be available. As a result of the calculations which were made to identify the most important factors, the perceived usefulness of online forums was the least factor, probably because experienced app developers were interviewed, who have already had a basic knowledge of development or who used other supporting tools.

- Review process fairness [47] [48]

When an app developer wants to publish his app, a review process has to be performed. The app store provider reviews each published app and tries to figure out if the app works properly and if no prohibited content is included. The fairness of this process is important to the app developer, because he wants equality for all developers who publish apps.

The constraint-based mechanisms according to Kim, et al. [47] include the following factors:

- Set-up costs [47]

The initial costs for setting up the whole necessary work environment and the registration of a developer account may require a lot of money. When an app developer hasn´t carefully considered those investments, the lost would be enormous if he decided to change the app store, where his apps should be published.

- Learning costs [47]

An app developer has to invest a lot of time and money in learning materials, courses, etc. when developing his first app. The whole costs of this investment need to be sustained as long as possible and the developer will try to avoid changing the newly learned programming language and the skills needed for developing an app in small time periods.

Especially when looking on the mHealth app market there exists a great number of different apps. Since the app stores have different naming conventions regarding the app categories, research2guidance [26] [27] figured out universal terms for every app category of the leading app stores in which mobile health apps are included. The largest numbers of mHealth apps in 2014 were in the fitness (30.9 %), the medical reference (16.6 %) and the wellness (15.5 %) category, whereby - like already mentioned - those categories may not be found in any app store since they are general terms.

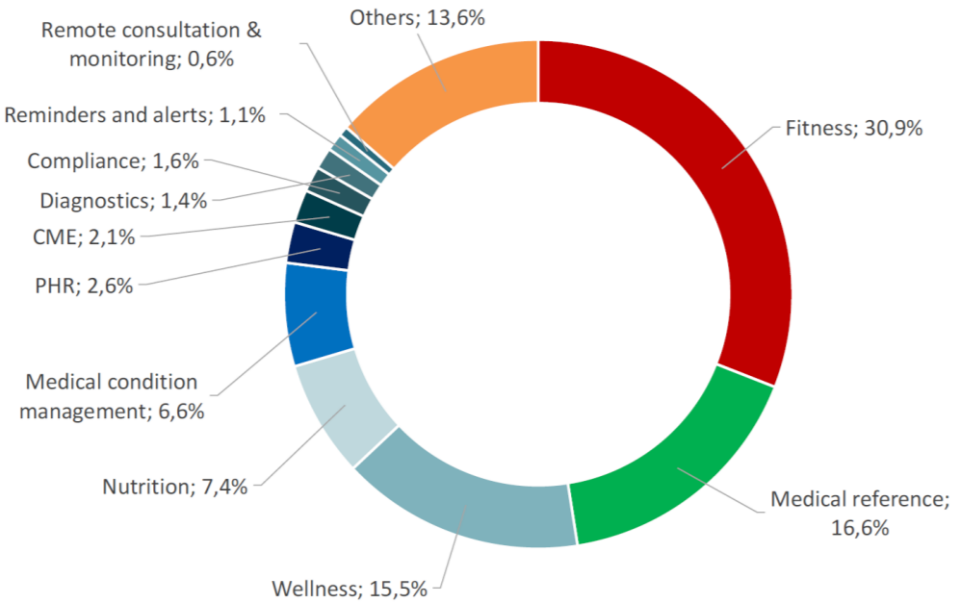

Figure 4: mHealth app category share [26]

When only looking at the Apple App Store it can be assumed that most of the mobile health apps are included in the “health and fitness” and “medical” category. According to a study [48] of the Apple App Store which was conducted by the IMS in 2013, about 2/3 of all available mHealth apps are designed for end consumers, whereby 1/3 is geared for healthcare providers. Within this study also the reference of the apps, which are contained in the Apple App Store’s “medical” and “health and fitness” category, to real mobile healthcare use cases was investigated and the conclusion was that only 54 % of those apps showed a real mobile healthcare use case, whereby the remaining apps were apps with no form of human health benefit [48].

On the mHealth app market each business actor has other requirements, whereby next to the app store providers a particular focus has to be on the app developers and the companies who provide wearables which contain sensors and other forms of medical-specific measuring elements to enable the communication between the app and a human. The leading mHealth apps have a special focus on the connection with any type of sensor or other medical-specific measuring element [26].

It is thus a crucial factor of each successful app to provide the possibility of connecting the own app with a lot of different medical sensors which could raise the customer's interest of using such an app. The vendors of sensors or other forms of medical-specific measuring elements have a similar focus because their main goal is the compatibility to as many mobile health apps as possible [26]. On the mHealth market the leading sensor vendors have the ability to connect to nearly 100 different apps, which makes a high effort on the development of such sensors [26]. To see which mHealth app platforms on the app market exist nowadays, the subsequent section will analyze the existing mHealth app platforms of the two leading app store providers: Apple and Google.

2.7. Apple HealthKit & Google Fit

The main element of Apple Health is the ”Health“ app, which was developed by Apple and is already pre-installed on new Apple iPhones and Apple iPods. The app was released in September 2014 and is not yet available for owners of devices of the Apple iPad series or the Apple iWatch series, with what a large user base is excluded of using the “Health” app. The app itself offers users the functionality to get an overview of their own health and fitness data. Specific health and fitness functionality can also be used on the Apple iWatch series, but not the whole functionality of the “Health” app is available. The “Health” app is simply a dashboard which can be customized according to the requirements of the respective user. [50]

Next to the original “Health” app of Apple some app developers have already developed similar dashboard apps which allow a broader and different use of the stored health data. With “HealthDash for Health App” for example the health data which is associated with the user who uses this app, is just conditioned in a different way [51]. The “HealthDash for Health App” app has originally been developed for a broader use of the available health data on the Apple iWatch series, since the health functionality of those devices is severely limited [51].

The main building block of the “Health” app is the “HealthKit” framework which was also developed by Apple. It is the application programming interface (API) for the whole health world of Apple and thus also the base of the “Health” app. The framework offers app developers the possibility to develop their own health apps for the Apple devices in a standardized and thus appropriate way, because all apps which were developed with “HealthKit” can communicate and interchange data with each other. The whole health and fitness data which is collected by health apps, developed with the support of “HealthKit”, can be displayed in the health dashboard, the “Health” app. [52]

According to Apple´s app developers program, the “HealthKit” offers the following benefits [52]:

- Separating data collection, data processing, and socialization
- Reduction of friction in sharing between apps
- Providing a richer set of data and a greater sense of context
- Letting apps participate in a greater ecosystem

The main advantage of “HealthKit” is that users can decide which data they want to store in the “HealthKit store” - which is the database behind the “HealthKit” - and can configure the read and write access of each app to the central “HealthKit store” separately. Apple promises users, who use any app developed with “HealthKit”, that no app will use their health or fitness data for advertising purposes, which does not mean that no ads can be included in the “Health Kit” apps, but rather that the ads are not allowed to use the user’s specific data for displaying a customized ad. [52] To broader the use of the app development with the “HealthKit” framework there exists a number of non-Apple hardware devices from hardware vendors like Garmin, Fitbit, Jawbone, Withings, etc. for which the development of “HealthKit” apps is already feasible [53].

Furthermore Apple developed the “ResearchKit”, which is an open source software framework and was developed for the medical research market. If a user agrees to provide his health data from the “HealthKit” for research purposes, the researching companies can work with the data of the users which use any kind of app developed with “HealthKit”. The underlying research and development analysis can be performed with the support of Apple´s “ResearchKit”. [54]

“Google Fit” [55] [56] is very similar to the “Health” app of Apple and was published by Google in October 2014, by which the “Google Fit” app can be seen as a direct competitor. The main strategy at the beginning was the placement as a software framework for app developers to ease the programming of health-related apps for end customers and medical staff, but then Google changed it to a consumer product. This strategic alteration has led to the necessity to announce some well-known partner companies like Nike, Adidas, RunKeeper, Withings, etc. which had already operated in the fitness and health market to get more attraction than Apple had at the beginning [56] [57]. The idea behind the “Google Fit” app is very similar to the concept of Apple: for app developers there is an application programming interface (API) available, with which they can develop apps that are compatible with a number of devices like smartphones, tablets or wearables which run on Android [56] [57].

The “Google Fit” environment is, compared to Apple´s “HealthKit”, much broader placed on the market, because next to the use of the app on mobile devices the “Google Fit” world also offers the possibility to link the health and fitness data with the own Google account and view the data from all over the world via a web browser [58].

The main difference between “Google Fit” and “Health” of Apple, like the names already reveal, is that they have another business focus in general [57] [58] [59] [60]. Google´s product is more focused on the fitness and sports market which can be identified by looking at the partners of “Google Fit” [56] [57]. In contrast, Apple´s “Health” is really focused on the health and medical market since it offers more comprehensive apps and underlying tools, and when looking at their partner network, a number of electronic health record companies can be recognized. Google had also tried to enter the consumer health sector in 2008 with its “Google Health”, but had to abort the efforts in 2011 and destroyed all the recorded data in 2013 because the program hasn´t brought the expected results [61] [62].

3 Related work

3.1. Value Network model frameworks

3.1.1. Introduction

The previous section discussed the necessary elements which need to be considered if a successful mHealth platform should be achieved, while in the Related Work section the existing scientific work on the subject of model framework approaches for Value Networks, two-sided markets and quantification mechanisms for Value Networks are being analyzed.

Nowadays there exists a number of many different Value Network model frameworks. Each of these frameworks has got another focus regarding the perspective and the broadness of the considered market. In a first step the term Value Network is described with the support of a book of Brandenburger and Nalebuff called Co-opetition [63] which is a combination of cooperation and competition, which actually means that next to the cooperation between companies on a market also competition between the same companies can exist. The book should show the basic idea of Value Networks and the subsequent sections will show different Value Network framework approaches, whereby especially the E3-value framework [64], the Allee´s framework [69] [70] and extensions of those two are discussed. Next to these common frameworks some other approaches are explained to show other possible frameworks of Value Networks.

3.1.2. Co-opetition Value net

In the book of Nalebuff and Brandenburger [63] the basic structure of a “value net” is described, which is actually a simplification of a - most of the time - more complex Value Network. The whole book is based on the concept of game theory and hence the participants of a value net are called “players”, whereby possible players are [63]: the company (which is the focal player), the customers, the suppliers, the complementors and the competitors.

The value net approach is structured into a horizontal and a vertical dimension, whereby the customers and the suppliers make up the vertical dimension and the complementors and competitors the horizontal dimension. Most of the time the players within a value net are any organizations or companies respectively their products and services. Only the customers may represent either a single private person or a group of private persons who will consume the product or service. [63]

Nearly all of the players in a value net are well-known from general economic's literature, wherefore I will only describe the exotic "complementors" which are players who help the (focal) company to create additional value for their products or service. This supporting activity is done by simply providing base or even additional products or services. Furthermore a supplier in a value net takes over a specific role because he is depended from the competitors and complementors within the value net. It can be the case that companies cooperate together on a research and development level to maximize the overall value, share costs and accelerating the technological progress, while they may compete against each other on a resource level to attract a specific supplier regarding the primary lead of limited supplied quantities. [63]

The demonstration of the value net approach was made via a case study which shows a university as the focal company and all the other players which are involved in the daily business of a university, whereby this example illustrates that the generic players can consist of a number of different organizations, companies or customers. [63]

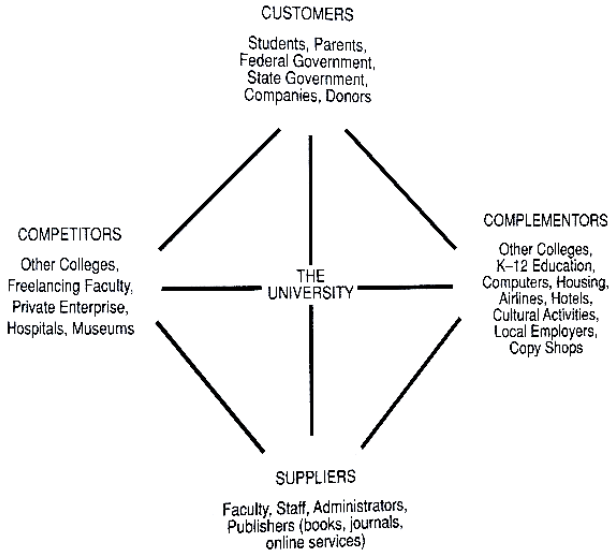

Figure 5: Value net „The university" [63]

It can be summarized that a value net (or a Value Network) is a specific market interaction of different organizations, companies and private persons which/who operate in different markets and work together to achieve higher results or in other words to maximize the received value of this business interaction. In the following sections the frameworks of the - most of the time - more complex Value Network is the main focus, whereby each framework has a different perspective and the approach of the respective framework is not always named Value Network, even if the idea behind the approach is very similar to the common term Value Network. Some of the existing frameworks are stand-alone approaches, whereby nowadays also frameworks which are based on those stand-alone approaches exist.

3.1.3. E3-value framework

The basic idea of the E3-value framework [64] is very similar to the ARA model of Håkansson and Johanson [65] which divides a Value Network into three concepts: actors, resources and activities.

In a first step the concept of the E3-value framework distinguishes between two different model types: the terminating and the originating model, whereby those two models include the business concepts/strategies of the respective companies and when building up a Value Network it is important to decide which type somebody wants to use. [64]

The terminating model shows the common steps of performing a business or in other words it simply describes how the business process is performed in the common way. In contrast the originating model shows an alternative way of performing the business process and thus deviates from the common performed steps. To have a clear understanding of the two models the paper [64] described a business process of a newspaper company which provides an online article. In the terminating model the last mile internet service provider (ISP) gets paid by the customer. This last mile operator pays the general ISP and the general ISP pays the newspaper for the online article, which is the common model of performing such a business process in this newspaper company. On the contrary the originating model should show a non-common, alternative way of providing an online article: the customer pays the newspaper, the newspaper pays the general ISP and the general ISP pays the last mile ISP. The distinction and the understanding of the differences between the discussed models are necessary because it is important to know how the business interactions in a company flow. [64] For building up a Value Network the subsequent figure shows which elements can be included into the model:

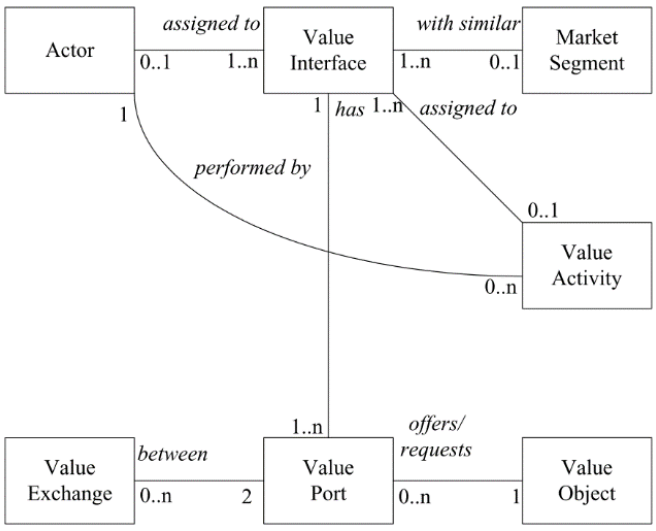

Figure 6: The (simplified) e3-value ontology for e-business models [64]

The base of a Value Network according to the E3-value framework is built up of multiple actors, which represent a firm, an organization or a customer which is basically the same like it was for a value net, but some more elements may exist in a Value Network according to the E3-value framework, which will be described in the next paragraph. [64]

If an actor performs a so-called value activity, his profit or utility increases, whereby if two single actors exchange so-called value objects with each other via a directed edge, this exchange is called value exchange. Every value object represents a service, a product, money or consumer experience and is of value for the receiving actor. The value ports are each actor's point of contact where the value exchange edge leaves an actor or connects to another one. Single value ports of an actor can be summarized in a value interface even if there is only one value port, whereby an actor can have more than just one value interface. The value interface determines that only specific value objects contained in the value ports of this value interface can be exchanged when another value object is received at this value interface. A market segment is simply a cluster of actors which have the same or a similar interest or in other words if their value interfaces are similar. Furthermore, the E3-value framework has some more elements to describe a specific scenario in the Value Network or in E3-value words "a specific sequence of performing value activities". This use case modeling elements will not be discussed in this master's thesis because it would unnecessarily blow up the scope. [64]

The E3-value framework offers an extensive approach to model a Value Network, whereby on the one hand the different elements which can be used for modeling the Value Network provide the possibility to present a deep dive into the Value Network and on the other hand the terminating and the originating model offer great possibilities to model one and the same Value Network in different ways. Next to the E3-value framework there were proposed some extended frameworks in the past because the original framework has - according to the extended frameworks - a restricted perspective in some areas and therefore it is necessary to broader the perspective to include other important issues which are not representable in the original E3-value framework.

3.1.3.1. Business model options within the E3-value framework

In general, a business model may contain different options, which may be changed or extended over time and the paper of Kundisch and John [66] provides the possibility to address this necessity in business models. The paper uses the term “real options” which comes from the financial/banking industry in which call and put options exist. For the application of such options the authors were looking for an appropriate and already existing business model approach in which their option approach could be included to show how the approach worked and if it was applicable. [66]

The authors have chosen the E3-value model framework because, according to the authors, it is the only framework which provides a software tool that can also perfom a financial evaluation next to the graphical representation. The paper introduced four different options to handle possible scenarios in business models: defer, expand, abandon and contract. Whereas the first two options may remind of call-similar options of the financial/banking industry the last two options seem similar to put options. [66]

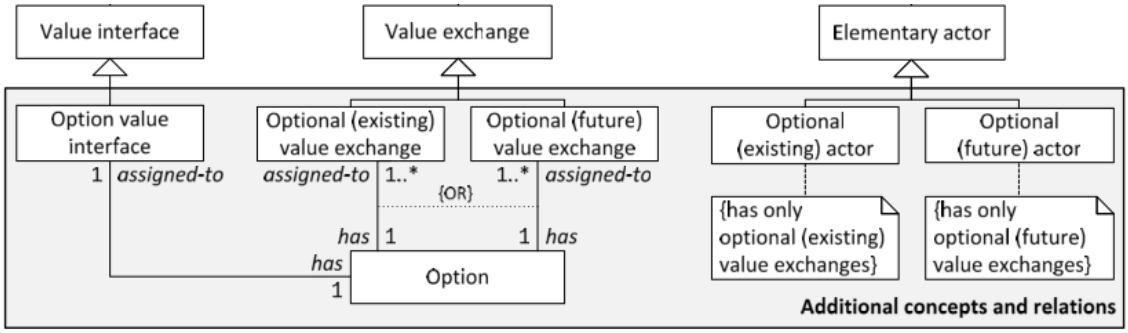

Figure 7: Additional formal concepts and relations [66]

The main focus of the option extension is on the value exchange between actors of the E3-value framework. The deferral and the expansion options have the possibility to introduce option value exchange elements into the model and are therefore called “optional (future) value exchanges”. Additionally, the exercises of those two options can add new actors to the model, but only if they are connected via optional value exchanges. Those optional actors are called “optional (future) actors”. Whereas the deferral option can include a completely new value exchange in the model, the expansion option adds a new value exchange next to an already existing value exchange. [66]

In contrast to the call-like options the abandonment and the contraction option can remove value exchanges or actors from the model and the elements are therefore called “optional (existing) value exchange” and “optional (existing) actor”. [66]

Whereas the abandonment completely destroys the connection via a value exchange to an optional (existing) actor, the contraction option only removes a single value exchange connection to another actor with what there still remains one or more other value exchange connections to this actor. Next to the already discussed extension elements also some new “option value interfaces” were introduced into the existing E3-value model framework approach. Those new elements are necessary to show which actor is responsible for and has the power of performing the option of deferral, expansion, abandonment or contraction. [66]

A business model often has a number of options and Kundisch and John [66] have found a great possibility to integrate this necessity into the E3-value model framework. The basic idea behind their approach seems great, but to offer a sophisticated option-based mechanism for the E3-value model framework, the approach should provide the possibility to model all of the possible E3-value model framework elements as additional options which can be included or excluded from the model on demand.

3.1.3.2. Strategic analysis within the E3-value framework

The C3-value framework [67] simply extends the E3-value model in such a way that it can support strategic analysis. Many of the existing Value Network frameworks only show which kind of value is created but not directly in which way this value is created and why - therefore which benefits it has for whom to create a specific value. A main concept behind the whole C3-value framework is, that there exists a primary value object that conveys the intended businesses of an actor and a secondary value object that enhances the value delivered by the primary value object. The strategic analysis is performed through the following three dimensions: customer, capabilities, and competition. For a better understanding of the C3-value framework each dimension is described in the subsequent paragraphs. [67]

Competition dimension [67]:

The competition analysis has two sides: on one side the identification of the industry, in which a company operates, is defined, whereby the other side identifies how the company distinguishes from its competitors. The industry can simply be detected through the value object that a company provides, which represents the first-order value and the way how a company differs from competitors is the second-order value. This second-order value can be the following: safety, reliably, friendly, conveniently, responsiveness, etc. Next to those second-order values there are also complementary value objects, like for example a user manual that is provided together with a technical product.

The second-order and complementary values are those two types of values which build up the competitive values which lead to a so-called Competitive Value Model.

Costumer dimension [67]:
The customer dimension knows two models: In the Customer Activity Model it is necessary to value activities and their effects on the resources of the customer, whereby these resources can be: time, money, effort or attention. Next to those resources there are once again second-order values for them which show the added value. In the Customer Profile Model it is defined which value a customer ascribes a resource of the Customer Activity Model.

Capability dimension [67]:
In the Capability Resource Model the resources and capabilities for the focal actor are identified which offers him a sustainable competitive advantage. After matching those capabilities together with the activities, which create the sustainable competitive advantages, decisions about outsourcing can be made.

The C3-value approach is especially focused on the strategic analysis and tries to find answers on why and how value is created. The authors simply made a deep dive into the description of value in general and derived some dimensions to analyze the strategic considerations in an appropriate way.

3.1.3.3. Value encounter within the E3-value framework

The value encounter framework [68] is based on the E3-value framework and extends the existing framework. The value encounter approach focuses, as the name suggests, on the value encounter in the Value Network, which is an interaction space where every actor of the Value Network provides specific resources, which will be combined in such a way that value can be created for all of the involved actors. Through the single value encounters it should be visible how value is created within the Value Network and the exact understanding which value is created from whom is uncovered. [68] The whole value encounter framework approach consists of a three-step process [68]:

1.) Value Encounter Modeling [68]
In the first step the involved actors are defined and the value encounters need to be defined by simply creating an interaction space within the Value Network where a number of actors of the Value Network will work together to create value.

2.) Value Activity Modeling [68]
Within each value encounter there have to be so-called value activities which are connected via input or output value ports - term is already known from the classical E3-value approach - to the outside world or in other words to the value ports of the actors of the Value Network.

3.) Value Encounter analysis [68]
The whole value encounter model can be finally analyzed from four different dimensions: financial, operational, knowledge and social.

In summary, the value encounter framework comes with a similar idea as the C3-value approach. The authors of this approach also tried to make a deep dive into the creation of value, so they actually explored how value is created and analyzed the actors regarding who contributes the most to the value creation.

3.1.4. Allee model framework

Allee's model framework [69] [70] is based on the HoloMap diagram [70] which is actually constituted of the following graphical elements: participants, transactions and deliverables. The approach of Allee tries to build up an own understanding of a Value Network in which each element can stand for multiple things, whereby Allee especially focuses on the transactions. To comprehend what Allee understands by all these terms, I will describe them in more detail in the subsequent paragraph.

A participant represents an individual or a group of people, whereby in detail participants can be individuals, small groups or teams, business units, whole organizations, collectives, such as business webs or industry groups, communities or nation states. Every participant needs to be a human and must not be any kind of technology. Transactions, often also called activities, refer to a transfer of a deliverable from one participant to another and it is helpful to use directed transactions to determine the sender and the receiver of a deliverable. If there is an additional transaction between two equal participants which is pointing to the other direction, it means that a deliverable will be returned if the other transaction is executed. Such a scenario is called an exchange. Deliverables are simply things which are transferred between participants and can be tangible such as goods, services, and revenue, or intangible such as knowledge and benefit. The key element of the whole approach of Allee is the different graphical representation of transactions which contains tangible and intangible goods as deliverables. [69] [70] [71]

Allee provides a very special perspective on Value Networks, because her focus is on the transactions and the exchanged deliverables, whereby she puts a special attention on the distinction of the types of the exchanged goods. The involved actors are actually only participants which enable the - in Allee´s eyes - important transactions.

3.1.4.1. Value stream map based on Allee´s model framework

The base of the value stream map approach [72] are the actors, the value streams between the actors and the resources which are necessary to create and receive the value of the value streams. A clear focus of this approach is made on the process which has to be executed to build up a value stream map correctly, whereby the whole approach is based on the Value Network model framework of Allee and the business model approach of Timmers. [72]

The whole process of creating a value stream map constitutes of three process phases [72]:

1.) Offering collection and requirements identification [72]

In this phase it is necessary to name the offerings, which are offered through an actor, as precise as possible. The insider knowledge of the products or services will help to understand and clearly name the offerings. Next to the offerings also the requirements of its supply-side need to be named.

2.) Value stream derivation and actor association [72]

The focus in this phase is on the derivation of the single value streams whereas the contents of a value stream are specific products or services. Based on Allee´s model framework the following value stream types were defined: goods (e.g. books), free goods (e.g. web browser software), services (e.g. ad space), free services (e.g. ad supported e-mail) and information (e.g. user information). After all the value streams were identified, the directed association to the actors which should receive the value stream is necessary.

