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VALUE CREATION IN VIRTUAL AND AUGMENTED REALITY

Master of Science thesis

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ABSTRACT

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The technologies of virtual and augmented reality (VR/AR) have huge potential and their market value has been predicted to reach $100 billion within the next few years. However, the lack of peer-reviewed literature and the media-hype concerning these new technologies makes it difficult to tell the difference between quality information and exaggerated expectations. Therefore, there is a need for research about VR/AR solutions and the value potential they propose.

In this study the case study method was applied, together with a method called the business model canvas, to answer the research question: how do enterprises create value with VR/AR solutions and how this value can be communicated? Material was collected from multiple sources and qualitatively analysed to form 10 different VR/AR related business models from 5 different industries. The goal was to examine the key value creation processes in VR/AR business models.

As a result, each individual VR/AR business model case had their own specific insights about how enterprises create value with VR/AR. However, when analysed together, the 10 business model cases also revealed common themes of value creation of VR/AR solutions as a whole. The most important value creation opportunities of the technologies lie within their ability to: 1) provide more engaging experiences as well as the possibility to create more engaging content, 2) improve previous graphical user interfaces by eliminating complexity, 3) reduce costs by transforming physical resources to virtual resources, and 4) improve communication and collaboration. In addition, companies can support these value creation opportunities with various business model processes that fit the current state of the VR/AR business ecosystem.

The business model canvas works well as a method for communicating the value creation process of VR/AR enterprises. In addition, the method is suitable for creating new VR/AR business models and/or improving existing ones. However, the lack of common practices and transparency in how the method is used can often diminish its value as a communication and collaboration tool. This study proposes one possible way to use the business model canvas. However, there exists a need for further research regarding the business model canvas and how it should be used in both business and research context.

TIIVISTELMÄ

Joel Vanhalakka: Arvonluonti virtuaalitodellisuuden ja lisätyn todellisuuden avulla
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Virtuaalitodellisuuden ja lisätyn todellisuuden teknologioilla on valtava potentiaali: markkinoiden arvon ennustetaan saavuttavan 100 miljardia dollaria muutaman vuoden kuluessa. Vertaisarvioidun tutkimuksen puutteen ja uusiin teknologioihin liittyvän mediahypen takia laadukasta informaatiota ja liioiteltuja odotuksia on vaikea erotella toisistaan. Siksi tarvitaan tutkimusta VR/AR-sovelluksista ja niiden arvopotentiaalista.

Tässä tutkimuksessa tapaustutkimusmenetelmän ja liiketoimintamallikanvaasin (eng. the business model canvas) avulla haettiin vastausta seuraavaan tutkimuskysymykseen: Kuinka yritykset luovat arvoa VR/AR-sovellusten avulla ja kuinka tämä arvo voidaan viestiä? Materiaalia useista lähteistä keräämällä ja analysoimalla muodostettiin 10 erilaista VR/AR-ratkaisuihin liittyvää liiketoimintamallia 5:ltä eri toimialueelta. Tavoite oli tutkia keskeisiä arvonluonnin prosesseja VR/AR-liiketoimintamalleissa.

Työssä kullekin yksittäiselle VR/AR-liiketoimintamallitapaukselle löytyi omat tapauskohtaiset löydöksensä. Kun kymmentä liiketoimintamallia analysoitiin yhdessä, esille nousi yhteisiä VR/AR-sovellusten arvonluontiin kokonaisuudessaan liittyviä teemoja. Tärkeimmät arvonluonnin mahdollisuudet liittyvät teknologioiden kykyyn: 1) tuottaa sitouttavampia ja kokonaisvaltaisempia kokemuksia sekä sisältöjä, 2) kehittää graafisia käyttöliittymiä monimutkaisuutta poistamalla, 3) vähentää kuluja muuntamalla fyysisiä resursseja virtuaalisiksi resursseiksi, ja 4) kehittää kommunikaatiota ja yhteistyötä. Näitä arvonluonnin mahdollisuuksia yritykset voivat tukea erilaisilla liiketoimintamalliprosesseilla, jotka sopivat hyvin yhteen olemassa olevien VR/AR-liiketoiminnan ekosysteemien kanssa.

Liiketoimintamallikanvaasi on hyvä ja toimiva metodi tiedon välittämiseen VR/AR-yritysten arvonluontiprosesseista, uusien VR/AR-liiketoimintamallien luomiseen ja/tai jo olemassa olevien mallien parantamiseen. Metodin käyttöön liittyvä yleisten käytäntöjen ja läpinäkyvyyden puute voi kuitenkin usein vähentää sen arvoa kommunikaation ja yhteistyön välineenä. Tämä tutkimus nostaa esille yhden mahdollisen tavan hyödyntää liiketoimintamallikanvaasia. Tarvitaan kuitenkin lisää tutkimusta siitä, kuinka liiketoimintamallikanvaasia pitäisi käyttää sekä liiketoiminnan että tutkimuksen välineenä.

PREFACE

This thesis was made throughout the year 2017 and early 2018 as part of the research project VIRJOX, exploring the new possibilities of virtual and augmented reality.

It has been a great opportunity to explore the development of these novel technologies. During the research process I have had the chance to see and learn how businesses and business models evolve in the case of emerging technologies.

The thesis work has often been challenging because scientific research related to the technologies of VR/AR is still in its infancy. However, a challenging subject has also been an excellent opportunity to learn. I would like to thank my thesis instructors Ilona Ilvonen and Nina Helander for pushing me to make a work of high quality. Special thanks for Ilona Ilvonen for patiently teaching me how to be precise and how to motivate my argumentations. In addition, I would like to thank the two proof-readers I had back home, with a special remark for my dear academically oriented mother, for questioning every stage of my research, thus motivating me to make everything bullet-proof for objections.

Tampere, 18.02.2018

Joel Vanhalakka

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ABBREVIATIONS

VR/AR	Virtual and Augmented Reality. VR immerses you in a virtual environment and AR augments your reality by adding data and objects into it (Riva et al. 2016).
HMD	Head-Mounted Display, for example, HTC Vive. There are many different models, however, their key goal is to present information to the user in a hands-free manner directly in the user's field of view (Rijnsburger and Kratz 2017)
MR	Mixed Reality. The concept of MR is a combination of the concepts of VR and AR. The definition exists somewhere between them (Milgram et al. 1994), therefore, a true MR device is a device that can achieve both, immerse the user in a virtual environment and/or augment real environment with digital data and objects.
IP	Intellectual Property. Knowledge that is recognized and protected by law, through the use of, for example, patents and/or copyrights, and can be given a monetary value (Park and Allaby 2017).
IT	Information Technology. Computers and other electronic means of processing and distributing information (Law 2016).
CPU	Central Processing Unit. A computer component (Butterfield and Ngondi 2016).

1. INTRODUCTION

Since the public release of virtual reality (VR) head-mounted displays (HMDs) such as the Oculus Rift and HTC Vive in 2016, and the commercial success of the mobile augmented reality (AR) game Pokémon Go, the technologies of VR/AR have been increasing their market value fast. The potential of the technologies is huge and their market value has been estimated to reach $100 billion during the next decade (Bellini et al. 2016; IDC 2016; Digi Capital 2017a). This potential is explained by comparing VR/AR to PC's and smartphones: like the easy to use mobile technologies of today that took people's virtual desktops from their homes to their pockets, VR/AR can re-create the same virtual desktops to people's surroundings, without confining them to the size of the physical screens (Bellini et al. 2016; Scoble and Israel 2017). However, since the core applications of VR/AR were only recently published to wider audiences, scientific research related to the technologies is still scarce. The technologies have received a lot of attention in the media, but with commercial publications it can often be difficult to discern between quality information and "hype" surrounding the technologies. Therefore, there exists a need for an overviewing study about the technologies of VR/AR that can discern between false expectations and the real value potential the technologies propose.

1.1 Research background and motivation

This study is a part of VR/AR research project VIRJOX, which aims to ideate, create, develop and evaluate innovative service concepts, service environments, and journalistic storytelling concepts for VR/AR in real usage contexts (VIRJOX 2017). The project is funded by Tekes, the Finnish Funding Agency for Innovation, and as such the results of the project aim to create long-term benefits for the local economy and society. Studying value creation in VR/AR has been a research agenda of VIRJOX since summer 2016. However, before starting to analyse the concepts of value and value creation in VR/AR, understanding the characteristics of technologies required a lot of field work, ranging from company visits to industry events and professional interviews. As a part of this "field work", a scientific research paper called "Utilizing Knowledge Networks in Virtual and Augmented Reality Solution Creation" was written (Vanhalakka et al. 2017). This paper provided insight into the current state of the local VR/AR industry and helped in refining the methodology and research questions of this study.

The problem about hype with emerging technologies is that it can create false promises about the future capabilities of their future capabilities. These expectations can cause a lot of investments, however, they can set the markets on a false trajectory, based on a wrong premise and thus slow down the development of the technologies (Geiger and

Gross 2017). Many investors and enterprises realize this and thus remain skeptical towards emerging technologies until sufficient proof has been provided. This is a problem, since the use of VR/AR could already provide advantages to many industries and since it will become a key source of competitive advantage for many in the future, companies should already be experimenting with the technology and its possibilities. The lack of public knowledge regarding the technologies is also a problem for companies and start-ups developing VR/AR solutions, since it makes it difficult for them to find potential partners and customers. These problems may be connected to each other; VR/AR start-ups have a problem with communicating their value, or targeting the right customer, therefore, enterprises/investors do not see the necessary incentive to collaborate. Thus, the problem is not only about what is the value potential of VR/AR solutions, but also about how this value can be communicated.

1.2 Research questions

This study seeks to address what is the value potential of VR/AR solutions. However, due to the subjective nature of value (Sánchez-Fernández and Ángeles Iniesta-Bonillo 2007; Grönroos and Voima 2013), the question is not only about "what is the value?", but about "what is the value and who is it being created for?". In addition to answering what is the value, this study also seeks to address how this value can be communicated, since 1) VR/AR solution creators could benefit from a new way to communicate how they create value to both their partners and customers and 2) there are not yet many studies that connect the newer theories and conceptualizations of value and value creation to practical methods. Therefore, to provide both practical results for the VR/AR industry and to provide some insight into how the current theories of value creation reflect upon practical methods that analyze value creation, a main research question was formulated:

- **How do enterprises create value with VR/AR solutions and how this value can be communicated?**

The formulation of this research question was complex due to the multi-faceted nature of value and is explained more thoroughly in section 3.5, analyzing enterprise value creation. To summarize, value is subjective, therefore, when analyzing value creation, it is important to ask who the value is being created for. The scope of this research is intentionally set to enterprises, because the aim is to produce industry wide results. It should also be mentioned that analyzing value creation on enterprise level also provides answers to what value VR/AR solutions provide to single customers or users, however, in a more aggregated form than for example, what could be achieved with a customer research regarding a single VR/AR solution. The aim is not to analyse every single aspect of how companies create value with VR/AR solutions, but to identify the key aspects in the value

creation process. The objective is to create understanding about the value of VR/AR solutions in general and provide insight into how enterprises create value with the help of these solutions (i.e. how value is created, delivered and captured).

1.3 Research structure

Chapter 2 is about VR/AR. The chapter gives a definition of both technologies, explains how their business ecosystem operates and identifies some of their key actors. In addition, it discusses the current problems and limitations of technology that need to be solved before it can reach mass markets. It also sheds light on mixed reality and how it is related to the future of VR/AR.

Chapter 3 introduces the theoretical concepts of this study: value, value creation, business models and the business model canvas. In addition, this chapter explains how these different concepts are related to each other, the formulation of the research question and why the visualization method, the business model canvas, was chosen to analyze value creation in enterprise context.

Chapter 4 explains the research methodology and the choices made regarding the research. These choices include the research philosophy, the research approach, the research strategy, and the data analysis and collection method. An especially important section is the section 4.4, as it explains how the business model canvas is used as a method for both data collection and analysis. In addition, the section explains how the different canvas models were built and how these models are later presented.

In Chapter 5, the case study method is used together with the business model canvas, and 10 different business cases from 5 different industries are presented. In addition to presenting the cases, each business model case has its own specific key findings.

Chapter 6 presents a summarization of the empirical findings from the 10 business model cases and discusses how these findings were made. The chapter has many examples that relate the identified concepts to the business models of the previous chapter.

Chapter 7 presents the results of this study. It presents the answers relating to how enterprises create value with VR/AR and the answers to the question regarding how this value can be communicated. In addition, the chapter discusses the theoretical implications of the study and evaluates its success. The final section of the chapter is concerned with the limitations of the study and identifies possibilities for future research.

2. VIRTUAL AND AUGMENTED REALITY

VR/AR technology is not a new phenomenon. However, within the last few years, major advances have taken place in the development of the VR/AR, such as the public release of head-mounted displays (HDMs) and the integration of the technology with handheld devices. VR has already passed the stage of early adaptation and AR is following close behind. The current Gartner's hype cycle (2016), Figure 1, predicts that the mainstream adaptation of VR/AR is taking place within the next 5-10 years. More important, VR has already reached the slope of enlightenment, meaning that VR enterprises are already experiencing net benefits and that the technology is beginning to be socialized (Dedehayir and Steinert 2016). The technologies have the potential to become the next computing platform and can change the way things are done, from watching a movie to purchasing a product online (Bellini et al. 2016). This makes VR/AR important to any industry.

Figure 1. Hype cycle for emerging technologies (Gartner 2016)

As mentioned before, scientific research relating to the field of VR/AR is still scarce. Therefore this chapter is supplemented with public materials, such as, for example, the VR/AR industry reports from Goldman Sachs (Bellini et al. 2016), IDC (IDC 2016) and Digi Capital (Digi Capital, 2017a and 2017b). The validity of these references is critically assessed by comparing the references with each other and making sure that the authors provide enough logical proof for the arguments used. Section 2.1 introduces the different characteristics of VR/AR. Section 2.2 exemplifies the business ecosystem of VR/AR.

Section 2.3 discusses the current problems and limitations of the technology. The final section, 2.4, discusses the future of the technology and the concept of mixed reality.

2.1 The definition of VR/AR

Although the terms VR and AR often come up in scientific literature, they are rarely given a specific definition. The most fitting definition in the context of this research and in the views of the current VR/AR industry professionals, comes from Milgram et al. (1994), who introduced the "Reality-Virtuality Continuum" (Figure 2).

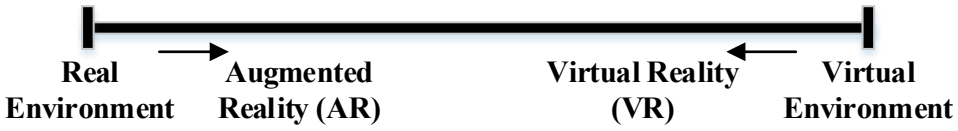

Figure 2. Reality-Virtuality Continuum (inspired by Milgram et al. 1994)

While VR is something that immerses you in a "virtual environment", AR augments what you see around you in your "real environment", for example, with computer generated images and data. As complete VR would mean that the user would be completely be isolated from the real world (e. g. laws of physics, physical reality), the used concept of VR exists somewhere on the right side of the continuum. This means that there is a relationship between the two terms, and instead of viewing the two concepts as antitheses, they should be viewed as the opposite ends of a continuum, as introduced in Figure 2.

One of the most recognizable examples of VR are flight simulators. VR cockpits, that imitate the innards of real airplanes have already existed for decades (Oberhauser and Dreyer 2017). Flying planes is expensive and the use of computer-assisted methods is a way of saving resources and, for example, training pilots in a safe way. At the beginning these applications were very simple; consisting from a 'cockpit' and computer screens with very simple graphics. Today, there is no requirement for building a mock-up of a cockpit. For realistic cognitive experience, users can wear a virtual reality headset and audio headphones to enter a photorealistic computer-generated environment of a desired plane cockpit and fly the plane using a controller. This can be described as a VR experience. However, this is only utilizing 2 of our 5 senses: sight and hearing. The experience can be made even more realistic with the help of haptics, for example, gloves that imitate the reactive force in response to touching objects in VR (James 2017). While the complete experience of taste, sight, touch, smell and hearing in a virtual environment is still years away, there are already companies developing solutions for each of the senses. This is also linked to one of the problems of VR: simulation sickness, which refers to the phenomenon caused by the mismatch of visual stimulus and other senses (Oberhauser and Dreyer 2017).

While AR applications have existed from as early as 1968 (Arth et al. 2015), the term has only recently become mainstream because of advances in information and mobile technologies. Commercially, the most known application and example of augmented reality is Pokémon GO. This game, released for Android and iOS smart devices in 2016, combined augmented reality with location based massively multi-player features (Shea et al. 2017). The game is about catching virtual creatures called Pokémon. However, instead of sitting in front of a screen at home, the game uses a geographically accurate map and real world locations, for example, monuments and museums, that the player is required to physically visit in order to progress in the game (Raj et al. 2016). In addition, players can turn on an option, which utilizes the smart phone's camera and enables "seeing" the Pokémon in the real-life environment. Pokémon GO is only a simple example of what AR can do, however, it encompasses the idea of what AR is: combing real environments with computer generated data. In the future, AR has the potential to take the current generation of physical computer displays and to transfer them into pocket-sized devices. These devices could display the same information, however, instead of using a traditional screen for display, the information can be displayed in the field of view of the users.

While the two technologies are very similar, there is one key difference that separates them from each other: immersion. Currently, VR technologies are more advanced and can be used to create more realistic experiences. As such, the possibilities the technology offers, for example, in industrial trainings or simulations are still often better than what can be achieved with AR. However, as AR technologies become more advanced and more available, many of the VR solutions can also be achieved with AR. Therefore, in the future, what separates the choice between which technology to use for a solution is, whether the experience can gain additional value from immersion (VR) or presence (AR). In fact, in many cases "presence" is requirement. For example, fixing an elevator requires being present and can be assisted with the help of information provided by an AR headset. This, "AI assisted presence" is the key reason, although rarely articulated, why the market impact and importance of AR will be bigger than VR.

2.2 The business ecosystem of VR/AR

Within the current VR/AR industry, it is important to understand that, while its potential applications and solutions could reach a wide variety of industries, there is currently only a handful of companies that manufacture the core devices required for VR/AR content. These core device manufacturers are supported by component manufacturers, who make the various parts required for the VR/AR devices varying from cameras, to graphics, to memory and to processors.

Although these device manufacturers are also creating content, a bulk of the content comes from separate content creators that can be anything from single users to large enterprises. There exists a co-dependency between the core device manufacturers and con-

tent creators: without the devices, content creators cannot create content and without content, the devices are not attractive to the customer. This may seem like a trivial fact, as it can be seen in a multitude of different industries, however, in the light of this research, it is important to look at VR/AR as a large network of supplier-customers that are providing value to each other. This business ecosystem is visualized in Figure 3.

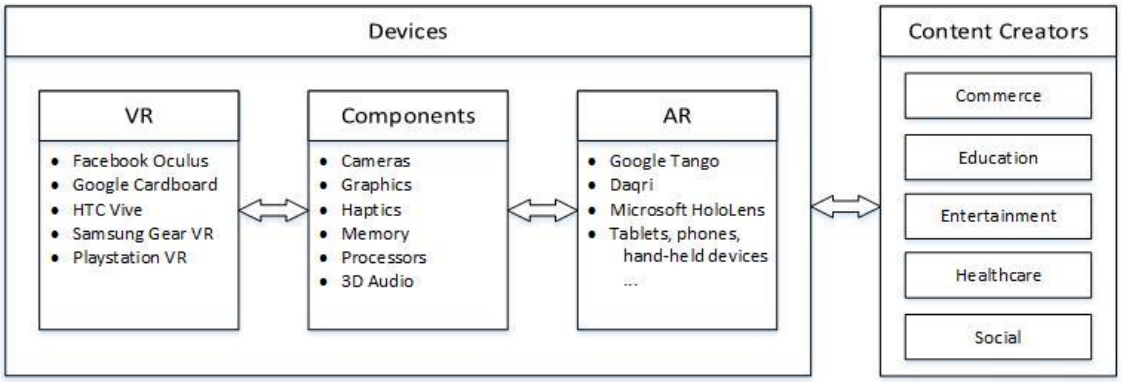

Figure 3. A simple representation of the VR/AR ecosystem (Vanhalakka et al. 2017)

At the centre of the business ecosystem are the most important actors of VR/AR: the various device manufacturers. These companies are important to know, since they are currently driving the VR/AR business ecosystem. As component manufacturers are mostly the same as with basic computing (except for haptics), listing all the different manufacturers is not important. VR's biggest names are the manufacturers of the two main HMDs on the market: Facebook Oculus and HTC Vive (Digi Capital 2017b). For reference, the current manufacturer retail price of Oculus Rift is 399$ and the price of HTC Vive is 599$ (August 2017). In addition to the actual price of the HMD device, a high-end computer is required. The current AR HMDs such as the Microsoft Hololens and Daqri Smart Helmet are carrying an even heftier price tag with the Microsoft Hololens commercial version costing 5000$ and Daqri Smart Glasses costing 4995$ (August 2017). The prices are dropping fast, especially with VR, therefore, having a HMD display as a part of a gaming setup may become more commonplace. However, high-end AR HMDs will take much more time to reach consumer-friendly prices.

Currently, to the common consumer, the most accessible VR HMDs are Google Cardboard and Samsung Gear VR, where the user can combine their own smart phone with a HMD frame, simulating the same experience as its more expensive and better counterparts. In addition, Google has a whole product line of phones build for virtual reality use (Google Daydream 2017). A large majority of current AR applications are based on using a mobile device such as a tablet or a smart phone and its camera. For example, in Pokémon GO, users can use their phones and location tracking to capture AR Pokémon in real environments. Googles project Tango combines mobile devices with area learning, motion tracking and depth perception, granting the device full spatial awareness, leading to strong AR capabilities (Mundy 2017). Although there are not yet many Tango-equipped

mobile devices, having a mobile device that can measure the dimensions of a room and using it together with AR applications shows much promise. For example drones equipped with RealSense camera (the same one that Tango Devices are using) can automatically avoid obstacles in the environment (Mundy 2017).

While the business ecosystem of VR/AR is still growing and adapting to the fast development of the technologies, it is important to understand that the business ecosystem of VR/AR already exists. Another important thing to note is that the technologies are not only for entertainment and videogaming purposes. On the contrary, some of the technologies' best current applications can be found in industrial context, in companies such as the IrisVR (IrisVR 2017a). Their software enables architects and other 3D designers to view their blueprints in VR with just a click of a button, enhancing the design process immensely. The question is no longer whether VR/AR will be big; the question is how long will it take until the technologies reach the same amount of popularity as, for example, smart-phones or computers.

2.3 Problems and limitations of VR/AR

The market size of VR/AR is estimated to reach around $100 billion in the next five years (Bellini et al. 2016; IDC 2016; Digi Capital 2017a). However, this cannot happen until certain problems and limitations of the technologies are solved. With VR, the current problems and limitations are related to the price, the user experience and the number of content available. All three of these problems are related to each other.

First, the price of premium VR headsets (HTC Vive & Oculus Rift) is quite high compared to the amount of available VR content on the market. For example, Best Buy, a consumer electronics company, sells a bundle with a premium VR headset and a VR-able computer that costs around $1500 (Best Buy 2017a). Second, the technology still has a lot of issues with how to handle the user experience. A good example of this is found in a review of a VR version of the popular video game Skyrim, according to which "Skyrim VR is at once the best way to experience Skyrim and the worst way to play it" (Stapleton 2017). This refers to the fact, that while VR gives the player a unique immersive experience, the experience is diminished by the decreased graphics and clunky controls. Mobile VR headsets are more available price-wise, however, while according to studies, the amount of immersion they provide is the same, the problems regarding the user experience, such as usability, workload and simulator sickness, are much more prominent (Papachristos et al. 2017). Bad experiences, such as simulator sickness can turn away users from the mobile VR (Habig 2016). Third, there is not yet much content for the VR headsets other than games and industrial applications, which are less available for the common consumers. The amount of content on VR platforms is directly related to the number of users the technologies have, as without users, the platform is not yet very attractive business-wise which again links then problem to the previous problems, price and the user experience.

With AR, the problems are the same as with VR. However, since the technology is inherently more social and mobile (Shea et al. 2017), there is a very specific set of limitations the technology needs to solve before entering mass consumer markets: 1) a hero device, 2) all-day battery life, 3) mobile ecosystem, and 4) telco cross-subsidization (Digi Capital 2017a). First, AR need a hero device like the flagship mobile devices, i.e., an AR smart-device that the users can carry around with them. Second, the battery of these devices needs to last a full day. For example, the battery life of the most known current premium AR headset, the Microsoft HoloLens is around 5 hours in average use (Warren 2016). This is not enough within the current smart-phone standards. Third, the mobile AR applications need an ecosystem, i.e. a set of platforms where AR users can commute and get their AR applications, meaning something similar as Google Play or App Store (Digi Capital 2017c). Fourth, teleco-subsidization means that AR device markets should operate like current smart-phone markets (Digi Capital 2017b) where telecommunication companies sell devices with a lower price, since a majority of the actual profits come from the side-products, i.e. phone and network contracts (Curien 1991).