3.) Resource association [72]

Every single value stream needs to be associated to the resource which is responsible for creating or receiving it. Within the paper the following resource categories can be defined: software development capabilities, service capabilities, technological capabilities, information, ICT systems and technologies, immaterial assets and contracts & partnerships. All the resources of each actor should be assigned to one of the resource categories.

In a case study the paper showed the use of the whole value stream map process, whereby the authors used four different internet business companies and compared their findings afterwards. After the offerings were defined, the value streams were named and the association to the resources were made, the paper summed up the differences between the single companies and identified especially which resources were essential for each company. With this overview it was possible to show how many resources of a single resource category a company had and with this, the focus of the overall business strategy could be derived. [72]

The value stream map approach is very similar to all of the other existing Value Network approaches, whereby a special focus of the framework is on the process of building such a value stream map. Allee´s framework is used in the value stream map framework to get a clear understanding of how the different value streams - or in Allee´s words the deliverables - can be categorized reasonably.

3.1.4.2. Business webs based on Allee´s model framework

The term business web (b-web) is used in this approach [73] which is - from the idea behind it - actually pretty similar to the term Value Network which was used in some of the approaches before. The business web approach makes a deep dive into the analyses of the actors of a Value Network and tries to figure out which actor can contribute which value. There exists a graphical representation of the b-webs which is based on the Value Network framework of Allee and thus a clear focus of this approach is made on the process of building up such a business web [73]:

1.) Describe value proposition [73]
An overall description of the current value proposition of the end customer should be done. Therefore it is important to know on which customer the whole business is focused, which products and services are offered and finally which value those elements bring to the end customer.

2.) Disaggregate [73]
It is necessary to disaggregate the whole network of participants, so therefore all contributors (also the end customers) and especially their strengths and weaknesses should be considered. The author grouped different possible contributors into five groups:

- Customers: receivers of the value of the b-web
- Context: direct connector between customer and b-web who leads the value creation
- Content: the provider of the core value who designs, produces and delivers the value
- Commerce: provides the indirect business services for the b-web like financing, logistics, etc.
- Infrastructure: all resource providers which are necessary to create value within the b-web

3.) Envision b-web-enable value [73]
The creative development of new paths of the business is the main aim in this step. With the usage of creative design techniques the new alignment of the business should be achieved.

4.) Reaggregate [73]
The necessary steps to run the new orientation and the new value proposition in a proper way should be defined and all previous participants of the network need to be aligned to each of the required steps.

5.) Prepare a value map [73]
The b-web is built up via a graphical representation of the participants and the transactions between them which includes the (new) value exchanges. This model is built with the help of the model framework approach of Allee with which it is possible to define the value exchange of tangible and intangible goods.

In conclusion, the business web framework comes with a similar idea as the C3-value and the value encounter approach which were described before. The authors of this approach also tried to make an exploration of the most important actors and hence tried to figure out who contributes the most to the value creation. Finally a graphical representation of the business webs has been invented with the knowledge of Allee´s model framework approach.

3.1.5. Value Network Configurations

The term “Value Network Configurations” was introduced in a paper of Casey, et al. [74], which stands for the creation of different Value Network scenarios or constellations which are possible within the same domain. Next to this term the authors also defined a framework for building up Value Networks and developed their own annotation and graphical representation of those networks. The main graphical element is the actor who represents a company or an individual end customer. Each of these actors can have one or more roles each of which contains technical components. The technical components of the roles of the actors can have technical interfaces to each other over which they are working together by e.g. exchanging data. A further annotation element is the business interface which can connect two different actors involved in a Value Network. This type of interface shows that there exists a cooperation or any relationship between those two actors on the business level. [74]

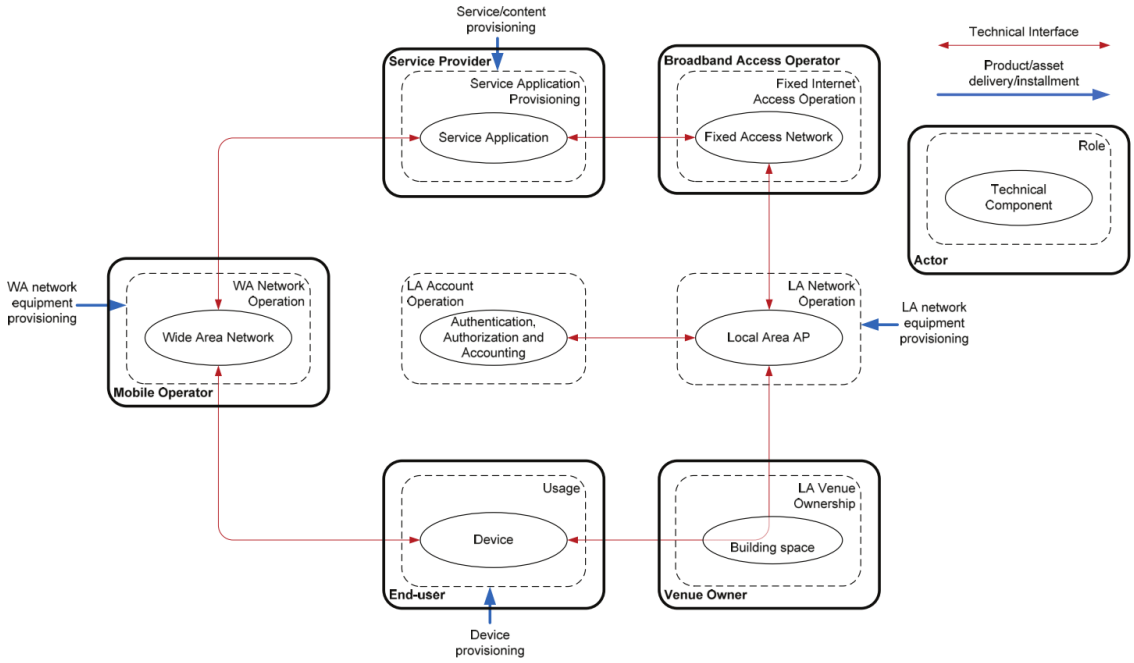

Figure 8: Generic role configuration for wireless local area provisioning [74]

The whole approach and different Value Network Configurations of the wireless local area access domain are shown to demonstrate a possible use case, while the analysis of the probability of occurrence of those different Value Network constellations is not made within the paper. The main difference between the single Value Network Configurations is the positioning and importance of a single role, the “local area access account operation”, which is simply the first point of contact between the whole Value Network and the end customer. [74] Finally, the paper showed all identified Value Network Configurations in form of one consolidated graphic and categorized them into possible future scenarios of the wireless local area access market which were described by Smura and Sorri [75].

The approach of Casey, et al. [74] about Value Network Configurations and Value Networks in general is very sophisticated, since it offers the possibility to examine a Value Network from a technical and a business perspective. The whole annotation method which is described in their paper provides a clear understanding of the involved actors and their relationships. Furthermore, it is interesting that they consider the distinction of different roles which a single actor can have at the same time and hence offer the possibility to analyze the tasks and activities of a single actor in detail.

3.1.6. Stakeholder Value Network Framework

A network-based modeling framework for stakeholder analysis was created by Fu, et al. [76] especially to address the issues that exist with energy conservation campaigns in China. The name of the framework is Stakeholder Value Network approach, because the direct and indirect relationships between the single stakeholders are built up and analyzed. The framework contains four different steps to create and analyze a Value Network [76]:

1.) Mapping [76]

In a first step the roles and aims of each stakeholder need to be defined, whereby in every Value Network a single focal stakeholder should exist. After all those definitions the mapping of the stakeholders can be performed whereas all stakeholders are connected via their value flows between them, in form of a Value Network. The paper proposes to color each value flow and therefore defines the following flow categories:

- Blue: Goods and Service flows
- Red: Regulatory flows
- Green: Financial flows
- Purple: Information flows

2.) Quantification [76]

At this point each value stream that connects to an actor has to be quantified. Every single value stream needs to be quantified by a metric called value stream score which can be extracted of a matrix which was developed by Berger, et al. [77]. On one side of the matrix the importance of the value for the source stakeholder is defined and on the other side the need intensity of the value for the receiving stakeholder.

		Need Intensity Score				
		A = 0.11	*B = 0.19*	*C = 0.33*	*D = 0.57*	*E = 0.98*
Source Importance Score	*1 = 0.11*	0.01	0.02	0.04	0.06	0.11
	2 = 0.33	0.04	0.06	0.11	0.19	0.32
	3 = 0.55	0.06	0.10	0.18	0.31	0.54
	4 = 0.78	0.09	0.15	0.26	0.44	0.76
	5 = 0.98	0.11	0.19	0.32	0.56	0.96

Figure 9: Matrix for calculating value flow scores based on attribute scores [76] [77]

Finally many value paths are created which include all the paths from one stakeholder to another (final) stakeholder. In the whole Value Network many of this value paths will exist because one value flows from one stakeholder to another and will pass through many other stakeholders on his way to the final stakeholder who should receive the value. Each of such value paths is simply quantified by multiplying the value stream scores along this path.

3.) Searching [76]

It is proposed that if a specific stakeholder should be analyzed, all value paths beginning at this stakeholder and ending at him should be selected, so the search for all value paths which need to be analyzed is made at this point.

4.) Analyzing [76]

The analysis of the whole Value Network is simply done by some special metrics which were especially created for the Stakeholder Value Network approach. These metrics are:

- Weighted Stakeholder Occurrence: This metric is calculated by dividing the score sum of value paths including a certain stakeholder through the score sum of value paths including the focal stakeholder. The WSO shows the importance of the stakeholder in comparison to the focal stakeholder.
- Weighted Input Occurrence: This metric is calculated by dividing the score sum of value paths which include a certain input to the focal stakeholder through the score sum of all value paths including the focal stakeholder. The WIO shows the most important values, in which the sender is any stakeholder and the receiver is the focal stakeholder.

- Weighted Output Occurrence: This metric is calculated by dividing the score sum of value paths which include a certain output of the focal stakeholder through the score sum of all value paths including the focal stakeholder. The WOO shows the most important values which come from the focal stakeholder.
- Weighted Value Flow Occurrence: This metric is calculated by dividing the score sum of value paths containing a specific value flow through the sum of the score sum of value paths containing a specific value flow. The WVFO shows the relative importance of each single value flow.

The Stakeholder Value Network approach of Fu, et al. is special, because they deal with the graphical representation of value flows and their quantification, but also the analysis through specially developed metrics is an important part. It is, compared to the other model frameworks which were described before, a broad approach which tries to create an overall model and analysis framework for Value Networks, but in my opinion a single paper can´t cover the development, the validation and the application in an appropriate way. The application of the proposed framework is described in the paper, but no form of validation of the findings is made and since even the authors call their paper a “pioneering study”, they might know that their approach needs a detailed investigation in the future.

3.2. Two-sided markets

3.2.1. Introduction

The base of a two-sided market is, that there exist two different partners which perform any business interactions over a platform, whereby those two actors operate any exchange over this platform, with what I will use two-sided markets and two-sided platforms as synonyms [78]. A very popular example for an offline market where a two-sided platform exists is the payment or credit card market [79] [80]. On such a market there are two different types of agents and an intermediary that connects these two. The consumers want to make a payment through a specific card and the retailers are looking for many customers who buy any product. The intermediary in such a case is often any bank or credit card institute which makes both sides happy by simply transferring the money via a secured and fast connection. [79] Other possible scenarios of two-sided markets include, according to Rochet and Tirole [80] respectively Eisenmann, et al. [81]: videogames, streaming media, web browsers, operating systems, newspapers, TV networks, credit and debit cards, shopping malls, real estate, online platforms, etc.

Next to the two-sided markets there also exists the concept of multi-sided markets, where more than two business actors interact with each other. Especially with the emerging digital technologies in the last years the term of “multi-sided platforms”, which are digitalized multi-sided markets, is becoming more and more important. For the involved customers those platforms are only of value if the opposite sides are present and if the business interactions create value for the actors. According to Osterwalder [17] multi-sided platforms are: “Platforms which bring two or more different and from each other independent customer groups together.” The platform operator has the challenge to bring together the involved business actors in such a way that value can be created. [17]

3.2.2. Network effects

In general, one side of the two-sided market only benefits from using the platform if the other side of the platform is large enough, which leads to the concept of network effects [79]. The term network externalities was defined by Katz und Shapiro [82] as: „the value or effect that users obtain from a product or service will bring about more values to consumers with the increase of users, complementary product, or service.”, whereby the network externalities can be understood as the source of the network effects [83].

It is important to understand that network effects can only appear at a special type of a product or service, the so-called network goods or network effect goods [83] [84]. Such a good has the characteristic that it can be a physical (e.g. telecommunication networks) or a virtual (e.g. online application) good, but has to be used from multiple participants within a network [83]. Direct network effects are those, in which the value of the customer is directly dependent from another user who uses the same product or service and these two customers can build up a connection with each other (e.g. telecommunication networks). In contrast, indirect network effects are generated, when the whole network is growing and the emerging experiences through the large customer base lead to learning effects (e.g. app store). [82] [84]

Most of the analyses of network effects assume that those effects always have positive impacts for the customer or the user, when looking on a digitalized network. Of course many strategic approaches and business constellations will try to maximize the value which the user gains and hence also the analyses will focus on the positive outcomes since they are more obvious. Especially digital networks seem to have stronger positive network effects when more users participate, which can be shown on the basis of social networks. It doesn´t make sense for any user to register for a social network in which he doesn't know anybody, because all of his friends in real life don´t participate. But also in such network scenarios negative network effects may appear with an enlarged user base, because the more users participate the more capacity and performance, e.g. higher bandwidth, of the underlying technical systems will be required [83] [85]. If those additional requirements aren't fulfilled, the users will receive negative network effects and consequently value will decrease if the user base increases. Also non-technical networks, e.g. highways, can provide negative network effects if the number of users, which is the number of cars in this case, increases since a traffic jam is more likely if the number of cars on a highway is higher [83].

When the focus of a digital platform is laid on the network effects of this platform it is important to consider, that the platform has to be positioned on the market against the competitors in such a way, that there is a possibility to offer positive network effects to the user base, because elsewise no user will use the platform and will switch to the competing platform [86] [87].

3.2.3. Two-sided market constellations

According to the master's thesis of Zhao Hanbo [88], six different market models were built up to show that next to the classical known two-sided platform model also some other models can exist. All models are based on the two-sided market model and extend it in more or less different ways.

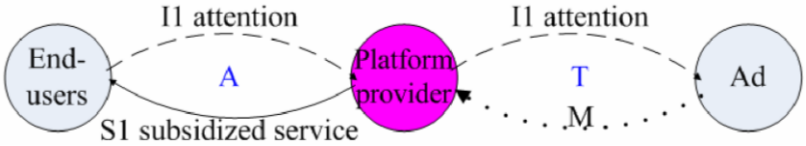

Figure 10: Classical two-sided market model [88]

This model is the classical two-sided market model, in which a platform provider is the intermediary between end users and any providing company that wants to provide their service for the customers.

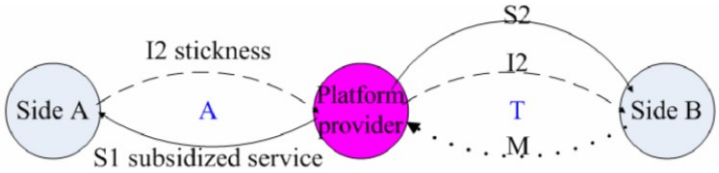

Figure 11: Two-sided market where the intermediary tries to create a stronger appealing for the providing company [88]

In this model the intermediary is trying to bind the customers (who use the platform and the service of the company which is offered on the platform) and makes the big money with the company who wants to offer the service on the platform via a stronger appealing to the customers.

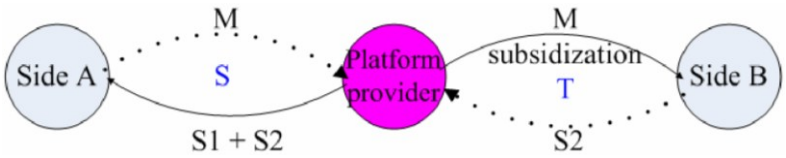

Figure 12: Two-sided market where the intermediary (financially) supports the providing company [88]

In this model the platform provider supports the service of the company which offers the service on the platform because then the platform benefits from great services of this company.

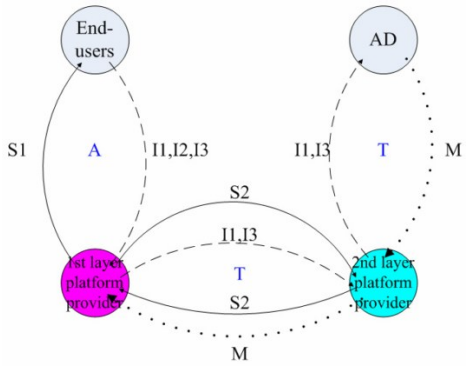

Figure 13: Two platforms exist which support each other [88]

In this model there are two platform providers who support each other. One intermediary is the direct service provider for the customer, whereby the other one is simply his supporter and the primary contact point for the providing company who wants to offer its service on the platform.

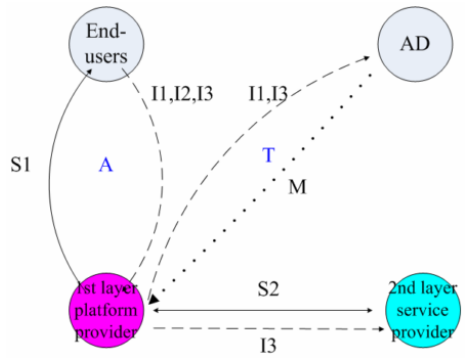

Figure 14: One service provider exists who supports the platform provider, who is the primary point of contact for all entities [88]

This model is similar to the model described before, but now the platform provider is the only contact point for all entities within the market. He makes deals with the providing companies who want to offer their services on the platform, works closely together with a (supporting) service provider and has direct contact to the end customers.

3.2.4. Challenges of Two-sided Markets

According to the paper of Eisenmann, et al. [81] there are many challenges for platform providers, which can - if considered well and early enough - lead to a competitive advantage against other platforms. The challenges are [81]:

1.) Pricing [81]

The platform provider has to find appropriate prices for the services he offers. This is necessary because the actors of both sides need to be satisfied well in such a way that every side will benefit from using the platform.

In many two-sided market scenarios there is a so-called “subsidy side” which is the end customer side and needs to be very large to create value for the other side - the “money side” which has a larger budget and tries to sell its service via the platform to the end customers. The creation of positive cross-side network effects is crucial for the platform provider.

2.) Set Winner-takes-it-all strategy [81]

Each platform provider has to analyze the market he operates in as precise as possible, while the platform provider permanently has to have one eye especially on the competitors. The market has to be analyzed in such a way that the platform provider knows if:

- he is the only one in the market and this is fine
- he is the only one in the market but he needs competitors to reach a higher number of customers in the whole market
- he has to share the market with his competitors in a friendly way
- he has to fight from day to day against his competitors to assert himself on the market

The own strategy has to be well-constructed because the wrong decision can lead to bankruptcy.

3.) Threat of envelopment [81]

There might be the threat that another platform provider enters the market and has similar end customers to the first platform. These two platforms now have the same group of customers, which would not be much if the offered service between the two platforms differ from each other. It will only become crucial for an existing platform provider if the new platform provider offers the same service or even multiple services from which one of them is the same as the own service. He so to say envelopes the existing platform provider. The only way to prevent or get out of such scenarios is suing the new platform provider, changing the own business model, cooperating with the new platform provider or find another platform provider with which together the new entered provider can be combatted.

3.3. Quantification of Value Networks

To understand the subsequent quantification concepts of Value Network, in a first step it is necessary to understand the Five Forces of Porter and the idea behind the gini coefficient.

3.3.1. Excursion: Porters Five Forces

Porter defined five different attributes in his paper [89] which influence an industry and show the profitability of it. Those forces influence the prices, the costs and the necessary investments of the companies within the industry. It is important to understand that each industry and each market shows other structures and consequently also different power levels of the five forces. The five forces are [89]:

- threat of new entrants
- bargaining power of suppliers
- bargaining power of buyers
- threat of substitute products or services
- rivalry among existing firms

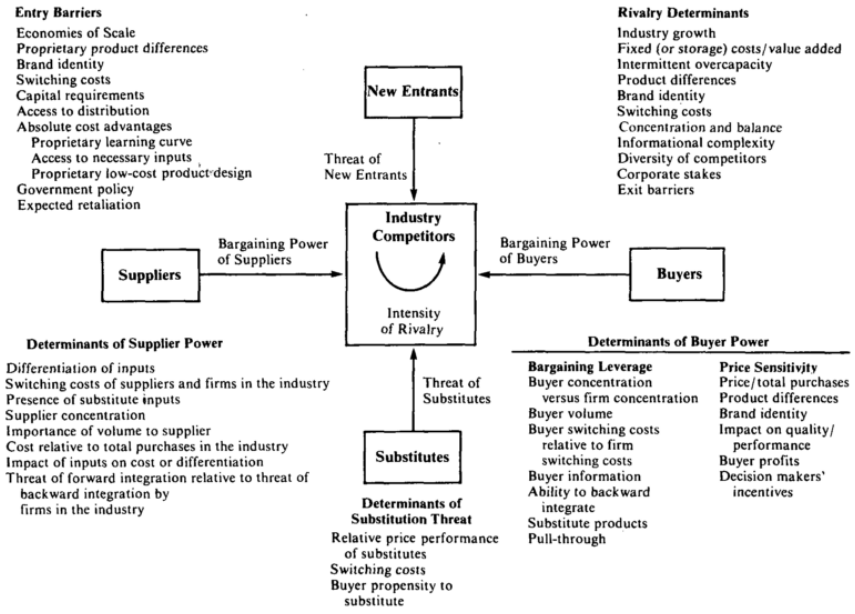

Figure 15: The five competitive forces that determine industry profitability [89]

The aim of each company operating in any industry should consider the above mentioned forces and should align the own business strategy in a way that as many forces as possible can be handled. A company also has to keep in mind that it operates in a market or an industry and when it modifies its own strategy, it has consequences on many other companies operating in the same industrial sector. Those companies may also change their strategy according to the changed strategies of the other companies. In general, a business strategy has to be aligned along the own aims, but also the resulting changes of the competitors have to be considered.

3.3.2. Excursion: Gini index

The gini index or often also called the gini coefficient is a measure which was developed by Corrado Gini who introduced his index for the first time in 1912 in his book “Variabilità e Mutabilità” [90] which stands for Variability and Mutability. The gini coefficient was introduced in the variability part of the book, because this part deals with the measurement of quantitative phenomena [91].

The gini index can be related to the concept of the Lorenz curve which was even done by Corrado Gini in 1914 [92]. Nowadays the Lorenz curve is often used to explain the concept of the gini index via a graphical representation. The basic concept of the gini index looks like followed, whereby in the following example the most popular example, which is simply the calculation of the gini coefficient for the distribution of income within a country, is shown:

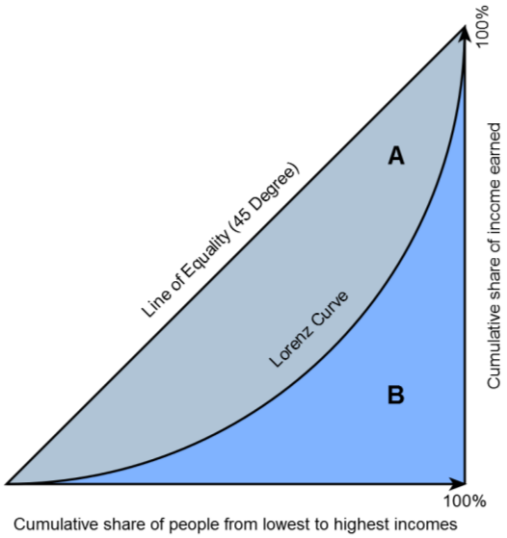

Figure 16: A typical Lorenz curve [93]

The x-axis shows the cumulative share of people from lowest to highest incomes whereas the y-axis shows the cumulative share of the earned income. The gini coefficient can now be calculated by [94]:

$$Gini = \frac{A\text{-}B}{A}$$

Whereas A is the whole area below a perfect equal distribution and B represents the area below the actual distribution [94]. The gini coefficient can also be calculated by simply [94]:

$$Gini = 2*A$$

The gini coefficient can always just take a value between 0 and 1 or sometimes expanded to 0 to 100, which means a value near to 0 is perfect equality while a value which is near to 1 (or 100 on a scale expanded to 100) is nearly perfect inequality [95].

The subsequent graphs show how the gini coefficient would look like depended from different values, whereby G_x always represents the respective value of the gini coefficient for each graph:

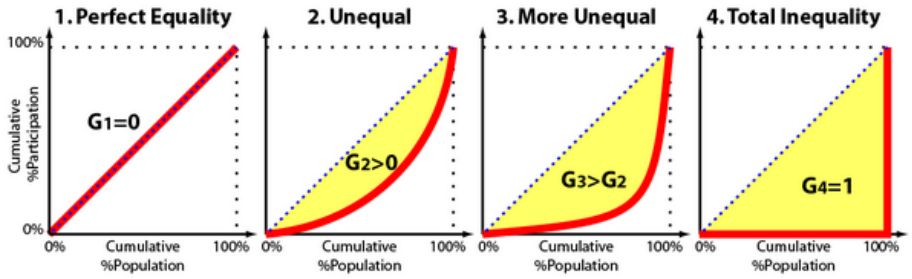

Figure 17: Different gini coefficient values [96]

3.3.3. Quantification of Value Networks with Porter´s Five Forces and Gini coefficient (approach 1)

The base of the discussed approach [97] in this chapter is a Value Network Dependency Model which has six dependency indicators which are calculated for each entity within the model. Five of the six indicators are based on the concept of Porter´s Five Forces which are: bargaining power of suppliers, bargaining power of customers, threat of substitute products or services, threat of new entrants and the rivalry among existing competitors. After the successful calculation the single indicators are aggregated to get an overall entity dependency for each entity within the Value Network. The higher the overall entity dependency of a single entity is, the more likely it will be replaced. [97]

Especially the first three dependency indicators (bargaining power of suppliers, bargaining power of customers, threat of substitute products or services) work with the value of the single incoming (for the bargaining power of suppliers) or outgoing (for the bargaining power of customers) relationships in the first calculation step, whereby for the bargaining power indicators the single values are divided by the overall value of all incoming or outgoing relationships of a single entity. Afterwards the proportions get squared and summed up which leads to the gini coefficient for this actor. Finally, the gini coefficient of this actor is set in proportion to the maximum gini coefficient within the whole Value Network which leads to the bargaining power of suppliers or customers for this actor. In contrast, the dependency indicator on the threat of substitute products or services multiplies the substitution costs (or the substitution effort) for each outgoing activity or resource of this entity with the proportion of the single outgoing relationship proportions which were described before. The final value of the dependency indicator on the threat of substitute products or services is calculated as the difference between 1 and the proportion of the weighted costs of the concerned entity and the maximum weighted costs which exist for one entity in the Value Network. [97]

The fourth dependency indicator focuses on the threat of new entrants and is simply calculated as the difference between 1 and the proportion of the costs for replacing an instance of the concerned entity and the maximum costs for replacing an instance which exist for one entity in the Value Network. The last dependency indicator which is based on the Five Forces of Porter is the indicator of the rivalry among existing competitors. In a first step there is the necessity to multiply all incoming and outgoing relationships with the cardinality to the target-side entity of the concerned entity and building the sum of these products afterwards. The final value of the dependency indicator on the rivalry among existing competitors is calculated as the difference between 1 and the proportion of the weighted cardinality of the concerned entity and the maximum weighted cardinality which exists for one entity in the Value Network. [97]

The sixth dependency indicator is the only one which is not based on Porter´s Five Forces. It is called the resource dependency indicator and should show the flexibility of the resource that is exchanged with the opposite actor. The flexibility factor can have a value between 0 and 1. Money in general is more flexible than other goods and therefore the type dependency factor has the value of 0, whereas goods with a specific purpose which can only be used by or are only useful for one entity have the value 1. In a first step the sum of the multiplied products of all outgoing relationships and the type dependency factor of the concerned entity is built. Afterwards the resource dependency indicator can be calculated as the proportion of the weighted relationship value of the concerned entity and the maximum weighted relationship value which exists for one entity in the Value Network. [97]

3.3.4. Quantification of Value Networks with Porter´s Five Forces and Gini coefficient (approach 2)

Based on the knowledge of the previous quantification concept the authors extended and improved their approach to get an even better quantification approach for Value Networks. The main concepts of this new approach [98] are the dependency of alternatives and the bargaining power.

According to the paper “Of Values and Networks: Designing Quantitative Analysis Methods for Pluralistic Telecommunication Markets” [98] each entity of the Value Network can have none, one or multiple incoming and outgoing relationships which represent the supplier and customer side of this entity and if there exists a relationship to any other entity, this relationship can have one or multiple relationship instances.

It can thus be summed up that a relationship can either be of incoming (supplier) or outgoing (customer) type. The following section will focus on the quantification of all incoming (supplier) relationships of a single entity, whereby all of the following calculations can also be performed for all other entities and also for outgoing (customer) relationships in the same manner. [98]

For each relationship instance an own single utility value has to be calculated, whereby the utility is calculated by:

$$U(j) := [\varphi_j - c_j - i_j] \cdot [1 - \delta_f(j)]$$

whereby ϕ_j is the initial value, c_j are the operation costs, i_j the investment costs and δ_f (j) is the resource type dependency for alternative j. The resource type dependency for alternative j is calculated by

$$\delta_f(j) := 1 - \frac{k(j)}{|M|}$$

whereby k(j) is the number of entities of the whole Value Network to which a resource could be supplied or sold and |M| represents the number of all entities in the Value Network.

After the single utilities for each relationship instance were calculated it is necessary to calculate the proportion of the relationship instances by dividing the utility of a single relationship instance by the sum of all single relationship instance utilities of this incoming relationship.

$$p(j) := \frac{U(j)}{\sum_{k \in \{1,\ldots,n_r\}} U(k)}$$

With decreasing value (= decreasing utility) the interest of the customer should shrink - therefore the sum of all utility proportions is built, whereas each proportion is squared by 3, which means that v in the subsequent formula is 3. The value of 3 was chosen to show the competition between different entities in a Value Network in an appropriate way. This idea comes from the famous gini coefficent and leads to the dependency of alternatives value δ^r_{in}, which is in this case named Gini(r)^v. A general explanation of the gini measure was done in the previous chapter to prevent the disruption of the necessary calculation steps at this point.

$$Gini(r)^v := \sum_{j \in \{1,\ldots,n_r\}} [p(j)]^v$$

The overall utility of a single incoming relationship can be calculated by $U_r(1)$ (the highest single utility of a relationship instance) and the dependency of alternatives indicator δ^r_{in}:

$$U(r_{in}) := U_r(1) \cdot \delta^r_{in}$$

In the next step it is necessary to calculate the proportion of each overall utility $U(r_{in})$ of a single incoming relationship and the overall utilities of all incoming relationships from this entity. All those proportions are subsequently raised by the power of 2 (v=2), because of the gini coefficient approach, and with the sum of all (squared) overall utilities proportions of all incoming relationships, the bargaining power of the supplier side can be calculated. In this case the gini measure is used because of considering the utility distribution of the incoming relationships $U(r_{in})$ and the value of 2 was chosen because the calculation concerns the utility distribution within an entity, in which the competition is always less than the competition between entities.

$$Gini(r)^v := \sum_{j \in \{1,\ldots,n_r\}} [p(j)]^v$$

Furthermore it is necessary to set the bargaining power in relation to the size of each entity, whereby the bargaining power of each entity of the incoming relationships is multiplied by 1 minus the size of the respective entity.

$$Gini(R^{e,\{in\}})^{v=2} \cdot (1 - S^e_{\{in\}})$$

The size of the respective entity is thereby not just any enterprise or market value, but the proportion of the overall utility of this entity and the overall utilities of all entities in the Value Network.

$$S^e_{\{in\}} := \frac{\sum_{r \in R^e_{\{in\}}} U(r)}{\sum_{k \in R_{\{in\}}} U(k)}$$

In the next step the bargaining power of the supplier side is normalized in such a way that the largest bargaining power of the supplier sides in the whole Value Network gets the value of 1 and all the other bargaining power values are calculated again by putting the original bargaining power value of this entity into proportion of the largest original bargaining power value, by which they will receive a value between 0 and 1:

$$\delta^e_s := \frac{Gini(R^e_{in})}{\max_{j \in E}\{Gini(R^{j,in})\}}$$

All the described calculations lead to a bargaining power (or dependency) value of the supplier side of a single entity, whereby the calculations can be performed in the same manner with outgoing relationships instead of incoming relationships for calculating the bargaining power (or dependency) value of the customer side. Finally the normalized bargaining power of the supplier side, the normalized bargaining power of the customer side and the risk factor of one entity can be aggregated and weighted. To give the same importance to every value each factor has to be weight with 1/3.

$$\Delta^e := \sum_{i=\{s,c,r\}} w_i * \delta_i^e$$

3.4. Quantification of Value Networks - Application

The contents of the paper “On the quantification of Value Networks” [97] also included the representation of the functionality of the calculations. For this purpose the domain Video on Demand (VoD) service was chosen, whereas until this master’s thesis the calculations were not yet performed for any other domain. In the Video on Demand case five different entities were built up whereas every entity has a different role in the Value Network. The VoD is the entity that provides the on demand service and is the focal entity in the Value Network together with the end customer (EC). Furthermore the intermediary Network Service Providers (NSP) are also defined within the network, because they are important for the analysis. The VoD entity and the end customer have their own NSP. Between those two Network service providers another entity, the Transit NSP was introduced which is an intermediary of the two Edge NSPs. [97]

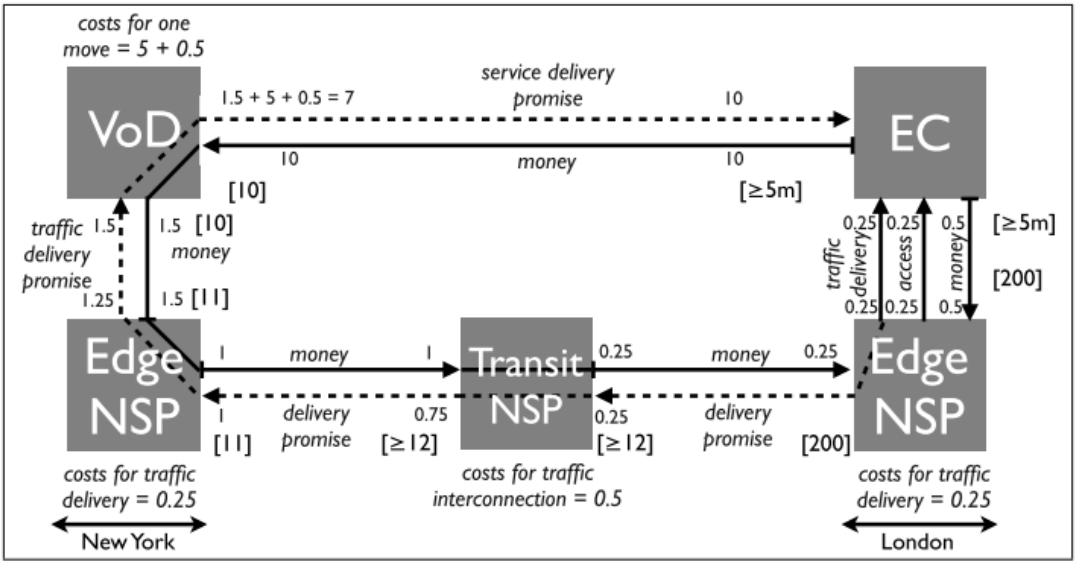

Figure 18: Video on Demand - Value Network [97]

	VoD	EC	Edge NSP (VoD)	Edge NSP (EC)	Transit NSP
δ_1^e	0.85187	1	0.57294	0.61212	0.74923
δ_2^e	0.85028	1	0.57187	0.36658	0.74783
δ_3^e	0.33	0	0.33	0.33	1
δ_4^e	0.66	1	0.33	0.33	0.33
δ_5^e	0	0.99998	0.99999	0.23333	0.99994
δ_6^e	1	0.65079	0.26667	0.11111	0.13333
Δ^e	0.44869	**0.66666**	**0.46747**	**0.31201**	**0.63783**

Table 4: Calculation results of Video on Demand - Value Network (approach 1) [97]

The result of the calculations was simply the above table where each dependency indicator was calculated, so that the single values can be contrasted against each other. In the first row there is the name of the entities, in the following rows the values of the dependency indicators and in the last row the value of the overall (weighted) dependency indicator is stated. The first column actually shows the respective name of the dependency value. In this case the results show the highest overall dependency at the end customers and the Transit NSP. It is pretty difficult to exclude the end customer of the whole Value network because he is the only one for whom the network was built up. Hence the view has to be changed onto the Transit NSP - which leads to the conclusion that this entity might be excluded from the whole Value Network because it is the only entity which has such a high dependency value. [97]

Similarly, the contents of the paper “Of Values and Networks: Designing Quantitative Analysis Methods for Pluralistic Telecommunication Markets” [98] also included the representation of the functionality of the calculations by applying the concept on a case study. The case study was separated into two different cases although both cases built up a Value Network in the Video on demand market similar to the case of approach 1. On the one hand there is a case considered which includes side payments, whereby by definition side payments are payments which are necessary if one side wants more than the other side and needs to compensate those additional wants with money [99]. On the other hand there was a case study created without any side payments. [98]

In the paper “Of Values and Networks: Designing Quantitative Analysis Methods for Pluralistic Telecommunication Markets” [98] an annotation based on the annotation of Casey, et al. [74] was used to draw up the graph of the Value Network.

The whole non side payments case was quantified via different market data which was made up out of classical business metrics. Especially the following metrics were used: market size where each entity operates, average prices for the different provided services and the net profit margin of the involved entities. Furthermore the risk factors were out of scope and were therefore distributed equally to all entities. [98]

	End user	**Content provider**	**Access ISP (USA)**	**Transit ISP**	**Access ISP (UK)**
w/o side payments	0.944	0.766	**0.597**	**0.934**	**0.994**
with side payments	0.942	**0.635**	0.654	0.998	**0.999**

Table 5: Calculation results of Video on Demand - Value Network (approach 2) [98]

For the case with side payments the connections between the different entities were changed, but despite that, the difference between the case without side payments and with side payments was not that great. Especially the Access Internet Service Provider (ISP) who was responsible for the provision of the internet service to the consumer market showed a very high value of overall dependency in both cases, which can be seen in the above table, which means that he has a high dependency on the Value Network and very less market power. Also the Transit ISP showed high values which means also a high dependency on the Value Network for him. The content provider and the Access ISP, who is responsible for the business market, showed normal dependencies, which shows less competition against other companies on their market. [98]

4 PRECIOUS

4.1. Introduction

In the previous section the general ideas and concepts of mHealth and Value Networks were discussed which already gave a clear understanding of certain terms. In the following section I want to describe the essential elements which need to be considered if a preventive mHealth platform should be successful in the long-term. PRECIOUS is a technical-medical research project which is funded by the European Union where eight different organizations of six different countries work together [100]. The participating organizations are universities, small and medium enterprises and hospitals whereby each of them brings different expertise into the project [101].

"PREventive Care Infrastructure based On Ubiquitous Sensing" is the written-out term of PRECIOUS, which means that the main aim of the project is the provision of a preventive health care system which should promote healthy lifestyles [100]. To achieve such a system, the project has the following elements in its main focus [101]:

- Transparent sensors for monitoring user context and health indicators (food intake, sleep and activity) deliver ambient data about current user behavior
- Users are represented by individual virtual models which allow inferring health risk and desired behavioral changes
- State-of-the-art motivational techniques originating especially from gamification and motivational interview trigger as a set of feedback tools to change the user's habits toward more healthy conducts

The PRECIOUS project is especially focused on type 2 diabetes, but because of the preventive focus of the whole project not on people who already have diabetes problems, rather on people who are candidates for a potential risk group [102]. According to the World Health Organization (WHO) type 2 diabetes, which is sometimes also called non-insulin-dependent or adult-onset diabetes, is caused by a disturbing insulin balance of the body [103]. Most of the time diabetes 2 results from overweight, obesity or even physical inactivity [103]. PRECIOUS will deliver a preventive health care system which can also be used for other disease which originate from the form of lifestyle the affected human lives, whereby often unhealthy lifestyles include a wrong diet and physical inactivity [102]. In the subsequent sections the theoretical concepts behind the PRECIOUS project, which are the base of the considerations within the project, are reviewed, which include intrinsic motivation, behavior change and gamification.

4.2. Concepts

4.2.1. Intrinsic motivation

The intrinsic motivation theory is a theory which comes from the psychology domain and tries to analyze the necessary aspects for a human to motivate himself during his work or other tasks, whereby the rewards of intrinsic motivated tasks come from the human himself. It considers reasons like why somebody wants to extend his own knowledge or skills by learning or taking challenges which are new for him/her. Many of the approaches that address intrinsic motivation or the theory behind it, try to move the focus onto the working world, but actually intrinsic motivation can also be identified at non-working tasks, e.g. hobbies. In the existing literature different approaches were reviewed to determine which aspects, factors, conditions or elements support, minimize or even hinder intrinsic motivation. Within the scope of this master's thesis two different theories are reviewed to show their focuses, commonalities and differences between them.

The first reviewed theory is the self-determination theory which was introduced by Richard Ryan and Edward Deci [104]. It actually tries to investigate human motivation and personality and uses well-known empirical methods together with the support of an organismic metatheory which should show the resources of personality development and behavioral self-regulation. Furthermore, the self-determination theory does not only consider the positive factors which influence the intrinsic motivation, but also the possible social environments which may hinder the development of intrinsic motivation. The opposite of self-motivation or intrinsic motivation is the extrinsic motivation theory and especially the self-determination theory studies the type of motivation which may emerge from different factors or social environments. The whole theory is focused on the possible conditions which trigger and preserve such intrinsic motivation approaches. [104]

Ryan and Deci determined three different factors which are the main conditions that have to be created to generate intrinsic motivation: autonomy, competence and relatedness. The autonomy factor is a brick that is included in many intrinsic motivation scenarios. This necessary condition actually only states that the freedom of a human during the execution of his task can create intrinsic motivation whereby strict control and punishment in case of violations of the guidelines may hinder the appearance of intrinsic motivation. Next to the autonomy factor also the competence condition might be conducive for intrinsic motivation. [104]

If a human performs a task and some positive social-contextual events like for example positive feedback may be given to him during the task execution, his intrinsic motivation will rise, because he feels competent in doing his job which motivates himself even more in his current challenges. The relatedness, which is the third condition that has to be enabled for the creation of intrinsic motivation, might not be as clear as the other two conditions. It just relates to the situation when a human performs any task and another superordinate human ignores the execution of this task. Within such a case it seems clear that the human will have less intrinsic motivation than in a scenario where the superordinate human is interested in the performance. [104] The relatedness was also reviewed in a study by Ryan and Grolnick [105] in which they observed much lower intrinsic motivation of students when their teachers conducted cold and uninterested instead of warm and interested in the task the students were performing.

It is important to understand that it depends on the situation or scenario which might be optimized and therefore all three mentioned factors need to be considered in different ways. For example, in some scenarios the creation of an environment with less or even without any autonomy wouldn't be possible and in some other cases intrinsic motivation might only be created with competence and relatedness.

The second theory which will be reviewed within this master's thesis is the drive theory of Daniel Pink [106]. In his book he focuses on the classification of motivation via different motivation levels. The first level of motivation is the motivation 1.0 which simply states the recognition of a human´s biological needs. A human which has a motivation 1.0 will only work to get money for the purpose of buying food and won´t be motivated to reach any higher levels that may be imagined.

Motivation 2.0 is the next motivation classification level according to Daniel Pink which is based on the extrinsic motivation. The so-called "type-X-behavior" should define all behaviors which a human in the second level will adopt. The extrinsic motivation defines that a human can only be motivated by some external monetary or non-monetary incentives to perform his tasks. The human himself thinks that all the tasks which may be motivated by extrinsic motivation are boring and trivial non-self-motivating tasks. [106]

The third level is called motivation 3.0 and is based on the intrinsic motivation which was already stated in the self-determination theory of Ryan and Deci. A human will adopt a so-called "type-I-behavior" to perform the tasks which lead to intrinsic motivation. [106]

Similar to the self-determination theory of Ryan and Deci the drive theory of Daniel Pink introduces three different factors or elements which are necessary to generate intrinsic motivation: self-determination, self-fulfillment and perfection. [106]

The self-determination factor stated in the drive theory is very similar to the autonomy factor which was stated in the self-determination theory of Ryan and Deci. It is important for the human to know that the results matter, while method and time of performing the tasks to achieve the desired results do not matter. Also the inclusion of the management is important in such a work environment because the managers should also only focus on the output, should not give their employees any type of obstacles to restrain the progress and should thereby support the generation of intrinsic motivation. [106]

Self-fulfillment is a factor which differentiates the two reviewed theories because this element is not mentioned by Ryan and Deci in any way. An employee should feel self-fulfilled in the tasks he performs and furthermore there should be a sense behind the tasks he fulfills. Especially in the medical sector many self-fulfillment and sense-maximization jobs are available. The humans who work in this sector have a high intrinsic motivation because next to the self-fulfillment they can help other people and can consequently maximize the sense of their job. [106]

The third element mentioned by Daniel Pink for generating intrinsic motivation is perfection. The employee is highly intrinsic motivated if he is an expert in his domain, because the execution of his tasks is as easier for him as higher his skills are. An employee has to know about and has to get the offer to expand his knowledge and his skills in his current job to get even more motivated trough himself respectively generating intrinsic motivation. [105]

4.2.2. Behavior change

The behavior change technique taxonomy was formulated by a consortium of seven different universities in the United Kingdom [107]. Actually a university project was created to investigate the possible techniques and the main aims of the project were the following [107]:

- the development of a nomenclature of different behavior change techniques for the purpose of deriving complex behavior change interventions
- achievement of a broad acceptance and use to motivate other research facilities to continuous development

The consortium defined overall 93 different behavior change techniques, whereby behavior change technique according to the project was defined as: “By BCT, we mean an observable, replicable and irreducible component of an intervention designed to alter or redirect causal processes that regulate behavior”. [108]

It is important to mention that a single behavior change technique can be used as a stand-alone approach or together with other behavior change techniques to reinforce the desired change. The techniques were clustered within the taxonomy into 16 clusters whereby each of them contained at least three different behavior change techniques. [108]

The paper of Stawarz, et al. [109] reviewed already existing papers which try to analyze if the existing apps in the leading App Stores (Apple App Store and Google Play Store) are already focusing on behavior change techniques or any other form of behavior change. The results were sobering because many of the existing applications do not have any type of scientific behavior change background or any other theoretical base as their strategy for the user. The paper states that the apps have to create a habit through the use of it, which means a “consistent repetition of a behavior in the presence of stable contextual cues that increases the automaticity of that behavior” [110] or in other words once a person makes a decision to change its behavior and takes action, that action needs to be regularly repeated. [109]

Furthermore the existing apps - even the behavior change focused ones - have no theoretical fundament of habit creation, but are rather focused on the tracking of many different types of activity metrics of the user. [109]

Functionality	Habit formation elements	Behavior change techniques	Examples apps
Task tracking	-	Self-monitoring, Feedback on behavior	Daily Habit[a]
Reminders	-	Prompts / cues	Healthy Habits[i]
Graphs & stats	-	Feedback on behavior and its outcomes, Self-monitoring	Way of Life[i]
Goal setting	-	Goal-setting	HabitFlow[a]
Calendars	-	Feedback on behavior, Self-monitoring, Goal-setting	Habit Calendar[a]
Goal progress tracking	-	Feedback on outcomes of behavior, Self-monitoring	Strides[i]
Rewards / points	Positive reinforcement	Rewards & incentives	Habit RPG[ia]
Notes	-	Prompts / cues	Any Habit[i]
Habits library	-	Goal-setting, Action planning	The Fabulous[a]
Pictures	Cues	Positive self-talk, Rewards & incentives, Prompts / cues	The Habit Factor[ia]
Motivational quotes / own statements	Positive reinforcement	Positive self-talk, Rewards & incentives	Good Habit Maker[i]
Peer support / feedback	-	Social support, Feedback on behavior	Lift[ia]
Visual cues on home screen	Cues	Prompts / cues, Feedback on behavior	3 Week Habit[a]
Routine creation	Implementation intentions	Action planning, Goal-setting	Habitual Free[i]

Table 6: Apps functionality with corresponding elements of habit formation, behavior change techniques, and examples of apps that provide such functionality [109]

The table before should show that even the term “Habit” in an app’s name does not necessarily mean that there exist any habit formation elements. Only a few classical functionalities of health and fitness apps include habit formation elements. This lack has to be the focus when designing apps in the future to ensure that any behavior change intervention, which should be trigged through the app, will have effects in the long-term [109].

4.2.3. Gamification

4.2.3.1. Basics

According to the paper “From Game Design Elements to Gamefulness: Defining “Gamification”” [111] the term gamification stands for “the use of game design elements in non-game contexts” [111].

Nowadays gamification is used in many different areas and domains. The term has its origin in the digital media industry and was first used in 2008 [111]. There are actually two main causes why gamification has become popular within the last years [111]:

- The increasing use of (video) games in the life of every human
- Different elements of (video) games have the possibility to make non-game products and services more enjoyable

Gamification is a form of service packaging in which a core service is enhanced by a rules-based service system that provides feedback and interaction mechanisms to the user with an aim to facilitate and support the user’s overall value creation [112]. The term rule-based systems is used in the definition above because Cook defined game mechanisms as: “rule based systems / simulations that facilitate and encourage a user to explore and learn the properties of their possibility space through the use of feedback mechanisms” [113]. Those companies that figure out how to effectively use gamification to amplify the intrinsic motivation of their employees, fans, and customers will have a lasting competitive edge in their markets [114].

4.2.3.2. Application in health apps

The purposes of the study of Lister, et al. [115] were to review 132 free health and fitness apps from the Apple App Store regarding elements of gamification, to determine the relationship between health app use of gamification and core elements of effective games, and to determine the extent of apps with gamification elements that contain critical health behavior constructs.