These problems and limitations suggest that VR/AR are still not at the level, where they can reach a sustainable number of consumers in the mass markets. However, the niche markets, like early adopters, gamers and industrial users do exist. Especially, in the industrial context the positives of the technology can often already outweigh the costs. While AR still requires substantial technological advancements to enter mass consumer markets, VR is beginning to be very close to mass adoption.

2.4 Future implications: mixed reality

As mentioned before, the concepts of VR/AR are not an antithesis, but rather exist on a continuum. There is a third concept in between: “Mixed Reality” (MR), as presented in Figure 4.

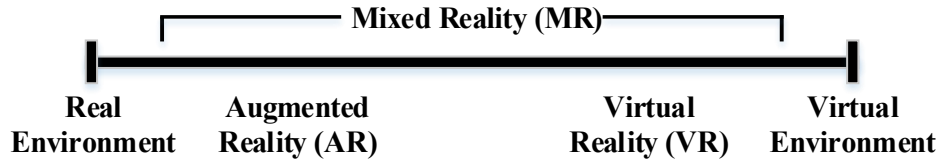

Figure 4. Reality-Virtuality Continuum (inspired by Milgram et al. 1994)

In the media, the term MR is often used as a synonym for AR applications. This is not entirely incorrect, since MR encompasses any applications that utilizes features from both virtual and augmented reality. A true MR device is something that can do both: it can augment the world around the user, and it can also completely immerse the user in a virtual environment. The concept of MR will be important in the future, as it combines both the concepts of VR and AR into a single platform. As mentioned before, the one

thing separating VR and AR is immersion. Whether it is possible or not within the constraint of the technology, having the option for both: immersion and presence in a single platform could open a plethora of new possibilities for the technologies. For example, an office worker could be wearing an MR device in the office, switching between the VR/AR settings according to need. VR could be used for an immersive workspace, or online meetings, separating the worker from the distractions of the physical office and AR could be used for collaborating when collaboration is as a tool for enabling collaboration at the physical office.

However, MR will not be further explored in this study, as it is still unclear, for example, at what point an AR device can be considered a MR device. Currently, the closest example of a mixed reality device, is the recently released Windows Mixed Reality headset (Acer 2017). In addition, it should also be noted, that the terminology in VR/AR and the concepts related to the technologies are still subject to change. Therefore, the term MR itself might not be important. The reason why the concept is important to understand is because it paints a picture about the future of the technologies and the possibilities they propose.

3. VALUE CREATION AND BUSINESS MODELS

This study is related to three different theoretical concepts: value, value creation and business models. In addition, this study utilizes the business model canvas (Osterwalder and Pigneur 2010) as a method of representing the different concepts visually. Sections 4.1-4.3 provide definitions of the different theoretical concepts and review the current state of literature concerning them. Section 4.4 introduces the visualizing method used in this study, the business model canvas. The final section, 4.5, explains how the different concepts are related to each other, the formulation of the research question and why the method, the business model canvas (Osterwalder and Pigneur 2010), was chosen to assist in answering to the research question. The literature was gathered from the multi-disciplinary scientific search engine Andor (Tampere University of Technology 2017). The core literature was gathered using the search terms “value”, “value creation”, “business models” and “business model canvas”, from which some seminal pieces were identified and used for further identification of important literature related to the theoretical concepts.

3.1 Value

Value is often viewed as a self-evident concept. To put it simply, value can be described as something that makes the customer “better-off” (Grönroos 2011). However, the actual definition behind the term is elusive. There are conceptualizations of value such as Woodruff’s (1997) definition of customer value, according to which: “value is a customer’s preference for and evaluation of those product attributes, attribute performances, and consequences arising from use that facilitate (or block) achieving the customer's goals and purposes in use situations”. This definition synthesizes many of the previous conceptualizations which viewed value, for example, as: the tradeoff between benefits and sacrifices (Monroe, 1990, p. 46), the perceived worth in monetary units relative to other offering on the market (Anderson et al. 1993), and the perceived quality relative to the price of the product (Butz and Goodstein 1996). However, more recent studies argue that these definitions of value remain vague and do not take in account the subjective, interactive and relativistic nature of value (Sánchez-Fernández and Ángeles Iniesta-Bonillo 2007; Grönroos 2011; Grönroos and Voima 2013).

First, value is a subjective concept, i.e. something that is perceived (Woodruff 1997; Sánchez-Fernández and Ángeles Iniesta-Bonillo 2007; Grönroos and Voima 2013). This means that whenever value is being created, it is being created for "someone". In addition to being subjective, value is interactive, situational and perceptual (Sánchez-Fernández and Ángeles Iniesta-Bonillo 2007). For example, when customers purchase ice cream, they gain value. However, at the same time, by purchasing the product, they are also

providing value for the supplier of the ice cream (interactivity). A customer who feels hot, can find the ice cream more valuable due to the circumstances (situational). If the ice cream store is clean and has a good decoration, customers can find its products more valuable than the products of the less clean store next door (perceptual). Therefore, "what is value?", does not have a single answer, but rather an answer relative to the situation, who is perceiving the value and how the value is perceived. Therefore, the more recent conceptualizations explore value as contextual, accumulating and dynamic concept that stems from the customer and has different stages of value creation and value co-creation between the customer and the supplier (Grönroos 2011; Grönroos and Voima 2013). Thus, the concept of value does not exist alone and is rooted within the process of value creation. The concept of value in relation to value creation is explained more thoroughly in the next section.

3.2 Value creation

Value creation often refers to the creation of value for either the customers or the companies themselves (Ketonen-Oksi et al. 2016). In the traditional conceptualizations, the companies and consumers had very distinct roles and value creation was viewed as a series of activities from production and consumption (Prahalad and Ramaswamy 2004; Vargo et al. 2008). According to this thinking, i.e. goods-dominant logic, value is created (manufactured) by the firm and distributed to consumers through the exchange of goods and money (Vargo et al. 2008). For example, a bicycle manufacturing company creates value through processing raw materials, such as metal, plastic and composites into bicycles. These bicycles are then delivered to the markets, where customers can purchase them in exchange for money. This "exchange" is the measure for the created value.

The more recent studies approach value creation from the point-of-view of service-dominant logic, according to which, the roles of the value producers and value consumers are not distinct, but rather in interaction between each other (Vargo et al. 2008; Vargo and Akaka 2009). The company manufacturing the bicycle is creating and offering potential value through the manufacturing and product delivery process, but the value is only realized "in-use" when the customers use the products in the context of their own lives. This context can refer to the ability to drive a bicycle, the access to maintenance, or the different functions and social meanings a bicycle can have to customers. Therefore, it can be concluded that all value creation is co-creation: manufacturers apply their knowledge, skills, networks and branding in the "goods" and customers "realize" this value by using the goods within the context of their lives (Vargo et al. 2008).

It is important to understand that while the product or the "goods" play an important part in the "perceived value" by the customers, a large amount of the perceived value might also come from the way the product delivered, i.e. the business logic of the supplying enterprise, especially in cases where the product is a service, for example, a software (Helander and Ulkuniemi 2011). It should also be mentioned, that even though the terms

"customer", "manufacturer" and "supplier" come up often in value creation research, value creation should not only be analyzed from the customers' or the suppliers perspective but from many different viewpoints, also including other stakeholders who are relevant to the value creation context (Seppänen et al. 2007). Therefore, value creation should be viewed as process interactive, contextual process where stakeholders create value for each other. This network nature of value is further elaborated by, for example, Helander and Kukko (2009), who highlight the importance of relationships and core-competencies, and their relation to the perceived end customer value in value creation networks.

The notion that value creation is a network process, where all actors, customers and firms alike, co-create value in an all-encompassing process works well as a metaphor to indicate how all actors are a part of the value creation process (Grönroos and Voima 2013). However, this definition lacks clarity and structure for analytical usage. In addition, it has a discrepancy with the subjective nature of value: if value is subjective, value creation should refer to creating value for "someone". Therefore, to provide a more comprehensive definition to value creation, value should be defined as the "value-in-use" of the customer, which makes the customer the value creator and the provider the value facilitator (Grönroos and Voima 2013). Through this definition of value, value creation can be defined by dividing into three spheres: the provider sphere, the joint sphere and the customer sphere. This is represented in Figure 5.

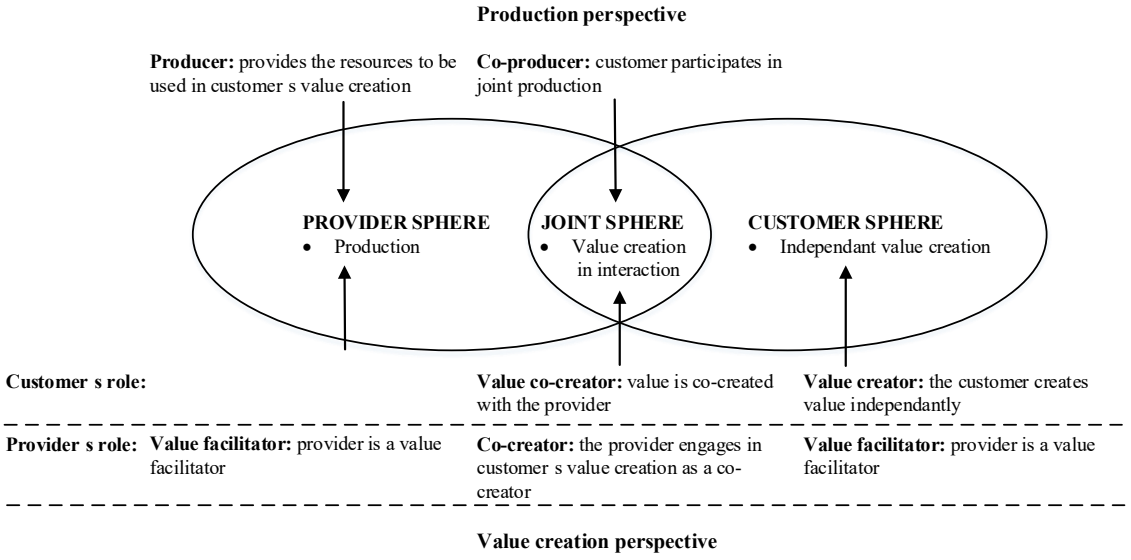

Figure 5. Spheres of value creation (Grönroos and Voima 2013)

In the first space, the provider sphere, a company that produces products or services is creating "potential value". The activities in this sphere facilitate the customer's value creation process, thus making the provider a value facilitator (Grönroos and Voima 2013). The value is later "realized by the customer" in the joint sphere. Since this sphere refers to the stage where the customer and the producers are in interaction, both actors can be seen as value co-creators (Grönroos and Voima 2013). This signifies that even though the

customers oversee value creation itself, the providers can affect their value creation process in the joint sphere. The third space, customer sphere, is the experiential sphere where the customers create value alone, outside of direct interactions from the provider company (Grönroos and Voima 2013). This is the stage where customers combine the product within their own context, experiences, skills and knowledge.

Therefore, value refers to customer's value-in-use and creation of this value (positive or negative) takes place in three different spheres: provider sphere, joint sphere and customer sphere (Grönroos and Voima 2013). This view takes in to account value's nature as a dynamic subjective, interactive and relativistic concept. However, it should be noted that the definition by Grönroos and Voima (2013) still leaves open questions. The definition has been criticized, since it indicates that value creation is a dyadic phenomenon between "a provider and a customer", when in reality value creation is a more complex process of multiple actors (Vargo and Lusch 2016). The conceptualization is, for example, unclear on what is the role of other stakeholders of the provider company, such as strategic partners, who could also be argued to be considered co-creators of value.

To summarize, the definition of value creation is still a highly debated subject in the academic circles. For the context of this study, the key aspects to note are that: 1) value is a subjective concept and it only exists once it is realized by its "beneficiary" (i.e. the perceiver of value or in many cases, the customer), 2) the process of value creation can be viewed as separate spheres, indicating that there are some stages of value creation the value provider company can affect (sphere of interaction) and some stages that it cannot affect (sphere of independent value creation) and 3) the value creation is not only a process between a provider and a customer, but a process between (often a very large amount) different actors (i.e. stakeholders).

3.3 Business models

As the concepts of value and value creation, the concept of business models is frequently mentioned in both theoretical and practical literature, however, it is rarely analyzed (Teece 2010). The term has been used since 1950s, however, often in a very unspecific manner (Wirtz et al. 2016). Most often the term seems to refer to a loose conception of how a company "does business" and generates revenue (Porter 2001). There is ubiquity in how the term has been defined in the past, and because of this, in its current use there is not a single existing concept, but many (Zott et al. 2011; Baden-Fuller and Haefliger 2013; Wirtz et al. 2016). However, in recent years, a more uniform view of the concept is forming.

Even though business models have been used in a wide variety of ways, the literature regarding business models shares some common themes: 1) business models are approved as a new unit of analysis, 2) business models emphasize a holistic system-ap-

proach as to how firms do business, 3) firm activities, such as firm processes, functionalities and transactions have a role in business model conceptualizations and 4) business models deal with how companies create and capture value (Zott et al. 2011). Especially the fourth theme regarding value creation and value capture is important in the context of this study, as it connects enterprise value creation with their business model theory, and many authors have explored this definition further.

For example, Teece (2010) defines business models as the articulated logic of how companies create and deliver value and how they turn the process into revenue (i.e. value capture). Casadesus-Masanell and Enric Ricart (2010) agree on the notion that business models refer to how companies create value for their stakeholders and connect the concept with business strategy by arguing that "a business model represents the reflection of the firm's realized strategy". Osterwalder and Pigneur (2010) specifically define that "a business model describes the rationale of how an organization creates, delivers and captures value" and call it the blueprint of how companies implement their strategy through organizational structures, processes and systems. Therefore, it can be concluded that business models are the link between the company's strategy and how it creates, delivers and captures value through its operational structures, processes and systems.

The most recent conceptualization by Wirtz, Göttel and Daiser (2016) further summarizes the concept of business model as "simplified and aggregated representation of the relevant activities of a company". The relevant activities refer to the companies' architecture of value creation, and include strategic, customer and market components, all having the goal of achieving competitive advantage. To achieve the latter, businesses need to evolve and innovate themselves, therefore, business models should always be regarded as dynamic. This study agrees that business models should be viewed critically as dynamic concepts and that they represent a simplified and aggregated form of the relevant activities of a company. However, this study argues that market components exist outside the business model of a company and while they are relevant, they should be considered as outside forces, rather than relevant activities of a company. This is further explained in section 4.5.

3.4 Business model canvas

In 2010 Osterwalder and Pigneur published "Business Model Generation: A handbook for visionaries, game changers and challengers", which popularized the concepts of business modeling. One of the concepts introduced in the book was the business model canvas: a one-page, visual representation of a company's business logic (e.g. business model). The business model canvas is represented in Figure 6.

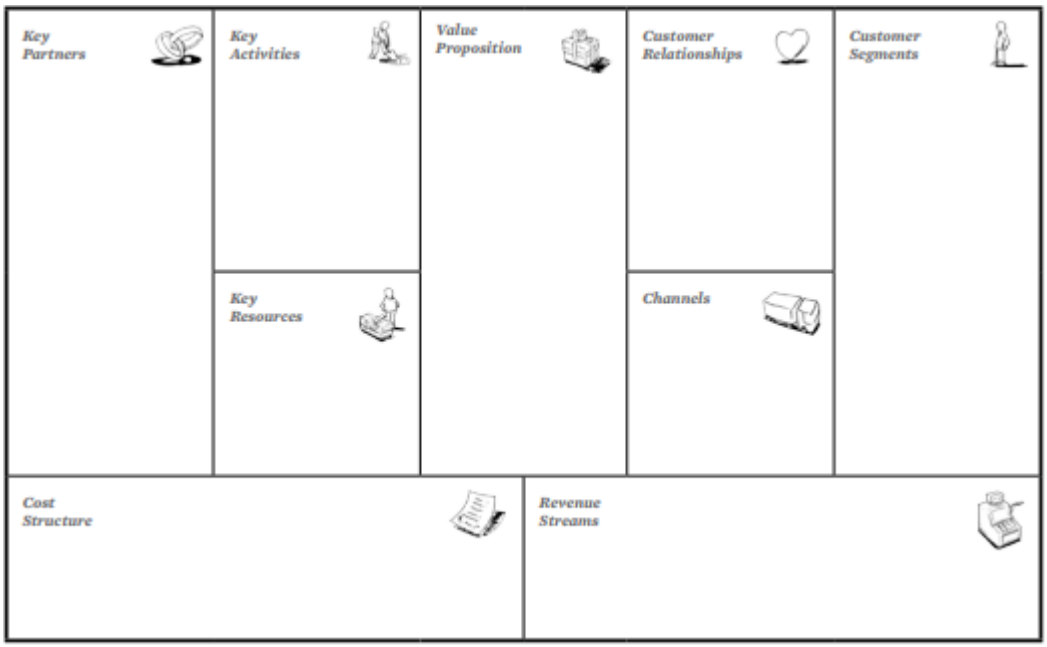

Figure 6. The business model canvas (Osterwalder and Pigneur 2010)

The business model canvas comprises of 9 different building blocks that describe the company's business model (Osterwalder and Pigneur 2010):

- *Customer segments* are the people or organizations who the value is being created for
- *Value Propositions* are the products/services/features that are offered to customer segments. Each customer segment has their own corresponding unique value proposition
- *Channels* are the means of delivering the value proposition to the customer segments, for example retailers or an online store
- *Customer relationships* outlines the type of relationship the company has with its customer segments
- *Revenue streams* explain how and where the revenue comes from
- *Key resources* are the assets that are indispensable to the business model
- *Key activities* show what is required to perform well
- *Key partners* are the organizations that can be used to leverage a business model
- *Cost structure* describes the costs that incur from operating the business model

The business model canvas is a tool for describing and improving existing business models, and a tool for creating new ones. It is a tool for testing business models before they exist and a tool for discussing the different building blocks that form the "blueprint" of a company (Osterwalder and Pigneur 2010). It should also be noted that the actual canvas model was first published in 2008, in a blog post by Alexander Osterwalder, and since then many variations have been created. For example, the lean business canvas focuses

specifically for lean start-ups, emphasizing more on customer-problem-solution vs. general oversight (Maurya 2010) and is ideal for early stage innovation projects. Service model canvas is designed for exploring and deconstructing existing services, or innovating new ones (Turner 2015). However, the business model canvas introduced by Osterwalder and Pigneur remains the most well documented and most used version of the canvas models.

There is not much literature about problems/criticisms regarding the business model canvas. However, there is some that argue that the business model canvas is over-simplistic and is not addressing some key issues, such as competition between companies (Ching 2014) or business sustainability (Yang et al. 2017). At the same time, it can be argued that the simplicity of the canvas is one of its main strengths, since it allows to look at the big picture, and reviews only the most critical aspects of a business model. Since the canvas model is a simplified representation, it is also easy to compare it with other business models, thus gaining insight into how well the business models compete. In addition, it should be noted that there are many tools that can be used together with the business model canvas to enhance its ability as analytical tool. For example, in addition to the business model canvas, there is another canvas tool called the "value proposition canvas" that can be used together with the business model canvas to further explore the value propositions offered to different customer segments (Osterwalder et al. 2014). To answer to the previous question of competition between other companies more thoroughly, the business model canvas could be analyzed with, for example, Porter (2008) "Five Forces Framework" to see how well it copes with industrial competition. Therefore, it can be concluded that the simplicity of the business model canvas can also be positive, as it makes it easier to combine the method with other tools.

3.5 Analyzing enterprise value creation

The original reason behind this study was to find out, what is the potential value of VR/AR solutions. After the initial review about the theories of value and value creation, it was evident that due to the subjective nature of value (Woodruff 1997; Sánchez-Fernández and Ángeles Iniesta-Bonillo 2007; Grönroos and Voima 2013), the question was not only about "what is the value?", but about "what is the value and who is it being created for?". As the goal of this study was to produce industry wide results, it was concluded that the analysis should be done on the level of enterprises. However, due to the subjective, situational and relativistic nature of value (Grönroos and Voima 2013), to gather more specific insight about the value the technologies of VR/AR propose to single customers or users on an industrial scale, would require a very time consuming approach. For example, many customer interviews or queries. Within the context and resources of this study, this was not possible, nor was this important. Value propositions, i.e. what the companies offer to their customers are an important part of the value creation process. Analyzing what enterprises offer, for example, from their websites, gives insight into their

own customer research and what their customers want, or at the very least: what they think their customers want (i.e. the value they propose). Therefore, analyzing value creation on enterprise level also provides some answers, although very aggregated, to what value VR/AR solutions provide to single customers or users. This thought lead to the formulation of the research question: how enterprises create value with VR/AR solutions and how this value can be communicated.

The additional part about communication was added for two reasons: 1) it was identified that VR/AR solutions creators could benefit from a new way to communicate their value creation process (i.e. their business model) to both their partners and customers and 2) there are not yet many studies that connect the newer theories and conceptualizations of value and value creation to practical methods. As such, it was felt important to both find a method for communicating the value creation process of companies, and to link the theories of value creation together with a specific methodology.

One area of studies that chime with the context of this research and had a direct connection to value creation was business models. Many authors agree that a business model can be seen as a depiction of a company's value creation process (Casadesus-Masanell and Enric Ricart 2010; Osterwalder and Pigneur 2010; Teece 2010) and, therefore, analyzing a company's business model could be related to the process of enterprise value creation. In addition to value creation, the authors bring up the concepts of value delivery and value capture, however, it can be argued that the two concepts are also a part of a company's value creation process. Value delivery refers to how the value is delivered to the customers (Osterwalder and Pigneur 2010) and as such, has an effect to the end value of the product or the service. Value capture refers to how the company captures value to itself, usually referring to monetary sum, through its value creation process (Osterwalder and Pigneur 2010). Therefore, value capture can be seen as either what kind of value the company creates for itself or as depiction of how valuable customers perceive the company's value propositions.

The analysis method, the business model canvas (Osterwalder and Pigneur 2010) was chosen because it is currently the most known and the most used method for depicting business models (i.e. enterprise value creation) (Yang et al. 2017). In addition, the method fits in the current theoretical concepts of value and value creation. In Osterwalder and Pigneur (2010), the business model is defined as: "the rationale of how an organization creates, delivers and captures value". As previously established, value delivery and capture can be viewed as depictions of certain parts of the enterprise value creation process. While the book itself does not link the business model canvas with the theories of value and value creation, it can be linked with the notions made about them in the end of section 4.2: 1) value is subjective and does not exist before it is realized by the beneficiary, i.e. the customer, 2) value creation can happen in different spheres of production, interaction and independent value creation, some of which the value provider can affect and some of

which it cannot affect, and 3) value creation is not only a process between a provider and a customer, but a process between all stakeholders.

First, value is subjective and remains as potential value until it is realized by the beneficiary, i.e. the customer. With the business model canvas, it is possible to look at different value propositions in relation to different customer segments, thus considering the subjective nature of value. While the business model canvas does not differentiate between potential and realized value, understanding the difference between these two concepts is important to understand how the concept of value works. Second, the business model canvas can depict different parts of the value creation from all three spheres at the same time. While the different building blocks cannot directly be linked to different spheres, since, for example, key resources such as software can play a part in all three spheres, (production, co-creation and independent value creation), the strength of the canvas is that it can depict the important parts of the all three spheres at the same time. At the same time, the notion about independent value creation can have practical value for companies, since with it, companies can identify which parts of the value creation they can and should affect. Third, the business model canvas can be used to illustrate the most important stakeholders of a value creation process of an enterprise and how they connect to the different parts of value creation.

4. METHODOLOGY

The research onion (Figure 7) depicts the choices made in this study regarding data collection techniques and analysis procedures. While the research strategy and data collection methods are key elements in the study, it is important to note the factors behind the chosen strategies and methods (i. e. the research philosophy and approach).