The authors of the paper identified six different core components of gamification for health apps: (1) leaderboards, (2) levels, (3) digital rewards (points, badges), (4) real-world prizes, (5) competitions, and (6) social or peer pressure. The findings of Lister, et al. included, that developers and health practitioners who try to influence behavior change and health outcomes should consider comprehensive integration of behavioral theory, independent of whether or not games or gamification is being used. [115]

4.2.3.3. Criticism

Deterding, et al. has found three different elements which are often missing when discussing the term gamification or analyzing implementations that consist of gamification aspects [116]:

1.) Meaning: The gamified implementations have to include elements which are already meaningful to the user or which make the user think they are meaningful

2.) Mastery: The user has to achieve something that makes him happy and proud of himself

3.) Autonomy: A sort of freedom or a free space for creativity has to be included in the gamified implementations

Robertson states in her article [117] that “Games are good, points are good, but games are not equal with points”. She actually means that many games include a point system, but those point systems are not the elements that constitute a game. They are actually just a small element with little importance in a game and hence just offer upwards escalation. Without any pain in the case of a loss such point systems mean far less for a user who plays such a game. She went as far as to say that gamification is not the correct word for the purpose the term should express, so she introduced the term pointsification for applications who are just enhanced by point or similar reward systems in the classical gaming world. [117]

4.2.3.4. Examples

The Starbucks corporation, which is an American coffee company and famous for their coffeehouses, have been selling their products with gamification elements for years in their “My Starbucks Rewards” customer relationship program. Every time a customer buys a specific Starbucks product he gets so-called stars which he can collect for himself to enjoy free drink and food rewards. The customers have the possibility to earn stars by either paying their food and drinks they bought in a Starbucks coffeehouse with the Starbucks card or the mobile app. This special payment form is needed to identify the customer and assign the stars to him. [118]

Another way of earning stars is through buying Starbucks products in a normal grocery store or buying coffee or tea products at the Starbucks online store. For those two scenarios it is also necessary to identify the customer, whereby in the grocery store the customer must only enter a star code (which is printed on the bought product) in his Starbucks online account to assign the earned stars to him and in the Starbucks online store he has to log into his user account before buying any products. [118]

For strengthen the gamification aspect within the Starbucks business they introduced different star levels, whereby a higher level offers better rewards [118]:

1) Entry level: Welcome level
   This level is simply offered to customers when they register a Starbucks card - from now on the customer can be identified and the earned stars can be assigned to him. In this level he gets the following rewards:
   - Birthday drink or treat on us
   - Birthday coupon for 15 % off a purchase at Starbucks Store online
   - Custom offers via email

2) Intermediate level: Green level
   This level can be achieved by collecting at least five stars in a single year, whereby in this level the customers gets (additional to the rewards of the "Welcome level") the following rewards:
   - Free in-store refills on hot or iced brewed coffee and tea

3) Master level: Gold level
   This level can be achieved by collecting at least 30 stars in a single year, whereby in this level the customers gets (additional to the rewards of the "Welcome level" and "Green level") the following rewards:
   - A free food or drink item after another 12 Stars earned
   - A personalized Gold Card

The business benefit for Starbucks is that customers are motivated to buy more and more Starbucks products over a longer time period, because if they stopped buying the products they would fall back to the lower level and lose the possible rewards whether or not they have consumed their rewards.

Also in the mobile app world, next to the classical game apps, many gamified apps emerged in the last years and some of them are even focused on the health sector [119]. An example of such an app is Mango Health [120] [121], which can be downloaded from the Apple App store or the Google Play store and is assigned to the health & fitness category. This app supports humans who have to take in their physician-directed medications in regular intervals. The most important offers are the reliable medication reminder, the daily health diary, the drug interaction warnings and the timely refill alerts [120] [121].

The gamification aspect of the Mango Health app can especially be observed at the reliable medication reminder feature. If a human sticks to the regular time intervals of his medication intake he earns monetary rewards which should motivate the user to take his medications and to generate a habitually and naturally behavior. The whole app is based on notifications and when the physician-directed medications are taken within a specific time window the user will even earn greater rewards. It is important to know that the user won´t get any money although he gets monetary rewards. The earned rewards can be used for example gift cards or donations to charity organizations. [120] [121]

4.3. HealthCOIN

HealthCOIN is a theoretical business concept for a health currency, whereby the main target of the business model is the usage as a currency for digital services and especially the preventive healthcare platform business on which the PRECIOUS project is focused on. Next to this project the whole concept can also be adapted as a currency for any other e-Health applications. In general many of the current membership point systems - which are often part of a customer relationship program - were designed to meet the following two cases: points usable for purchases and points as activity indications, whereby those two cases can also be identified in the e-Health application market. In contrast to many other industries, the e-Health application business has to focus even more on the end user because his sensitive data is used and his overall condition and needs have to be monitored permanently. Next to this aspects also the involvement of domain experts is essential and an important success factor to create reasonable and useful business cases. [122]

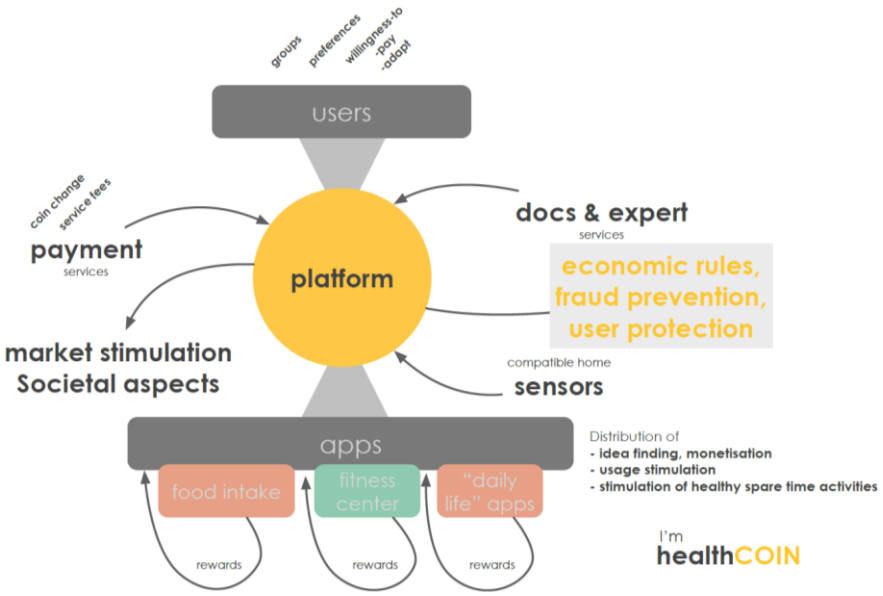

Figure 19: HealthCOIN business model [122]

The platform which connects the end users with other stakeholders, for example app developers or service providers, is the main element in the healthCOIN business model. All the users which use healthCOIN as a currency within the e-Health application business should be protected through the platform from any fraud or other threats which may emerge. [122]

HealthCOIN was designed with the support and the experience of already existing and established currency concepts and hence also the healthCOIN business model includes two different metric types [122]:

1.) Activity coin (non-monetary)

Each activity which was executed by the end user will be rewarded with activity coins, but when the user reduces his activity level the activity coins will become less over time. For the comparison with other users, which also use a healthCOIN based app platform, the platform provides a social comparison feature with which users can compare with each other. The whole concept of activity coins should motivate the users to increase the number of activities they conduct, whereby the coins cannot be used to buy any sort of digital or physical product or service. Activity coins are thus just a progress metric which should show the user his own achievements as against the other users.

2.) healthCOIN (monetary)

healthCOIN per se is a virtual currency and is actually the main monetary metric of the healthCOIN business model. A virtual currency is defined as “a type of unregulated, digital money, which is issued and usually controlled by its developers, and used and accepted among the members of a specific virtual community.” [123] According to the ECB there exist three different types of virtual currencies [123]:

type 1) closed virtual currency schemes (can only be earned through activity - used in playing online games)
type 2) uni-directional flow virtual currency schemes (only the purchase of the virtual currency with real money is possible and the purchase of a selection of specific digital or physical products or services)
type 3) bi-directional flow virtual currency schemes (buying and selling the virtual currency is possible and thus the purchase of any type of digital or physical products or services is possible)

The healthCOIN currency can be understood as a type3 virtual currency according to the definition of the ECB. healthCOIN is simply an equivalent to real money, which can be increased by a real money investment via for example a credit card or via rewards, which have been achieved through an app. Every app of the platform can be bought with the healthCOIN currency, whereby also non-digital health services, e.g. fitness studio fees (if there exists any contract with them), can be bought with it. The healthCOIN currency in contrast to the activity coin currency will not decay. healthCOIN is thus a virtual currency similar to a real world cash which can be used for purchasing a selection of specific digital or physical products or services. If the healthCOINs are payed out in real money - which is possible - the user can indirectly maximize his real money just through the exercise of healthy activities and a strict diet. With real money he can of course purchase any digital or physical products or services. [122]

5 Preventive user-centric mHealth Value Networks

5.1. Introduction

The previous sections gave a clear understanding of Value Networks and mHealth, but at this point the term “pucHealth” is introduced which stands for “preventive user-centered health” and is a not yet existing term based on the mHealth term. The main aim of this term is to extend the perspective in two ways above the existing mHealth approaches because most of the time those approaches are focused on the mobile technology behind.

The first perspective extension is necessary to focus on the customer or end user who uses the product. This actor is the most important one in the whole approach and needs to receive the value of a healthcare system [124]. It should always be the main aim to maximize his well-being. Some years ago pharma companies still had their focus on prescribers, but in the last years they changed their strategies and now focus on a patient-centric approach [125]. In none of the mHealth definitions which were mentioned in a previous chapter the customer / end user was mentioned in any way, whereby he is the only one who can assess and control the access of a mHealth environment. It makes few sense that a health institution introduces a new mHealth system, while no non-medical person is using it.

The second perspective extension is necessary to sharpen the focus on preventive care. Many of the existing healthcare approaches focus on reactive healthcare, which means any type of health is provided when the patient is already sick. The pucHealth approach should focus on humans who are still healthy and are provided with wellbeing activities to keep their healthy state as long as possible. Therefore, like in the first perspective extension, the main actor is not anymore a named patient, rather a consumer or end user. People who are sick or who are already provided with healthcare are already treated, but people who are healthy are nowadays not “treated” to stay healthy.

On the healthcare market some companies like Pfizer and Philips already offer value-based services which have a patient-centric focus [124]. Those solutions are only focused on patient monitoring and patient treatment whereby both categories assume that the end customer is already a patient or in other words is already sick. The preventive, user-centered and mobile healthcare sector does not really show any practical examples according to pucHealth yet.

When looking up the roadmap for scaling up a heart monitor which is an illustrative example of a mHealth application of ATKearney [34] it has to be mentioned that a pucHealth mobile application will concentrate on the “WELL” and “UNWELL” section on the right bottom. Each other state within the app is especially designed for patients and not for customers or end customers. With such a non-preventive app design it is assumed that the patient will get sick at any time which is not a good sign for an app which should care about the health of the end user.

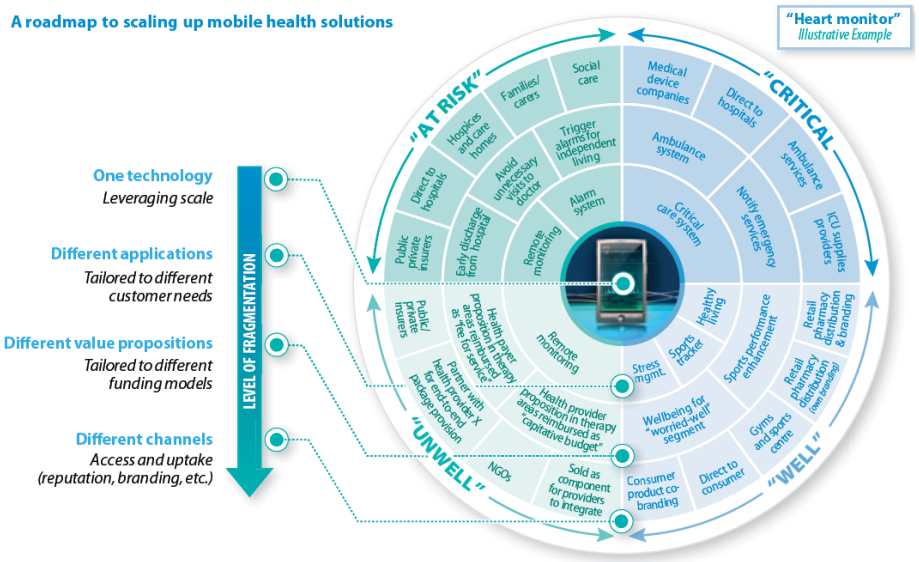

Figure 20: A roadmap to scaling up mobile health solutions [34]

Equipped with the knowledge of the pucHealth term, the subsequent sections will set up the corresponding Value Networks, quantify and analyze them, and will finally derive effective treatment recommendations for the involved business actors to improve their position on the respective market.

5.2. Design Decisions

In a first step it is necessary to understand the mobile health market itself and the whole market structure, which includes the involved business actors and the necessary business interactions between them. As the mHealth market itself was described in detail with all his benefits and limitations in one of the previous sections, I now have to determine which part of the market I want to analyze, because it is nearly impossible to describe and analyze each detail of such a market. I decided to concentrate on the mHealth platform market, because this market has not got enough attention so far, although the mHealth market as a whole is related with high economy expectations [8] [9] [10]. The mHealth platform market is hence a very important part of the whole mHealth market and since I assume that the mHealth market can´t exist in the long run without any special mHealth platform I have to analyze this market sector.

The mHealth platform market as part of the mHealth market is actually a market on which a single business actor, e.g. a company, has the overall control of a mHealth platform and has to interact with a number of other business actors to get his business done, whereby his primary business is the supply and distribution of mobile applications (apps) to users of any type of mobile device. This complex business structure leads to the assumption that especially the approach of Value Networks is suitable for such an environment to get a holistic view and the possibility to analyze the market in a comprehensive way.

Based on the previous abstracts I can derive that the mHealth platform market has to include any type of user or end customer who uses the platform and is motivated to use the platform because he receives a specific value or added benefit by using it. Since healthcare in a country is a public topic in general which has to be considered by the public institutions, it can be assumed that, like in many other business sectors or markets in which citizens are included as business actors, also on the mHealth market there is the possibility to identify a public-funded, but also a private-funded market or even a mixture of both.

To get a clear understanding of the possible market types the deliverable 2.2. called “Interim report on socio-economic factors and business models” [122] of the PRECIOUS project [100] gave a starting point of the whole knowledge acquisition. In this deliverable a basic draft of such mHealth platform market structures was built up whereby they were only graphically represented in form of a model via the graphical annotation for Value Networks of Casey et al. [74], but no further quantitative or qualitative analysis was made so far which needs to be done to get a clear understanding of the proposed market architectures. Furthermore a quantitative and qualitative analysis is necessary to assess if the described drafts are realistic or if they are simply imaginary and could never exist in reality.

For a detailed analysis of the mHealth platforms market it is necessary to decide with which graphical annotation and quantification approach such a market can be analyzed in an appropriate way. The quantification approach of Peter Reichl and Patrick Zwickl which is described in the paper “Of Values and Networks: Designing Quantitative Analysis Methods for Pluralistic Telecommunication Markets” [98] will be used, since it is a feasible approach for many different - especially digitalized - market structures and thus also the structure of the mobile health market can be quantitatively analyzed with this underlying approach.

Since the authors of the previous mentioned paper only address the quantification aspect of Value Networks for a graphical representation of the respective Value Network, the annotation of Casey, et al. [74] will be used, because it has a hand full of useful annotation elements and offers the possibility to visualize the mHealth platform market in a neatly arranged way.

As already described in one of the previous paragraphs the base of a possible mHealth platform market architecture was the PRECIOUS project [100] and therefore the proposed market structures have to be analyzed in detail to get a better understanding and to see if the concepts can be valid. Therefore the paper of Glova, et al. [126] which is called “Business Models for the Internet of Things Environment” has been used, which especially helped to get an overview of the involved business actors and their business interactions to other business actors on the market.

The benefit of this paper was, that the mHealth platform market was discussed within the paper with the concept of Value Networks, whereby the authors used the Value Networks model framework approach of Gordjin and Akkermans, the so-called E3-value model framework [64], which was described in one of the previous sections of this master’s thesis. Like already mentioned before, the paper supported the whole design of the mHealth platform market because it engaged with the same topic, but from another perspective. The main aim was to check the usefulness of the E3-value model framework for an Internet-of-Things market structure and that´s why the mHealth platform market was chosen, since it is a modern market with many different business scenarios regarding the Internet-of-Things trend.

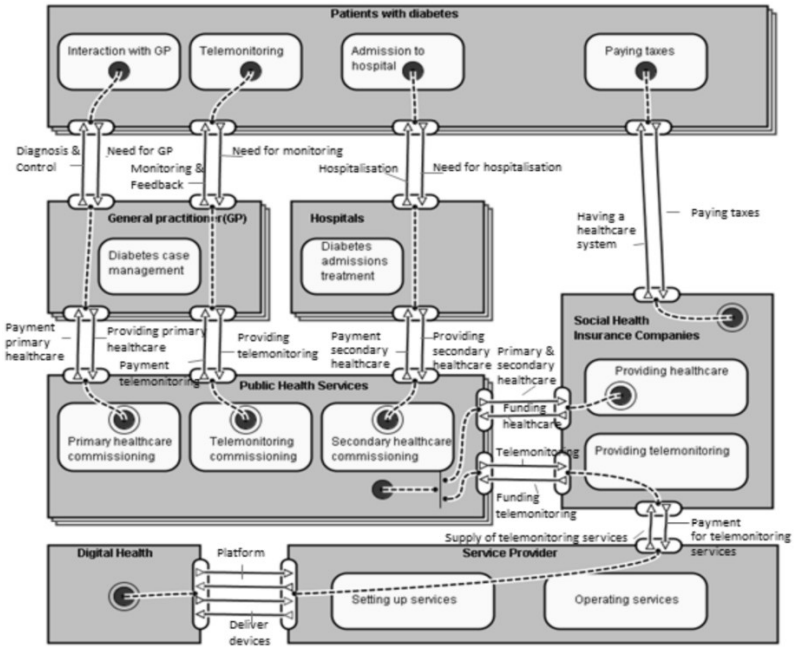

Figure 21: Tele-HealthCare System - Value Network [126]

To deeper the analysis of the proposed market structure of the PRECIOUS project [100] a number of other sources [19] [25] [34] were scanned to get further sources of possible market constellations in the mHealth business. The starting point of those analyses was the classical healthcare market which was simply extended by the actors which are additionally involved in the mHealth market. This further analysis has led to the following table, in which the classical healthcare ecosystem is compared with a mHealth ecosystem, with what the involved actors are changing because new actors need to be added to the market:

Classic healthcare [34]	**mHealth ecosystem [19] [25]**
Employers	Employers
Government agencies	Government agencies
Healthcare institutions	Healthcare institutions
Insurance companies	Insurance companies
Non-governmental organisations	Non-governmental organisations
Patients/Consumers	Patients/Consumers
Payers	Payers
Pharma companies	Pharma companies
Pharmacies	Pharmacies
Primary care providers	Primary care providers
Research institutions	Research institutions
Secondary care providers	Secondary care providers
Social services	Social services
-	Hardware companies
-	Internet service providers
-	Medical device wholesalers/retailers
-	Software companies
-	Telecommunication service providers

Table 7: Actors of the classical healthcare market vs. Actors of a mHealth ecosystem

In an overall view the whole mHealth market consists of six market segments where each of the above described actors can be categorized: hardware, software, services, sales, transaction and promotion [28]. It has to be in mind that each of the actors of the table above can be categorized into multiple market segments. For example a pharma company can operate in the sales segment, selling its own products, as well as in the promotion segment via promoting its own products.

With all those analyses of possible issues in the proposed market structures of the PRECIOUS project [100], it can be summarized that the Value Networks which were described in the deliverable [122] are suited to use in a quantitative analysis of the mHealth platform market since all of the described business actors and the corresponding business interactions have been rediscovered in any of the sources which were additionally analyzed. In general the study of the mHealth platform market of this master's thesis will hence use the "Private app store value network" and the "Public insurance healthCOIN value network" market models which are described in the deliverable [122] of the PRECIOUS project [100], but to get an even clearer understanding of the single business actors some business actors are split into two business actors because it makes the quantitative analysis even better. Who of the discussed business actors will be affected of such a split, will be revealed in the next sections.

5.3. Quantification

5.3.1. Private mHealth platform Value Network

The "Private mHealth platform Value Network", which is based on the "Private app store value network" of the deliverable [122] of the PRECIOUS project [100], is the first Value Network which will be graphically developed, afterwards quantified with market data and finally the outcomes of the quantification will be analyzed. It is important to understand that the whole use case is based on global market data, so each number or used key figure represents the whole world.

The term "Private" in the name of the mHealth platform Value Network refers to the form of funding of the whole market. In the private industry there are no public financing operations and thus only private companies operate in such a market. The subsequent figure should show how the model of a mHealth platform market would look like if the Value Network notation of Casey, et al. [74] was used:

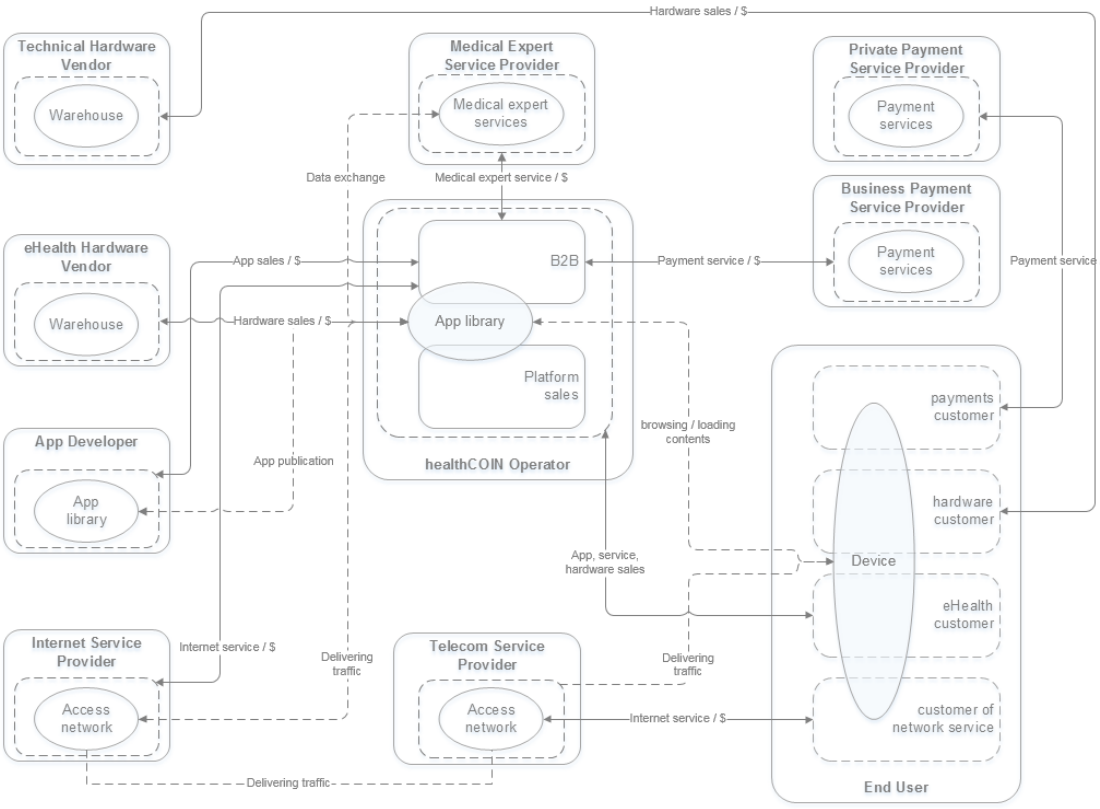

Figure 22: Private mHealth platform Value Network (based on "Private app store value network" [122])

Each business actor in this market structure is from now on either called actor or entity and has relationships or interactions to the other entities. The term of an entity and a corresponding relationship is similar to the terms in entity relationship diagrams (ER-diagrams), which are used in modeling relation databases. The single elements in such a graphical representation of Value Networks according to Casey, et al. [74] are:

- Solid rectangular boxes: actors or entities, which play one or more business roles
- Dashed rectangular boxes: business roles
- Solid edges: business interactions between two roles
- Ellipse: technical components
- Dashed edge: technical interaction between two technical components

In the following sections each actor in the Private mHealth platform Value Network will be analyzed and quantified with market data, whereby the market data which is used is based on the years 2013, 2014 and 2015 since some parts of the required data have not been collected every year.

Especially for the quantification it is necessary to calculate the following key figures:

- the global market size of the market in which the actor operates, which is defined by the overall market revenue
- the number of the operating companies on the particular market, which are represented by a single actor, to determine how many relationship instances can exist between two actors
- the average price of a product or service which is sold to another actor to calculate the utilities of the relationship instances to other actors
- the average net profit margin of each actor which is needed to calculate the utilities of the relationships instances to other actors

All these key figures are necessary to fill the quantification model of Peter Reichl and Patrick Zwickl which is described in the paper “Of Values and Networks: Designing Quantitative Analysis Methods for Pluralistic Telecommunication Markets” [98].

The first actor who will be analyzed and quantified is the healthCOIN operator, since he plays a major role in the whole Value Network because the bulk of the relationships between the actors have its source or destination at the healthCOIN operator. Although the end user also plays a major role in the whole Value Network he will be the last actor who will be analyzed, because since he has many relationships to the other actors, those actors have to be described before to understand his role in the whole Private mHealth platform Value Network. The end user is the only actor who will be quantified in the quantification model by only two of the four above described key figures: the global market size and the number of humans which are represented by the end user actor. The average price and the average net profit margin doesn´t have to be calculated since the end user can´t be quantified with those two key figures, because he does not offer any type of product or service to the other actors.

Next to the quantification of each actor the description of the existing relationships will be done in each section, to understand which interactions an actor can have to the other actors of the Private mHealth platform Value Network, whereby each relationship will always be described from the perspective of the actor who provides a product or a service, but not any form of payment, for the other actor. It has to be understood that the analyzed Value Network is only a model of the reality and should show the most important relationships when analyzing a mHealth platform Value Network. In reality an actor in such a market constellation has a few more relationships to other actors. Also further relationships to external actors which are not considered in the Private mHealth platform Value Network are not modeled or described clearly.

5.3.1.1. healthCOIN operator

The healthCOIN operator is the actor who runs the mHealth platform and is thus the central actor of the Value Network. To understand this privately funded actor as a whole it is important to understand which type of platform he provides. The mHealth platform in the Private mHealth platform Value Network is simply an app platform where an end customer can connect to and download specific healthcare apps which are designed for preventive healthcare issues. The apps will work together in such a way, that results achieved in one app can be transferred to another app and furthermore the whole healthCOIN concept described in a previous section will be included in the mHealth app platform with which the approaches of intrinsic motivation, behavior change and gamification should be integrated into the platform.

An end customer or a user of the apps won´t be a patient who is currently treated by any healthcare institution or clinic - the necessity and the causes of this restriction are described in the pucHealth section. The focus of the mHealth app platform is thus on healthy humans who want to sustain their healthy lifestyle or even improve their life through a healthy diet or physical activity. With such an mHealth app platform it is possible to reduce the number of diseases which are caused by the higher proportion of the intake of unhealthy food and the unhealthy life environments because of the increasingly sedentary workplaces in some jobs and the human-inactivity-form of transportation nowadays [5].

The healthCOIN operator can thus be compared with the operator of an app platform like Apple who operates the Apple App Store or Google who operates the Google Play Store, whereby the app platform of this master's thesis will especially focus on healthcare issues. It is therefore a helpful tool to analyze the medical and health & fitness categories of the currently existing app stores to understand those market segments in a possible healthcare-focused app store.

Based on the number of available apps, globally there are five large app stores currently [43], whereby especially the Apple App Store and the Google Play Store are in the lead and fight against each other for the first place. The worldwide number of five app stores will also be used as a representation of the number of companies which are represented by the healthCOIN actor in the Value Network. Currently the Apple App Store is in the lead regarding the overall app revenue and the Google Play Store is in the lead regarding the number of available apps [43] [127]. Each of these companies is tight behind the respectively other company when looking on those two measures.

In 2014 together those two major players achieved a revenue of about $ 35.4 billion through their app stores, whereby from Q1 2014 to Q4 2015 the revenues of the Google Play Store more than doubled and the revenue of the Apple App Store nearly doubled too [127]. Analysts currently try to figure out at which stage the Google Play Store will overtake the Apple App Store regarding the earned revenue since they wonder why Apple isn´t in the lead, although they offer a higher number of apps. The analyses show that the revenue-based position change - which means that the Google Play Store will earn a larger revenue from app sales than the Apple App Store - will occur approximately in the mid of 2018 [127].

By July 2015 these two app stores had about 3.1 million available apps and the subsequent top app stores, which are the Amazon Appstore, the Windows Phone Store and the Blackberry Store, together had about 870 thousand available apps by July 2015 [43]. When putting together all those numbers of apps, there were about 4 million available apps in the five globally leading app stores by July 2015. In a next step it is now necessary to understand how many of those apps are related to or categorized into the medical and health & fitness sector.

Since the Apple App Store and the Google App Store amount for about 77.5 % [43] of all apps in the leading app stores, those two app stores are used to analyze how many apps exist in the medical and health & fitness sector.

	Health & Fitness category	Medical category	Overall
Apple App Store [128]	43,050 (2.87 %)	30,450 (2.03 %)	1,500,000
Google Play Store [129]	48,640 (3.04 %)	23,711 (1.48 %)	1,600,000
Summarized	91,690 (2.96 %)	54,161 (1.75 %)	3,100,000

Table 8: Absolute and relative number of apps in each category and overall per app store

It is especially interesting how many apps in the medical and health & fitness sector exist overall and therefore the numbers of the two leading app stores are used for an approximation. The above table shows that on average 2.96 % of all apps of an app store are apps which relate to the health & fitness category and on average 1.75 % of all apps relate to the medical category, which leads to a summarized value of 4.71 % of all apps and, projected to the top five leading app stores, to a quantity of about 187,000 apps.

The whole mHealth app market is often ascribed a high business success and high revenue expectations [8] [9] [10] since the apps in this business sector are supposed to show higher average app costs than apps of other app categories. Once again the medical and health & fitness category of the Apple App Store and the Google App Store are used to get an overview of this claim.

	Health & Fitness category	Medical category	All categories
Apple App Store [130]	$ 3.36	$ 8.71	$ 4.84
Google Play Store [129]	$ 3.31	$ 9.80	$ 3.53
Average	$ 3.34	$ 9.26	$ 4.19

Table 9: Average app price per category and overall

The claim can only be confirmed for the medical category, because this category shows a higher average app price than the overall average app price of all categories for the Apple App Store as well as for the Google Play Store. When summing up the health & fitness category together with the medical category the overall average app price of $ 6.30 will also exceed the average app price of all app categories, by which the claim can be confirmed.

For the detailed quantification of the healthCOIN operator it is necessary to analyze the overall market size - actually the overall market revenue - of the mHealth app market since this market represents the market in which the healthCOIN operator operates. There exists a number of different estimations about the overall mHealth market revenue and the mHealth app market revenue and therefore the overall mHealth market revenue estimations are adjusted in an appropriate manner according to Markets and Markets, who say that only 18.8 % of the mHealth market revenue will account for mHealth apps [131]. Because many different revenue estimations exist, an average of the subsequent revenue estimations of 2014 will be used to calculate a more realistic market value.

Research2Guidance [26]	$ 4.00 billion
Markets and Markets [131]	$ 2.06 billion
PWC [8]	$ 0.78 billion
ABI Research [132]	$ 0.94 billion
CSMG [132]	$ 0.86 billion
Juniper Research [132]	$ 0.34 billion

Table 10: mHealth app market revenue estimations of 2014

On average a market revenue potential of $ 1.497 billion is estimated which will be used as the quantification value of the mHealth app market. In the quantification model it is further necessary to consider the average price which a healthCOIN operator requests for using an app of the healthcare-related app store. This price will be an average of the average app prices for health & fitness and medical apps of the Apple App Store and the Google Play Store, which are described in a previous table, which leads to a price of $ 6.30 for a single app.

Finally it is necessary to calculate, which amount of this app price the app store provider - in my case the healthCOIN operator - can retain and which amount he has to give to his partners who support him in operating his business. It is well-known that Apple and Google, but meanwhile also other app store providers, give 70 % of the app price to the respective app developer, whereby 30 % is kept [133] [134] [135] [136]. This share is not directly running into the cash of the app store provider because he still has to pay his partners who provide the technical infrastructure behind the app store or payment providers who only offer him the possibility to accept different payment methods. The true value which such an app store provider can retain of an app sale will never be uncovered, but estimations of the Apple App Store show approximately how much Apple can keep of his app price. The gross profit margin of Apple for his App Store lies somewhere between 14 % and 22 % [137] [138], depending on the observed year, whereby I will use the mean value of 18 % which leads to a net profit margin of about 9 % according to the overall net profit margin of Apple, since the overall gross profit margin of Apple amounts 37-40 % [139] and the overall net profit margin is about half of it. With those numbers it can be concluded that the app store itself doesn´t contribute very much to the overall revenue of Apple. In 2010 some market analysts stated that an app store is a poor business since the Apple App Store only contributed about 1 % of the overall gross profit of Apple [138].

Before one of the other actors is described in detail, the relationships in which the healthCOIN operator is involved will be analyzed. Since the healthCOIN actor only has one business interaction with which he provides something, only this single relationship will be considered. All the other relationships are simply those, in which the healthCOIN operator uses a product or service and pays for this usage, with what those interactions can´t be classified as relationships in which the healthCOIN operator provides something to others. In those relationships, most of the time the healthCOIN operator acts as intermediary between the other actors and the end user since he provides and operates the mHealth platform.

The only relationship which has to be described in this section is hence the interaction with the end user, which includes the provided products and services of the healthCOIN operator for the end user. Those products and services are: the healthcare app from the mHealth platform, the corresponding healthcare service (including also the medical expert service) and possibly the sale of a hardware device. The first two offerings were already described before, whereby the hardware device is a new offering which was not yet mentioned. The healthCOIN operator offers a selection of healthcare specific mobile hardware devices for the end user, whereby the focus is on wearables since most of the end users don´t own such a device yet because they have had no specific use case so far. Other types of mobile hardware devices like smartphones or tablets are not offered by the healthCOIN operator since I can assume that most of the end users already have such a device and it would be very expensive for the healthCOIN operator to act, next to the role of a mHealth platform operator, also as a large hardware device supplier with a broad range of products. An end user has to pay the sales price of the chosen app of the mHealth platform in exchange for using the healthcare app together with the corresponding healthcare service, whereby the sale of a wearable will be charged additionally.

In the next sections the other actors of the Private mHealth platform Value Network are described and quantified to fill them into the quantification model. Furthermore the relationships between the other actors and the healthCOIN operator or other actors of the Value Network are illustrated and analyzed.

5.3.1.2. App developer

The app developer is an actor in the Private mHealth platform Value Network who supports the healthCOIN operator in doing his business. Of course the app developer actor is not a single person, but rather a number of different app developing companies or single app developers who together represent this actor. Globally there are about 630,000 app developers whereby alone 565,000 of them are developing apps for the two leading app stores, the Apple App Store and the Google Play Store [140]. Each of those app developing companies or single app developers sells their apps to the healthCOIN operator and earns therefore 70 % of the app revenue after the app was sold [133] [134] [135] [136]. The end customer price of an app is thus once again the same price as it was for the healthCOIN operator before: $ 6.30, which represents the average price of an app in the health & fitness and medical category of the Apple App Store and the Google Play Store. The app developer actually earns 70 % of this end customer price.

A small app developing company or even a single app developer has a hard life, even though he earns 70 % of the app price, because he just earns a lot of very little revenues by doing his primary job - developing and providing apps. Multiple statistics show that app developers can´t get rich by doing their job unless they are part of the top worldwide app developers who have a very high number of app sales, even not if they are part of the more valuable mHealth app market. With the subsequent table I want to show this fact in numbers:

research2guidance [27]		**VisionMobile [141]**		**VisionMobile [142]**		**VisionMobile [143]**	
mHealth apps 2014		**general apps Q3-2014**		**general apps Q1-2015**		**general apps Q3-2015**	
%	revenue per year in $	%	revenue per month in $	%	revenue per month in $	%	revenue per month in $
48	0	24	0	17	0	19	0
19	1-10k	23	1-100	18	1-100	32	1-500
10	10k-50k	22	100-1k	17	100-1k	21	500-5k
7	50k-100k	19	1k-10k	24	1k-10k	7	5k-10k
10	100k-1000k	9	10k-100k	14	10k-100k	8	10k-50k
4	1000k-5000k	1.4	100k-500k	5	100k-500k	9	50k-500k
1	5000k-10000k	1.6	500k+	5	500k+	4	500k+
1	10000k+						

Table 11: Revenue of app developers per month or per year in 2014/2015

It seems clear that with the fact that on average more than 50 % of all app developers earn less than $ 1,000 revenue per month this market is a very poor market and many of the app developing companies and single app developers work below their poverty line. If somebody wants to have great success in developing apps and earns more than $ 100k per month he has to be part of the top 1 % of the app developer market which is easier said than done.

Although most of the app developers are very poor and some of them work even below their poverty line I have to calculate an overall market estimation of the market value. The market value of the global app developer market is assessed by the overall market revenue, which needs an average estimation of the different existing sources:

App development and deployment in 2013 [144]	$ 81.773 billion
IT services revenue app development in 2013 [145]	$ 107.716 billion
App development project revenue in 2014 [146]	$ 64.5 billion
App development and deployment in 2014 [144]	$ 88.485 billion
IT services revenue app development in 2014 [145]	$ 112.637 billion
App development project revenue in 2015 [146]	$ 100 billion
IT services revenue app development in 2015 [145]	$ 117.776 billion

Table 12: Global app developer market revenue estimation

The average estimated value of these global app developer market revenues was $ 96.127 billion in 2014 which will be used as market size in the quantification model for this Value Network.

Since many of the app developers are operating negative nowadays only those app developers can survive in the long-term who achieve to operate with a positive net profit margin. To assume an estimation for the net profit margin of the app developers I thus assume that they have a small net profit margin of 1 % on average which can still include some developers which operate negative, but the mere operates positive to survive. This net profit margin will be used in the quantification model for this Value Network.

The app developer has only one business relationship in the Private mHealth platform Value Network in which he provides a product to the healthCOIN operator. He actually is the actor who develops one or even multiple healthcare apps and therefore earns a payment of the healthCOIN operator who provides this app to the end user in the next step. An app developer will hence only interact with the healthCOIN operator and should hence endeavor to create and sustain a good business relationship to the healthCOIN operator since his business is heavily dependent from the healthCOIN operator. In general an app developer should focus on developing apps which are compatible with a large number of different mobile hardware devices and can be used together with many different types of healthcare sensors or other forms of medical-specific measuring elements to strengthen his position. Successful app developers show that this strategic decision is a guarantor for a prosperous and healthy business [26].

5.3.1.3. Hardware vendor

The hardware vendor is separated into two different actors because also in reality there exists a number of different hardware vendors, whereby some of them, most often retailers, are more focused on the end consumer market and others, often wholesalers, are focused on the business market and thereby act as suppliers for different retailers who sell the products to the end customers.

I also want to show these different types of hardware vendors within the Private mHealth platform Value Network by splitting the actor into the "technical hardware vendor" and the "eHealth hardware vendor". The "eHealth hardware vendor" actor represents a number of wholesalers who offer specific products to other businesses like the healthCOIN operator, whereby in the mHealth market those businesses especially demand wearables because an end customer often already owns a smartphone or a tablet for other use cases but hasn´t got any type of wearable because until now he has had no use case for it. In contrast the "technical hardware vendor" represents a group of retailers who directly sell different types of mobile devices to end customers. A mHealth end customer thus demands mobile hardware devices like smartphones, tablets and wearables. The reason why a classical mHealth end customer demands those types of devices was already described in a previous section of this master's thesis.

For the quantification model also the overall market revenue of the two defined hardware vendors needs to be determined, whereby the eHealth hardware vendor only includes the sales revenue of wearables and the technical hardware vendor includes sales revenue of smartphones, tablets and wearables. The calculation of the eHealth hardware vendor was based on the revenue estimation of the following sources:

Digital fitness device in 2013 [147]	$ 0.330 billion
Smartwatches in 2013 [148]	$ 0.711 billion
Wearable healthcare in 2014 [149]	$ 0.900 billion
Wearable consumer fitness in 2014 [149]	$ 1.500 billion
Smartwatches in 2014 [148]	$ 1.291 billion
Fitness tracker in 2014 [150]	$ 2.000 billion
Smartwatches in 2015 [148]	$ 8.900 billion

Table 13: eHealth hardware vendor market revenue estimation

The average estimated value of these global wearable revenues is $ 2.247 billion, which will be used as market size in the quantification model for this Value Network.

Furthermore the technical hardware vendor needs a broader perspective and includes, next to the wearables market, also the market of smartphones and tablets. The global smartphone and tablet revenues in the years 2013, 2014 and 2015 were:

	Smartphones [151]	Tablets [152]
2013	$ 264.75 billion	$ 74.91 billion
2014	$ 276.39 billion	$ 95.45 billion
2015	$ 272.28 billion	$ 124.15 billion

Table 14: Global smartphone and tablets revenue

When those two markets are added to the already calculated market revenue of the wearables, the global market revenue of the market in which the technical hardware vendor operates is approximately $ 371.557 billion, whereby this market is thus more than a factor of 100 larger than the market of the eHealth hardware vendor.

Next to the market sizes the net profit margins of the two hardware vendors have to be calculated. The eHealth hardware vendor is represented by the nowadays leading companies in the wearables market according to the number of wearable devices sold in Q2 2015, which are Apple, Samsung, Garmin, Xiaomi and Fitbit [153]. These companies are used to calculate an overall net profit margin for companies who act on the wearables market:

Company	**Net profit margin**
Apple [154]	21.61 %
Samsung [155]	11.19 %
Garmin [156]	17.42 %
Xiaomi [157]	1.8 %
Fitbit [158]	24.66 %

Table 15: eHealth hardware vendor net profit margins

The above table leads to an average net profit margin of 15.34 % for the eHealth hardware vendor.

On the other hand the technical hardware vendor is simply a group of retailers and therefore I can use the net profit margins of existing electronic retailers on the market:

Source	Net profit margin
Chron	4.68 %
NYU Stern School of Business	3.56 %
Yahoo! Industry browser	2.70 %

Table 16: Electronic retailer net profit margins

This table leads to an average net profit margin of 3.65 % for the technical hardware vendor and shows that the eHealth hardware vendor has a larger net profit margin because he has less upstream businesses and thus has to share the revenue of the product with a smaller number of companies than the technical hardware vendor.

Furthermore it is necessary for the quantification model to define the selling price of a product which is sold by an eHealth hardware vendor (wearables) and a technical hardware vendor (wearables, smartphones, tablets), which brings the necessity to analyze the existing products on the market in reality and to derive an average selling price of them. In a first step the eHealth hardware vendor who only sells wearables to the healthCOIN operator becomes the focus. The wearables are a relatively new mobile device on the market and are therefore high prized. A study of Vandrico shows that the average selling price of wearables is about $ 290 [162] which seems very high at a first glance, but when considering the current maximal prize of an Apple Watch which is about $ 1,099 this seems realistic again. In contrast the technical hardware vendor offers also smartphones and tablets, next to the wearables. Since the smartphone market is a very large market from the global perspective, there exists a number of different analyses about the average selling price. The selling prices differ from region to region, whereby in North America the average price is about $ 531 [163], whereas the average price in the Asia/Pacific area is about $ 262 [163]. Together with the average selling price of smartphones of the Computerworld which is $ 314 [164], the regional analysis showed a globally average selling price of $ 288.58 which leads to an average price of those two sources of $ 301.29. Next to the smartphones and the wearables, for which the selling prices were already determined, the average selling price of tablets is still missing and since tablets most often offer better displays and hence need a better computational power they are much more expensive than smartphones and wearables. The global average selling price of tablets is currently about $ 439 [165].

It is pretty hard to calculate how many companies globally operate in the eHealth hardware vendor and in the technical hardware vendor market, because there are many small companies which offer their own products in some regions, but some of those companies are only external suppliers who actually produce no customer-ready product. Like already mentioned in the previous section, the wearables market is a new market on which successful companies must crystallize out and hence there still exists a high number of such businesses these days. Overall there are globally 245 companies named in the wearables network [166], which represent the most famous and most important players of this market. On the contrary, the smartphone and tablet market has been existing a bit longer and the dominating companies have already took their positions in the market while the less successful businesses have already left the market again. According to the phonearena [167] and the gsmarena [168] there are about 107-122 designated smartphone hardware vendors and since many of the smartphone vendors also offer tablets or at least phablets, which is a product in between, I assume that the same number of tablet vendors on the global market exists. This analysis leads to a worldwide number of 450 designated technical hardware vendors, who offer either smartphones, tablets or wearables.

Since there are two hardware vendors in the Private mHealth platform Value Network, these two actors have different roles. The eHealth hardware vendors offer healthcare specific hardware devices to the healthCOIN operator, whereby this type of hardware vendor focuses on the sale of wearables which offer healthcare related features. Those mobile hardware devices are sold to the healthCOIN operator in exchange for a specific amount of money, whereby the healthCOIN operator resells them to the end users. In contrast, the technical hardware vendor offers mobile hardware devices which can be used in the mHealth context (smartphones, tablets and wearables) directly to the customer. When an end user interacts with such a hardware vendor he has to pay a specific amount of money for buying such a device. A major benefit of buying a device from the technical hardware vendor can be the price, because with the sale of a device which comes from an eHealth hardware vendor the healthCOIN operator also wants to earn a small margin of the sale, whereby in contrast a device of a technical hardware vendor may be cheaper because it was directly sold to the end user.

5.3.1.4. Payment service provider

The payment service provider (PSP) is also separated into two different actors because there exists a number of different PSPs in reality, whereby some of them offer their payment services to businesses and the other ones to customers. The PSPs that are discussed in this Value Network are always online PSPs who offer the possibility to pay via an online transaction.

Since the distinction of private and business providers exists in reality, I also want to use this distinction in the Private mHealth platform Value Network by splitting the PSP into the Private PSP which is focused on end customers and the Business PSP which is focused on businesses. It is important to understand that this distinction is made because the fees of such PSPs differ between businesses and end customers, which can be observed when analyzing the different fees of PayPal [169], one of the most famous PSPs. Next to this fact the distinction is necessary because the market sizes differ since I assume that end customers of the Private mHealth platform Value Network make their payment transactions via a mobile device while businesses use any type of general online payment service.

PayPal [169] is also a good example to explain that most of the PSPs offer their services simultaneously to business and private customers, whereby the two target groups are served and satisfied by two different departments in a single corporate structure of a PSP. This leads to the necessity that the PSP actor has to be split, whereby I assume that the Private PSP and the Business PSP are simply two different departments of the same company and are therefore modeled as two separate actors. Thus they are not two different autonomous and independent companies.

In a first step I want to describe the main difference between the Private PSP and Business PSP with the underlying transaction fee models. Some PSPs offer the possibility of micropayments which are payments of small amounts - in the case of PayPal less than 12 dollars [170] - and for those payments the normal fee models are not convenient since the high transaction fees of the normal transaction fee models will swallow a great amount of the actual payment. In most of the payment scenarios the payer doesn´t have to pay any additional fee next to the selling price, but the supplier of a product or service has to pay a transaction fee to the PSP for each financial transaction through which he receives money. Of course especially the supplier of a product or service is hence anxious to use micropayments to maximize his amount of the actual payment.

The PSP who offers the possibility of micropayments is called Private PSP, whereby the PSP who uses the traditional transaction fee models is represented by the Business PSP actor.

If those restrictions are represented in numbers according to PayPal the PSP for micropayments demands 5 % of the transaction volume plus a fix amount of 5 US-cents [170]. On the contrary, when assuming a large business which has monthly sales above $ 125,000, the normal fees of providers such as PayPal are a monthly fee of $ 35 and an additional transaction fee of 1.9 % of the transaction volume plus a fix amount of 30 US-cents [170]. The difference in the transaction fees makes a distinction between a Private PSP and a Business PSP necessary.

The number of online shoppers increases from year to year, but next to the online shop operators also the PSP's benefit of this emergent trend. The online payment transactions market amounted about $ 1,532 billion in 2014 [Table 23: Payment service provider (PSP) - Global market volume] and today something between 19.6 % [Table 23: Payment service provider (PSP) - Global market volume] and 27.2 % [173] of all online payment transactions are carried out via a mobile device which lead to an average amount of $ 358.6 billion in 2014 [Table 23: Payment service provider (PSP) - Global market volume]. The online payment transaction volume is used in the quantification model as market size of the Business PSP, whereby the mobile online payment transaction volume is used as market size of the Private PSP because I assumed that the end customer actor of the Private mHealth platform Value Network makes his payment transactions via a mobile device and businesses use any type of general online payment service.

Of course one of the most famous PSPs is PayPal, which was founded amongst others by Elon Musk and had been an important part of ebay for a few years, but next to this provider also a number of other PSPs exist worldwide. It is pretty impossible to determine an exact number of globally acting PSPs, by what I must have confidence in the numbers which are available online. Even since Wikipedia.org is not a scientific source I will use statistic data of this platform, because this platform is viewed and reviewed multiple times on a single day. Wikipedia.org states in an article about PSPs that there exists an overall number of 900 PSPs worldwide [176], whereby this number will be used for the Business PSP and for the Private PSP because I assume, like described in a previous abstract, that these two actors are not two different autonomous and independent companies, but one company with two separated departments.

For the quantification model it is furthermore necessary to calculate the net profit margin of a classical PSP. A statistic shows that PayPal is offered on 65.4 % [177] of the globally existing websites and therefore PayPal offers a good estimation value for the net profit margin of a typical PSP. As PayPal has split from ebay in the mid of 2015 financial statistics of PayPal today only exist for 2015 and not for the previous years. In 2015 the net profit margin of PayPal was 13.0 % [178] and if this margin is compared with other PSPs on the market, for example with the Paysafe Group [179], the same or almost a similar value can be observed also in the financial overview of other PSPs. Thus the net profit margin of PayPal will be used in the quantification model for the Private PSP and the Business PSP.

There are two different PSPs in the Private mHealth platform Value Network, whereby each of them has another target group. The Private PSP has a relationship to the end user, which means that each user of the Value Network uses the payment service of this actor. In exchange for the usage of such a service the end user has to pay a specific amount of money, but only when the end user is the receiver of money. The Private PSP is focused on micropayments which require no service fee, but charge a small amount of money to the end user for receiving money. The interaction between a Private PSP and an end user thus not always has to be charged if the end user only pays for products or services and avoids the receiving of money.

On the other hand the Business PSP is responsible for the businesses and in case of the considered Value Network especially for the healthCOIN operator. The healthCOIN operator has to pay for different products and services provided by other actors and therefore needs a PSP. In contrast to the Private PSP, the payment service of the Business PSP is always fee-based even if no money is transferred at all. The Business PSP requests a monthly fee for simply having the possibility to use a payment service even if it is not used. Next to this fee a transaction-based fee is only charged for receiving money. If a healthCOIN operator receives any money, e.g. from the end user, he has to give a small amount of the transaction value to the Business PSP for using the payment service.