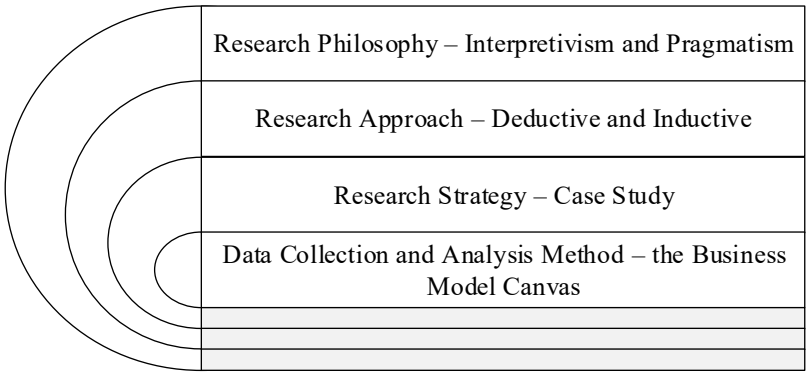

Figure 7. Research onion (adapting Saunders et al. 2016 p. 124)

Research onion is read from the outer layers to the inside: research philosophy, research approach, research strategy and data collection and analysis method. These layers are explained in subchapters 2.1, 2.2, 2.3 and 2.4.

4.1 Research philosophy

Saunders et al. (2016, p. 135) propose five different major philosophies for business and management research: positivism, critical realism, interpretivism, postmodernism and pragmatism. These research philosophies refer to the beliefs about the nature of reality (ontology) and the development of knowledge (epistemology). While it is acknowledged that in practice, a research question rarely falls into a single research philosophy, the researcher should have an understanding about the commitment a certain research philosophy proposes, therefore, it should be reflected upon the research.

This research falls dominantly in to the category of interpretivism, where reality is seen as a social construct (Saunders et al. 2016 p. 136-137). The core of interpretivism is to work with subjective meanings that already exist in the social world: acknowledge them, reconstruct them, understand them, avoid distorting them and to use them in theorizing (Goldkuhl 2012). Value, a core concept in this research, is subjective and based on experiences. One customer buys a car based on its looks and another buys it based on its low fuel consumption. A bottle of water is more valuable to the thirsty man. Creating general models, that are common to the positivistic research philosophy, is not possible in this

case. In value creation, it is necessary to understand humans as social actors and to understand that the interpretation is dependable on the context. The researcher's own experiences, beliefs and biases also play an important part in the results of the study.

It should also be noted that this research is meant to be highly practical, thus some of the research choices are made according to the pragmatic research philosophy. Goldkuhl (2012) argues that it is possible to combine interpretivism and pragmatism, adopting a stance that aims for constructive knowledge that is appreciated for being useful in action. The qualities of these two different research philosophies are summarized in Table 1.

Table 1. The qualities of interpretivism and pragmatism (adapting Saunders, Lewis and Thornhill, 2016, p. 136-137)

	Interpretivism	**Pragmatism**
Ontology: *view about the nature of reality*	Socially constructed and subjective, can change, many realities	External, multiple, chosen based on the ability to answer the research question
Epistemology: *the view regarding what is acceptable knowledge*	Subjective meanings and social phenomena. Focus on situational detail and subjective motivations.	Observable phenomena and/or subjective meanings can (both) provide acceptable knowledge upon the research question.
Axiology: *the researcher's view of the role of values/bias in research*	Research is based on the values/bias of the researcher and thus will be subjective	Values/bias play a large role in result interpretation, the researcher can adopt both objective and subjective points of view

The most important notion of Table 1 is that pragmatism allows using any methods necessary to answer the research question. Instead of only viewing the nature of reality as a social construct, a pragmatist may adopt a stance that there are many different views about the nature of reality. Instead of only focusing on subjective meanings and social phenomena, a pragmatist may combine both subjective meanings and observable phenomena. Instead of only having a subjective point of view, a pragmatist can adopt both objective and subjective points of view.

The way the above relates to this study, is that while interpretivism is the main stance of the research, some pragmatic freedoms are taken to answer the research question in the best possible way. This is because in one of the key subject of the research, business models, there are certain features or relationships between the different building blocks,

that can be viewed as generalizations. For example, a business model based around advertising (i.e. Google) is often based around two value proposals: a platform for users and an audience for an advertiser. The building of business models based around previously established generalizations such as this relates more towards a positivistic approach. However, whether the business model of a company is based on a specific pre-established generalization or not, is an interpretation, and while it can be validated by data and, for example, interviewing professionals, the narrative behind the business model will change depending on social context. This study combines the philosophies of interpretivism and pragmatism in the perspective that, while the study itself is based on subjective meanings, there are some pre-existing generalizations that can be used in exploring new situations phenomena.

4.2 Research approach

This study combines the deductive (producing a hypothesis from a theory) and inductive (proposing theories through observation) approaches. There is no defined theory regarding value creation or business models, but rather a large amount of different possible theories to use. Instead of deducing a hypothesis from a defined theory (deduction), the study is searching for theories that VR/AR can be related to. This requires analyzing qualitative materials. The actual research approach is iterative and is visualized in Figure 8.

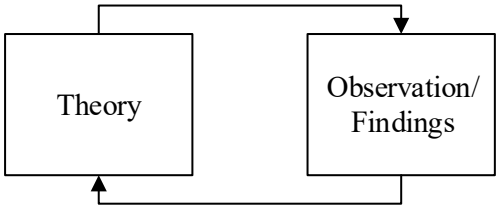

Figure 8. The iterative research approaches

The iterative process goes from theory to observation and findings, and continues into a loop. It is a method of continuously evolving knowledge. Saunders, Lewis and Thornhill (2016) argue that even though it is possible to divide between inductive and deductive research approaches, in reality, combining the two can often be advantageous. Especially in this case, where the research topic is new. With VR/AR it is more appropriate to inductively generate data by content analysis and reflect what theoretical themes of value creation and business models it fits under. It could also be argued that this study could fit the description of the abductive approach, where the emphasize is on entering a research field with a very broad theoretical base and developing the theoretical repertoire throughout the research, aiming to find creative and novel theoretical insights (Timmermans and Tavory 2012). However, the iterative process model of Figure 8, is a sufficient representation for how this research was approached.

4.3 Research strategy

The research strategy chosen for this research is the case study method (Stake 2000). According to Yin (2014), case study method can be a preferred method when: 1) main research questions are "how" or "why" questions, 2) the researcher has little control over behavioral events and 3) the focus of the study is a contemporary phenomenon. This study fits all the above-mentioned categories. While the methodology proposed by Yin is based on a positivist research philosophy aiming at generalized conclusions, Walsham (1995) argues that the question "how?" and "why?" can also be adapted by the interpretivist stance. It should also be noted that viewing the case study research as a iterative process as proposed by Yin (2014) is in accordance with interpretivism: the researcher must be willing to modify initial assumptions and theories during the research process.

While positivism aims at building models and generalizations, from the point-of-view of interpretivism, generative mechanisms should be viewed as "tendencies" which provide insight for past data, but cannot be used as predictive models for future (Walsham 1995). Case studies do not necessarily have to contribute to scientific generalization or the building of models, like in positivism, but can rather aim at intrinsic understanding of what is important about a case in its own world through interpretation (Stake 2000). According to Stake (2000), in interpretivism, studying cases serves in building enough understanding to encapsulate complex meanings into finite reports (which is also a small step towards generalization). The cases are not chosen based around a tight set of criteria or attributes that tie the different cases together, but are chosen rather by intrinsic interest: the learning potential they propose to the researcher. While in this study, there are multiple cases that may or may not manifest some common characteristics, each case introduced is a concentrated inquiry into a single case.

In the context of this study this means that the aim is not to create generalizations or reusable business models. The aim is not to analyze cases in comparison, although they may or may not share similarities between each other. The motivation behind choosing and studying the cases in this research is to provide insight into the phenomena behind them (how enterprises create value with VR/AR). The motivation behind using the business model canvas to present the cases is two-fold: 1) it answers the question on how to present the whole value creation process (i.e. value creation, delivery and capture), 2) it provides a narrative to explain the case and its environment. However, while triangulation (i.e. using multiple methods to collect data) is used to validate presented canvases, the narrative remains subjective, and as such, the results of the study also depend on its ability to transfer knowledge to its reader.

4.4 Data collection and analysis method

In this study, the business model canvas (Osterwalder and Pigneur 2010) is used as the method that guides the collection of data and its analysis. The method has evolved significantly since its original rise to popularity. While the building blocks remain the same, research has identified some problems with the business model canvas approach, mainly with the lack of clarity on how the modeling process should be undertaken (Fritscher and Pigneur 2014). Especially in research, where the business model canvas is used in a large variety of ways, the lack of common practices and transparency in how the method is used makes it difficult to evaluate its value as a research tool. For example, Seppänen et al. (2007) use it as a framework for analyzing value creation, capturing essential business model elements and as a tool for exploring new business ideas. Shahand et al. (2015) use it as a tool for pivoting between business model alternatives and as a method for structured case reflection. Deepa & Rupashree (Deepa and Baral 2017) use it to identify measures of effective employer brand strategy. In all three examples, the 9 different building blocks of the business model canvas (customer segments, value proposition, channels, customer relationships, revenue streams, key activities, key resources, partners and cost structure) are well defined and each building block is filled with elements and information. The business model canvas is used as a framework on which information is built on, however, the visual canvas representations vary and the design choices regarding the canvas are not explained.

These problems: the varying canvas representations and the lack of explanations regarding the design choices of the canvas model, can diminish the method's potential as an analysis tool. The design choices play a key role in how the researcher can learn during the canvas generation process. For example, visualizing the mechanics and story behind the business model in the right way may reveal additional insight about the interaction between the elements that may not emerge when looking at individual elements (Fritscher and Pigneur 2014). Therefore, in this study, a systematic method for using the business model canvas was devised. The devised process is summarized in Figure 9.

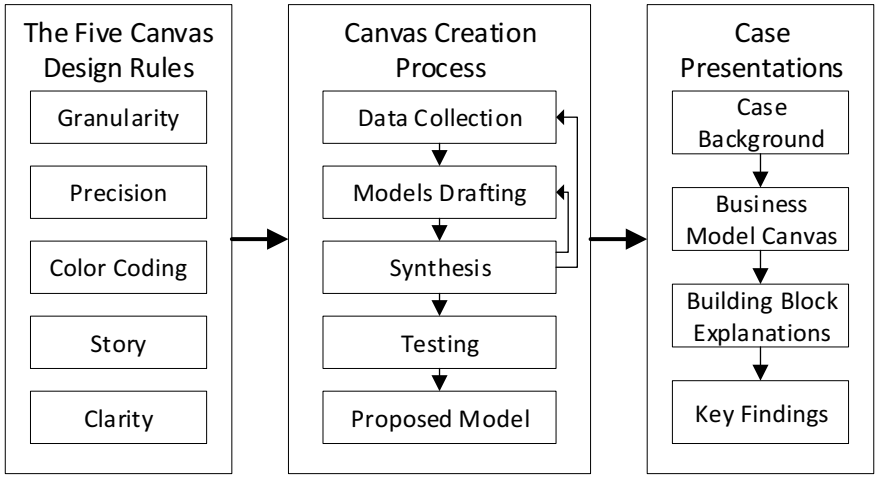

Figure 9. A process model for utilizing the business model canvas

Figure 9 consists from three parts: 1) the five canvas design rules, 2) canvas creation process and 3) canvas presentations. The first part consists from the five design rules that are applied in the canvas creation process. These rules are further explained in section 4.4.1. The next part is the canvas creation process, which is explained in section 4.4.2. The final part is the case presentations, which is explained in section 4.4.3.

4.4.1 The five canvas design rules

This study is guided by the business model canvas design principles by Fritscher & Pigneur (2014) and Garner (2015). These principles support the method's usage as a tool for creative thinking and communication, and can be summarized to 5 design rules: *granularity, precision, color coding, story and clarity*. The rules are explained below.

Granularity. The canvas is a condense form of presenting large quantities of information and it is meant to present the "big picture" behind a company's business model. High granularity, e.g. long sentences, bullet points and lists reduce the readability of the canvas and make it difficult to see the connections between the different building blocks (Garner 2015). As such, the design of the canvas model, should aim for a level of granularity that is good for viewing the "big picture", but is still understandable.

Precision. While information inside the canvas should be summarized, the information should still be precise and understandable (Fritscher and Pigneur 2014; Garner 2015). For example, calling Google's main revenue stream "*advertising*" is not precise, since the revenue comes from auctioning keywords to advertisers, i.e. "*keyword auctions*"(Garner 2015). The context of every building block should be thoughtfully chosen.

Color coding. Color should be used to distinguish the connections between the different building blocks and to make the narrative of the canvas model clearer (Fritscher and

Pigneur 2014; Garner 2015). In this study, colors represent different value propositions and the customer groups they are connected to.

Story. Every block inside the business model should be connected to form a coherent story. This means that there should not be redundant building blocks that are not necessary for the business model to work and there should not be "orphan elements" that are not connected to other blocks of the canvas. (Fritscher & Pigneur 2014; Garner 2015.) If a single building block is removed from the canvas, the business model should collapse (Garner 2015).

Clarity. Too many ideas in one canvas make it difficult to understand. One canvas should not have too many products, ideas or stories. In the case, where the ideas become convoluted, the canvas should be separated into multiple canvases. (Garner 2015.)

In this study, *granularity* is achieved through summarizing the concepts inside the business model canvas into brief and simple descriptive keywords. Brief definitions help make connections between the other building blocks of the canvas. *Precision* is achieved by using unique keywords that fit the business context. In addition, the canvas models are validated with professionals from the various industries presented in this study and changes are made according to feedback. *Color coding* is used to differentiate between the different value propositions and customer segments they are connected to. All the blocks that share the same color, are connected to the same value proposition/customer segment. Overlapping different colored blocks mean a shared element. *Story* is kept coherent by making sure all elements are connected to each other and by removing any orphan blocks that are not connected to the other blocks. *Clarity* is achieved through iteration, meaning that convoluted ideas are divided into different canvases and only combined once the ideas are clearly connected with the same business model.

4.4.2 Canvas creation process

This study will present 10 VR/AR related cases from 5 different industries: entertainment and videogaming, architecture and engineering, commerce, healthcare and education. The analyzed industries were chosen because they all have meaningful market potential for VR/AR (see Bellini et al. 2016). The motivation behind choosing and studying the individual cases in this research, is to provide insight into the phenomena behind them (how enterprises create value with VR/AR?). As such, the reasoning behind each one of the individual case studies presented in this study is different and will be presented more thoroughly in their respective sections. The business models are built using publicly available information and the amount of time it takes to draft a business model is often dependable on the quality and availability of the materials. Even with good materials, it should be noted that using the business model canvas is a creative learning process and quality canvas models often require multiple iterations. This creation process of the business canvases of this study is presented in Figure 10.

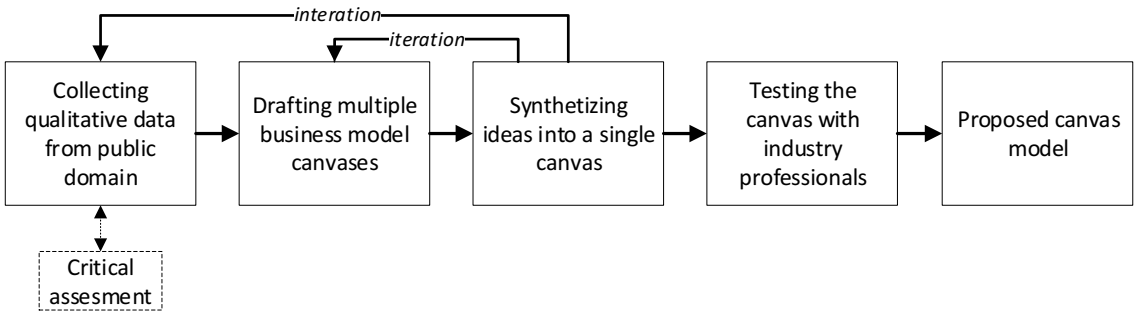

Figure 10. Canvas creation process

First, qualitative data is collected from public domain about the case at hand. Finding a scientific and/or peer-reviewed source that is directly linked to the actual business model of a company is often rare. The business models of this study are mostly built using public domain data, such as company websites relating to the respective business model cases, scientific articles from Andor and Google Scholar (when possible), news articles, and when felt required, any other materials, such as news articles and/or videos. Since many of the materials used with the business models or industry introductions are not scientific, all sources used are chosen based on critical assessment to ensure the validity of the findings.

This critical assessment involves two parts: 1) critical analysis of the information publisher/author and 2) triangulation with other sources. First, the author and the publisher of the information is analyzed. Important factors in this stage are whether the publisher is publicly known and whether the author has expertise in the subject matter. For example, an article from Forbes written by a technology expert journalist is found more valuable than an article from an unknown blog. Second, the reference is validated through triangulation, i.e. by comparing its contents with other sources related to the same subject. For example, if the main source of a business model is the company that owns the business model, it is important to understand that the information on their website is only the information they wish to be public. Because of this it is important to use other sources to validate whether the claims made by the company are in alignment with reality. In addition, triangulation provides insight into the quality of the reference, since it can be used to assess whether the information is correct or not. It is important to note, that triangulation is also important in finding supplementary information that fills information gaps in the other sources.

Second, during the collection of the qualitative data, multiple business model canvases are drafted using printed versions of the business model canvas and post-it notes. These draft canvas models can, for example, represent different ideas or customer segments with their representing value propositions. Usually, at least 3 different canvases are worked on simultaneously moving from one idea to the next as fast as possible to create a big picture view of the business model.

Third, the ideas from the draft canvas models are synthetized into a single canvas, removing redundant elements, combining the ones with similar aspects and replacing unclear keywords with better versions. At this stage, it is often necessary to go back to either collecting more data or to multiple canvas drafting, as some of the ideas might still be too convoluted to be examined in a single canvas. Sufficient amount of iterations are made, until the canvas is finished. It should also be noted, that at this stage, some cases pivoted from one business model case to another. For example, the idea for examining the case of Psious (see Psious 2017a), a VR mental healthcare platform, came from examining the business model of a company offering VR treatment methods (see The Virtual Reality Medical Center 2017) (section 5.5).

Fourth, after the process has been iterated sufficiently the synthetized canvas model is tested orally with industry professionals who have experience in both VR/AR and the industry the business model is related to. The chosen professionals related to each business case are listed in Table 2.

Table 2. List of industry professionals for canvas testing

Industry	Professional
Entertainment and videogaming	A user experience designer and a researcher with two years of experience in both game design and 360/VR videos
Architecture and engineering	An architect with 3D modelling experience currently working as the head of marketing and art in a technology start-up that has future plans with VR/AR
Education	A principal lecturer (PhD), who is an expert in digital learning and who has experience using VR technologies in an educational context
Commerce	A bachelor of business administration with more than two years of experience running multiple online stores. Currently studying a master's degree in media and communication sciences
Healthcare	A chief executive officer of a medical company with more than 15 years of experience with medical technology related business models

It should also be noted that, in addition, to discussing the canvas models with specific industry professionals, all models are discussed with researchers of project VIRJOX as well. The idea is to refine the canvas model, remove any inaccurate terminology, replace unclear keywords with more precise versions and add any essential missing elements or remove redundant ones. In addition, discussing the canvas with another person provides researcher triangulation, meaning that the presented models are not only based on the subjective views of the researcher. This stage also plays an important part in learning: the

various elements of the business model are discussed in detail, providing more clarity into how the business model operates. This in turn, affects how the case is presented in the study and increases the number of key findings.

Fifth and final, the finished canvas is then translated to digital form with Microsoft Visio, utilizing the business model canvas (Osterwalder and Pigneur 2010). After this stage, the business model canvas is written out systematically.

4.4.3 Case presentations

When presented orally, the blocks inside the business model canvas are often shown one block at a time to prevent a cognitive information overload (Garner 2015). In addition, there is no regular order in which the different blocks are introduced. The main goal is to present the business model as a story, beginning from the blocks that are deemed the most important. In this study, however, the business models are presented in written form. As such, a structured order helps the reader to understand and compare the presented models with each other. Here, cases are divided into their own chapters by industry. Each chapter begins with VR/AR background relating to the industry and what business models were chosen for analysis and for what reasons. The cases itself are presented in four stages (Figure 11).

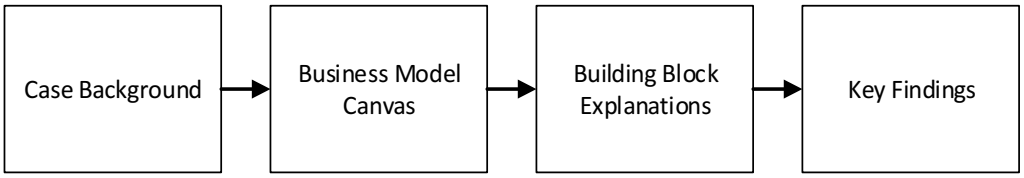

Figure 11. Case presentation process

First, the background of the case is explained. This includes the discussion about the analyzed product/service and the company. Second, the built visual representation of the business model canvas is presented. Third, the different building blocks are explained by using the nine categories of the business model canvas (*value proposition*, *customer segments*, *channels, customer relationships*, *revenue streams*, *cost structure*, *key partners, key resources*, *key activities*). Finally, the key findings that were found important in the case are presented are discussed. The first business model presented in this study, Pokémon Go (section 5.1.1) is presented more thoroughly and exemplifies how the business models in this study are created, presented and explained. In addition, it illustrates how the design rules are used. The example was chosen, because the business is well known and easy to understand. The case also works as a good introduction to the business model canvas as a method.

5. BUSINESS MODELS IN VR/AR: A CASE STUDY

In this chapter, 10 VR/AR related business model cases from 5 different industries: entertainment and videogaming, architecture and engineering, commerce, healthcare and education are presented using the business model canvas (Osterwalder and Pigneur 2010) and the methodology described in section 4.4. The business models chosen for analysis are presented in Table 3.

Table 3. List of the cases chosen for analysis

Industry	Case 1	Case 2
Entertainment and videogaming	Pokémon Go, a known AR game released in 2016 (Pokémon Go 2017)	NYTVR, New York Times' platform for VR/360 content (NYTVR 2017)
Architecture and engineering	IrisVR, a software that translates 3D models to VR environment (IrisVR 2017a)	VR co-creation, a business model for VR assisted building projects
Education	Google Expeditions, a mobile VR/360 application for virtual field trips (Google Expeditions 2017)	zSpace, a company selling high-end VR/AR classroom to learning institutions (zSpace 2017a)
Commerce	IKEA Place, an AR application for IKEA furniture (IKEA 2017a)	VR Shopping, an explorative business model for shopping in VR
Healthcare	Psious, a platform for VR mental treatment (Psious 2017b)	OssoVR, a VR training solutions for surgeons (Osso VR 2017)

In this study, the business model canvas is used as a tool for analyzing existing business models and as a tool for communicating the value creation process of companies, i.e. how value is created, delivered and captured. It should be noted again that the business model canvas is not only a method for structured information collection or presentation, it is a method for visual learning (Fritscher and Pigneur 2014). The goal is not to examine every single aspect of a company or a product in the VR/AR industry, but to examine the *key aspects* that are required for a business model to work and the *connections* between the

different elements. The business model cases of Table 3 are presented below in sections 5.1-5.5.

5.1 VR/AR in entertainment and videogaming industry

The most known applications of VR/AR come from the entertainment and videogaming industry. HMDs like HTC Vive and Oculus Rift are no longer expensive by gamer standards and smart-phone integrated solutions bring VR/AR to everyone with a smart-phone. VR can create immersive realistic experiences virtual worlds that cannot be achieved with traditional systems, and that provide at the same time a new level of social interaction through information technology (Liszio and Masuch 2016). AR can make entertainment, such as sports, more engaging through overlaying graphics that make spectating more comfortable and efficient (Bozyer 2015).

The two business model cases chosen for this industry are: 1) Pokémon Go, a known AR game that was released in 2016 and 2) NYTVR, New York Times' platform for VR/360. The first case, Pokémon Go, was chosen because the case is well known due to its large success and because it is a good example of the methodology used in this study. In addition, the case business model has scalability and is capturing value from two different customer segments. The second case, NYTVR, is about New York Times' VR/360 video platform. Currently, the platform consists mostly of 360 videos. It was chosen for analysis for two reasons: 1) while 360° videos do not often fit in the definition of VR, they share the same characteristics of immersion. In addition, in many cases they are more cost-efficient to produce and their production is more traditional in the sense that they use photography instead of advanced 3D modelling. 2) 360° videos are the most easily accessible immersive content for mass markets, however, the value proposition of 360° videos is still unclear (Watson 2017). These videos are inherently different from the traditional sense, since when experienced together with a HMD, they immerse the user in the content. Research shows that these immersive videos increase the audience's emotional involvement (Fonseca and Kraus 2016). For example, in Google's case study for VR 360° advertisement, the traditional video format outperformed the 360° format in the number of views, however, the new format incited more engagement: viewers who watched the 360° advertisement interacted with the material more and had more tendency for sharing, subscribing and watching related content (Habig 2016). The NYTVR case can be used to learn about the current state of 360 video related business models.