5.3.1.5. Medical expert service provider

At first view the medical expert service provider is an actor who is not directly part of every mHealth platform Value Network when thinking of the actors involved in such a market structure, but the forecasts show a high market potential, wherefore the actor has to be included. This actor represents a relative new type of business which is currently only a niche market when looking on the whole healthcare sector and very often the term “telehealth” or “telecare” is used for describing the offerings of such an actor. The medical expert service provider thus engages with the supply of different digital and thus most of the time online services which support the patient or any healthy end customer in his health situation, whereby in the chosen Value Networks I will concrete on preventive approaches and services of medical expert service providers. Such a provided online service answers health-related questions, tries to give health advices to a user or analyzes his medical findings. The user of such a system should thus interact with a medical expert, which doesn’t necessarily have to be a medical doctor, per a remote session, whereby some of currently existing solutions offer the possibility to connect with the medical expert via a webcam by which the possibility of simple texting or talking is extended by a live video stream to see the opposite side which strengthens the personality of the whole communication.

As already mentioned the whole medical expert service provider market is a relative new business in which only a few more or less successful businesses operate. Many of those businesses invested a lot of money at the beginning of their business activities and as it is a new market the investments have logically not amortized yet. The most important company of the market today is Teladoc [180] which has already bought some other providers that had been competitors before. Next to Teladoc, known competitors on the market are: Doctor on Demand [181], MD Live [182], Doctorspring [183], AmericanWell [184], Second Opinion Expert [185], but few more exist. All of those providers offer different services, whereby online services like Healthcare Magic [186], which just offers simple Question & Answer online sessions, are not declared as medical expert service providers. It is important that the provider offers one or multiple services in which real medical experts are part of the service, to classify as a medical expert service provider according to the Private mHealth platform Value Network.

Since Teladoc is one of the most successful players on the concerned market today this business will be used to analyze the net profit margin of the businesses operating as medical expert service providers.

Teladoc net profit margin [187]	
2013	-39,13 %
2014	-30,20 %
2015	-76,92 %
2016	-32,70 %
2017	-6,46 %

Table 17: Net profit margin estimations of Teladoc

The above table shows that even Teladoc, which is one of the more successful businesses on the medical expert service provider market, won't be able to make any positive net profit margin until 2017. Of course the margins for 2016 and 2017 are just estimations according to the business strategy of Teladoc, but with the buyout of other competitors the company made it heavier for itself to come into a positive margin area at the soonest. Amazon is a great example to get an overview of how hard it is to get into a significant positive net margin area even if the concerned company is the leader of the respective market. Amazon is expected to make - for Amazon conditions - a "significant" yearly net profit margin of 1.78 % in 2016 [188], whereby the years before the company have made a maximum net profit margin of 0.5 % and in some years even a negative net profit margin [188]. In the long-term every company has to reach at least a small net profit margin to survive on the market and thus I also assume a small positive net profit margin of 1 % of every company for the market of medical expert service providers, which is in fact very low compared to other business sectors.

Although the companies on the market seem very poor and the whole market is still in the children´s shoes, the global market revenue was about $ 980 billion in 2014 [189] [190] [191]. The worldwide number of telehealth patients was about 640000 in 2014 [192], whereby they performed about 19.7 million telehealth video consultations in 2014 [193]. The number of patients who use any kind of telehealth services will rise in the next years which can be confirmed with the estimated number of 158.4 million telehealth video consultations in 2020, which was claimed by Reuters [193]. A major part of the earned revenues is made through the online service itself, whereby also additional services, like the general availability of printed results which are sent by post if desired, are offered which of course bring additional costs with them. Each medical expert service provider has his own price model, so some of them simply ask for monthly fees in form of a bounded contract similar to mobile phone contracts, whereby others ask for money per consultation and don´t force any contracts with the users.

A few of the existing medical expert service providers offer their medical services to companies, which pay a flat rate, and employees of those companies can afterwards use the services for a small amount of money or even for free.

The focus of medical expert service providers in the Private mHealth platform Value Network will be on all three different price models which were described before. In the quantification model I will use the subsequent middle-class providers, whereby each price includes a slightly different service, but always relates to a single consultation or represents a monthly fee:

AmericanWell [194]	$ 49 / visit
Doctor on demand [195]	$ 40 / visit
Doctorspring [196]	$ 180 / visit
Healthtap [197]	$ 99 / month
LiveHealth Online [198]	$ 49 / visit
MD Live [199]	$ 38 / visit
MeMD [199]	$ 35 / visit
MyConsult [199]	$ 565 / visit
NuPhysicia's Medicine at Work [200]	$ 25 / month
Ring a doc [201]	$ 69 / visit
Second opinion expert [202]	$ 300 / visit
SecondOpinions [203]	$ 29 / visit
Teladoc [204]	$ 39 / visit
Virtuwell [205]	$ 49 / visit

Table 18: Medical expert service price per visit or per month

In the market analyses of the medical expert service provider market I found a number of different providers, with which it is difficult to get an exact number of providers. I assume that globally there exists a number of 100 medical expert service providers, whereby this number is an estimation based on the serious companies found in my market analysis. For the quantification model the exact number of companies in the respective market is not as important as the number of companies of this actor in relation to the number of companies of the other actors. Since the whole medical expert service provider market is a young market, the number of companies have to lie below the number of companies of other actors in which the markets and the businesses have already been established for years.

The Medical expert service provider offers his medical expert service to the healthCOIN operator whereby this actor pays an amount of money for the possibility to offer such a service if an end user requests such a service. In another use case it could be conceivable that the medical expert service provider offers his service directly to the end user, whereby this use case is not modeled in the Private mHealth platform Value Network to retain the overview.

5.3.1.6. Internet service provider

The internet service provider (ISP) is the actor who offers internet services, but in the Private mHealth platform Value Network I assume that the ISP only offers his services to businesses and not to end users. In contrast, the Mobile telco service provider provides internet services to end users, whereby this actor will be described in a subsequent section.

Most often an ISP is a general telecommunication provider who provides, next to the broadband internet service, also additional services such as mobile phone contracts or mobile internet access points, the so-called web cubes which also work with SIM cards. In this master's thesis I understand an ISP as a business whose business focus is on the tethered broadband internet service. Since a great number of ISPs exists worldwide I want to focus on the most important ones, which are the Tier 1 ISPs. Those ISPs focus on the direct connection with the global internet backbone network in specific regions and are hence very important and responsible for an efficient internet reliability. Different sources show a different number of Tier 1 providers, but the number of those companies is always above 10 and in my case I will work with an overall number of 14, whereby for the quantification model the following Tier 1 ISPs are included:

AT&T [206]	Centurylink [207]	Cogent Communications [208]
Deutsche Telekom [209]	GTT [210]	Level 3 Communication [211]
NTT [212]	Orange SA [213]	Sprint Corporation [214]
Tata Communication [215]	Telecom Italia [216]	TeliaSonera [217]
Verizon [218]	Zayo Group [219]	

Table 19: Tier 1 Internet service providers

I calculated an average net profit margin of the above ISPs since those ISPs represent a great amount of all existing ISPs. The calculations lead to an average net profit margin of 4.34 % in 2014 [Table 24: Internet service provider (ISP) - Net profit margins] for the ISPs which will be used in the quantification model, whereby the overall market revenue of the worldwide ISPs was $ 532 billion in 2015 [220].

For some of the Tier 1 ISPs listed above the prices for a tethered broadband internet service with unlimited data volume were compared to calculate an approximation of the worldwide average price of 1 GB data volume over a fixed line, whereby I assumed that each end customer needs 100 GB per month. An average value of $ 0.64 [Table 25: Internet service provider (ISP) - Contracts] was calculated, whereby the chosen broadband contracts have got a download speed of at least 16 Mbit per second and a maximum of 500 Mbit per second, to show an average value for all types of companies since the ISPs in the Private mHealth platform Value Network are only responsible for providing internet access for businesses.

The internet service provider offers his internet service only to businesses and in case of the Private mHealth platform Value Network only to the healthCOIN operator. The healthCOIN operator has to pay a specific amount of money in exchange for this service. Of course, it will be conceivable to model the interaction between all the businesses and the ISP, but this would unnecessarily blow up the scope of the thesis.

5.3.1.7. Mobile telco service provider

The mobile telco service provider (MTSP) is the actor who offers internet services, but in the Private mHealth platform Value Network I assume that the MTSP only offers his services to end users and not to businesses. In contrast, the Internet service provider provides internet services to businesses, whereby this actor was already described in a previous section.

A MTSP is a telecommunication service provider who often also provides, next to mobile phone contracts, landline phone services. The digitalized and mobilized world has changed the proportion of mobile phones and landlines, because since 2001 there have been more mobile phones than landlines and in 2013 there were nearly as much mobile phones as humans in the world [231]. These days there exists are large number of MTSPs, whereby for the quantification model I have chosen the 12 largest in the world, according to the number of subscribers, which are [232]:

America Movil [233]	Axiata [234]	Bharti Airtel [235]
China Mobile [236]	China Telecom [237]	China United Network Communications [238]
MTN Group [239]	Orange SA [240]	Telefonica [241]
Telenor [242]	Vimpelcom [243]	Vodafone [244]

Table 20: World´s largest mobile telco service provider

I have calculated an average net profit margin of the above MTSPs since those MTSPs represent a great amount of all existing MTSPs. The calculations lead to a net profit margin of 7.40 % in 2014 [Table 26: Mobile telco service provider (MTSP) - Net profit margins] for the MTSPs which will be used in the quantification model, whereby the overall market revenue of the worldwide MTSPs was $ 1,038 billion in 2014 [Table 27: Mobile telco service provider (MTSP) - Global market revenue].

Compared to the ISPs it seems strange why the global market revenue of the MTSPs is more than the double. This effect can be explained by simply comparing the average prices of the offered services and the underlying contracts. The average price of a mobile phone contract including 1 GB data volume is nowadays about $ 12.74 [Table 28: Mobile telco service provider (MTSP) - Contracts] which is much higher than the average price of $ 0.64 for 1 GB offered via a tethered broadband by an ISP. Especially the prices of mobile phone contracts differ from country to country since the wireless network coverage also differs between different regions and therefore, from the global perspective, different price levels have been set, that even countries with a bad wireless network coverage can close up to countries with a better wireless network coverage within the next years. The higher average price of the MTSPs also originates from the included services in the price. As compared with the average price of the ISPs the average price of the MTSPs includes also a specific amount of phone minutes and text messages next to the mobile data volume, whereby the price of the ISPs only includes the broadband internet service. It is pretty hard to calculate which amount of the included services (data volume, phone minutes and text messages) makes which part of the price and thus I assume that every service amounts to one-third of the price. The price of 1 GB data volume on a mobile phone, for which a mobile phone contract deal is closed, amounts thus $ 4.25, which is still much higher than the average price of an ISP contract.

Globally the MTSP market is a very large market and hence a great number of providers exist, whereby also virtual network operators (VNO) are emerging, who just offer a mobile telco service to the customer, but actually use the infrastructure of another MTSP. Therefore the VNOs have to pay a rental fee to the infrastructure-providing MTSP for each customer who signs a mobile phone contract. In the quantification model I only consider the 12 MTSP which were named above, but in reality an end customer can´t ever choose a MTSP from China in his own country which is located e.g. in Western Europe.

Thus the competition and rivalry which exist in reality isn´t modeled in the quantification model because the 12 providers are distributed around the whole world and each end customer can only choose from those which are located in his region. Consequently I have to assume in the Private mHealth platform Value Network that the 12 MTSPs which were listed above represent the same competition level for a single region that exists in reality.

The mobile telco service provider offers his mobile telecommunication service only to the end user actor via a mobile phone contract including an internet service. The end user, in exchange for this service, has to pay a specific amount of money to the MTSP each month.

5.3.1.8. End user

The end user is, next to the healthCOIN operator, one of the major actors in the whole Private mHealth platform Value Network because his behavior and interests are an important success factor for the whole mHealth platform. Although this actor is so important, he will be described in this (last) section because he interacts with nearly every other actor and therefore it is necessary to understand the purpose and the business activities of the other actors before.

A mHealth platform and the corresponding Value Network needs any person or institution who uses the platform and receives some value by using it. The end user takes on this role and his benefit of the participation in such a Value Network constellation has to be maximized. To determine how many end users participate in such a use case it was necessary to calculate the amount of end users which are able to participate because they have some key prerequisites which are essential. To get a realistic market size which will be measured by the overall market revenue I use two different approaches:

(1) mHealth population approach

In this approach the worldwide population is used as a starting point to calculate the proportion which is in an adequate age group. Of this target group the proportion of non-diabetes patients who have internet access via a health app mobile device (smartphone, tablet, wearable) is calculated, whereby only those humans are selected who already use any type of mHealth app. The previous calculations lead to an overall number of 805,706,876 humans [Table 29: End user - mHealth population approach]. To get a revenue-based market size I have to determine the number of apps which are fee-based and check their average price.

Since I pursue a cautious calculation I assume that everybody who uses any type of mHealth app only uses one mHealth app which may not be correct in reality. All these calculations lead to a worldwide revenue of the mHealth end user market of $ 634.494 million [Table 29: End user - mHealth population approach].

(2) Downloaded apps approach

In this approach the worldwide number of downloaded apps in 2014 is used as a starting point to calculate the number of mHealth related apps which were downloaded. With the overall proportion of fee-based and mHealth apps I can calculate how many fee-based mHealth apps have been downloaded. A global number of 287,545,275 apps [Table 30: End user - Downloaded apps approach] is fee-based and mHealth related. To get a revenue-based market size I have to determine the average price of the mHealth related apps. All these calculations lead to a worldwide revenue of the mHealth end user market of $ 1.811 billion [Table 30: End user - Downloaded apps approach].

Since the two approaches supply two completely different revenue-based market sizes I will use an average value of $ 1.222 billion for the quantification model to define the end user market size of the worldwide mHealth platform market. Of course, the end user actor does not represent any business or institution, but a large group of humans who may use the mHealth platform which is provided and operated by the healthCOIN operator. Hence also the size of the end user actor has to be determined. Since the mHealth population approach has already described the user base which may use such a mHealth platform I will use the number of 805,706,876 end users as the number of humans who are represented by the end user actor.

The end user actually doesn't provide any service or product to any other actor, but without him the whole Value Network would make no sense, since he is the one for whom all actors are operating to maximize his benefit and received value. He is thus the financier of the whole Value Network and all endeavors of each actor should be directed to him to provide a successful mHealth platform in the long run.

5.3.2. Public mHealth platform Value Network

The “Public mHealth platform Value Network”, which is based on the “Public insurance healthCOIN value network” of the deliverable [122] of the PRECIOUS project [100], is the second Value Network which will be graphically developed, afterwards quantified with market data and finally the outcomes of the quantification will be analyzed. It is important to understand that the whole use case is based on global market data, so each number represents the whole world.

The term “Public” in the name of the mHealth platform Value Network refers to the form of financing of the whole market. In the public industry there exists a number of different public financing operations on the market, whereby also private companies can operate in such a market. The subsequent figure should show how the model of a mHealth platform market will look like if the Value Network notation of Casey, et al. [74] is used:

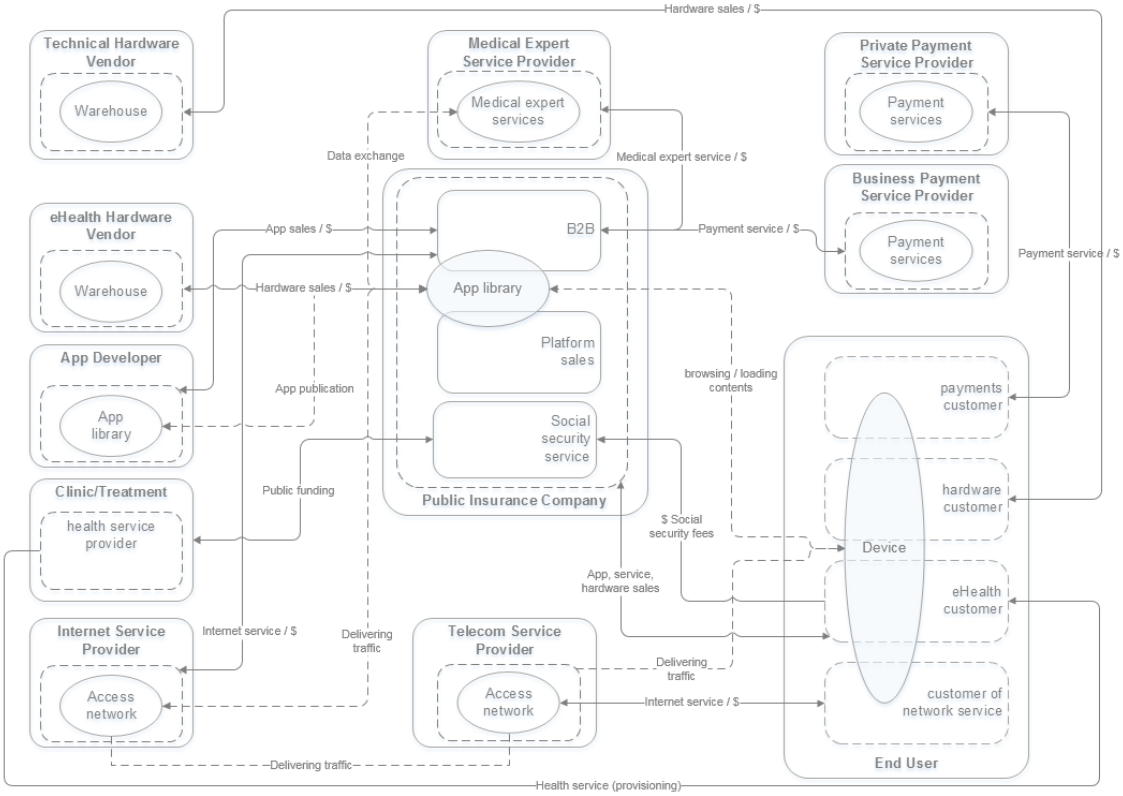

Figure 23: Public mHealth platform Value Network (based on “Public insurance healthCOIN value network” [122])

The “Public mHealth platform Value Network” is very similar to the “Private mHealth platform Value Network” which was described and analyzed before. The main difference are the actors, whereby one actor was just renamed, with what he now represents a different role, and additionally a new actor was added to the Value Network. These two new actors have changed the Value Network from private funded to more or less, but not only, public funded.

The procedure of the analysis of the Value Network will be the same as it was in the Private mHealth platform Value Network: at the beginning each of the changed or new actors will be described and quantified with market data, whereby the market data which is being used is based on the years 2013, 2014 and 2015 since some parts of the required data has not been collected every year. Especially for the quantification it is necessary to calculate the following key figures:

- the global market size of the market in which the actor operates, which is defined by the overall market revenue
- the number of the operating companies on the particular market which are represented by a single actor, to determine how many relationship instances can exist between two actors
- the average price of a product or service which is sold to another actor to calculate the utilities of the relationship instances to other actors
- the average net profit margin of each actor which is needed to calculate the utilities of the relationships instances to other actors

All those key figures are necessary to fill the quantification model of Peter Reichl and Patrick Zwickl which is described in the paper “Of Values and Networks: Designing Quantitative Analysis Methods for Pluralistic Telecommunication Markets” [98].

Next to the quantification of the new actors, the description of the existing relationships will be done in each section, to understand which interactions an actor can have to the other actors of the Public mHealth platform Value Network, whereby each relationship will always be described from the perspective of the actor who provides a product or a service, but not any form of payment, for the other actor. It has to be understood that the analyzed Value Network is only a model of the reality and should show the most important relationships when analyzing a mHealth platform Value Network. In reality an actor in such a market constellation has a few more relationships to other actors. Also further relationships to external actors which are not considered in the Public mHealth platform Value Network are clearly not modeled or described.

5.3.2.1. Public insurance company

The public insurance company represents the actor who was renamed, whereby this actor was called healthCOIN operator in the Private mHealth platform Value Network. Even if the healthCOIN operator is not part of the Value Network anymore, the basic ideas of the healthCOIN approach should still be included in the mHealth platform with which the approaches of intrinsic motivation, behavior change and gamification will be integrated into the platform. The public insurance company is a company which is funded by the state, either directly or via a ministry, and is actually the administrative apparatus of the state healthcare. Since the mHealth platform is now public funded, the strategic focus of such a platform is now a bit different than it was in the Private mHealth platform Value Network. The strategic alignment is now more focused on a commonweal and also a support of the poor population, whereby the focus of the mHealth platform in the Private mHealth platform Value Network was more in the direction of profit maximization and less on a healthier population.

All these changes have led to the requirement of collecting different market data for the new actor, because the operator of the mHealth platform is now public, and hence the quantification model needs different numbers. The market size which is once again determined through the global market revenue is now higher because the public sector is motivated to invest into public healthcare and in new approaches to improve the global health state. The financing of the healthcare sector is most of time done by the so-called social security contribution rates, which is the amount of money a citizen has to hand over to the state to get any kind of social security or social benefits like healthcare, unemployment compensation, etc. The global average of the social security contribution rate a citizen has to spend is $ 98.83 [Table 33: Public insurance company - Global social security] a month which was calculated by the worldwide average monthly wage and the percentage of the social security contribution rate for each region. The global labour force is 3,384,107,327 [273] which leads to a revenue-based market size of $ 334.441 billion [Table 34: Public insurance company - Global social security spending per month (absolute)]. Since the whole calculation is based on employed people and there exists a great number of unemployed people in the world, this leads to the assumption that in reality the market size has to be much higher because also unemployed people need some type of social security and have to pay their social security contribution rates, even if they reduce their own unemployment compensation to receive social security.

Furthermore it is interesting which amount of money these public insurance companies have to keep to secure their own administration burden, which leads to the calculation of the net profit margin of the public insurance companies. Globally a net profit margin of 4.7 % [Table 35: Public insurance company - Net profit margins] was calculated based on the available market data of companies of globally interesting countries because of their high number of population. The positive net profit margin suggests that even public insurance companies may have to invest money for their research & development and improvements or have to build reserves for bad years.

Globally there exists an overall number of 193 countries which are part of the United Nations (UN) [295] and since I assume that not every country may have a public insurance company because their social security system is not public funded, while on the other hand some countries may have more than one public insurance company, I conclude that their exists an overall number of 200 public insurance companies worldwide. The calculated number of public insurance companies is just an estimation, but for the quantification model the exact number of companies in the respective market is not as important as the number of companies of this actor in relation to the number of companies of the other actors.

The public insurance company provides and operates the mHealth platform and thus offers preventive healthcare apps to end users. Since the whole market is public funded and the end users pay a social security contribution rate for their own social security, I assume that this amount already covers the fee (or app price) which is necessary to use the mHealth platform and download apps from the platform. In the Public mHealth platform Value Network an end user can consequently download any apps he likes if he pays his social security contribution rates on time.

The public insurance company has a great number of tasks in reality, but in the modeled Value Network the only task a public insurance company has, is the supply of the mHealth platform for the end users. In exchange to the possibility of using the mHealth platform in form of downloading apps and thus using the offered healthcare service (including the medical expert service) the end user has to pay the social security contribution rate.

5.3.2.2. Clinic/Treatment

The clinic/treatment actor can also be described as the term healthcare facility or healthcare institution, which means that the actor does not necessarily represent a hospital, but can also be any form of general healthcare center in which different types of healthcare or medical experts, e.g. doctors, nurses, orderly, etc. work to help people. Most of the time such institutions are public funded, but also some private funded clinics exist in parallel. In the subsequent abstracts the term hospital, clinic, healthcare facility and healthcare institution will be used as a synonym. It may seem curious that in a preventive healthcare Value Network the clinic actor is included since the preventive focus should prevent the need for such institutions. Of course, this seems correct for a completely health population which doesn´t exist anywhere, but the clinics are also useful and helpful in performing some general (preventive) health checks to prevent any forms of diseases.

Since a typical clinic in Western Europe looks different to clinics in less developed areas of the world, in less developed areas they often just represent a simple healthcare facility with a small number of medical experts. A statistic of “Maps of World” [296] tried to figure out how many of such healthcare facilities exist all over the world, whereby the statistic named all of those facilities hospitals. The statistic actually represents a ranking of countries, whereby the number of hospitals per country was collected and the list was sorted in descending order. Thus the countries with the greatest number of hospitals per country were in the lead, which are China, India and Vietnam which alone have about 97,000 hospitals. The subsequent countries have far less hospitals, whereby already the 8th country of the ranking, South Korea, has less than 1/10 hospitals than China which is in the lead with more than 69,000 hospitals. The ranking doesn´t show all countries of the world and since I want to calculate an overall number of global existing hospitals I have to use another source for calculating the overall number. I used data of a program of the World Health Organization (WHO) [297] to calculate a number of worldwide existing hospitals which has led to a number of 279,224 hospitals [Table 38: Clinic/Treatment - Number of hospitals (Maps Of World & WHO)].

Since especially large clinics are most of the time public funded, they are funded by the state, either directly via a ministry or via a public insurance company. To calculate the overall revenue of the globally existing clinics I have to look on the spendings the governments all over the world make for the healthcare sector, but especially for hospital care.

Different sources [298] [299] [300] showed that on average something between 30 % and 32.1 % of the overall healthcare spending of a state is spent on hospital care. The global healthcare spending in 2014 according to Deloitte was $ 7.57 trillion [301], which leads to an amount of $ 2.37 trillion which is spent on hospital care when assuming an average proportion of 31.31 % of the global healthcare spending which is spent on hospital care. The clinics actually receive some amount of the social security contribution rate from the public insurance company to operate their business and I assume that none of the existing hospitals which are public funded will make any profit, because their main aim is not the maximization of profit as it may be for private funded clinics.