5.1.1 Pokémon Go

Pokémon GO is the fastest game ever to hit $500 million in revenue (Perez 2016). While this is due to a very specific set of conditions, the success of the game is a major reason why many mobile companies began investing more into AR technologies (Digi Capital 2017a). The player numbers peaked in summer 2016, when Pokémon Go had more than

28 million active players in the US alone (Siegal 2017). This number has gone down a lot. However, there are still millions of active players. Pokémon Go offered something unique that did not only target fans of the series. Their value proposal appealed to so many different demographics that instead of just becoming another game, Pokémon Go became a phenomenon that took children and adults, players and non-players, to walk and catch these fantasy creatures in real environments. The business model of Pokémon Go is represented in Figure 12.

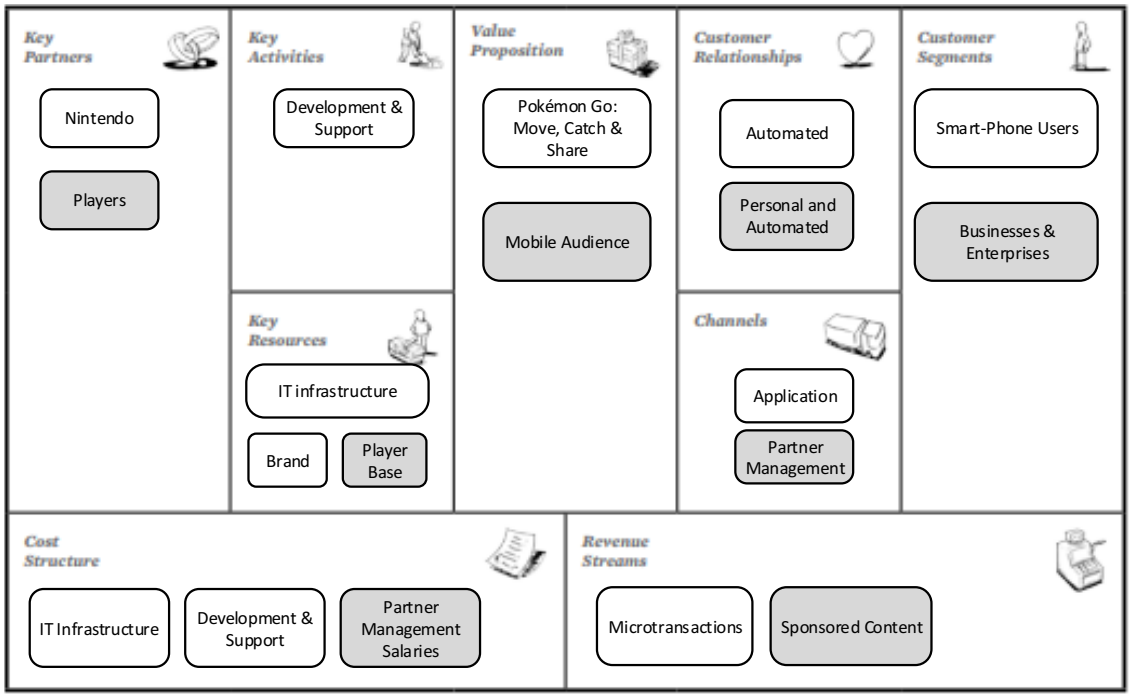

Figure 12. The business model of Pokémon GO (inspired by Pokémon Go 2017; Shea et al. 2017)

Value propositions and customer segments: The first value proposition of Pokémon Go is difficult to summarize. It is directed to all smart-phone users. This value proposition/customer segment is represented by white blocks in the canvas. Pokémon Go is a simpler version of previous Pokémon games, where you catch Pokémon, name them and fight with them. Some of the gaming aspects are toned down and they also appeal to demographics outside hardcore gamers. The game is easy enough for any smart-phone user to download, and start playing right away. However, instead of staying at home and playing in a virtual world, the game mobilizes people through AR. To catch the virtual creatures, people need to go out. The game is also integrated with social media, so people can share news on Facebook or Twitter on their latest parts of collection. As such, the value proposition of Pokémon Go could be summarized as the combination of three aspects: move (AR), catch (gamification) & share (socialize).

The second value proposition of Pokémon Go is the audience, meaning the player base of the game, and it is directed to businesses and enterprises. This value proposition/customer segment is represented by grey blocks in the canvas. Anyone who went to a large

city in summer 2016, could see crowds of people hanging around PokeStops, i.e. virtual places tied to real-life locations that allowed players to collect in-game items required for game progression. Most of the PokeStops were already tied to famous monuments or known locations when Pokémon Go was launched. However, if you were lucky, your business was either already a PokeStop or very near one. For example, imagine a milk shake bar, located right next to a PokeStop, where thirsty players, tired from walking for miles enter to get refreshing milkshakes. Pokémon Go was an opportunity for companies to get more customers.

Channels: The first value proposition (white blocks) is delivered to smart-phone (or tablet) users through the Pokémon Go application, which can be downloaded from App Store or Google Play. The audience value proposition (grey blocks) is delivered to businesses and enterprises through Niantic's partner management.

Customer relationships: The customer relationship between the players, i.e. smart-phone users, is automated through the game. The relationship between businesses and enterprises is both personal and automated. The initial relationship is more personal, as the connection between the enterprises and Pokémon Go happens through Niantic's partner management (Pokémon Go 2017). Both parties need to have the same interests since who they partner with affects their brand and status. However, once the "partnership" has been established, the sponsored content is automated through the game.

Revenue streams: The revenue stream that comes through the player base (white blocks) is micro transactions, i.e. items purchasable with real money from the application that help players progress in the game. The second revenue stream comes through companies and enterprises (grey blocks) who can purchase sponsored content. Companies and enterprises can pay a fee to make their enterprise, business or location into a PokeStop. For example, notable clients included huge chains like McDonalds and Starbucks (Briers 2016). It should also be noted, that some of the in game microtransactions came from enterprises purchasing "lures" to nearby PokeStops. These items attract more Pokémon in the general vicinity of the PokeStop and through that, more players in the neighbourhood (Simas 2016).

Key partners: Key partner for the game (white blocks) is Nintendo, who owns the brand of Pokémon. This brand is one the main reasons why Pokémon Go became such a sensation. Key partner relating to businesses and enterprises (grey blocks) are the players of Pokémon Go, since without them, sponsored content would not have an appeal.

Key activities: The only major key activity, development and support, is related to the first value proposition (white blocks). Development and supports refers to updating the game, fixing any issues or bugs and, in addition, adding more content into the game to keep players interested.

Key resources: The first two key resources, IT infrastructure and Brand, are related to the first value proposition (white blocks). First, Pokémon Go is a global game, tied to real life locations. To work everywhere, it requires an extensive IT infrastructure, i.e. servers to keep the game operational. Second, the brand of Pokémon is the main reason why Pokémon Go received so much media coverage and visibility.

The final key resource, the player base, is related to the second value propositions (grey players). The more players the game has, the more audience it can provide to the sponsored content and, therefore, increase its value as an advertising platform.

Cost structure: The first two blocks of the cost structure, IT Infrastructure, and development and support, are related to the first value proposition (white blocks). First, the game is global and, therefore, requires an extensive IT infrastructure to keep the game operational. Second, development and support is required to retain the current player base by fixing any issues they have and by offering new content to explore. New content may also attract new players to start playing or attract old players to come back.

For the second value proposition (grey blocks), majority of the costs come from partner management salaries. However, the cost can be seen as trivial compared to the other building blocks of the cost structure.

Key Findings: As mentioned before, Pokémon Go's large success is the combination of a very specific set of conditions and a very specific value proposition. While AR is one of the key aspects of what made Pokémon Go so appealing, it would not have worked without other key building blocks from the business model represented above. Niantic, the company behind Pokémon Go, had an earlier AR mobile game, Ingress, that operated on a very similar business model. It was based on a mobile AR game, where you caught and fought with virtual creatures in real locations (Ingress.com 2017). The game got its revenue through micro-transactions and sponsored content, however, its user experience was directed to gamers and did not appeal to larger audiences. To Niantic, it was more of a proof of concept (Turk 2016) that verified there is a market for mobile AR gaming. A key aspect what got Pokémon Go its initial boost was the brand *(*a key resource) of Pokémon, which Niantic got through partnering with Nintendo, which made Pokémon Go huge with a very little amount of actual marketing. In addition, it is important to note that Pokémon Go utilized a similar strategy as Nintendo; instead of just appealing to gamers, the value proposition appealed across all age groups, demographics and countries (Hollensen 2013). Pokémon Go's ability to mobilize large audiences is ingenious. There are even studies of people suffering from social withdrawal, who have not been outside in years, who the game has motivated to 'going out' (Kato et al. 2017). AR's ability to mobilize people will no doubt be important.

5.1.2 New York Times NYTVR

The methods of 360/VR have been explored in journalism during the last few years and news agencies such as New York Times, USA Today Network, Die Welt, Blick, Dagens Nyheter, ARTE, the Guardian, Sky, and Euronews have all invested in the development of these new methods (Watson 2017). In stories, these methods can be utilized to create a sense of presence and to build emotional connections, however, the way how narratives are developed in journalistic VR is still in its infancy (Sirkkunen et al. 2016). It is unclear how or why audiences should be engaged through this new medium, and how media companies can capture value from this production (Watson 2017). To learn how, the methods need to be explored more. It is possible to make short 360 news articles with low amount of resources, however, high-end 360/VR production, like documentaries, is still expensive and requires multidisciplinary knowledge (Watson 2017). This section analyses a company that does both.

New York Times was one of the first big media outlets to focus on 360/VR, and in 2016 they released an application called NYTVR for high-end 360/VR experiences for mobile headset audiences (Watson 2017). New York Times also has a section on their website called the Daily 360, where they release a new 360 video every day (The New York Times 2016). The presented business model (Figure 13) is made for their application NYTVR.

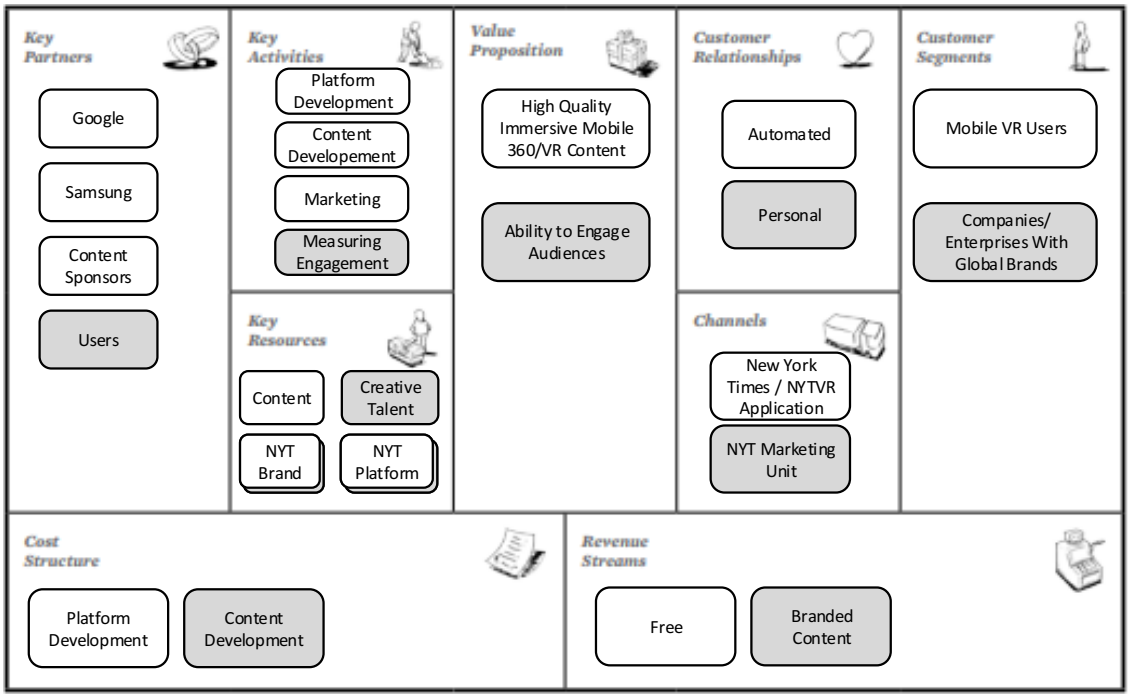

Figure 13. NYTVR Business model (inspired by Hopkins 2017; T Brand Studio 2017; Watson 2017)

Value propositions and customer segments: The first value proposition is high quality immersive mobile 360/VR content and it is directed towards mobile VR users. This value proposition is represented by white blocks. NYTVR has both 360 videos and actual VR

content meant to be experienced with a mobile VR headset. High quality in this case refers to high resolution and high production value content. The reason why content quality is important in this case, is because bad quality content that, for example, causes nausea, may turn customers off from the technology (Watson 2017).

The second value proposition of NYTVR is the ability to engage audiences and it is directed towards companies/enterprises with global brands. This value proposition is represented by grey blocks. As mentioned before, at the beginning of section 5.2, 360/VR content as a medium can be more engaging than the traditional methods of storytelling (Habig 2016). For this reason, NYTVR is not only offering companies an audience for targeted advertising, it is also offering an audience that is engaged, interactive and more prone to sharing their experience with their peers. This value proposition is executed through the content that exists in NYTVR.

Channels: The first value proposition (white blocks) is delivered to mobile VR users through NYTVR application. However, it is important to understand that the platform is largely marketed through the New York Times and its subscribers. So far, the company has already given more than one million free Google Cardboard headsets to its subscribers (Robertson 2016). By giving away free mobile VR headsets, the company is marketing its platform and increasing the number of users who are watching the content through mobile headsets instead of just through smart-phone screens.

The second value proposition (grey blocks) is delivered to companies/enterprises with global brands through New York Times' marketing unit. The unit consists of multidisciplinary teams, including editors, strategists, technologist, designers and producers, and is focused on creating multimedia work to illuminate brand stories (T Brand Studio 2017).

Customer relationships: The customer relationship with the users of the NYTVR is automated through the application. In case of questions or feedback, the customers can contact New York Times through their website. The relationship with companies/enterprises with global brands is personal, since the content production is done as a collaboration effort.

Revenue streams: NYTVR application is free of charge and anyone with a smart-phone can download it from the respective application stores. Inside the application some of the production, for example, videos from New York Times' Daily 360 are news or small documentaries. However, a majority of the content is currently "branded content", the main revenue stream of the NYTVR, and a form of native advertising that refers to content that is sponsored by a specific brand (Pophal 2014). The difference in New York Times' branded content, when compared to traditional display advertisements, is that it fits the other content of the New York Times and uses the same methods of journalistic storytelling (i.e. compelling stories). This content is created in collaboration with the New York Times' marketing unit and the price for this content is negotiated depending on the case.

Key partners: For the first value proposition (white blocks) there are three key partners, Google, Samsung and content sponsors. Google was a big part of the initial launch of NYTVR and the reason why NYTVR could provide their viewers with free Google Cardboards (Robertson 2016). In addition to Google, New York Times has a partnership with Samsung and it's gear VR (NYTVR 2017). By partnering with Google and Samsung, NYTVR can obtain more viewers using the mobile VR headsets, and Google and Samsung get more content for their mobile VR devices. The third key partner for the first value proposition is the other content sponsors (i.e. the branded content partners) as they sponsor more content for the platform, making it more compelling for users, and participate in content development costs.

For the second value proposition the key partner is the users of the platform, since they are the audience for the branded content and as mentioned before, due to the engaging nature of VR/360 production, the users are more prone to sharing their experiences (Habig 2016) and thus spreading brand awareness.

Key activities: Key activities for the first value proposition (white blocks) are platform development, content development and marketing. Platform development is important, because currently there are still issues with the mobile VR devices and interactivity. For example, how do mobile VR change videos in a user-friendly way without removing the headset? The platform needs to develop simultaneously with the devices and software. At the same time, NYTVR needs to continue developing content, in order to retain or bring users back to their platform by offering them new enticing content. Final key activity for the first value proposition is marketing, since by attracting more users, New York Times makes their platform also more attracting for enterprises and companies.

For the second value proposition (grey blocks) most important activity is measuring engagement, i.e. collecting metrics. These metrics can provide proof of concept about the different aspects of VR/360, for example, whether the videos attract more engagement than the more traditional methods of branded content.

Key resources: The most important key resource for the first value proposition (white blocks) is the content. The content is required to attract an audience. The most important key resource for the second value proposition (gray blocks) is the creative talent, i.e. content creators. New York Times' marketing unit consists of multidisciplinary teams, combining the same talents who are responsible for their news content with marketing specialists (T Brand Studio 2017). This enables them to combine journalistic storytelling with branded content. The shared resources (white blocks overlapping with gray blocks) between both value propositions are NYT Brand and the NYTVR platform. New York Times brand is known for high quality branded content (Main 2017) and as such, brings in customers for both value propositions. NYTVR platform is a key resource, as it enables both value propositions and from it, the company can collect metrics about the success of their content.

Cost structure: The main costs for the first value propositions (white blocks) come from the platform development. As mentioned before, the way mobile VR should be utilized is still exploratory and as such, the platform needs to be developed as the industry evolves. The main cost for the second value proposition comes from the content development. It could be argued that the content development costs are a shared cost for both value propositions, however, in this case it is linked to the second value proposition for a reason. The technologies of VR/360 have large potential for use in journalistic context (Watson 2017). The problem is that creating high quality VR/360 content is expensive. Instead of only exploring how to use this technology in the Daily 360 (the journalistic VR/360 channel of New York Times), New York Times is exploring it in their branded content. This means that their clients, the global brands, are paying for the content development and at the same time New York Times learns about the technology and also attracts more customers to their own platforms.

Key Findings: The most important finding from the business model is the synergy NYTVR offers to New York Times. Media companies are often advertisement-based business models, however, New York Times is a subscription-based business model and for them, advertisements are low-margin (NYT 2020 Group Report 2017). To get subscribers, New York Times needs to offer engaging content. The technologies of VR/360 offer a new possible platform for media, however, the technologies are still at an exploratory stage and as such, the methods still require more development (Watson 2017). Development can be expensive. New York Times is exploring how to use these new methods in their branded content, delegating the production costs to their enterprise customers, creating more engaging content for their subscribers, attracting new ones and at the same time learning how to use the technology in their own journalistic context.

5.2 VR/AR in architecture and engineering

Contrary to the public belief, VR/AR is not only for entertainment and video-gaming. One of the best already existing examples of this can be found from the architecture and engineering industry. For example, VR can be used as a collaborative design tool in architecture, bringing together architects, engineers and the end-users of buildings, enabling a better, more immersive design process (Portman et al. 2015). AR HMD's are already used as a tool in elevator maintenance, enabling service technicians to visualize and identify problems before the actual maintenance duties, and giving hands-free access to expert information onsite (Erickson 2016). The overlying idea behind why VR/AR is important in architecture and engineering is simple: both technologies excel as visualizing tools. They allow to see finished products in a real-life scale and perspective before a single component or a brick is laid. While virtual reality can take you inside completely virtual buildings, AR can combine real environments with real sized objects and computer-generated data.

Two cases were chosen for analysis: 1) the business model of a VR software company called IrisVR, that offers a software that takes 3D models and blueprints created with commonly used design software and translates them directly into a ready-to-use VR environment, and 2) the business model for VR assisted building design and construction. The reason why these two models were chosen, is because VR is already widely used as a design and collaboration tool in construction projects by, for example, large architecture and engineering companies such as Sweco (Sweco 2017). While some industries are still looking for ways to use and commercialize VR/AR, in architecture the technologies are already leveraging current business models by improving every stage of the building process. However, while smaller engineering and architecture companies often already use 3D modelling software's such as Revit, they lack the required knowledge, hardware and software resources required to introduce VR as a part of their design. The first case offers one answer to this problem. In addition, it can be used as a tool in assessing what kind of value does VR provide to the actual design process. The second case is more about exploring VR as a tool for collaboration between the designers and the clients of a building project, exploring the value provided to building projects.

5.2.1 IrisVR

IrisVR is a software company that makes the use of virtual reality as a design tool possible for engineers, architects and everyone else who uses current generation 3D modelling software such as Revit, SketchUp, OBJ, Grasshopper or Rhino. Its main product, Prospect, enables designers to take their existing plans and models, and with just a few clicks, see their creations in virtual reality. (Majewski 2016). The company has another VR related product, Scope, that enables viewing panorama pictures in VR with a smartphone. However, the business model presented (Figure 14) here focuses on Prospect.

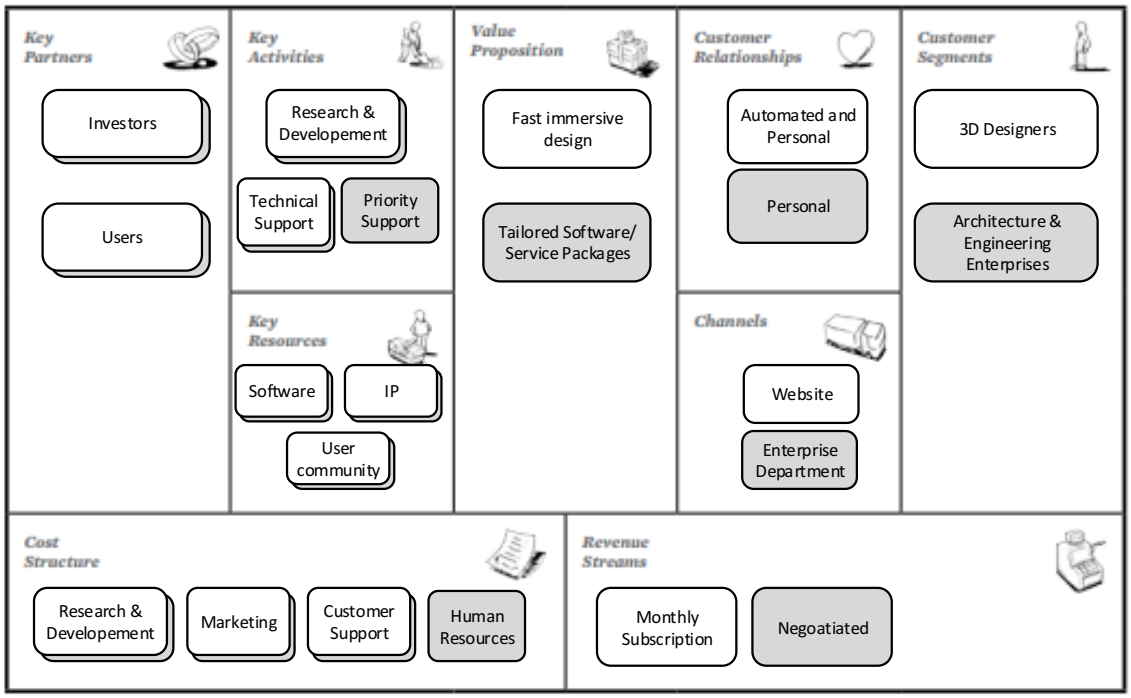

Figure 14. The business model of IrisVR (inspired by Ha 2016; IrisVR 2017a)

Value propositions and customer segments: IrisVR's first value proposition, fast immersive design, is directed to 3D designers (i.e. users of Revit, SketchUp, OBJ, Grasshopper or Rhino). This value proposition is represented by white coloured blocks. The software of IrisVR, Prospect, enables visualizing 3D models in VR, without having to learn any new tools (IrisVR 2017a). Instead, designers can use the same programs they already have in their workflow. The term, 'immersive design', refers to how VR can alter and enhance the design process; instead of looking paper or digital blueprints, the space can be experienced before a single brick has been laid. It is a faster and a better way to review any design choices before any money or materials have been spent.

The second value proposition is tailored software/service packages, and it is aimed at architecture and engineering enterprises. This value proposition is represented by grey coloured blocks. To enterprises IrisVR offers customized software/service packages tailored to their specific needs: bulk licensing, priority support, custom branding and previews of alpha features (IrisVR 2017a).

Channels: The first value proposal (white blocks) is delivered to 3D designers through IrisVR's website, where designers can buy a licence for their software (IrisVR 2017a). The website also harbours a community/forum for IrisVR users, who can support each other and share knowledge (IrisVR 2017b). The second value proposition (grey blocks) is delivered to architecture and engineering enterprises by IrisVR's enterprise management department (IrisVR 2017a).