Although I analyze the Private mHealth platform Value Network I can´t assume that a hospital, even if it is public funded, will make a negative net profit margin each year in the long-term, because this will mean that no reserves can be made for any type of renovation or maintenance. Instead, I will assume a small positive net profit margin of 1 % which will be used in the quantification model because it seems realistic that even public funded clinics have to have a small financial cushion. To ease the whole calculation in the quantification model I assume that the clinics will receive the whole social security contribution rate from the public insurance company and thus the global average of the social security contribution rate a citizen has to spend of $ 98.83 [Table 33: Public insurance company - Global social security] a month will be used as the basic price a clinic requests from the public insurance company to offer its healthcare services to them.

The main task of the clinic actor in the Private mHealth platform Value Network is the provisioning of a real healthcare service for the end user, whereby the public insurance company only offers an indirect healthcare service to the end user through intermediation to other actors who actually make the work. The clinic actor has thus only the challenge to offer a healthcare service to the end user and receives the payment for his activities from the public insurance company which is the administrative apparatus of the state healthcare and receives the necessary amount of money from the state or a ministry.

5.4. Coding

In the previous section it was described why and how each actor was quantified by a certain number, with what I now have to explain how these quantifications can be poured into the quantification model of Peter Reichl and Patrick Zwickl which is described in the paper “Of Values and Networks: Designing Quantitative Analysis Methods for Pluralistic Telecommunication Markets” [98].

The whole quantification model, which was used for the quantification of the mHealth Value Networks, was developed by Patrick Zwickl in Python, which is actually a scripting programming language. A number of different Python scripts work together in such a way that all the necessary calculations are executed in the correct order. Since the quantification model approach of Peter Reichl and Patrick Zwickl was already used for the quantification of a Video on Demand Value Network, I have used the existing Python scripts of this case study and modified some parts to get the possibility to pour the mHealth Value Networks into the scripts in the desired manner. Like already mentioned before, the majority of the scripts are simply a programmed implementation of the necessary calculation steps, which were already described in the paper of Peter Reichl and Patrick Zwickl.

The basic architecture of the Python scripts consists of two packages, whereby one package, the “core” package, contains a number of Python scripts which were developed to provide the basic configurations and some auxiliary calculations of the whole Value Network quantification model, and the other package, which always represents the case study specific data and calculations, is in our case called “private_VN” for the Private mHealth platform Value Network and “public_VN” for the Public mHealth platform Value Network. The distribution of the Python scripts into two different packages was selected on purpose in order to get a clear separation of the general functionality and the case study specific functionality of the code. Overall I had to create two different Python projects, whereby the core package is the same in both projects and the case study specific package was adapted to the respective mHealth platform Value Network constellation.

When analyzing the core package in detail there are six different Python scripts included, whereby each of them provides configurations or auxiliary calculations which are necessary for either some of the other Python scripts of the core package or the Python scripts of the case study specific package.

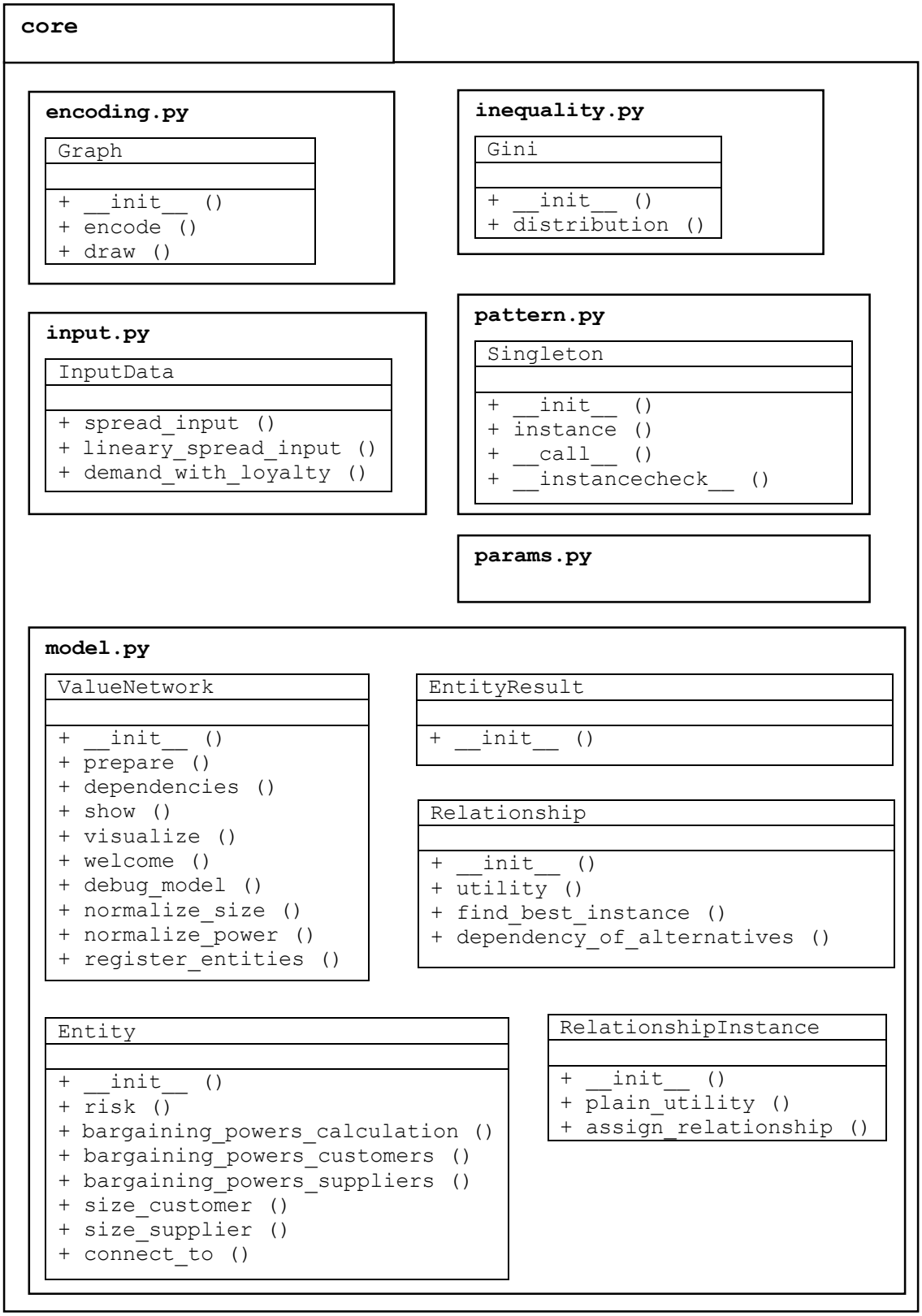

Figure 24: The „core“ package

In the subsequent paragraphs the main contents and functionalities of each Python script will be described, whereby in a first step all scripts of the core package are put under the magnifying glass and in a second step the most important tasks of the scripts of the case study specific package are described.

The encoding.py script contains the graphical configurations to draw the Value Network graph. Additionally to the calculation possibilities, which are provided by some of the other Python scripts, the encoding.py script offers the possibility to draw a simplified Value Network of the configured actors and their relationships, whereby the main aim of this graphical representation is the illustration of some important parts of the calculated results. In the graphical representation each actor is drawn as a circle, whereby the size of each circle shows the customer (outgoing) market size which is determined by the sum of utilities of the outgoing relationships of this specific actor. A large circle means that the respective actor has a high customer (outgoing) market size while a small circle means exactly the opposite. Furthermore, each circle is colored, which shows the overall dependency of this actor on the Value Network, whereby a higher overall dependency is colored more orange and a less overall dependency on the Value Network is colored more green, which leads to a color mixture for some of the actors if the overall dependency of the single actors is widely spread. Next to these circles the relationships between the actors are represented by directed edges, whereby each edge can have a different width. The width of an edge shows the overall utility of a single customer (outgoing) relationship to another actor in proportion to the overall utility of all single customer (outgoing) relationships within the Value Network, with what the most important relationships of the whole Value Network should be highlighted, whereby a higher overall utility in proportion to the others means a wider directed edge. Therefore the wider the edge is, the more important is the relationship.

Inequality.py is responsible for calculating the Gini value which was described in the “4.3.4. Quantification of Value Networks with Porter´s Five Forces and Gini coefficient (approach 2)” section of this master´s thesis. For the calculation of a realistic Gini value all of the single utility values of each relationship instance have to be positive. To deal with the negative single utility values of the single relationship instances it is necessary to manipulate the list of the single utilities in such a way, that all values get positive or at least zero.

Therefore the inequality.py script recalculates the values in such a way, that the absolute amount of the highest negative value of the whole list is added to all the negative values of the list which finally leads to the result that there is at least one value that has the value of zero and all the other values are positive.

The Python script input.py was created to handle business relationships of a Value Network in which the overall number of demander is higher than the overall number of suppliers. The script hence offers the possibility to linear spread the number of demanders in such a way that all demanders get a specific supplier assigned to them, which represents the respective business relationship partner for them. This actually means that a single supplier is now only responsible for a selection of the overall number of demanders.

All general parameters which are reused either in the core package or in the case study specific package, in my case the “private_VN” or the “public_VN”, are stored in the params.py script. The most important general parameter, which is also defined in this script, is the power value which is used for the Gini value calculation which was described in the “4.3.4. Quantification of Value Networks with Porter´s Five Forces and Gini coefficient (approach 2)” section of this master´s thesis. In one case the parameter has the value of 3 to show the competition between different entities in a Value Network in an appropriate way and in the other case, in which the utility within an entity is considered, the value of 2 was chosen because the competition within a single entity is always less than the competition between two or more entities.

The pattern.py script just includes a helper class to ease the implementation of a Singleton according to the Singleton pattern, which is a design pattern that was created to ensure that only a single object can exist for a specific class. The helper class Singleton was used for the Input_Data class in the input.py script.

Finally, the last Python script of the core package is the model.py which is the most important script of the whole core package and includes five classes: ValueNetwork, RelationshipInstance, Relationship, Entity, EntityResult. This leads to the necessity that the tasks of all these classes need to be described in detail in the subsequent paragraphs.

The ValueNetwork class of the model.py script unites all the calculations that were made in the other Python scripts or in the other classes of the model.py script. The class is hence the central collection point of all numbers or in other words: the main class. Although the class itself makes some simple calculations regarding the normalization of the calculated results, most of the main calculations happen in other classes or even in other Python scripts. Furthermore the ValueNetwork class is responsible for printing all the calculated results and some debug information about the single calculation steps, to draw the graph of the Value Network and to create a list of all the entities which are included in the Value Network, which is also just a debugging information to check if all desired entities are included.

The RelationshipInstance class is only a helper class of the Relationship class and has to calculate the single utility values of each relationship instance of each relationship. This class is hence the starting point of the whole calculation process. The Relationship class is actually the basis of the Entity class and is responsible for calculating the best utility value of each relationship according to the single relationship instances of each relationship. Furthermore the class calculates the dependency of alternatives or in other words: the Gini value which represents the competition between the entities.

The already mentioned Entity class includes all the definitions and calculations of a single entity. A main part of this class is the calculation of the bargaining power of the supplier and the customer side of the respective entity based on the dependency of alternative calculations which were made in the Relationship class. Furthermore the Entity class provides the possibility to calculate the market size of the customer and the supplier side which is also once again based on the calculations of the Relationship class. Finally, the connection of a single entity to another entity - to represent a business relationship between them - is also done by the Entity class.

The EntityResult class was just created to store the calculated results in objects of this class since all the values of calculated results should be cached to access them in an easier way.

The second package, which represents the case study specific data and configurations, only contains two different Python scripts, the configuration.py and the so-called private_VN.py in the case of the Private mHealth platform Value Network or the so-called public_VN.py in the Public mHealth platform Value Network case.

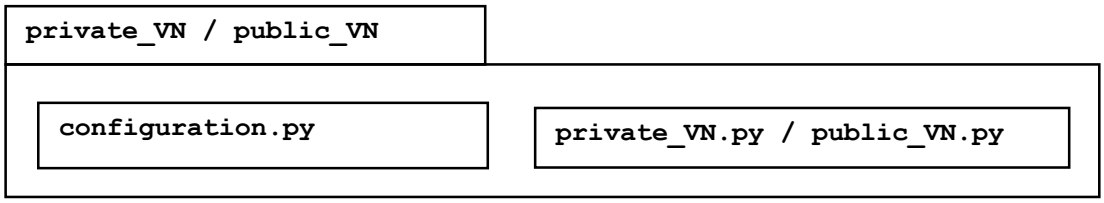

Figure 25: The „private_VN" / „public_VN" package

The two scripts of the case study specific package are very important for the quantification of a single mHealth Value Network, whereby in the configuration.py script the whole configuration for the respective case is made and in the case specific script, which is named creation script from now on, the respective Value Network with all its specific characteristics is defined. In this master's thesis two different Value Networks (Private mHealth platform Value Network & Public mHealth platform Value Network) were built up, whereby for each of them an own Python project was created and hence an own configuration and an own creation script had to be written. In contrast to the whole core package, the Python scripts of the private_VN / public_VN package do not contain any classes.

In the configuration script, which actually represents the input of the quantification model, it was necessary to include all the chosen numbers and key figures of the previous quantification section, so I actually just had to create a number of variables and fill those variables with the chosen or calculated values which were already described in the Quantification section of this master´s thesis. Furthermore some general calculations, like for example currency conversions or the creation of functions for a more easy definition of high numbers with many digits, were also made in the configuration.py.

The configuration script is the only Python script which doesn't include any number of the reality and is thus the most important script because every input has to be correct to achieve the desired results in the end. A great number of variables is thus included in the configuration script, but it was already necessary to make some simple calculations in this script such as mean value calculations, etc. as a preparation for all the subsequent calculations.

In contrast, in a first step the creation script performs the definition of a new Value Network through the instantiation of a new object of the Value Network class of the model.py script of the core package. In the next step, with the support of the Python scripts of the core package, all of the necessary actors (entities) of the respective Value Network are defined, whereby each actor is quantified by the configured numbers which are specified in the configuration script, and registered to the Value Network which was just created.

Furthermore, it is necessary to build up the relationships between the single actors and therefore some actors are connected to each other, whereby only the business interactions, the solid edges of the graphical Value Network representation according to Casey, et al. [74], are relevant for the quantification model. Also the connection process of single entities which was described before, is performed through a function which is provided by a Python script from the core package.

The most important step after building up the relationships is the quantification of the relationships. Since an actor may have multiple incoming and/or outgoing relationships to other actors, each single relationship has to be quantified in such a way that you can determine the single utilities of each relationship instance of such a relationship. With this quantification and the use of the actor specific defined values of the configuration script the further calculation steps of the quantification model approach of Peter Reichl and Patrick Zwickl can be performed. For all these calculations the different classes of the core package and their functions are used.

Finally, the output of the calculations, which were performed through the Python scripts, should show the overall dependency of each actor on the respective Value Network, whereby a high overall dependency means that the actor only has a little market power, which also means that he only has a small amount of bargaining power within the Value Network. The representation of the calculated results is also once again done via a Python script of the core package.

The most important results of the Python scripts will be discussed and analyzed in the subsequent section, to understand the final output of the Python scripts on a more detailed level.

5.5. Results & Analysis

5.5.1. Private mHealth platform Value Network

5.5.1.1. Graphical Results

The previous coding section has already described that the Python scripts also offer the possibility to create a simple graphical representation of the Value Network, which includes some major graphical elements which, next to the calculated numbers, also show the most important results of the whole calculations in an easier and clearer way.

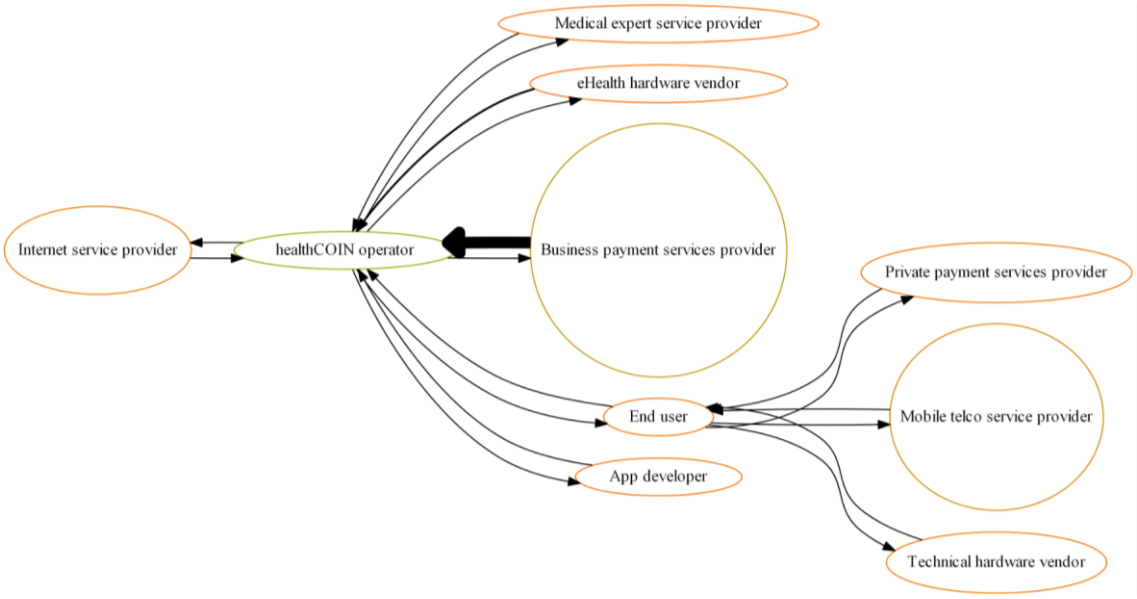

Figure 26: Private mHealth platform Value Network - Graphical result

The graphical representation of the Private mHealth platform Value Network via the Python scripts shows that the Business Payment Service Provider and the Mobile Telco Service Provider are by far the two actors who operate in the largest markets based on the global market revenue. Furthermore the colors show that the healthCOIN operator, the Business Payment Service Provider and the Mobile Telco Service Provider have got the lowest overall dependency. Additionally the bold solid edge from the Business Payment Service Provider to the healthCOIN operator shows that this relationship is very important, whereby also the relationship from the eHealth hardware vendor to the healthCOIN operator seems to be an important business.

5.5.1.2. Calculated Results

The major task of the Python scripts is the calculation of the overall dependency of each actor on the whole Value Network and this section describes the calculated results of the scripts. At the beginning it is necessary to show an overview which market sizes, based on the overall market revenues, were used as input for the quantification model since this overview shows which actors are the “largest” ones and may have the highest market power.

Actor	Global market revenue per year
Technical hardware equipment	371,557,000,000
eHealth hardware equipment	2,247,428,600
App developer	96,126,714,285
End user	1,222,044,052
Payment services (online = business)	1,532,331,292,931
Payment services (mobile = private)	358,600,000,000
Medical expert service	980,120,000
healthCOIN operator	1,497,000,000
Internet service provider (business)	532,000,000,000
Mobile telco service provider (private)	1,038,000,000,000

Table 21: Private mHealth platform Value Network - Market sizes

The above table was simply built together from the market size values of the quantification section of this master's thesis, but also the output of the Python scripts can - if desired - show the proportion of each market size of the sum of all the market sizes of the whole Private mHealth platform Value Network.

It can be summarized that especially the Business Payment Service Provider and the Mobile Telco Service Provider are by far the largest two actors in the Private mHealth platform Value Network. In contrast, the Medical Expert Service Provider and the End User actors are the two smallest ones, whereby it seems clear that these two actors are at the end of the list. Since the market where the Medical Expert Service Provider operates, like already mentioned in the quantification section before, is a very new and less developed market with high potentials, it has not yet generated a high amount of revenues. When analyzing the End User this market seems also very small against all the other considered actors, but I tried to create a realistic view and due to the fact that especially the End User is nowadays overfilled with different devices, different apps and accordingly different use cases for all those devices and apps, it nevertheless may make the operating companies of the mHealth platform market happy, because they can still get a slice of the pie.

Now I want to analyze one of the major results of the Python scripts which shows how dependent a specific actor is on the Value Network and how strong his market power on the Private mHealth platform market is.

```
Entity 'Technical hardware vendor':
Dependency: 0.938577 | Supplier: 0.302624 | Customer: 0.302624 | Risk 0.33333

Entity 'eHealth hardware vendor':
Dependency: 0.999794 | Supplier: 0.333232 | Customer: 0.333232 | Risk 0.33333

Entity 'App developer':
Dependency: 0.984233 | Supplier: 0.325451 | Customer: 0.325451 | Risk 0.33333

Entity 'End user':
Dependency: 0.981952 | Supplier: 0.315305 | Customer: 0.333317 | Risk 0.33333

Entity 'Business payment services provider':
Dependency: 0.746167 | Supplier: 0.206419 | Customer: 0.206419 | Risk 0.33333

Entity 'Private payment services provider':
Dependency: 0.940725 | Supplier: 0.303698 | Customer: 0.303698 | Risk 0.33333

Entity 'Medical expert service provider':
Dependency: 0.999990 | Supplier: 0.333330 | Customer: 0.333330 | Risk 0.33333

Entity 'healthCOIN operator':
Dependency: 0.605180 | Supplier: 0.203630 | Customer: 0.068220 | Risk 0.33333

Entity 'Internet service provider':
Dependency: 0.911982 | Supplier: 0.289326 | Customer: 0.289326 | Risk 0.33333

Entity 'Mobile telco service provider':
Dependency: 0.813479 | Supplier: 0.240075 | Customer: 0.240075 | Risk 0.33333
```

You can see that the risk factor is always 0.333 for all the actors since I assumed that I don´t want to analyze the risk of each actor in this master's thesis. The dependency value of the risk factor of 0.333 was chosen because next to the risk factor also the supplier and customer dependency is part of the overall dependency and since I don´t want to get any bias trough the risk factor, I simply set him to 1/3. Especially interesting are the supplier and the customer dependency of each actor, whereby the supplier dependency represents the dependency of the incoming relationships to the respective actor and the customer dependency represents the dependency of the outgoing relationships of the respective actor. When summing up the supplier, the customer and the risk dependency, an overall dependency for each actor can be calculated - which represents the dependency of the respective actor on the Value Network.

The highest overall dependency within the Private mHealth platform Value Network of 0.999990 can be observed at the Medical expert service provider actor. He is a very small actor and is thus very dependent on the Value Network and has very less market power. When comparing this dependency value with the reality, the theory can be confirmed, because also in reality this actor is very small and insignificant whatever business key figure I analyze. This effect arises from the age of this market, but also from the players on the market, since they are all new players and some of them simply make their first business steps on the mHealth platform market. The actor has been included into the whole Value Network, because the business forecasts of this market show high expectations in the next years. In 2014 there were 19.7 million telehealth video consultations executed worldwide, but already in 2020 globally 158.4 million telehealth video consultations will be carried out, which is about an eightfold increase of consultations [193].

Next to the Medical Expert Service Provider also the eHealth Hardware vendor shows a high dependency of 0.999794 on the Value Network which is even as high as the dependency of the Medical Expert Service Provider. This high value comes from two main factors: the market size and the dependency of other actors. The eHealth Hardware vendor is operating on a pretty small market regarding the overall revenue which can be achieved globally and thus from a general perspective the market power of the whole market is smaller than the power of the other markets which leads to a generally low market power of each actor operating in this market. Next to this fact also the dependency of the eHealth Hardware vendor on the healthCOIN operator, which is - because of model design decisions - the only customer, is very high and since the healthCOIN operator has a very high market power it seems clear that all the actors who interact with him must have a high dependency on the Value Network.

Since the healthCOIN operator plays a major role within the Private mHealth platform Value Network it seems clear that he is the actor who has the lowest overall dependency and thus the highest market power. With an overall dependency of 0.605144 the healthCOIN operator is by far the actor with the lowest dependency. He has hence a great market position and has a great bargaining power against all the other actors since they are more dependent on the whole Value Network. Nowadays there exists in reality and also in my quantification model an overall number of 5 prestigious app platform providers [43] which represents an oligopoly, because an oligopoly is a market structure in which a small number of firms has the large majority of market share [302].

Such a market structure leads to the effect that the market competition between the single healthCOIN operators is also very low and the market positions of each healthCOIN operator may be already occupied.

After the healthCOIN operator, the Business Payment Service Provider and the Mobile Telco Service Provider show the smallest overall dependency values, whereby the Business Payment Service Provider has a value of 0.746167 and the Mobile Telco Service Provider a value of 0.813479. As described at the beginning of this section these two actors operate in a by far larger market than all the other actors of the Value Network and thus it can be concluded that this is the main reason for the low overall dependency on the Value Network which leads to a greater market power of these two actors against the other actors. In general, players on a global market, where the market is very large and has got a high amount of revenue, must of course have a very low market dependency since they can offer their products or services to multiple customers and when they exercise their market power in an appropriate way they might even choose which market segment they want to satisfy.

On the one hand it can be summarized that in general it will be reasonable for an actor of a Value Network to act on a large market regarding the overall revenue, because then the large relative market size in comparison to the other markets will support every single actor of this market in getting an even greater market power within the Value Network. If I assume such a high importance of a single market against the others in a Value Network constellation, this higher importance will actually bring benefits for all actors operating on such a market. An actor should thus concentrate on operating in a market in which high revenues can be achieved and especially in the Private mHealth platform Value Network an actor who has a high dependency on the Value Network, additionally can try to align his business in the direction of other market segments to expand his business focus and enlarge the market size of the market in which he operates to reduce his dependency on the Value Network. But the previous proposed measure is not always necessary to reduce the dependency, because even if the market size of e.g. the healthCOIN operator is small compared to some of the other market sizes, he has a low dependency on the Value Network. This phenomenon is explained in the subsequent paragraph which concerns business relationships of the actors in a Value Network. On the other hand it can be observed that each actor of a Value Network can benefit of multiple relationships to other actors. A single actor will have a lower dependency on the Value Network if he has a large number of business connections to other actors because his own business is then less dependent from the business of another single actor.