Customer relationships: The relationship between the first value propositions and its customer segment (white blocks) can be both fully automated and personal. The product can

be bought and installed from the website of IrisVR without any personal connections between the company and its customers (automated). However, the product is a software and can require a certain level of customer support; this can create a more personal connection between the company and the customer. In addition, as previously mentioned in the channels segment, IrisVR also has a user community, in which users can form their own respective user groups and have a more personal connection with the developers of IrisVR.

For the second value propositions (grey blocks), the customer relationship is personal. All enterprise packages are tailored according to the needs of their respecting customers and as such, require negotiations. To retain and have a sustainable relationship with these enterprise customers, the relationship needs to be more personal.

Revenue streams: Fast immersive design (white blocks) is accessible for *3D* Designers with a monthly subscription. The subscription is currently priced $300 per user/month or $200 per user/month if bought with an annual contract (October 2017). The prices for the tailored packages (grey blocks) are negotiated by IrisVR's enterprise department and as such, there is no available information regarding them.

Key partners: All presented partners are important for both value propositions (white blocks overlapping with grey blocks). IrisVR began as a start-up in New York in 2016 and by the end of 2016 it had amassed $8 million in investments (Ha 2016). These investors remain important partners for the company. Another important partner for the company is its users: the company provides a platform for its users to communicate and share knowledge. This way, the users can support each other, and at the same time, provide valuable input for research and development.

Key activities: The most important activities for both value propositions (white blocks overlapping with grey blocks) are 1) research and development and 2) technical support. First, and the most important key activity for IrisVR is research and development. Since HMD's and 3D modelling programs are constantly updated, IrisVR must keep their product updated and compatible accordingly. IrisVR is not the only company on the market offering a similar solution, therefore, for them to beat the competition, their product must offer better features. Second, technical support is a key activity since IrisVR is a professional tool. Any problems inhibiting its use are affecting its value as a workflow instrument. It should also be noted that technical support can be a key source of information for research and development as they can have a lot of knowledge regarding the problems of the software and what features customers would like to see fixed or added.

In addition to the previous activities, there is one key activity that only relates to the second value proposition (grey blocks): priority support. This is a purchasable additional service to the tailored enterprise packages. However, it is an important one, since it emphasizes a service-based product model instead just the software licence. The software of

IrisVR that can transcribe 3D models to VR is something, that although difficult, can be copied. In addition to qualities such as product price and its features, services and their quality can be a key activity in retaining customers and learning what they want (Peng et al. 2014).

Key resources: All three key resources presented in the business model canvas are related to both value propositions (white blocks overlapping with grey blocks). First key resource is the software that enables the whole business model. Second, the intellectual property (IP) owned by the company. The software is a part of this, however, it also includes all other intellectual resources the company has, for example, the knowledge about its customers and their needs or the knowledge regarding interactivity in VR. Third, the user community, as it can be used to leverage both research and development and technical support.

Cost structure: The first three blocks of the cost structure are related to both value propositions (white blocks overlapping with grey blocks). First and the biggest factor of the cost structure is research and development. There are still many issues with VR, such as how to handle interactivity or co-operation in VR which need to be developed constantly to be able to offer a better product. Second, marketing is important, as to get more customers, IrisVR needs to reach them first. As mentioned previously, for professional architects, designers or enterprises, the advantages of the product can far exceed its costs. However, the initial cost of the hardware, including as VR-able computer and the HMD, can seem like a sizeable investment without sufficient proof about the advantages the technologies propose. The role of marketing is to demonstrate this proof to potential customers and currently, since the technologies of VR are still unknown to many, the role is especially important. Third shared block of the cost structure is customer support, and it is required to keep the product operational and to keep the customers happy.

In addition, to the previous cost structure blocks, there is one more additional block dedicated for the second value proposition (grey blocks). This block is human resources and it refers to the additional costs of the personnel required for the tailored enterprise services. The importance of visualizing this building block can be debated, as the research and development and marketing blocks can be seen as a much bigger piece of the business model. However, visualizing this building block serves to clarify that offering additional services to companies creates some additional costs, and this is important to keep in mind when comparing the two value propositions.

Key findings: The value VR can provide to a designer is easy to communicate. VR lets architects, engineers and the end-users of buildings experience them in a real-life scale before they are built, increasing consensus, decreasing errors and enabling a more efficient workflow. IrisVR offers an easy and economical way to implement VR as a part of normal workflow in building information modelling. The method does not require learning new programs or tools, but rather takes something that is already used and improves

it as a plugin. Using IrisVR's software requires an HMD (HTC Vive or Oculus Rift) and a computer powerful enough to run VR. This is a small lifetime investment (including the licence) when comparing the price to, for example, actual building projects.

An important thing to note about the business model, is the difference in the two value propositions operate. The first value proposition is mostly automated and based around a software licence. This makes it very scalable, meaning that the company can increase the number of customers from this specific customer segment substantially, without increasing its cost structure. The other customer segment, architecture and engineering enterprises, requires more personal services and as such, customers from this segment impose IrisVR with more costs. However, enterprise customers have more potential for two reasons: first, in addition to the product licences, revenue is created through services. Second, service model can help in retaining the customer long-term if the service is high-quality.

5.2.2 VR co-creation with end-users of buildings

The overlying idea for a traditional building project and the business model behind it is simple. For example, there is a client, who needs a building. The building is delivered to the customer through a building project. The price for this project is negotiated between the contractor and the client. Constructing a building costs money and for the project to be profitable, contractor needs to charge enough money from the client to cover all the costs of the building project and make profit in exchange. Even small building projects, like a house for a family of four, require many different types of expertise: the location where the house will be built needs to be surveyed and examined, the house needs to be designed, the plan needs to be according to any local building laws and jurisdictions, the budget needs to be handled, etc. In bigger building projects, like for example public hospitals, there might be dozens of different stakeholders involved, and 'thus good project management (and risk management) are key activities that ensure the success of the project. Misinterpretation of the spatial demands between the client and the contractor, or any other stakeholders, can lead to huge unexpected costs to all parties involved. One solution to this problem is offered by VR.

While the previous business model focused on the designer and architecture/engineering companies, and how VR can enhance the jobs they are trying to get done, this business model focuses on the clients and end-users of the designed products. The business model of Figure 15 represents a normal construction project leveraged with VR HMDs and is inspired by Anderson (2016).

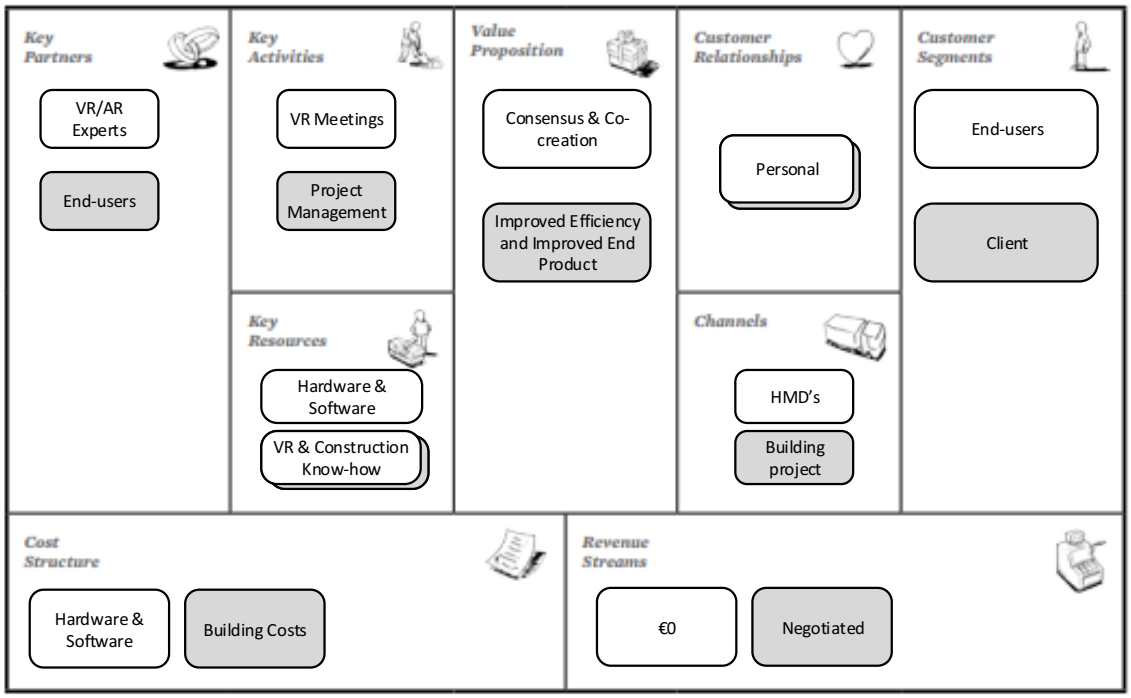

Figure 15. An example business model of VR assisted building project

Value propositions and customer segments: the first value proposition, consensus & co-creation is directed to the end-users of the building. This value proposition is represented by white blocks. To an average customer, traditional 2D documentation of a space tells little about reality. With VR, end-users can join designers in a realistic representation of the end-product. This builds consensus about the building choices, reduces errors and lets the end-users co-create together with the contractor. For example, in a highly utilitarian and cost/m^2 built, like hospitals, the practicality of the spaces also needs to be high and fit the requirements of the end-users. In these cases, VR can reduce mistakes and enhance the building project immensely.

The second value proposition, improved efficiency and improved end-product, is directed towards the clients of building projects. This value proposition is represented by grey coloured blocks. By utilizing VR, the communication between the different stakeholders can be improved: visualizing 3D models with VR is faster, than presenting them on a computer screen. In addition, utilizing VR, a lot of clashing design and utilitarian choices can be eliminated before wasting any resources on actual construction. This can ultimately lead to faster projects with better results.

Channels: The first value proposition (white blocks) is delivered through HMDs. By putting on VR displays end-users can join designers and other project stakeholders in a virtual projection of the end-product, i.e. a building. The delivery channel of the second value proposition (grey blocks) can be described as the building project, aided by the VR tools.

Customer relationships: the customer relationship with both value propositions and their respecting customers can be described as personal (white blocks overlapping grey blocks). While relationships in building projects are mostly personal, VR can make the relationship even closer, with both the end-users and the client itself, creating a better common understanding on what is going to happen.

Revenue streams: for the first value proposition (white blocks), there is no direct revenue stream. The VR service should be free, as it can help both the contractor and the client. However, it is something that creates competitive advantage through offering a better service and product. The revenue comes through the second value proposition (grey blocks), through negotiated contracts. However, it should be noted that the possibility to utilize VR as a part of the building process is a key source of competitive advantage and as such, can be used to leverage this negotiated price.

Key partners: for the first value proposition (white blocks) and the ability to use VR/AR in an efficient way the key partners are VR/AR experts, who understand how to use the technology as a collaboration tool and can help in improving the services provided. For example, VR models can sometimes be too cumbersome for computers to run. In these cases, the models need to be "optimized" and the actual knowledge on how to do that is more common in videogaming industry professionals than in 3D modelling alone. For the second value proposition (grey blocks) the end-users can be seen as a partnership, as with VR, they should be working together with the contractor to match the building with its actual end-product needs.

Key activities: a key activity for the first value proposition (white blocks) is VR meetings. VR meetings should be held at steady intervals before any construction operations to get the full value out of the first value proposition. For the second value proposition (grey blocks), a key activity is project management (and risk management). This is again, something that is being leveraged by using VR as a part of the building work flow.

Key resources: A key resource for the first value proposition (white blocks), co-creation service, is the hardware and the software that enables the use of VR. The second block, VR and construction know-how, is a shared block between both value propositions (white blocks overlapping with grey blocks). Without understanding both building projects and how to utilize VR, it is impossible to utilize the technology in an efficient way that leverages the business model. It should be noted that VR knowledge can be improved through partnering.

Cost structure: The key cost presented for the first value proposition (white blocks) is the hardware and software costs. The hardware and software required for VR collaboration does cost money, however, as the previous case study shows, there are alternatives on the market, that can make the hardware/software investment trivial, when comparing it to the overall costs of a building project.

For the second value proposition (grey blocks), the visualized block is “building costs”. In every building project, there are various costs such time, money and other resources. What is important to note, is that VR can be used to leverage every stage of the building project and therefore, its use can reduce the size of this building block, by replacing physical resources with virtual ones and making the workflow process a building project more efficient.

Key findings: the business model above is a very simplified representation of the different business elements involved in a building process. However, it is a prime example of the industrial possibilities of VR. Building projects are expensive and especially with large companies introducing VR/AR as working methods can often easily create more advantages than costs. It should be noted, that the main advantages of VR/AR are not necessarily for the architects, but often the other stakeholders of the building project. Programs like Revit with their large object libraries already give error messages in cases where there is something wrong in the 3D models. Professionals with a large amount of modelling experiences can easily navigate and understand the 3D plans with just a mouse and a keyboard. However, offering the same service in VR (or AR) offers a faster and a better way of navigating through the 3D models to anyone, whether they are the client of the building project or the end-user of a condo. This advantage of VR/AR and the simplicity of its usage can also translate to any other industry, where 3D models are currently used for displaying and/or testing products.

5.3 VR/AR in education

The reason why VR/AR is important to education industry is for similar reasons as in entertainment and architecture. The technology is a visualizing tool that induces engagement, an especially important factor for learning. A simple example can be found from aviation training: as previously mentioned in chapter 3.1, VR has been used in pilot training for decades, simulating the experience of flying (Oberhauser and Dreyer 2017). In pilot training context, the value of the technology is easy to understand: flying planes can be dangerous, difficult and expensive. VR enables training in a safe environment that is comparable to the real thing, especially with the modern level of graphics and notably less expensive. The reason why the technology was not applied much in education before, is because the expenses of the technology still often outweighed the gains. Now, due to the technology becoming more affordable and more available, the use of VR/AR in educational environments has become increasingly popular (Curcio et al. 2016).

There are not many VR/AR related business models operating in education industry yet, and the ones that are, are still in the investment stage. For example, one of the most interesting products found during the search for analysable business models is Engage, a free to use social education and presentation platform, where educators could teach classes in virtual worlds, instead physical ones (Engage 2017). For example, a course on astronomy could take place in the space and with their virtual avatars, the students could see star

constellations before their eyes. However, Engage is still in early access (beta testing) and does not have a business model. There is a lot of future potential, for example, in selling cosmetics to user avatars and monetizing content, however, this is only speculation. Another interesting example is Unimersiv, a company offering VR trainings and trips to historical locations such as the Ancient Rome (Unimersiv 2017). Their offer is the chance to subscribe to their website and get access to their content. In addition, they provide tailored services to, for example, schools and companies where customers can order specific content to them. However, they currently do not have much content their product portfolio is still small.

In the end, the two business models chosen for analysis in this context are: 1) Google Expeditions, a mobile VR/360 application that offers teachers the possibility to take their students to virtual field trips (Google Expeditions 2017) and 2) zSpace, a company selling high-end VR/AR classrooms to learning institutions (zSpace 2017a). Google Expeditions was chosen because their value proposition is simple, VR/360 videos directed for educational context using affordable mobile VR headsets. zSpace was chosen because they represent a more expensive high-end VR/AR solution. Both of these business models are already creating revenue and while zSpace is currently doing well based on their amount of customers (zSpace 2017b), Google Expeditions has a lot of potential for the future with their more affordable technology and scalability of their solution.

5.3.1 Google Expeditions

The idea behind Google Expeditions is simple: it is an application marketed for educators that enables them to take their students on virtual field trips to locations such as the great wall of china, the coral reefs of Galapagos and planet Mars (Google Expeditions 2017). The application itself is free and consists from various “tours”, i.e. VR/360 videos that are meant to be enjoyed with mobile VR headsets. The thing that differentiates Google expeditions from the rest of the mobile VR content is the ability to guide classroom-sized groups either through a phone or a tablet (Google Expeditions 2017). With a phone or tablet educators, such as classroom teachers, can guide students through the virtual tours and steer their vision towards points of interest. The problem with the initial value proposition of Google Expeditions was that to give proper “expeditions” to classroom-sized groups, a lot of tech was required: smart-phones, mobile VR headsets, chargers, the tablet used for guiding and fast Wi-Fi. At the earlier stages of Google Expeditions, schools and educators could apply for the “Expeditions Pioneer Program”, in which Google gave the selected teachers “kits” containing everything required for a classroom-sized expedition for free (Madda 2015). Currently, these kits are no longer free and the business model is centred around providing the expeditions application for free and selling the kits through a retailer. The business model of Google Expeditions is presented below in Figure 16.

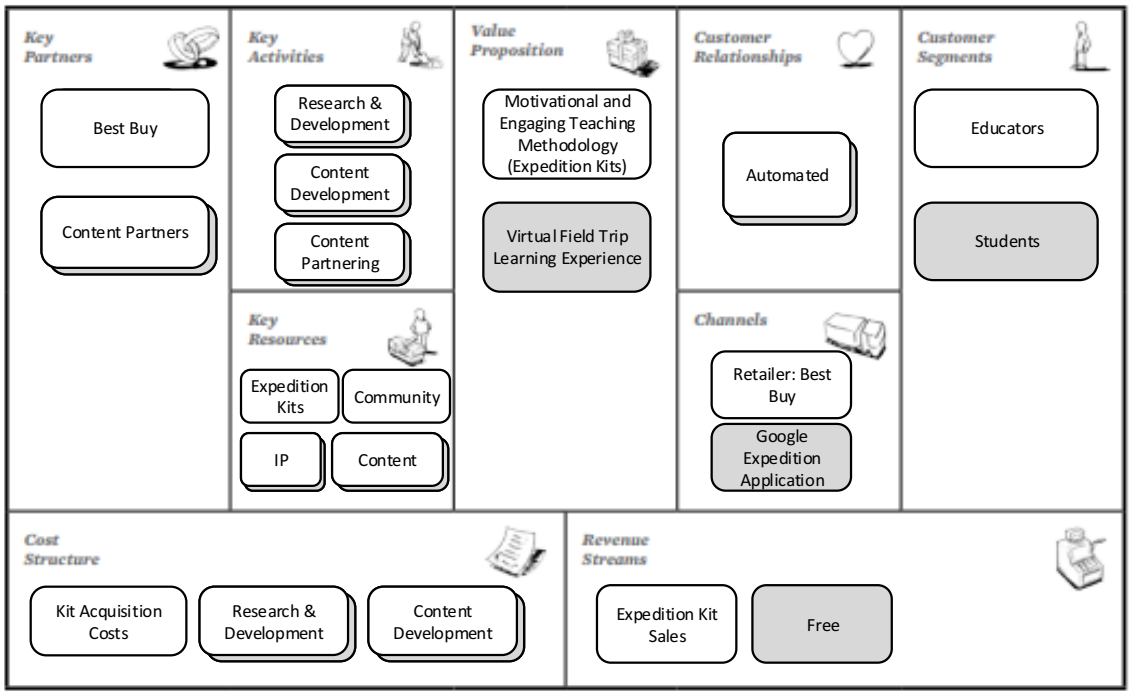

Figure 16. The business model for Google Expedition (inspired by Curcio et al. 2016; Google Expeditions 2017)

Value propositions and customer segments: the first value proposition is motivational and engaging teaching methodology and it is directed towards educators. In product form, it refers to the kits that have all the tools required for the classroom-sized virtual expeditions, i.e. the "Expedition Kits". This value proposition is represented by white coloured blocks. There is evidence that the technologies of VR/AR can increase motivation, engagement and critical thinking in students, and as such, help teachers facilitate learning (Curcio et al. 2016). Google Expedition Kits provide the educators with the possibility, for example, to turn a traditional geography lesson into a set of virtual field trips. Instead of only telling the students about the different capitals in Europe, the teachers can take the students to the locations, building lasting connections between the geographical locations and the actual places. Thus, Google Expeditions provides a new engaging teaching methodology.

The second value proposition of the business model is the virtual field trip learning experience and it is directed towards the users of the application, in this case, the students. This value proposition is represented by the grey coloured blocks. The value proposition refers to the experience the virtual field trips give to the students. The reason why this value proposition is separated from the first one, is to outline the fact that the Google Expeditions application is free and the students can also use it without the help of a teacher, whether it be at home or with friends. Teachers use the application, because it enables them to teach better, while students use the application either because they must, in teaching context, or better, because they find the experience interesting. By having this

second customer segment, the students (or other users), who are coming back to the application on their free time, the business model has more future possibilities, for example, capturing value through paid content or advertising.

Channels: the first value proposition (white blocks), the Expedition Kits, are delivered to educators through a retailer, Best Buy. The kits include everything required for an expedition session, student devices, VR viewers, rapid chargers, a teacher device, an internet router, a case/charging cart and customer service package. These kits are priced according to size (for 10, 20 or 30 students) and there is also an option for personalized kits, for example when the customer only needs the students devices and the teacher tablet. (Best Buy 2017b.) The second value proposition (grey blocks, meaning the virtual field trip experience, is delivered through the Google Expedition application.

Customer relationships: For Google, both customer relationships are automated. The more personal relationship of the Google Expeditions Kits (white blocks) is outsourced to their retailer, Best Buy, who takes care of the device installation and customer support.

Revenue streams: The main revenue stream for the business model comes from the first value proposition (white blocks) in the form of expedition kit sales. In this case, the product is sold through a retailer, Best Buy.

Key partners: The main partner for the first value proposition (white blocks) is Google's retailer, Best Buy, who takes care of selling the product, i.e. the expedition kits, and IT related customer service, while allowing Google to focus on its core competency in product development. The second block is the content partners and it is related to both value propositions (white and grey blocks). To make both value propositions work, Google Expeditions needs a lot of content. Creating content can often be expensive, so Google subsidizes these costs by partnering with companies in content creation. These companies get to experiment with the technology and get some visibility, while Google gets to outsource some of its expenses in content creation.

Key activities: All key activities are related to both value propositions (white and gray blocks). First block, research and development is a key activity, since the application and the expedition kits need to be updated according to evolving mobile VR technologies. Second block, content development is a key activity, since without a large amount of content neither the expedition kits or the application are attractive to customers. Third block, content partnering can be seen as a key activity, since it enables Google to create more content with less resources.

Key resources: First key resource for the first value proposition (white blocks) is the expedition kits, as they are currently the main source of revenue in the business model of Google Expeditions. The second key resource for the first value proposition is the Google Expeditions community. It is a discussion forum hosted by Google where the users of

Google Expeditions, i.e. educators, can share expedition plans (curriculum), provide feedback about expedition kits and the current application, and give suggestions on current and future content (Google+ 2017). This way Google Expeditions can gain knowledge about what its users want and how its business can be improved.

The remaining key resources are linked to both value propositions (white and grey blocks). First, Google is a technology giant, so it has a large amount of IP (Intellectual Property) relating to the technologies of mobile VR/AR. Google Expeditions is a platform for using and further developing this IP. Second, the resource that makes both the expedition kits and the application attractive is the high amount of content the application has. Google already has a large amount of 360/VR content as it is one of the main players in mobile VR/AR technologies, making it difficult for others on the market to compete on amount of content.

Cost structure: The first block in the cost structure, kit acquisition costs, relates to the first value proposition (white blocks). The reason why the block is not called kit manufacturing costs, is because Google does not manufacture the kits; the pieces it includes are compiled from already existing catalogue of their retailer, Best Buy. Acquisition costs refer to the amount of money Google pays Best Buy.

The other building block in the cost structure are related to the both value proposition (white and grey blocks). First shared block is research and development. It refers to the costs of developing and updating the expedition kits and the application. The second remaining block is content development and it refers to how much Google Expeditions invests in the creation of content. It should be noted, that Google already has a lot of content, from projects like, for example, Google Street view which can be utilized in the creation of Google Expeditions content. In addition, Google Expeditions is partnering with different enterprises and thus subsidizes the costs of content creation.

Key findings: Google Expeditions is operating on a very simple business model, selling technology kits to educators through a retailer. As the kit sales are operating on a single transaction model, the current business model is not very scalable. The current business model is also something that does not work in the future, depending on whether mobile VR headsets become more common place or not. If they do, the current customers of Google Expeditions do not have to purchase the kits required to make classroom-sized expeditions, as most of the students would already have their own devices.

However, it should be noted that Google is one of the big players in the technologies of mobile VR/AR. Any content Google creates for the mobile audiences also increases the attractiveness of its technology products like, for example, the Google Daydream (Google Daydream 2017). For Google, Expeditions is creating more traction towards the mobile VR/AR technologies and increasing the amount of the mobile VR devices on the market. Google is already doing an AR application for classroom and this same application is

already being marketed to the users of Google Expeditions (Google Expeditions 2017). The value Google gains through the current business model by increasing the amount of mobile VR/AR users and devices on the market has a lot of business potential for the future. While the current business model of Google Expeditions is operating on a single transaction model, there are many other possible ways to monetize it in the future when the application gains more users, like for example through advertising or paid content. Google Expeditions is already cutting content development costs through partnering and for these same partners, the visibility they get is also important.

5.3.2 zSpace

zSpace sells VR/AR learning labs that consist of hardware, software and educational content (zSpace 2017a). They stand out from other educational VR/AR companies with by having their unique solutions and being a display-based company (Kellenberg 2017). Instead of selling content for already existing HMDs, they have their own system. This system does not utilize an HMD, but consists of a specialized high-definition LCD display, lightweight z-space glasses and an interactive stylus pen (zSpace 2017a). This system operates in a similar manner as the traditional 3D movies, where objects seem to come out of the movie screen. However, the system is more advanced and with it, for example, instead of dissecting a real frog, students can do it virtually (Lacy 2017). zSpace began as a hardware and software solution, where schools would buy zSpace labs, classrooms equipped with multiple zSpace workstation. Since then, zSpace has moved more towards a business model where zSpace is sold as a complete service: including hardware, software, content and services, such as professional development and implementation (Kellenberg 2017). The business model of zSpace is presented in Figure 17.

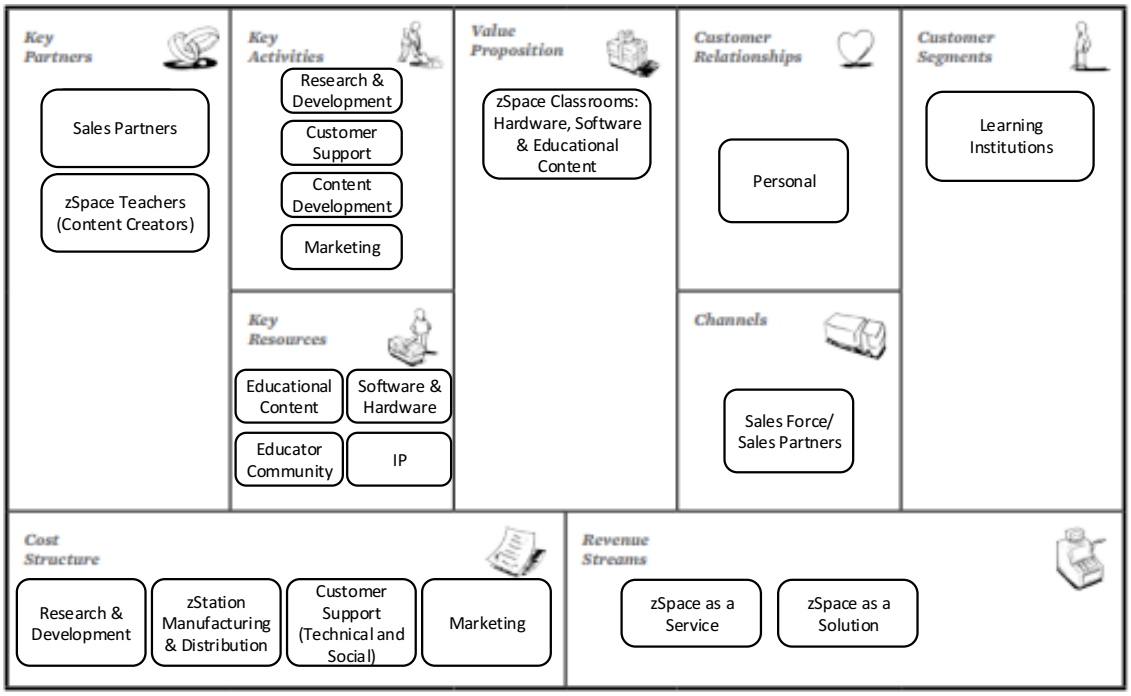

Figure 17. Business model for zSpace (inspired by Kellenberg 2017; Lacy 2017; zSpace 2017a)

Value propositions and customer segments: The value proposition of zSpace is the zSpace classrooms, "VR/AR learning labs" that are marketed to learning institutions, for example, schools and universities. In addition to providing the hardware, software and the tools required for the laboratories, zSpace provides high-quality peer-reviewed educational VR/AR content (Kellenberg 2017), solving one of the issues of VR/AR in education. While there is evidence that VR/AR tools can increase student motivation, engagement and critical thinking, there are still challenges within the theoretical and instructional guidelines on how educators can use these tools effectively (Curcio et al. 2016). In addition to providing required hardware and software tools, zSpace offers educators what they call "key enablers", including hundreds of lesson plans aligned with common educational standards, teacher trainings and professional development (Kellenberg 2017). This makes the value proposition for learning institutions much better, as they can get both state-of-the-art VR/AR classrooms, and if they want, training and a large variety of resources on how to use them efficiently.

It should be noted that in this business model, there is only one value propositions and one customer segment. While the product does provide value for other customers, for example, teachers and students, the whole business model is centred around marketing the product/service to learning institutions. The product/service is expensive, and as such, while teachers could theoretically purchase single zSpace working stations, the business model works, because its customers are purchasing the product as a larger service. For this reason, it was felt necessary to analyse only this customer segment.

Channels: The value proposition, zSpace classrooms, is delivered to the customers through contacting zSpace's sales force (zSpace 2017a). The product/service packages are customized to the needs of the customer, therefore, every delivery is different. In addition to their own sales force, zSpace has a large variety of sales partners, who have trained professionals capable of providing the same services as their own sales force (zSpace 2017a).

Customer relationships: In this business model, the customer relationship is personal. Product/service acquisitions are negotiated with each customer separately and zSpace is often purchased as a full service package (Kellenberg 2017). Even in cases where zSpace is purchased as a one-time solution, the customer can still actively take part in the zSpace educational community, which is presented more thoroughly in the key resources.

Revenue streams: The two building blocks in this segment are zSpace as a service and zSpace as a solution. zSpace labs are purchased as a service, creating recurring revenue (e.g. annual fee for classroom and services included), and in some cases as a solution, a one-time purchase (e.g. single fee for a single classroom) (Kellenberg 2017). These solutions are a large investment for a school. For example, a set of 12 zSpace Stations as a one-time purchase that contains hardware, software and support services costs schools $50-70k (Lien 2015). However, currently zSpace is moving towards a service business model where zSpace is sold as a complete service bundle, including hardware, applications, content and services, such as professional development and implementation that costs around $23k annually (Kellenberg 2017).

The service model is better for customer value creation and value capture, since it enables a better product and creates recurring revenue from additional services, for example, technical support and professional development. In this case the service model is also better for the fact that zSpace can utilize its customers better as a part of content creation by actively involving them more in the community as a part of their services. The customer acquisition and retention is an expensive process, therefore, the more value they capture from a single customer the better.

Key partners: First key partnership zSpace has, is with their sales partners. While most of these partners reside in the U.S, zSpace also has a large number of international sales partners (zSpace 2017a). Global sales partners leverage zSpace's ability to acquire and retain customers globally, and increase the company's ability to service their customers personally by taking care of the individual relationships between learning institutions. Second key partner for the business model is what the zSpace calls "zSpace Teachers", i.e. teachers who use zSpace services and create (currently free) additional community content for the zSpace workstations. As such, they work as free content creators for the platform and increase the amount of educational content zSpace offers.

Key activities: As with many other VR/AR business models, first key activity for zSpace is research and development. Their product is unique, with its own specific hardware and software, therefore, instead of keeping up with the updates on all the different head-mounted displays or mobile VR/AR systems, they work in their own technical ecosystem. However, they still need to keep their product within the standards of the industry. Second key activity is customer support. zSpace's product is a large investment and because of this, to retain their customers, they need to make sure their product works as it should. This is done through proper customer support which includes both technical support and training for the users. Third activity is content development, as without content the product is not attractive. zSpace already has hundreds of lesson plans (Kellenberg 2017), however, new content is needed to keep the old customers coming back to the VR labs and to get new customers from new fields of education. Fourth key activity is marketing. zSpace classrooms are a high-investment product and marketed to a very specific customer segment, and as such, customer acquisition should be done deliberately.

Key resources: First key resource for zSpace is the educational content. The content is required to make the hardware, software and tools attractive. The content is also what attracts their customers, for example, if they have content regarding chemistry, such as interactive 3D models of molecules, they can target learning institutions, who would find that attractive for their curriculum. Second key resource is the software and the hardware they own, and the IP regarding it. It is what makes their value proposition unique and protects it from competitors. Third key resource is the educator community they run on their website (zSpace 2017a). By owning and facilitating a community for the users of their product, zSpace can gather valuable feedback and input about its product. In addition, they get additional educational content for their users through the previously mentioned zSpace Teachers, users who create extra content for the community. The last building block in the segment is IP. The IP regarding the hardware and software was already mentioned before, however, it should be noted that zSpace also owns a large amount of IP regarding VR/AR related teaching practices. This gives them an advantage against competition, since they already have a large amount of peer-reviewed educational content.

Cost structure: The building blocks in this segment are research and development, zStation manufacturing and distribution, customer support (technical and social) and marketing. Research and development is a major cost, as often with business models regarding new technologies. Second major cost is the manufacturing and distribution of zSpace stations. Third major cost is the customer support, both technical and social, regarding the training of the users and other professional development. Final major cost is the marketing of zSpace's solution.

Key Findings: The solution zSpace offers is a large investment, however, they already have hundreds of customers world-wide (zSpace 2017b). Their current business model is service-based and has recurring revenues. They have their own hardware and software

solution and own a lot of IP relating to both the technologies and educational content, therefore, their product is well protected from being imitated or copied.

Currently, the business model of zSpace seems to be ahead of other education related VR/AR businesses. However, having their own hardware and software is also an issue. zSpace is a large investment for learning institutions, especially when comparing to the current mobile VR/AR technologies. These mobile technologies are also operating in a more open development environment and with much more users, and they might soon offer the same experiences as what zSpace Stations do, albeit it be with a much lower cost. zSpace is currently a good example of a successful business model in education VR/AR technologies, however, to stay ahead in the competition, they need to find a way to either increase the amount of value they propose, lower the cost of their services or find new ways to capture value. It should be noted that in June 2016 zSpace announced that they are working together with Google Expeditions to bring more VR content for their customers, however, what this relationship means for zSpace services is still unclear (zSpace 2016). One area of possible value capture, where zSpace excels, is the peer-reviewed VR/AR educational content. This educational content could, for example, be modified for other platforms with similar features as paid content.

5.4 VR/AR in commerce

The technologies of VR/AR have a lot potential in commerce, as they enable new methods of visualizing products. This is important especially for companies who operate in e-commerce, and this can be seen in investments by big players such as Amazon (McCormick 2016) and eBay (Bogle 2016). To make sales, these companies must present the value of their products to their customers through the internet. To support this presentation of value, e-commerce webstores such as Amazon or eBay often have long product descriptions, including customer reviews and pictures of the product from many different angles. Previously the only way to physically see and touch the products of e-stores, was to either visit their retail location or to order the actual product. However, VR/AR has the potential to change this. While realistic sensation of touch is still years away from the commercial applications of VR/AR, the current technologies already offer many ways to improve the existing online retail experience.

As with many other industries presented in this study, VR/AR related business models in commerce are not yet very common. However, there are some interesting experiments such as the virtual store experience by eBay, which lets consumers browse products and buy products using a mobile VR headset (eBay 2017), Thread Studio by Shopify, which lets users design and sell t-shirts utilizing VR (Beauchamp 2016), IKEA Place, which lets users experience and try IKEA furniture at home before purchase using AR (IKEA 2017a), ShelfZone by InVRsion, a simulated retail shopping experience using VR (InVRsion 2017a), and Vrooms virtual car showroom, which takes customers through a car buying experience in VR, including test driving the actual cars (Vroom 2016).

In this case, the business models chosen for analysis are IKEA's AR application IKEA Place's business model and a business model for VR shopping, inspired by InVRsion's VR shopping application ShelfZone. IKEA Place was chosen for two reasons: 1) the application seemed most promising from business perspective, because it is targeted to a large audience and it is easily available (if you own a new iPhone), and 2) furniture can often be expensive and as such, making buying decisions can have a higher threshold. IKEA Place's business model could provide insight about whether AR could affect customer decision making in electronic purchases. VR shopping was chosen as a second business model because, while InVRsion's ShelfZone was one of the most exploratory products from the mentioned examples, the companies idea about replacing a physical retail location with a virtual one and collecting user metrics is interesting. The focus is to analyse how the cost structure of a virtual store would differ and what kind of new value creation possibilities would VR create for e-commerce.

5.4.1 IKEA Place

IKEA Place is an application that lets people experience, experiment and share how IKEA's furniture looks at home, office, school or studio, with the help of AR technology (IKEA 2017a). The application was released in August 2017, as one of the first applications utilizing Apple's iOS 11 ARKit (Panzarino 2017). The way the application works is simple: users can choose items from IKEA catalogue and with the help of the application and the smartphone camera, place the objects in their home, visualizing how they would look in reality (IKEA 2017a). Placing AR objects in place with smartphones is nothing new, however, the quality of these objects is much better than the ones achieved with previous technology. The virtual objects of IKEA Place automatically scale to their real-life size respective to the environment where the objects are placed, and react to surroundings, such as the light in the given location (Panzarino 2017). The business model of IKEA Place is presented together with the business model of IKEA, in Figure 18, to visualize how it leverages the business model of IKEA.

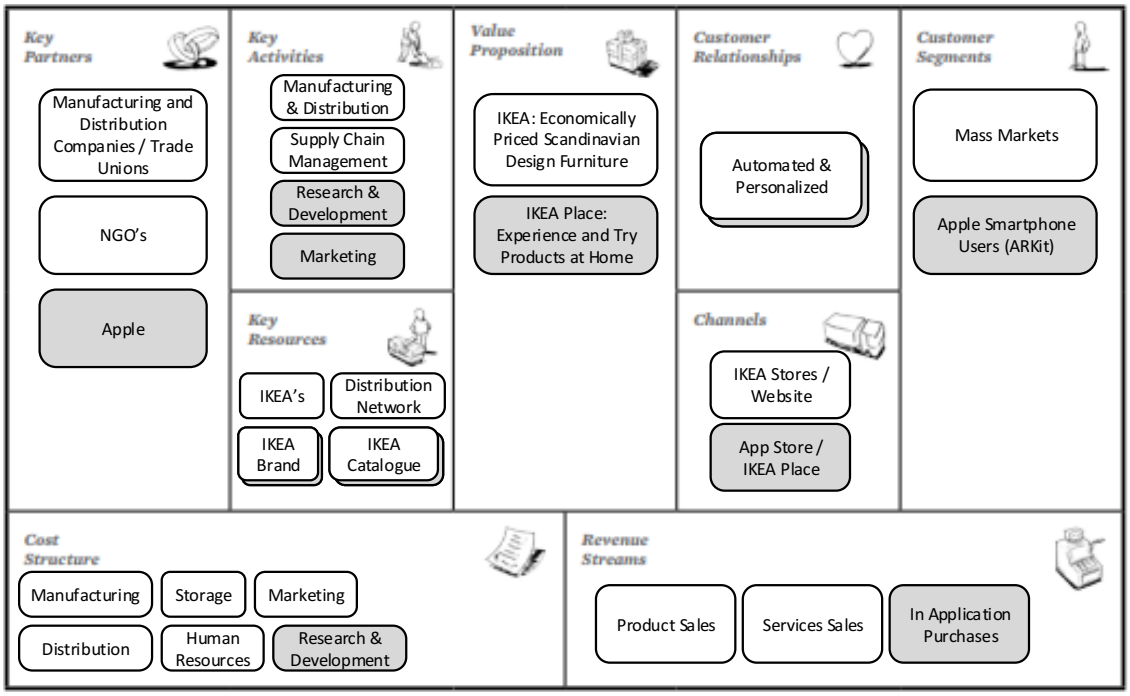

Figure 18. The business model of IKEA and their AR application "IKEA Place" (inspired by IKEA 2017a, 2017b; Lee 2017)

Value propositions and customer segments: The first value proposition in this business model canvas is the value proposition of IKEA, which can be summarized as economically priced Scandinavian design furniture. This value proposition is directed towards mass markets and represented by white coloured blocks. The value proposition of IKEA is more complex than just a combination of economical price and design, and consists of many different factors such as the smart department store layouts and the well-known brand of IKEA. However, in the context of this analysis the emphasize is on how IKEA Place synergizes with IKEA's business model, economically priced Scandinavian design furniture is a sufficient description.

The second value proposition in the canvas is the value proposition of IKEA Place, which enables customers to experience and try IKEA's products at home with the use of smartphones and AR technology before the actual purchase. This value proposition is directed towards Apple Smartphone Users (devices that have Apple ARKit) and represented by grey blocks. Furniture purchases can be expensive and products can often look different at home than in the catalogue pictures. Previously, if customers wanted to see how the IKEA products looked like in reality, they had to go to IKEA department store. IKEA Place addresses this problem and gives the customers the possibility to make more informed buying decisions at home, by letting them visualize IKEA products in a real-life setting. Important factor in this is the real-life scale and high-quality of the rendered objects, which provide contextual information about how well, for example, a sofa fits in the customer's living room and how its texture behaves in the actual light setting (Panzarino 2017).

Channels: The first value proposition, IKEA furniture (white blocks) is delivered to mass markets through their department stores and website. The second value proposition (grey blocks) is delivered to Apple Smartphone users through Apple's App store in the form of the IKEA Place application.

Customer relationships: The relationship for both value propositions and customer segments operates on the same basis (represented by a white block overlapping a grey block). The customer relationship is largely automated, meaning that IKEA does not have personal relationships with individual customers, however, IKEA has a membership program called IKEA Family. IKEA Family grants access to exclusive discounts, IKEA newsletter and personalized product suggestions (IKEA 2017c). Thus IKEA has both automated & personalized customer relationships.

Revenue streams: For the first value proposition (white blocks), IKEA Furniture, there are two main revenue sources. Revenue from product sales, for example, selling furniture and revenue from services, for example, home delivery and assembly. For the second value proposition (grey blocks), there is only one direct revenue source, application purchases. For example, if a customer likes a sofa from IKEA Place application, it can be reserved directly through the application.

Key partners: For the first value proposition (white blocks) there are two key partner groups. First, the manufacturing and distribution companies/trade unions. It should be noted that one of the main reason behind IKEA's competitive advantage is its ability to sell furniture at an economical price. One of the reasons why IKEA can do this, is their large industrial network of manufacturing and distribution companies, as well as their ability to outsource various parts of their production (Enrico 2008). This makes the members of their manufacturing and distribution network key partners. Second key partner for the first value proposition is non-governmental organizations. IKEA has partnerships with organizations such as Save the Children, UNICEF, UNDP and WWF (IKEA 2017d). These organizations support IKEA's brand as a company that takes responsibility of children rights and as a brand that supports the environment.

For the second value proposition (grey blocks) the key partnership is with Apple. IKEA Place is currently only available for devices with Apple's iOS 11 and ARKit (Panzarino 2017). The application is currently in a lock-in with Apple, since it operates through the ARKit technology. While the application, or something similar will probably be made for other platforms in the future, currently IKEA is dependent on its partnership with Apple.

Key activities: For the first value proposition (white blocks) the main key activities are manufacturing and distribution, and supply chain management. To offer furniture, kitchen appliances and other home design globally to mass markets, IKEA needs to do a lot of manufacturing and distribution. At the same time, this requires very proficient supply

chain management, which is also directly linked to the manufacturing and distribution partners mentioned in the key partners section.

For the second value proposition (grey blocks), there are two key activities. First, IKEA needs to do research and development regarding their application, to make sure it fits the standards of the AR industry. Second, the application needs to be marketed to get more users for the platform and in order to get more revenue through it.

Key resources: For the first value proposition, there are two key resources. First, the physical locations, i.e. IKEA's, since while the company is exploring methods of increasing revenue through online sales (Valdsgaard 2017), the stores are still the only places where most of their customers can see their products in real life. They are also a valuable part of IKEA's brand. Second, IKEA has their large distribution network, which gives them their competitive advantage and enables other parts of the business model, such as the economically priced furniture.

The two remaining blocks are shared key resources between both value propositions (white blocks overlapping with grey blocks). First, IKEA Brand is a key resource, as it is still one of the most valuable brands in the world (Forbes 2017) and forms a large part of the expectations projected towards the company. Second shared resource is IKEA's catalogue and refers to IKEA's products. All products IKEA has are owned by the company and the number of products is one of the things that keeps bringing customers back to IKEA. IKEA Place operates using this same catalogue, although it currently has only over 2000+ items (IKEA 2017a).

Cost structure: For the first value proposition (white blocks), the major costs come from manufacturing, distribution, marketing, human resources and storage. Manufacturing refers to the costs of manufacturing the products and distribution refers to the costs of delivering these products to the IKEA department stores and customers. Storage refers to the costs of storing IKEA's products in warehouses and human resources refers to the personnel costs in all IKEA locations. The only major cost block for the second value proposition (grey blocks) is research and development, which refers to the production costs of the application.

Key Findings: Buying furniture can often be expensive and IKEA's application provides customers with more confidence on their buying decisions. It is also possible that the IKEA Place brings completely new customers to IKEA. For example, customers who do not usually buy furniture online and do not live close to any IKEA department store can "test" the furniture with the application and be more willing to make the purchase, even though it is happening through an online method. IKEA Place application provides synergy to the business model of IKEA through offering the customer better decision-making power online, and possibly eliminating some of the product returns that happen due to the furniture not being satisfactory when brought to the actual homes of the customers, thus

saving IKEA money and resources. Online sales are cheaper for IKEA and the more business they can channel to their online sources, instead of the retail ones, the more revenue they can make. VR/AR technologies may play an important part in giving their customers more confidence in buying their products online.

5.4.2 VR shopping

The business model presented in this section, Figure 19, is inspired by InVRsion's VR shopping application ShelfZone, a retail space simulator, that enables customers to shop in a virtual store (a department store) using high-end VR headset such as the Oculus Rift or HTC Vive, and collects business intelligence regarding consumer behaviour (InVRsion 2017b). In all its simplicity, the application creates the same experience as a person would have, for example, when going to the local supermarket, however, in VR. It is important to note that the model represented in this section does not represent the business model of InVRsion. They are a developer company and their business model is selling ShelfZone as a concept. This section analyses a hypothetical business model of a VR department store utilizing a concept similar to ShelfZone. These kinds of completely virtual stores do not yet exist and there are not yet enough consumers who own the VR HMDs required to make the similar platforms commercially attractive.

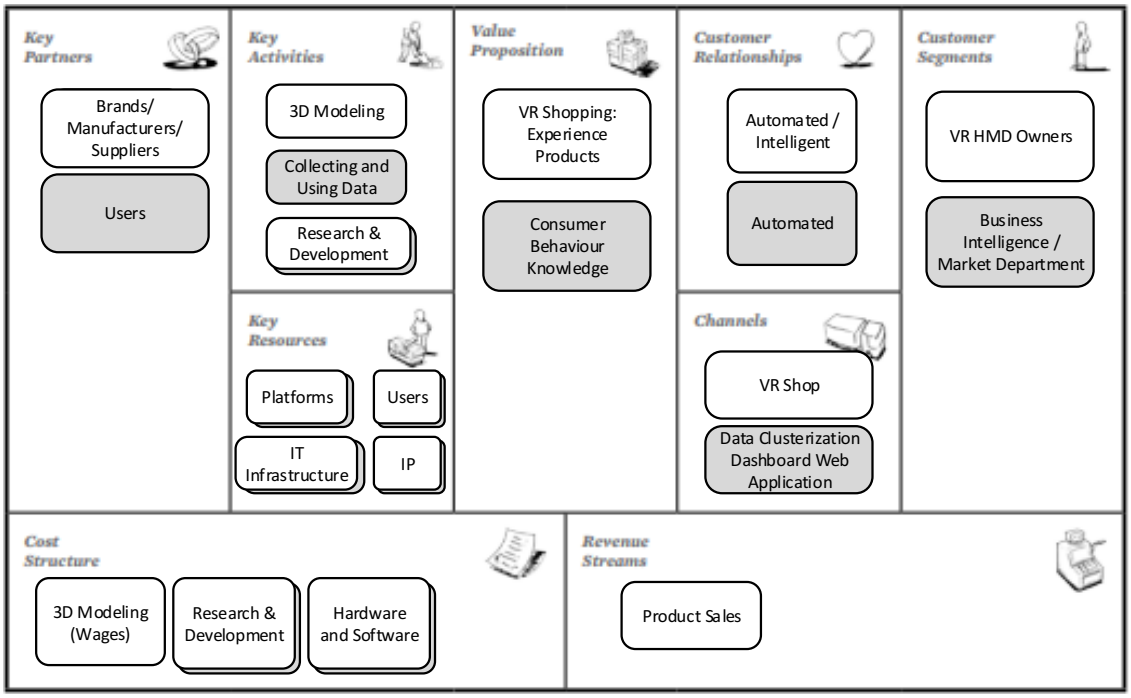

Figure 19. An example business model for VR store using ShelfZone (inspired by Brown 2017; InVRsion 2017a)

Value propositions and customer segments: The first value proposition in the business model is VR shopping and the ability to experience products virtually. This value proposition is directed towards VR HMD owners and represented by white coloured blocks.