In the Private mHealth platform Value Network the healthCOIN operator has a large number of business interactions with other actors and this is the main reason of his low dependency on the Value Network even if the market size of the market in which he operates is not the largest one. An actor should hence try to create multiple relationships to other actors to reduce his own dependency on the Value Network and since in reality a greater number of relationships between the actors of the prospective Value Network exist, the results may vary. So it has to be again mentioned that the Private mHealth platform Value Network is only a model of the reality and thus, like every model, has its restrictions.

5.5.2. Public mHealth platform Value Network

5.5.2.1. Graphical Results

The previous coding section has already described that the Python scripts also offer the possibility to create a simple graphical representation of the Value Network, which includes some major graphical elements which, next to the calculated numbers, also show the most important results of the whole calculations in an easier and clearer way.

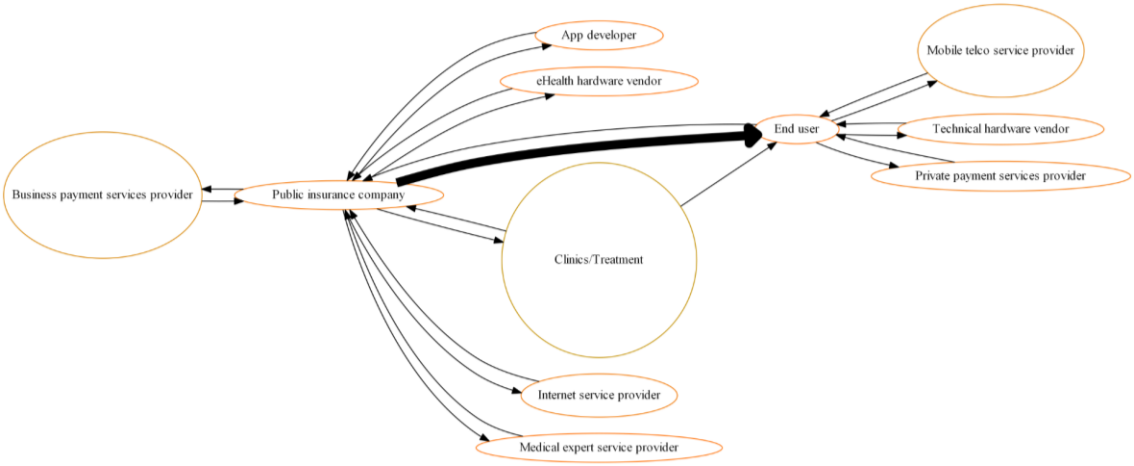

Figure 27: Public mHealth platform Value Network - Graphical result

The graphical representation of the Public mHealth platform Value Network via the Python scripts shows that the Clinics/Treatment is by far the actor who operates in the largest markets based on the global market revenue and that the Business Payment Service Provider and the Mobile Telco Service Provider are on the subsequent positions. Furthermore the colors show that the Clinics/Treatment, the Business Payment Service Provider and the Mobile Telco Service Provider have got the lowest overall dependency. Additionally the bold solid edge from the Public insurance company to the End User shows that this relationship is the most important within the Value Network.

5.5.2.2. Calculated Results

The major task of the Python scripts is the calculation of the overall dependency of each actor on the whole Value Network and this section describes the calculated results of the scripts. At the beginning it is necessary to show an overview which market sizes, based on the overall market revenues, were used as input for the quantification model since this overview shows which actors are the "largest" ones and may have the highest market power.

Actor	Global market revenue per year
Technical hardware equipment	232,920,990,000
eHealth hardware equipment	2,247,428,600
App developer	96,126,714,285
End user	1,222,044,052
Payment services (online = business)	1,532,331,292,931
Payment services (mobile = private)	358,600,000,000
Medical expert service	980,120,000
Internet service provider (business)	532,000,000,000
Mobile telco service provider (private)	1,038,000,000,000
Clinic/Treatment	2,370,167,000,000
Public insurance company	334,440,775,480

Table 22: Public mHealth platform Value Network - Market sizes

The above table was simply built together from the market size values of the quantification section of this master's thesis, but also the output of the Python scripts can - if desired - show the proportion of each market size of the sum of all the market sizes of the whole Public mHealth platform Value Network.

It can be summarized that especially the Clinic/Treatment is by far the largest actor in the Public mHealth platform Value Network. In contrast, the Medical Expert Service Provider and the End User actors are the two smallest ones like they already were in the Private mHealth platform Value Network. The reason why these two actors are the smallest ones in both Value Networks (Private & Public) was already described in the Calculated Results section of the Private mHealth platform Value Network.

Now I want to analyze one of the major results of the Python scripts which shows how dependent a specific actor is on the Value Network and how strong his market power on the Public mHealth platform market is.

```
Entity 'Technical hardware vendor':
Dependency: 0.963274 | Supplier: 0.314972 | Customer: 0.314972 | Risk 0.33333

Entity 'eHealth hardware vendor':
Dependency: 0.999873 | Supplier: 0.333271 | Customer: 0.333271 | Risk 0.33333

Entity 'App developer':
Dependency: 0.990570 | Supplier: 0.328620 | Customer: 0.328620 | Risk 0.33333

Entity 'End user':
Dependency: 0.999970 | Supplier: 0.333318 | Customer: 0.333322 | Risk 0.33333

Entity 'Business payment services provider':
Dependency: 0.848241 | Supplier: 0.257456 | Customer: 0.257456 | Risk 0.33333

Entity 'Private payment services provider':
Dependency: 0.964558 | Supplier: 0.315614 | Customer: 0.315614 | Risk 0.33333

Entity 'Medical expert service provider':
Dependency: 0.999990 | Supplier: 0.333330 | Customer: 0.333330 | Risk 0.33333

Entity 'Public insurance company':
Dependency: 0.963599 | Supplier: 0.313566 | Customer: 0.316704 | Risk 0.33333

Entity 'Internet service provider':
Dependency: 0.947374 | Supplier: 0.307022 | Customer: 0.307022 | Risk 0.33333

Entity 'Mobile telco service provider':
Dependency: 0.888484 | Supplier: 0.277577 | Customer: 0.277577 | Risk 0.33333

Entity 'Clinic/Treatment':
Dependency: 0.765211 | Supplier: 0.215941 | Customer: 0.215941 | Risk 0.33333
```

You can see that the risk factor is also in the Public mHealth platform Value Network 0.333 and the reason for this value was described in the Calculated Results section of the Private mHealth platform Value Network. Especially interesting at this point is thus the supplier and the customer dependency of each actor, whereby the supplier dependency represents the dependency of the incoming relationships to the respective actor and the customer dependency represents the dependency of the outgoing relationships of the respective actor. When summing up the supplier, the customer and the risk dependency, an overall dependency for each actor can be calculated - which represents the dependency of the respective actor on the Value Network.

The highest overall dependency within the Public mHealth platform Value Network of 0.999990 can once again be observed at the Medical expert service provider actor and since the business position of this actor hasn´t changed between the Private and the Public Value Network the explanations of the Private mHealth platform Value Network can be used to explain this high value.

Especially interesting in the Public mHealth platform Value Network is the high dependency of 0.999970 of the End User on the Value Network. The market size of the End User hasn´t been changed between the Private and the Public Value Network, but the greatest market size within the whole Value Network was increased, which leads to this higher value for the End User. Also the dependency of the focal actor, the Public insurance company, was raised to 0.963887, which was 0.605144 for the healthCOIN operator in the Private mHealth platform Value Network.

On the opposite side the actor with the lowest dependency on the Value Network is the Clinic/Treatment actor with an overall dependency value of 0.765211 which shows that this actor has a great market power. Since the Clinic/Treatment actor has the largest market size in the Public mHealth platform Value Network this is the main reason for his low overall dependency, but also the great number of business relationships of him makes him to the actor with the largest market power. Next to the Clinic/Treatment actor the Business Payment Service Provider and the Mobile Telco Service Provider show the smallest overall dependency values because of their market sizes, like they already did in the Private mHealth platform Value Network. The Business Payment Service Provider has a value of 0.848241 and the Mobile Telco Service Provider a value of 0.888484, whereby both values are higher than they were in the Private mHealth platform Value Network. This effect also comes from the large market size of the Clinic/Treatment actor which raises the dependency values of all of the other actors.

Finally the two derived reasons for a high or a low overall dependency values of each actor, which were described in the Calculated Results section of the Private mHealth platform Value Network, the market size and the number of business relationships, can also be identified for the Public mHealth platform Value Network which was shown through the analysis of specific actors before. It is hence very important to set realistic market sizes and justify why particular market sizes have been chosen. Next to the definition of the numeric market sizes, appropriate design decisions regarding the modeling of the Value Network and the therein included most important relationships have to be made since they are an important factor which can influence the calculated results strongly.

6 Summary

The whole topic of mobile health (mHealth) is very interesting since every human is concerned with any form of healthcare or treatment within his life and also the digitalized and mobile world nowadays affects everybody. Especially the new emerging trends on the subject of mobile health, keyword wearables, are increasingly becoming important and it will be necessary to explore the possibilities of those new approaches in a comprehensive manner. Together with preventive measures, the emerging trends can stop the trend of a rising number of widespread diseases, but also the mobile platforms, which can be seen as an essential building block of mHealth, are one of the factors that can determine the success or failure of the current ideas and therefore have to be analyzed comprehensively.

This master's thesis analyzed possible market constellations on the preventive mHealth platform market through Value Networks and concentrated on two different scenarios, a private-funded and a mainly public-funded one. Major differences between those two studies were the actors and their relationships to other actors within the respective Value Network. In a first step it was necessary to decide how to build up the Value Networks and especially the PRECIOUS project [100] helped to get a first understanding of possible market constellations. A well-conceived quantification model for Value Networks of Patrick Zwickl and Peter Reichl [98] was chosen to calculate the different relationships and market powers of each actor within the Value Network and the model framework approach for Value Networks of Casey, et al. [74] supported the graphical representation of Value Networks.

In a further step the calculated results were analyzed and the main findings of the two chosen Value Networks have been as follows: If an actor of a Value Network acts on a large market regarding the overall revenue and has a high market share, it has great benefits for him regarding greater market power within the Value Network and less dependency on the Value Network. Furthermore an actor can benefit of multiple relationships to other actors. A single actor will have a lower dependency on the Value Network if he has a large number of business connections to other actors because his own business is then less dependent from the business of another single actor.

7 Future Work

The ideas and findings of this master's thesis provide already good results which can be used for further research and development on the analysis of Value Networks on the preventive mHealth platform market. Since the scope of this thesis was limited, the whole analysis and the outcoming results had to be stopped at a certain point.

In the future it will hence be necessary to evaluate or even redesign the approach of this master's thesis, whereby especially the design decision part has to be further elaborated. This thesis focused only on two possible Value Network constellations, but in reality a few more or even broader structures may exist, which also have to be analyzed to strengthen the results of this master's thesis.

In a next step it is also possible to gather and calculate further market data to get a more comprehensive understanding of the market and to increase the accuracy of the calculated results. I consciously decided for this master's thesis to create analyses which always have a global view, but with a more detailed analysis of different regions the outcomings may have been even more interesting, since also the health sector in general shows different conditions depending on the region which is analyzed. Furthermore, the aggregated results of single regions may show other results than a purely worldwide analysis, where some regions may be ignored or average values of adjacent regions are used.

It should be noted that the exact results of the reality will never be achieved, since the market data, which has to be used for the whole quantification of Value Networks of the mHealth platform market, is always based on statistics which include fuzziness, uncertainty and estimates, with what it is necessary to concentrate on collecting data from different sources to get more reliable results.

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9 Appendix

9.1. Extended calculations

9.1.1. Payment service provider (PSP)

Payment service provider (PSP) - Global market volume			
	Metric	**Value**	**Source**
(1)	Mobile payment transaction market worldwide 2014	$ 392 billion	[171]
(2)	Mobile payment transaction market worldwide 2014	$ 325.2 billion	[172]
(3)	**Average mobile payment transaction market worldwide 2014**	**$ 358.6 billion**	**[calculated average from (1) and (2)]**
(4)	PayPal total mobile payment volume 2014	$ 46 billion	[174]
(5)	PayPal total payment volume 2014	$ 234.64 billion	[175]
(6)	Proportion of PayPal mobile payment transactions of overall online payment transactions	19.6045 %	[calculated proportion of (4) and (5)]
(7)	Proportion of mobile payment transactions of overall online payment transactions	27.2 %	[173]
(8)	Average share of mobile payment transactions of overall online payment transactions	23.40225 %	[calculated average from (6) and (7)]
(9)	**Online payment transaction market worldwide 2014**	**$ 1532 billion**	**[calculated from (3) and (8)]**

Table 23: Payment service provider (PSP) - Global market volume

9.1.2. Internet service provider (ISP)

Internet service provider (ISP) - Net profit margins	
Provider	**Net profit margin in 2014**
AT&T	4.7 % [206]
Centurylink	7.57 % [207]
Cogent Communication	0.21 % [208]
Deutsche Telekom	4.67 % [209]
GTT	-11.11 % [210]
Level3 Communications	4.63 % [211]
NTT	10.42 % [212]
Orange SA	2.34 % [213]
Tata Communications	0.52 % [215]
Telecom Italia	6.26 % [216]
TeliaSonera	14.35 % [217]
Verizon	7.57 % [218]
Average	**4.34 %**

Table 24: Internet service provider (ISP) - Net profit margins

Internet service provider (ISP) - Contracts			
Provider	**Type**	**Download speed**	**Costs per month**
AT&T	Broadband	up to 25 Mbit/s	$ 93.19 [221]
AT&T	Broadband	up to 45 Mbit/s	$ 113.90 [221]
AT&T	Broadband	up to 75 Mbit/s	$ 134.61 [221]
Verizon	Broadband	up to 25 Mbit/s	$ 67.29 [222]
Verizon	Broadband	up to 50 Mbit/s	$ 93.18 [222]
Verizon	Broadband	up to 75 Mbit/s	$ 119.06 [222]
Verizon	Broadband	up to 150 Mbit/s	$ 191.54 [222]
DE Telekom	Broadband	up to 16 Mbit/s	$ 39.46 [223]
DE Telekom	Broadband	up to 50 Mbit/s	$ 45.11 [223]
Telia	Broadband	up to 20 Mbit/s	$ 29.51 [224]
Telia	Broadband	up to 30 Mbit/s	$ 32.53 [224]
Telia	Broadband	up to 50 Mbit/s	$ 35.56 [224]
Tata	Broadband	up to 20 Mbit/s	$ 68.27 [225]
Tata	Broadband	up to 100 Mbit/s	$ 91.03 [225]
TIM	Broadband	up to 30 Mbit/s	$ 56.46 [226]
TIM	Broadband	up to 100 Mbit/s	$ 62.10 [226]
Orange	Broadband	up to 100 Mbit/s	$ 38.39 [227]
Orange	Broadband	up to 200 Mbit/s	$ 44.04 [227]
Orange	Broadband	up to 500 Mbit/s	$ 48.55 [227]
Centurylink	Broadband	up to 20 Mbit/s	$ 36.19 [228]
Vodafone	Broadband	up to 17 Mbit/s	$ 32.91 [229]
Vodafone	Broadband	up to 38 Mbit/s	$ 47.89 [229]
Vodafone	Broadband	up to 78 Mbit/s	$ 55.37 [229]
Tele2	Broadband	up to 24 Mbit/s	$ 42.07 [230]
Tele2	Broadband	up to 30 Mbit/s	$ 48.10 [230]
Tele2	Broadband	up to 60 Mbit/s	$ 54.15 [230]
Average			**$ 64.08**
Average / 1GB			**$ 0.64**

Table 25: Internet service provider (ISP) - Contracts

9.1.3. Mobile telco service provider (MTSP)

Mobile telco service provider (MTSP) - Net profit margins	
Provider	**Net profit margin in 2014**
America Movil	5.41 % [233]
Axiata	12.55 % [234]
Bharti Airtel	3.23 % [235]
China Mobile	17.04 % [236]
China Telecom	5.45 % [237]
China United	1.38 % [238]
MTN Goup	21.83 % [239]
Orange SA	2.34 % [240]
Telefonica	5.96 % [241]
Telenor	9.71 % [242]
Vimpelcom	-3.52 % [243]
Average	**7.40 %**

Table 26: Mobile telco service provider (MTSP) - Net profit margins

Mobile telco service provider (MTSP) - Global market revenue	
Global Mobile Telecommunication Services revenue	**Source**
$ 957 billion in 2013	[245]
$ 887 billion in 2013	[246]
$ 1140 billion in 2014	[247]
$ 979 billion in 2014	[245]
$ 1466 billion in 2014	[248]
$ 919 billion in 2014	[246]
$ 1001.5 billion in 2015	[245]
$ 954 billion in 2015	[246]
Average of $ 1038 billion in 2014	

Table 27: Mobile telco service provider (MTSP) - Global market revenue

Mobile telco service provider (MTSP) - Contracts				
Provider	**Nation**	**Data volume**	**Contract bond**	**Price per month for 1GB**
China Mobile	HK&CHN	3GB	24 months	$ 10.10 [249]
China Mobile	HK&CHN	6GB	24 months	$ 6.38 [249]
China Mobile	HK&CHN	8GB	24 months	$ 6.61 [249]
China Mobile	HK&CHN	10GB	24 months	$ 5.56 [249]
Vodafone	GER	2GB	24 months	$ 18.34 0
Vodafone	GER	4GB	24 months	$ 10.58 0
Vodafone	GER	8GB	24 months	$ 7.41 0
Bharti Airtel	IND	1GB	0 month	$ 60.69 [251]
Bharti Airtel	IND	2GB	0 month	$ 60.69 [251]
Claro (Amerca Movil)	PERU	1GB	0 month	$ 8.88 [252]
Claro (Amerca Movil)	PERU	2GB	0 month	$ 8.88 [252]
China Unicom	CHN	1GB	0 month	$ 25.89 [253]
China Unicom	CHN	2GB	0 month	$ 18.12 [253]
China Unicom	CHN	3GB	0 month	$ 15.53 [253]
China Unicom	CHN	6GB	0 month	$ 13.81 [253]
Celcom (Axiata)	MALAY	2GB	0 month	$ 5.52 [254]
Celcom (Axiata)	MALAY	5GB	0 month	$ 3.92 [254]
Movistar (Telefonica)	ESP	1GB	12 months	$ 7.90 [255]
Movistar (Telefonica)	ESP	2GB	12 months	$ 10.16 [255]
Movistar (Telefonica)	ESP	5GB	12 months	$ 10.16 [255]
MTN Nigeria	NIG	1,5GB	0 month	$ 12.08 [256]
MTN Nigeria	NIG	4,5GB	0 month	$ 7.48 [256]
MTN Nigeria	NIG	7,5GB	0 month	$ 5.52 [256]
Beeline (Vimpelcom)	RUS	1GB	0 month	$ 2.60 [257]
Beeline (Vimpelcom)	RUS	2GB	0 month	$ 2.60 [257]
Beeline (Vimpelcom)	RUS	5GB	0 month	$ 1.56 [257]
Beeline (Vimpelcom)	RUS	10GB	0 month	$ 1.95 [257]
Orange	FRA	1GB	12 months	$ 16.93 [258]
Orange	FRA	4GB	12 months	$ 9.31 [258]
Orange	FRA	8GB	12 months	$ 5.64 [258]
Telenor	NOR	1GB	0 month	$ 29.56 [259]
Telenor	NOR	3GB	0 month	$ 11.83 [259]
Telenor	NOR	4GB	0 month	$ 10.36 [259]
Telenor	NOR	6GB	0 month	$ 7.89 [259]
Telenor	NOR	12GB	0 month	$ 5.45 [259]
Average				**$ 12.74**

Table 28: Mobile telco service provider (MTSP) - Contracts

9.1.4. End user

End user - mHealth population approach		
Global population between 15 and 64	4,723,199,961	[260]
Global proportion of Non-diabetic	91 %	[4]
	4,298,111,964	
Global proportion of internet users	40.4 %	[261]
	1,736,437,233	
Proportion of internet users with a health app mobile device (at least a smartphone)	80 %	[262]
	1,389,149,786	
Smartphone owners who download and use mHealth apps	58 %	[263]
	805,706,876	
Proportion of chargeable “Health & Fitness” and “Medical” apps	12.5 %	[129]
	100,713,359	
Average price of “Health & Fitness” and “Medical” apps of the Apple App Store and the Google Play Store	$ 6.30	[129] [130]
Global revenue of “Health & Fitness” and “Medical” app downloads	**$ 634,494,162**	

Table 29: End user - mHealth population approach

End user - Downloaded apps approach		
Downloaded apps in 2014	36.747 billion	[264]
Proportion of “Health & Fitness” and “Medical” downloaded apps	6.26 %	[27]
	2,300,362,200	
Proportion of chargeable “Health & Fitness” und “Medical” apps	12.5 %	[129]
	287,545,275	
Average price of “Health & Fitness” and “Medical” apps of the Apple App Store and the Google Play Store	$ 6.30	[129] [130]
Global revenue of “Health & Fitness” and “Medical” app downloads	**$ 1,811,535,232**	

Table 30: End user - Downloaded apps approach

9.1.5. Public insurance company

Public insurance company - Global average monthly wage	
Global average monthly wage	$ 1600 [265]
Global average monthly wage	$ 1480 [266]
Average global average monthly wage	**$ 1540**

Table 31: Public insurance company - Global average monthly wage

Public insurance company - Global social security rate per individual (percentage)			
Region	**Proportion of worldwide population [267] [268]**	**Social security rate per individual**	**Social security rate per individual weighted with population**
Europe	10.11 %	10.9821 % [269]	1.1103 %
America	13.46 %	7.1463 % [270]	0.9619 %
Asia+Oceania	60.49 %	5.9790 % [271]	3.6167 %
Africa	15.96 %	4.5642 % [272]	0.7284 %
Global			**6.4173 %**

Table 32: Public insurance company - Global social security rate per individual (percentage)

Public insurance company - Global social security spending per month per individual (absolute)	
Average Global average monthly wage	$ 1540 [Table 31: Public insurance company - Global average monthly wage]
Global social security rate per individual	6.4173 % [Table 32: Public insurance company - Global social security rate per individual (percentage)]
Social security spending per month per individual	**$ 98.83**

Table 33: Public insurance company - Global social security spending per month per individual (absolute)

Public insurance company - Global social security spending per month (absolute)	
Social security spending per month per individual	$ 98.83 [Table 33: Public insurance company - Global social security spending per month per individual (absolute)]
Global labour force	3,384,107,327 [273]
Social security spending per month	**$ 334,440,775,480**

Table 34: Public insurance company - Global social security spending per month (absolute)

Public insurance company - Net profit margins			
Region	**Public insurance company**	**Population [268]**	**Net profit margin**
China	People's Insurance Company of China [274] China Life Insurance Company [275]	1,376,048,943	5.36 %
India	New India Assurance [276] National Insurance [277] Oriental Insurance Company [278] United India Insurance Company [279] Agriculture Insurance Company of India [280]	1,311,050,527	5.67 %
Europe	- [291] [292] [293] [294]	738,442,070	0 %
USA	Aetna [281] American Family Insurance [282] Bankers Life [283] Kaiser Permanente [284] Mutual of Omaha Insurance Company [285] Premera Blue Cross [286] Thrivent Financial [287]	321,773,631	4.48 %
Indonesia	Asuransi Jasindo [288]	257,563,815	6.65 %
Japan	Japan Post Insurance Co [289]	126,573,481	0.56 %
Philippines	Philippine Health Insurance Corporation [290]	100,699,395	5.38 %
Global			**4.70 %**

Table 35: Public insurance company - Net profit margins

9.1.6. Clinic/Treatment

Clinic/Treatment - Number of hospitals (WHO)	
Region	**Number of hospitals according to WHO program [297]**
Africa	949
Americas	5669
Eastern Mediterranean	1485
Europe	5998
South East Asian	1188
Western Pacific	3216
Sum	**18505**

Table 36: Clinic/Treatment - Number of hospitals (WHO)

Clinic/Treatment - Proportion of hospitals (Maps Of World & WHO)			
Country	**Number of hospitals according to Maps Of World [296]**	**Number of hospitals according to WHO program [297]**	**Proportion of WHO and Maps Of World**
China	69105	201	0,002909
India	15067	644	0,042742
Vietnam	12500	77	0,00616
Nigeria	11588	278	0,02399
Russia	11200	11	0,000982
Japan	9413	51	0,005418
Egypt	7411	91	0,012279
South Korea	6446	4	0,000621
Brazil	6410	556	0,086739
USA	6097	2932	0,480892
Average			**0,066273**

Table 37: Clinic/Treatment - Proportion of hospitals (Maps Of World & WHO)

Clinic/Treatment - Number of hospitals (Maps Of World & WHO)	
Number of hospitals according to WHO program	**Proportion of hospitals (Maps Of World & WHO)**
18505 [Table 36: Clinic/Treatment - Number of hospitals (WHO)	0,066273 [Table 37: Clinic/Treatment - Proportion of hospitals (Maps Of World & WHO)]
Number of hospitals	**279,224**

Table 38: Clinic/Treatment - Number of hospitals (Maps Of World & WHO)