The actual value of VR shopping does not only come from being able to visualize the products better than in an online shop. In inVRsion's concept, all products are modelled in a way that the users can hold them in their hands, turn them around and see information in their packaging, as they would in real life (InVRsion 2017a). In addition, users can have access to overlaying information about, e.g. product prices and nutritional contents. This kind of overlaying of information has the potential of making virtual shopping experience better than in real life in some ways.

The second value proposition in the business model is consumer behaviour knowledge and it is directed towards the business intelligence / market department of the company who owns the VR shopping platform. The second value proposition is represented by grey colour. ShelfZone has built in business intelligence tools including customer location mapping, shelf and eye-tracking (heat-mapping of products that a customer is looking at) and live monitoring (InVRsion 2017a). If necessary, market researchers or business intelligence experts can follow the customer live and when required, connect to the customer using voice chat. Together these tools give important insight about customer behaviour and can be utilized to develop the virtual shop experience according to the needs of the customer.

Channels: The first value proposition (white blocks) is delivered through the VR shop, which is possibly a stand-alone application or a program. The second value proposition (grey blocks) is delivered through "Data Clusterization Dashboard", an online tool that is connected to the VR shop and gathers all the different statistics and functionalities together for the business analysts to use (InVRsion 2017a).

Customer relationships: The customer relationship between the first value proposition (white blocks) and the first customer segment is automated through the application. However, in ShelfZone concept, the application has an intelligent virtual assistant, for whom the customer can give commands to, ask for directions and who can provide personalized service to the customer (InVRsion 2017b), therefore, the word intelligent has been added to the building block. For the second value proposition the customer relationship is automated, since all the information/data is collected to the data clusterization dashboard automatically.

Revenue streams: The revenue comes through the first value proposition (white blocks) in the form of product sales. The virtual store works like a normal store, however, the "shopping basket" in this case is virtual and the actual items are ordered online and delivered to the customer's home after the VR shopping experience.

Key partners: In actual execution, the key partners for the first value proposition (white blocks) are the same as in traditional webstores, for example, all the brands/manufacturers/product suppliers the company has, as without inventory there is no store. In a case,

where the company handles all its inventory manufacturing by themselves, this key partner block would not exist. However, it was chosen to be represented in the business model since the VR shopping application could offer many possibilities for these different partners, for example, in advertising. For the second value proposition (grey blocks) the key partner is the users, i.e. the consumers who use the VR store application, as they create the information for the business intelligence needs.

Key activities: For the first value proposition (white blocks) a key activity is 3D modelling as both the store and every item in it needs to be modelled into the virtual environment. With the current tools, making every item in the store interactive is a laborious process, however, this will become easier, as the VR environment item libraries get larger and more available. For the second value proposition (grey blocks), a key activity is collecting and using data, the emphasis being on use. The data is being collected automatically, however, if this data is not used to provide the customers with a better service, one of the big advantages of a virtual store is lost. A shared key activity for both value propositions (white blocks overlapping with grey blocks) is research and development, which is required for both the platform (VR store) and for the data clusterization dashboard. The data collection dashboard can leverage the research and development process through offering information and feedback about customer behaviour which can be used to improve the virtual store. However, the dashboard still needs to be research and developed according to new information needs that arise during the knowledge process.

Key resources: In this case, all four key resources have a relation between both value propositions (white blocks overlapping with grey blocks). First, the platforms (VR store and data dashboard) are key resources, as the VR store enables the service and data dashboard enables the data analytics involved. Second, users are a key resource since without them there is no incentive to have a VR store and without them there are no metrics to be collected. Third, IT infrastructure is required as the enabler for the services and it should be scalable, because when the number of users for the platform gets higher, so do the requirements for the IT. Finally, a key resource is the IP, as with the combination of the VR store and platform, the VR store knows its customers better than anyone else, therefore, the IP they have creates a lot of potential for other value capturing methods.

Cost structure: Main cost for the first value proposition (white blocks) comes from 3D modelling, which is an ongoing cost. Whenever new items are brought to the inventory of the VR Store, they need to be modelled. The shop should either have its own specialized developers handling the 3D modelling or this service could be outsourced to another company. The two remaining blocks in the cost structure are shared resources between both value propositions (white blocks overlapping grey blocks). First shared block is the costs of research & development, i.e. updating and improving the platforms, and second shared block is the hardware and software costs for both value propositions, for example, server rent.

Key findings: As with the first value proposition, it can be debated whether VR or AR increases buyer's confidence to make purchases online. However, the technology is something that improves the current system of product descriptions and pictures in e-commerce. While the first business model brought IKEA's products to home using AR, this second business model could possible bring IKEA to your home. It was mentioned earlier, that the value proposition of IKEA is not only the products they sell. With IKEA, they also offer you the IKEA experience, the stores with their smart layouts and showrooms that facilitate making buying decisions. However, physical venues introduce a lot of costs and are available only locally, while with VR stores most of the costs would come from software and hardware, and research and development. In addition, the application concept of inVRsion, with its business intelligence tools, shows that VR stores could offer more possibilities to collect knowledge about users, which is a key ingredient for competitive advantage, especially in e-commerce (Bahman et al. 2015). VR stores could also offer more support for the creation of "experiental stores", such as IKEA, where the store experience is an important part of the making purchases. VR breaks the boundaries of physical spaces, and in doing so it also creates new possibilities on how brands want to present themselves. For example, why should a food store follow the layout of a traditional food store, when it could be personalized to the needs of the customer by showing only the products that the customer is interested in.

This business model is explorative. Therefore, it should be viewed critically. E-commerce already has its own distinct costs and challenges, therefore, VR is yet another challenge on the list. The business model shows that VR could have the possibility to offer the same advantages as physical location retail stores do, without having any of the physical location costs. In addition, VR stores have a lot of new potential advantages, for example, reaching global customers, monetization through new advertising methods, faster brand changes (no need for physical renovation) and giving a more personalized service to customers. "VR stores" are not entirely an unknown concept, since in the field where acquisition costs are high enough to make the costs of VR hardware and software seem low, like in architecture, "VR stores" are already in use in the form of 3D building models (see section 5.2). Customers can see different design choices for their house in the form of VR 3D models and choose the ones they like. However, before any of this can happen with more common products, HMDs or other VR devices need to become available for the common consumers.

5.5 VR/AR in healthcare

As mentioned before, flight training is one area where VR has been in use for decades, since flying planes is expensive enough to make the investment into VR small in comparison. In healthcare training the same applies, but for slightly different reasons. Medical professionals are dealing with humans. Traditionally, training a surgeon can involve studying manuals, videos and attending training courses (Jung 2017). However, consistently

practicing the procedures on actual human beings, especially with rarer surgical techniques, is often not possible. VR offers a new way of training surgical professionals, and while this has been known for many years, the problem has been that the technology has not been at the level where the experience could be comparable to the real thing (Olasky et al. 2015). However, this has changed and companies such as OssoVR are already creating very realistic surgery simulators (Jung 2017). In addition to training, VR also has potential in new psychological treatments methods for, for example, phobias, pain and PTSD (Wood 2016).

In this section, two business models where chosen for analysis: 1) Psious, a platform for mental health treatment using VR (Psious 2017a) and 2) OssoVR, the previously mentioned tool for surgical training. They were chosen because one of the problems in utilizing VR/AR in healthcare is that new methods or methodologies cannot just be applied in hospitals right away, but require a long process of validation and testing before becoming approvable treatments or training methods. Both Psious and Osso provide a substantial amount of proof for their value propositions. In addition, they both already have existing business models that utilize VR/AR as a platform. This means that the product they sell is not only a new solution, but a wide array of solutions.

For example, the idea of analysing 1) Psious, a VR mental healthcare platform, came from examining the business model of a company offering VR treatment methods (see The Virtual Reality Medical Center 2017). The initial analysis with the business model canvas revealed that while the VR Medical Center offers novel VR treatment services (method and technology) and their value proposition is interesting, their business model is not very scalable due to the amount of resources they require in order to offer their services. In addition, their product portfolio is quite small considering how rapidly VR production is developing. This raised the question of whether there is a platform for VR phobia treatment where different content creators could collaborate: this led to the discovery of Psious VR, and because of these results, a similar platform based model was looked for as the second business model to analyze, which lead to the discovery 2) OssoVR. While OssoVR is still in its funding stage, their value proposition has a lot of potential, as they are combining knowledge from both the video gaming industry and the healthcare (OssoVR 2017). Examining their business model, could also provide insight how the business model canvas work as method in cases, where there is not yet a clear value capturing model.

5.5.1 Psious

One area where VR has shown promise in healthcare is with the treatment of phobias (Munoz 2009; Notzon et al. 2015). Psious is a company that provides a platform for peer-reviewed VR treatments for phobias targeted towards therapists and other mental health professionals (Roig 2016). Their product consists of an online platform, called Psious Toolsuite, meant for therapists, that is used to control and collect statistics from a smart-

phone mobile VR application, meant for patients. The platform currently has over 50 VR/AR scenarios that mental health professionals can use in the treatment of anxiety disorders, fears and phobias (Psious 2017b). Initially, Psious targeted patients directly with an online self-treatment platform, but their research showed that consumer markets were not yet interested in self-treatment with VR (Roig 2016). However, there was another customer group who was interested: therapists. This steered their initial idea from an online VR self-treatment platform to an online platform for VR mental health treatment. The business model of Psious is represented in Figure 20.

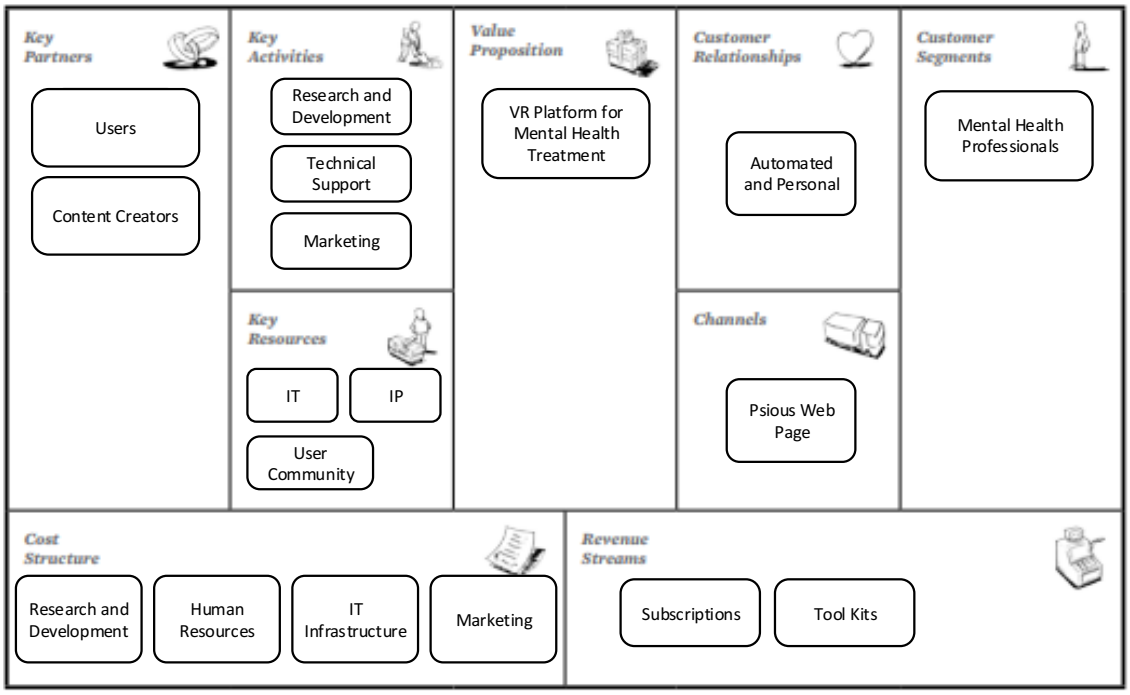

Figure 20. Business model of Psious (inspired by Roig 2016; Psious 2017b)

Value propositions and customer segments: The value proposition of Figure 20 is the Psious VR platform for mental health treatment and it is directed to mental health professionals. In this case, only one value proposition/customer segment is analysed since, while in the future Psious is planning to reach consumers through self-treatment methods, their platform is currently only marketed to mental health professionals. Their value position, i.e. the platform, creates value on multiple levels. First, VR has been proved to be a more effective way of doing phobia treatment than the traditional methods (Munoz 2009; Notzon et al. 2015). However, as these methods are quite new, there is not much research about how these phobia treatments should be undertaken. Psious gives mental health professionals the access to more than 50 different peer-reviewed VR/AR treatment resources (Psious 2017b). In addition, the online platform has trainings and manuals for VR treatment, regular updates for services, a personalized customer service and access to a community of professional (Psious 2017a).

It should also be noted, that the value proposition is not only formed by the VR/AR resources. An important part is also the technology and how it is utilized. The online platform together with the Psious application enables therapists to apply virtual reality treatments with the help of a smartphone, mobile VR headset and a biofeedback sensor (Roig 2016). While the patient is receiving the treatment, using the online tool-suite, the therapist can have a real-time view on what the customer sees and what is happening during the session. In addition, the sessions can be controlled through the Psious web application, which also collects automatic reports about each session and saves them to each patient's own files (Psious 2017b).

Channels: The value proposition, i.e. the platform and the technology is delivered to mental health professionals through Psious website, where customer can purchase both the tool kits required for Psious platform and the treatments.

Customer relationships: The customer relationship can be both automated and personal. The initial purchase of the Psious Toolsuite and the services included can be done entirely automatically through the Psious website without the need of a human connection with the company. However, mental health professionals can get more value out of their relationship with Psious, if they have a more personal relationship with Psious and take part in the Psious community discussion channels, thus gaining access to more knowledge about the treatment methodologies and at the same time, have the possibility to share their feedback about what future features they would like to see in Psious products.

Revenue streams: Revenue comes from two streams: 1) subscriptions and 2) tool kits. Psious offers three different subscription plans: basic (29,99 € / month), professional (59,99 € / month) and platinum (999,99 € / year) (Psious 2017a). The subscription models affect certain features, such as the amount of free sessions therapists can do with the software, the price of online trainings available on the website and the amount of different materials the customers get access to, for example, marketing support and patient histories. In addition, for therapist who do not yet own the tools necessary for the VR therapy sessions they offer the possibility of buying the whole tool kits required (smartphone, goggle frames and bio sensor) for 700 € (Psious 2017a).

Key partners: In this business model, there are two key partners, 1) users and 2) content creators. First, a key partner is the users of the platform, as they are utilized as an important factor in developing the platform through the Psious community. Second, a major partner of Psious are its content creators. The company is aiming to bridge the gap between content creators and health care professionals through their platform (Roig 2016). Partnering with content creators is a win-win situation as it gives Psious access to more materials, in addition, it gives content creators the access to interested customers.

Key activities: There are three key activities, 1) research and development, 2) technical support, and 3) marketing. First, Research and development is a key activity, since Psious

constantly needs to evolve and update the toolset it has with the current VR technologies. Second, technical support is a key activity, as the customers of Psious, mental health professionals, are often not as well acquainted with the technologies of VR as their engineering counterparts and as such, providing quality technical support is key in keeping their customers happy. Third, marketing is a key success activity, since the service is new and if mental health professionals do not know about it and the value it proposes, Psious cannot gain any customers.

Key resources: The key resources in this business model are 1) IT, 2) community and 3) IP. 1) IT refers to their online platform and all the infrastructure it requires. 2) Community refers to their users, who are also a key partner for the company, as they provide free feedback, support and marketing through the online platform by working together. 3) One of the biggest advantages of Psious is their IP. They have access to a huge amount of information regarding mental healthcare with the use of VR and as such, they also have a large capability to the research and development of future solutions.

Cost structure: The most substantial costs of the business model are 1) research and development, 2) human resources, 3) information technology and 4) marketing. First, research and development is the costs regarding the development of Psious platform and software. Second, human resources add some additional costs to the business model, as they need more extensive customer service than some of the other business models presented in this study. Third, IT infrastructure refers to the costs of their software and hardware. Finally, marketing is an important cost, since the more users Psious has, the more value it can capture.

Key Findings: Nationally owned healthcare can be a slow changing industry because treatment methods need to be scientifically validated before they can be utilized as widespread treatment methods. To bring VR/AR to an industry like this companies like Psious are required. These companies are pioneers in peer-reviewed healthcare content for the new technology. Whether Psious is doing this consciously or not is not clear, however, they have realized that creating both content and solutions (i.e. hardware and software) requires a lot of resources. As such, having a platform based application where they can also introduce content from other creators is valuable.

5.5.2 OssoVR

OssoVR is a training solution for surgeons and while the company currently focuses on orthopaedic operations and spine procedures, they are working to expand into other specialties and procedures. Their product consists of training software and content, and focuses on emerging medical technologies (OssoVR 2017). OssoVR can be used in training seasoned surgeons on new or uncommon surgeries or as an instruction tool for medical students (Comstock 2017). While the product is still in demo stage, the company has

already secured over $2 million in funding (Dorbian 2017). Currently, OssoVR is working towards fixing a very specific problem: the learning curve associated with adopting new medical technologies (Barad 2017). The problem with adopting new medical devices in healthcare is that training these new instruments to surgeons takes time. In addition, the training is often very expensive and medical device companies are currently spending more resources on training surgeons than they do on, for example, marketing (MedTech 2017). OssoVR does these same medical device trainings in VR, utilizing a high-end HMD, such as the Oculus Rift or HTC Vive, using much less resources than the traditional methods and providing similar results (Barad 2017). The business model of OssoVR is presented below, in Figure 21.

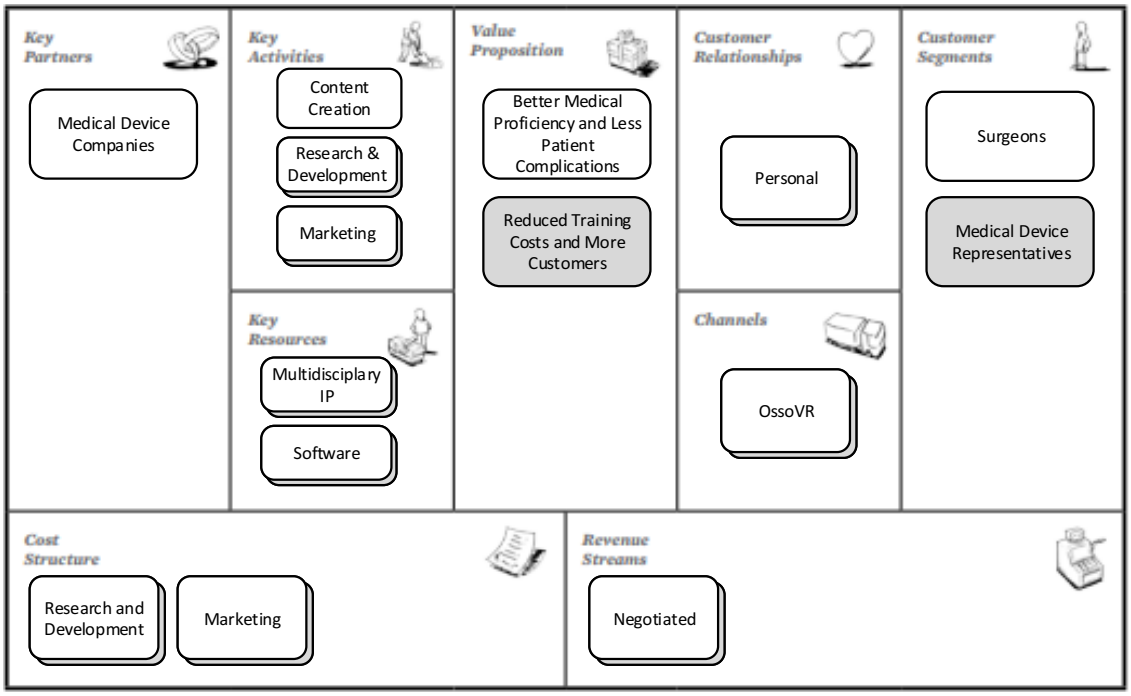

Figure 21. The business model of OssoVR (inspired by Barad, 2017; OssoVR, 2017)

Value propositions and customer segments: The first value proposition of OssoVR is better medical proficiency. This value proposition is directed towards surgeons and represented by white coloured blocks. Currently, if a surgeon wants to learn how to use a new medical device in a surgery, as mentioned before in this section, expensive training is often required. Even if the surgeon attends the training, the actual chance to use the technology might not appear until many months after the actual training, leading to complications during the procedures (Osso VR 2017). For a surgeon to become properly proficient in new procedure might require more than 50 actual cases (Barad 2017). OssoVR reduces this learning curve by offering a less expensive method of repeatable training for surgeons thus offering medical professionals better proficiency and less complications with their patient cases.

The second value proposition is reduced training costs and more customers. This value proposition is directed towards medical device representatives and represented by grey coloured blocks. Currently medical device customers (e.g. hospitals, clinics) sometimes back out from initial commitments due to the lack of continuous training tool (MedTech 2017). While these medical device manufacturers currently have their own trainings, they are both costly to the manufacturers themselves and to the professionals attending them (Barad 2017). As such, replacing their current training methods, i.e. workshops, with the OssoVR training methods could be beneficial for improving their business.

Channels: Both value propositions have a shared channel (a white block overlapping with a grey block). OssoVR is still in the development stage, meaning that they do not yet sell

their solution to open markets, and currently the only way to get the demo of their services, whether you are a surgeon or a medical device representative, is through the OssoVR team (Osso VR 2017).

Customer Relationships: The relationship between both value propositions and customer segments is personal (a white block overlapping with a grey block). This is because the product is still in development stage and both customer segments are useful for development (Barad 2017). Surgeons can provide feedback on the VR training quality and how well it compares to the current training methods. On the other hand, medical device representatives can work together with OssoVR and transcribe their device trainings into VR trainings. Thus, the medical device companies could possible reduce the costs they spend into training surgeons in the future and in addition, provide more content for OssoVR's platform once it is released to the public.

Revenue Streams: It is yet unclear what kind of revenue model OssoVR is planning to use in the future once their product is released. Currently the demo contracts are individually negotiated with both value propositions (white block overlapping with grey block) (Osso VR 2017). With content, i.e. VR medical trainings, they could go with subscriber models or licensing. There is also the possibility that they choose to utilize the second customer segment, the medical device representatives, as the main source of income by, for example, charging fees for having specific trainings on their platform.

Key partners: The main partner in this business model is related to the first value propositions (white blocks). It is the medical device representatives and their respecting companies. OssoVR's focus is currently in reducing the learning period regarding emerging medical technologies. To create learning content for this focus, OssoVR benefits in partnering with technology device manufacturers.

Key Activities: There is one key activity related to the first value proposition (white blocks), content creation. To be perceived as valuable, OssoVR needs to have content, and the content has to be of high quality enough to be able to replace the traditional training methods. The two remaining key activities are shared blocks with both value propositions (white blocks overlapping with grey blocks). First, research and development is a key activity as with many other business models presented in this study, because the platform needs to be developed and adapted to the evolving technologies of VR. Second, marketing is a key activity, as many surgeons or device manufacturers do not yet know about the possibilities VR training offers. It should also be noted that the technology is difficult to market, as the training experience can be difficult to communicate without a hand-on experience (Barad 2017).

Key Resources: Both key resources are related to both value propositions (white blocks overlapping with grey blocks. First, OssoVR has multidisciplinary intellectual property. The chief executive officer of OssoVR is a former game developer turned orthopaedic

surgeon and many other members of the OssoVR team also have a background in game development (Osso VR 2017). Having a combination of hands-on medical and game development knowledge gives OssoVR a competitive advantage, as they have a good understanding of both the problem, i.e. high learning curve of new surgical procedures, and the tools (VR/AR and game development) they are trying to fix it with.

Cost Structure: As a company that is still in the investment stage, the cost structure mainly consists of two things, research and development, and marketing. Both costs are related to both value propositions (white blocks overlapping with grey blocks). Research and development is the main cost, because currently the company is looking for funding to "develop" the actual product. To get this funding, the company needs to do marketing, which is communicating the value of their product to investors and future customers.

Key Findings: OssoVR is targeting a very specific niche market. They have a very clear knowledge of the problem: traditional medical device training methods are not resource friendly and do not offer the repeatability required for a mastery of the procedure. According to them, many emerging technologies that could potentially improve the life of both the patient and the medical professionals do not become more common due to the significant learning curve related to them (Barad 2017). In this case, the problem is solved with VR training. The case is similar to flight training, in a sense, as OssoVR solves the problem of training being expensive. However, it should be noted that it is also solving the problem, that since the traditional hands-on training requires a cadaver, it is not possible to do it very often. VR provides a very similar experience to the real experience, without requiring any other physical resources than the hardware. Creating such an experience in a user-friendly way that imitates the real experience is not possible without having an extensive knowledge of both the actual procedures and how to create user-friendly VR content. OssoVR's advantage is that it has both medical professionals and game developers working on the product, which again works as a good example of why developing products for VR/AR often requires multidisciplinary knowledge.

6. EMPIRICAL FINDINGS

This section summarizes the results from all the business models analysed in this study. However, it should be noted that each business model remains a separate case, because every single building block from value propositions to cost structure is connected to each other. When looking at the aggregated results of the different segments below, the existence of connections between the building blocks should not be forgotten.

6.1 Value propositions

In the study 18 different value propositions were identified. Although each value proposition has its own special nuances regarding their respective business context, four major themes emerged that relate to the nature of VR/AR and what the technologies can do: 1) the experiential nature of the technologies and their ability to create engagement, 2) the way they can eliminate complexity and mimic natural movements, 3) the way they reduce costs and improve previous products by replacing physical resources with virtual resources and 4) the technologies as a collaborative platform.

First, and the most recurring theme regarding the value propositions, that comes up in every business model, is the experiential nature of both technologies and their ability to create engagement. In marketing, engagement often refers to consumers "reacting" to marketing campaigns, such as videos or pictures through liking them or sharing them in their own respecting social medias (Abramovich 2012). However, the actual concept is much more than that. Engagement refers to the "merger of motivation and thoughtfulness" (Guthrie 2001). For example, a person motivated to read looks forward to reading a book. Engagement, on the other hand, manifests as the reader being fully absorbed and engrossed in the activity of reading (Afflerbach and Harrison 2017). This is what VR/AR enables: more engaging experiences and more engaging content. For example, instead of reading a news article about a rocket launch, VR can place the user inside the cockpit, and put the user in astronaut's shoes. Instead of reading a chemistry text book, AR can visualize the molecules right in front of the students. The value comes from creating the feel of physical experiences and visualizing something unseen.

Second, much in the same way as touch-interfaces eliminated complexity when compared with the previous generation of graphical interfaces, VR/AR can eliminate complexity when it comes to controlling the experiences. For example, when entering a virtual world, users can look around by moving their heads and bodies, with movements that are natural. There is often no need for training, and this makes many professional experiences, such as exploring 3D blueprints, faster, easier and much more accessible. However, as mentioned in section 3.3, there are still many issues with interactivity with both VR/AR and

with how the different interactions, such as movement should be done. However, many movements, such as looking around, are already natural with both VR and AR, therefore, using these technologies has a much lower learning curve.

Third, VR/AR can eliminate costs by replacing physical resources with virtual resources. The importance of this is currently most visible in solutions like OssoVR, where the comparing physical costs (surgeon training weekends), are very substantial and the subject matter is very important (human lives) (Barad 2017). However, as the technologies become more common and the costs of content creation are reduced, the importance of this possibility is tremendous for all industries. For example, a physical sign with the menu of a restaurant could be replaced with an AR object. Whether the customers prefer the digital or the physical sign is debatable, however, it should be noted that the virtual sign is not consuming any natural resources. It does not get worn or eroded and is not susceptible to vandalism.

Fourth, VR/AR are technologies that can support communication in new ways. While this is brought up directly only in the case about VR co-creation in architecture, it is also a very important factor in other business models of this study, such as the presented two education and two healthcare business models. For example, Google Expeditions is not only a tool for engaging memorable experiences for the students, it is a tool that helps the teachers communicate with their students and, therefore, teach better. While OssoVR is currently a solution for training surgeons alone, it can also be used as a communication tool between surgeons to discuss about procedures. VR/AR not only breaks many of the previous boundaries of virtual collaboration, but creates completely new ways of collaboration altogether. There is already much untapped potential in the way these technologies can be used for communication in many industries. VR co-creation case is a good example of a situation where virtual collaboration can be better than the physical equivalent of “going through plans”.

These aggregated value propositions do not exist alone and they are often connected to each other. For example, in phobia treatment, replacing a physical resource with a virtual resource is not providing any additional value, unless the option is 1) engaging enough to create results that also apply in real life, 2) easy to use by both patients and the therapists, 3) the costs of the virtual content exceed the costs of achieving the same results with physical resources and 4) supporting the communication between the therapist and his/her patient. It should also be noted that while these 4 themes summarize the different findings of the business models, there were many other smaller findings that could be very important. For example, VR/AR enables a new platform for collecting metrics about customers and what they see; this can help companies to know their customers better.

6.2 Customer segments

Value is different depending on the beneficiary. As such, each customer segment in this study is different and related to its respective value propositions. However, there were some overall findings about the different customers segments in the VR/AR industry. The customer segments of this study can be summarized in four different groups: 1) mass markets, 2) gamers, 3) professionals and 4) enterprises.

First, mass markets. While the technologies are becoming more affordable and more available, there are not yet many high-end VR/AR headsets on the market (Digi Capital 2017a). Therefore, the only VR/AR applications that can currently reach a sufficient number of consumers to be called mass markets are the ones utilizing mobile technologies (e.g. smart phones and tablets). However, there is still a huge gap in what can be achieved with the mobile technologies comparing to the high-end devices. The AR applications remain simple and the VR/360 applications are still tackling with problems such as content quality and the high cost of content production. Some success stories, such as Pokémon Go exist. However, these success stories are based on very specific circumstances. Most mobile VR/AR business models, for example, the presented NYTVR and Google Expeditions are still exploring the possibilities of the technologies and how to monetize them. However, there is something important to note: both New York Times and Google supported their applications' reach by giving the mobile VR headsets to users for free (subsidization) and by using sponsored content to cover development costs.

Second, gamers. The gaming markets were not studied thoroughly in this study, however, they are important, as it is currently the only market where many consumers own high-end VR devices such as Oculus Rift or HTC Vive that also have the most potential for value creation. In addition, gamers already have well known content platforms, such as Steam, making it easier for VR content creators to reach customers.

Third, professionals. In many professional solutions (e. g. IrisVR and OssoVR) the advantages of VR/AR already outweigh its costs. For a customer group that consists of, for example, engineers, architects, surgeons or airplane pilots, the technologies are a working tool that increase their ability to perform in their respective professions. The results of this study point to the direction that professional solutions are currently where the technologies of VR/AR are creating the most value and as such, their importance seems more substantial than what many of the forecasts predict (see Bellini et al. 2016; IDC 2016; Digi Capital 2017a).

Fourth, enterprises. This customer group is very related to the previous customer group, professionals. However, this customer segment refers to the bigger picture; many enterprises, whether they are architecture companies or educational companies, can reduce costs, improve stakeholder communication and/or improve their organizational compe-

tencies by involving VR/AR to their normal workflows. Again, the reason for this customer group being important is that the costs of even the high-end VR/AR devices can in many cases be minimal when comparing the costs with the advantages they can provide. In addition, it should be noted that due to their engaging nature VR/AR have a lot of potential as marketing methods. Therefore, sponsored content can be used to monetize or subsidize the costs of VR/AR content creation in many industries, like for example, in journalism.

6.3 Channels

One issue with VR/AR that was previously established by Digi Capital (2017a) and came up in the business model analysis of this study, is that the technologies of VR/AR are lacking channels, such as application ecosystems and open content platforms. For example, many of the applications of this study, like IrisVR and OssoVR, were very difficult to find and their biggest channel of sales was their website. Mobile VR/AR applications are often found from the pre-existing platforms such as Google Play and App Store. However, in mobile application stores it is difficult to differentiate VR/AR applications from everything else the stores offer. This makes it difficult for VR/AR providers and content creators to reach each other, their customers and vice versa. Therefore, there is a need for dedicated specialized VR/AR platforms that make publishing content and reaching customers easier.

6.4 Customer relationships

There were no specific findings that only relate to VR/AR. Customers relationships are personal when its required and automated when it is possible. Automated customer relationships are more scalable since the number of customers can be increased without it imposing much additional costs to the business model. However, there was one factor in the business model in section 5.5.2, VR shopping. The technologies of VR/AR offer a new method for collecting metrics about customers, what they see and how they interact with the world around them. Therefore, this offers enterprises new possibilities to collect business intelligence and improve the relationship with their customers. This idea does impose some problems relating to privacy and security, however, it can be debated whether this is any different from the way the current mobile technologies collect information about their users.

6.5 Revenue streams

The only completely new VR/AR specific value capture method, i.e. revenue stream, that was discovered in this study was the sponsored locations model of the AR application Pokémon Go. However, cases like Pokémon Go with its large direct revenue streams are still rare. Especially with mass markets, VR/AR monetization models still seem to be in

an explorative stage. For example, with New York Times VR, the technology and content is financed by branded content collaboration, but the application, NYTVR, itself is free. Rather, the company is still learning and exploring how these technologies could create value in the future.

Currently, the more consistent streams of direct VR/AR revenue seem to come from professional solution sales such as IrisVR or enterprise solutions such as zSpace. It should also be noted that while the value capturing mechanisms of VR/AR are still exploratory, utilizing the technologies can create large positive impacts into the cost structures of many companies, either by making their work more efficient or by replacing physical costs with virtual costs. In many cases, like in architecture and healthcare, VR/AR is not a tool for creating direct revenues through services, but a tool for improving the existing value creation processes and leveraging other parts of the business model.

6.6 Key partners

Many key partners of this study, such as sales partners, investors and retailers are not directly related to creating value with VR/AR, but simply partners that let the companies focus on their core competencies. It should also be noted that "users" were listed as key partners seven times in this study, however, leveraging users as a part of the research and development process is again, not only important to VR/AR, but any business that wants to tap into the potential value creation it could gain through its users. For VR/AR, the most important partners are 1) VR/AR experts / game developers, 2) key VR/AR industry players and 3) content creators.

First, especially high-end VR/AR products require some special expertise such as developing user experience design, 3D modelling and optimization. This knowledge is most prominent with game developers and as such, partnering with game developers is not only useful for industries developing new VR/AR solutions, but also beneficial for the game developers, as it provides a new platform for utilizing their skillsets.

Second, while only a few of the key VR/AR industry players (e.g. Google, Samsung, Apple, Microsoft, Sony, HTC and Facebook) came up as 'key' partners in the business models analysed, their importance should not be forgotten, as many of the actual products themselves are dependable on their services and future directions regarding the technologies. In addition, they are the actors with most centralized knowledge of VR/AR, so partnering with them can always be beneficial.

Third, partnering with content creators came up in 5 of the 10 business models and is beneficial, because for many of the applications presented in this study, the amount of content they can provide for their customers is a vital factor of their 'value'. Partnering with content creators can often be a win-win situation: while the content creators are

providing the enterprise with more content, the enterprises are providing content creators with a platform for an audience.

The most important thing to note about VR/AR and partnering, is that VR/AR solutions creation is a multidisciplinary field and it is often impossible for one company to have all the knowledge resources required for the application development. As the technologies are often something that can vastly improve existing business models, creating networks and partners are often win-win situations for all actors involved.

6.7 Key activities

The most recurring key activities in the business models of this study are: 1) research and development, 2) marketing, 3) content development and 4) technical support. These are listed below.

First, research and development is a key activity with VR/AR, in the same way it is a key activity with any other emerging technology. What is important is not the existence of this key activity, but its importance: VR/AR are interconnected to many developing technologies, therefore, any company in the industry must keep their application updated accordingly.

Second, marketing is a very important key activity, as many still do not know about the possibilities of the technology and reaching potential customers can be cumbersome. It should also be noted that the value of the technologies is often very difficult to communicate. For example, according to Justin Barad (2017), the CEO of OssoVR, the game-changing nature of the technology is often very difficult to convey to customers and the only way to get the real experience is by trying the technologies by yourself.

Third, content development is a natural key activity in many of the cases, since the "products" are platforms of multiple services and more content equals more value. However, the importance of partnering for content should not be forgotten.

Fourth, technical support is a key activity with any new technology, since it teaches the customers how to use the technologies and, in addition, leverages research and development by gathering feedback.

The other key activities were often dealing with special characteristics of the business models key value propositions. For example, 'collecting and using data' was a key activity in VR shopping business model, as it was a major organizational key activity regarding the second value proposition 'consumer behaviour knowledge'. As such, they are important, however, do not provide industry wide insight into VR/AR itself.

6.8 Key resources

Most recurring key resources in this study are resources related to 1) IP and 2) Technology (Hardware, software and IT infrastructure). These are listed below.

First, IP is currently a key resource in VR/AR, albeit a difficult one, as it is often connecting many different fields (multidisciplinary). It is not only the knowledge on how to use the technologies, but the knowledge of how to use the technologies in an efficient way that fits the context or when and how to use experiences such as VR/360. It is something that provides key advantage in VR/AR, however, the line between when to share knowledge (i.e. the IP) and when to protect it is difficult (Vanhalakka et al. 2017). In addition, VR/AR are new technologies and without laws or previous cases it can be difficult to determine what can be considered as IP and what cannot be considered as IP.

Second, the finding on key resources often being related to technologies in VR/AR is natural, since VR/AR are technologies. However, in this context, looking at the key resources in connection with the other building blocks of the business models is especially important. As mentioned above, one value proposition of VR/AR is the fact that it can transform physical resources to virtual resources. This signifies that VR/AR can change the way many business models operate, removing the emphasis from physical resources to virtual ones. For example, a client meeting with VR does not require a physical space or transport, other than putting on an HMD headset. However, it does require a virtual meeting room with virtual meeting tools. This is a new territory that requires different kind of skillsets and different kind of resources, and should be kept in mind when implementing VR/AR into workflows.

Again, as with key activities, the other key resources in this study are related to specific characteristics of the specific business models. However, the importance of user communities and platforms is worth mentioning. User communities can become a very important key resource, as it lets companies tap into their users as part of their development processes. Platforms, on the other hand, are not only important for the companies themselves, but for the whole VR/AR industry, since they are providing small companies and independent content creators with a place to reach customers.

6.9 Cost structure

The key activities and key resources have a direct relation with cost structure blocks in the business models of this study. ‘Key’ cost structure blocks are research and development, marketing, content development, technologies (hardware and software). However, making common notions about cost structure is not very important, as, in the business model canvas, the cost structure outlines the key (i.e. most important) costs for manufacturing value. Therefore, the cost structure enables analysing what resources and how much are required to operate the business model. Thus, the context is very important.

However, there is one overall finding that was already identified in key resources and value propositions. VR/AR solutions can be enablers that make the transition from physical resources based cost structure to virtual resources based model possible: this can often lead to saving resources and making the cost structure more scalable.

6.10 Key findings

While each case in this study was analysed separately from each other, they enabled a very wide perspective in the VR/AR industry. While value propositions were found to be the most useful category for picturing what kind of value the technologies propose to different customer segments, describing the value propositions and their more intricate mechanisms would not have been possible without analysing value creation process as a whole on the enterprise level. For example, the finding about VR/AR enabling saving resources in many cases is not sufficient on its own; VR/AR can reduce costs by replacing physical resources with virtual ones, however, doing this requires a new set of competencies and resources. Determining what these competencies or resources are in each individual context is a key requirement for using the technologies efficiently.

7. DISCUSSION AND CONCLUSIONS

The main research question of this study is: **how do enterprises create value with VR/AR solutions and how this value can be communicated?** The answers to the first part of the research question, how do enterprises create value with VR/AR solutions, are presented in section 7.1, Value creation with VR/AR. Section 7.2, communicating value with the business model canvas, focuses on the business model canvas: how well it worked as an analysis and communication method, and how it fits the theoretical concepts of value and value creation.

In this case, the managerial implications and theoretical contributions of the study are not separated into their respective sections. This is because of the highly practical nature of the study. In addition, it can be argued that many of the results of this study contribute to both managerial implications and research literature. Managers can use section 7.1 as a framework for understanding the value of VR/AR technologies, for innovating new VR/AR products and business models, or as a framework for improving existing ones. Section 7.1 has some theoretical contributions as well, and can be used, for example, in identifying future research subjects for both VR/AR and business models. The more substantial theoretical contributions of this study are in section 7.2, which focuses on the method: the business model canvas. The method is widely used in both business and research, however, the reasons why and how the method is used are rarely discussed. Section 7.2 provides some insights into these specific questions. However, section 7.2 also has some managerial implications, as it provides managers with practical insights about the business model canvas as a business tool.

There are, however, some theoretical implications that do not fit the context of the first two sections. These implications are discussed in section 7.3. Section 7.4 is an evaluation of the success of the study. The final section, 7.4 reflects on the limitations of this study and discusses potential subjects for future research.

7.1 Value creation with VR/AR

In business, value is often treated as a self-evident concept. In research, however, the concept is more complex, and due to its subjective nature, providing answers to what value is always requires a beneficiary, i.e. the actor who the value is being created for. This study looks at value creation from the point of view of enterprises: when an enterprise is creating value, it is creating value for its customers, for its stakeholders and for itself. As such, on enterprise level value creation is a complex process that often consists of a substantial network of different actors and different stages of value creation. Therefore, providing an all-encompassing answer to how enterprises create value with VR/AR

solutions is not possible. However, with a clear focus it is possible to provide some insight into how enterprises create value with VR/AR solutions. In this study, this focus was achieved by combining value creation theory with business model theory and the use of the method, the business model canvas (Osterwalder and Pigneur 2010).

The nine building blocks of the business model canvas (value propositions, customer segments, channels, customer relationships, revenue streams, key partners, key activities, key resources and cost structure) canvas can all be considered as parts of an enterprise's value creation process. One of the questions that came up during this study was whether the value of VR/AR solutions could be summarized on a business level, or whether the value or the value propositions the technology proposed were too complex and would suffer from over-simplification. As the study progressed, it was noted that the process of taking these complex value propositions and condensing them into aggregated concepts in the business model canvas was often advantageous for analyzing value creation, as it revealed the connections between the different sections of value creation. The compression of these ideas highlighted that the products and their value propositions are only a small part of the value creation process, therefore, it made it easier to compare the different business cases to each other. The insights gathered from the 10 different VR/AR business models are presented in Figure 22.

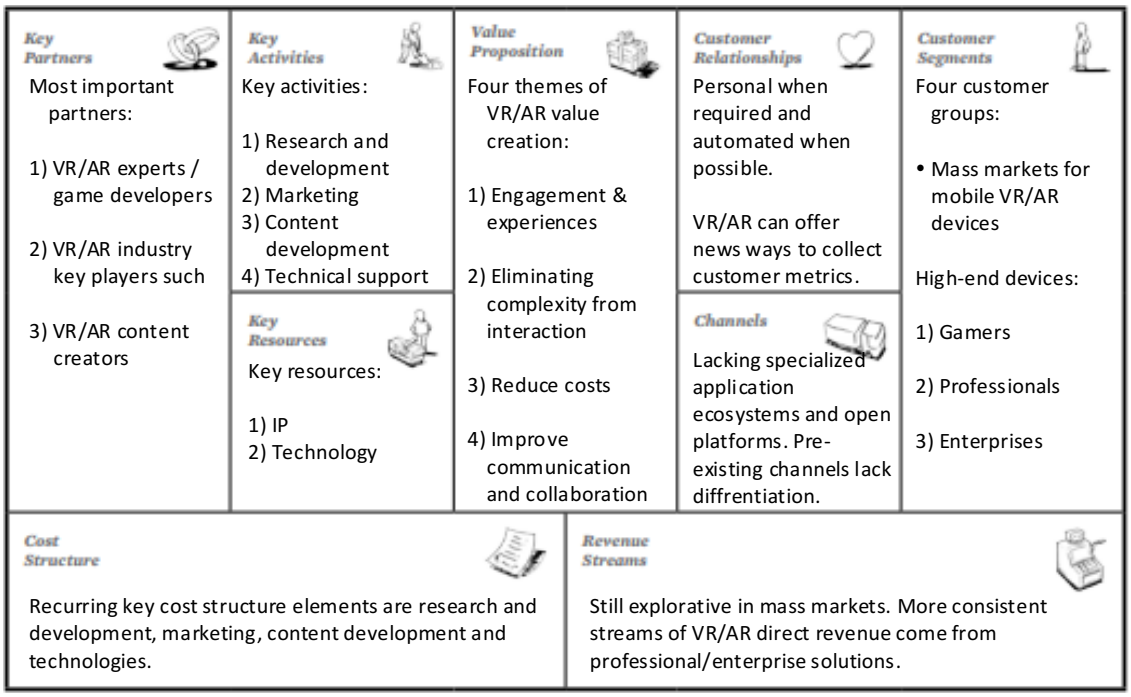

Figure 22. A summarization of the business model findings

Value propositions: The study identified four value creation themes about what the technologies of VR/AR can offer to customers: 1) they can provide more engaging experiences as well as the possibility to create more engaging content, 2) they can improve previous graphical user interfaces by eliminating complexity and mimicking natural

movement, 3) they can reduce costs and improve previous products/processes by transforming physical resources to virtual resources, 4) they can improve communication and collaboration.

These themes can be used as guiding notions on how to create value with VR/AR to different stakeholders or customers. Companies can, for example, reason which physical resources could be replaced with virtual resources and whether these virtual resources could be better than the regular ones by increasing engagement, eliminating complexity and introducing new methods of communication.

Customer segments: First, it should be noted that mobile VR/AR applications can reach mass markets and that they have potential. However, the capabilities of mobile technologies are still lacking in many aspects, thus limiting the business potential the technologies have. On the other hand, the high-end devices on the other hand can achieve much more and have three important customers groups: 1) gamers, who already own the devices or VR-capable CPUs, 2) professionals, for whom the advantages of the technology outweigh its costs, and 3) enterprises, for whom the technology can improve processes and save resources.

The most important notion here, is that high-end VR/AR devices can already offer a lot of value to professional and industry solutions. On the other hand, gaming markets on the should be followed closely, since they have the most users of the high-end devices. Mobile VR/AR markets have the biggest demographic, however, the technologies have more limitations.

Channels: The technologies are lacking a specialized application ecosystem and open platforms for content creators. Pre-existing channels can be used, however, they lack differentiation. Therefore, there is a need for channels that VR/AR content creators can use to reach customers.

Customer relationships: Customer relationships are personal when required and automated when possible. Automated relationships are more scalable. The technologies are essentially wearables that can collect data about what the users do and, therefore, can offer news ways to collect metrics and understand customers better.

Revenue streams: AR has some new possibilities with location based marketing, however, most mass-market key players, such as New York Times, Apple and Google still seem to be exploring with how to monetize VR/AR content. It should also be noted that these key players are doing subsidization, i.e. giving away devices either for a cheaper price or free, to get more users for their applications. Therefore, there is a need for innovation regarding monetization models in the VR/AR mass markets. More consistent streams of VR/AR direct revenue come currently from professional/enterprise solutions such as IrisVR or zSpace.

Key partners: VR/AR is a multidisciplinary field and because of this, partnering is a key success factor. Most important partners that can leverage VR/AR business models often include: 1) VR/AR experts / game developers who have experience in subjects such as 3D modeling, optimization and UX design, 2) VR/AR industry key players, who are developing the technologies/services behind most VR/AR products and thus can leverage research and development processes of the solutions creators and, 3) VR/AR content creators who can increase the amount of content provided by solution creators platforms.

Key activities: Most recurring key activities in the business models of this study included: 1) research and development, 2) marketing, 3) content development and 4) technical support. There are no special insights about these building blocks as they are typical for any emerging technologies.

Key resources: Most recurring key resources were related to 1) IP and 2) Technology. IP is an important factor, since especially regarding VR/AR it is a research agenda. This is because the technology is new, and it is often difficult to determine when and how to protect IP regarding it (Vanhalakka et al. 2017). Therefore, there should be some research of how to handle IP, when it comes to VR/AR. It is not a surprise that technology is a key resource in VR/AR business models, and the more important notion here is the technologies' ability to transform physical resources to virtual resources.

Cost structure: The most recurring key cost structure elements are research and development, marketing, content development and technologies. However, the most important notion about cost structure is again the transition from physical to virtual resources.

Key findings: From a practical point-of-view the most important findings of this study are the four different themes of VR/AR value creation. They can be used both as innovation for new solutions and as a framework for discussing existing ones. However, it should be noted that these value creation themes do not exist alone: a good product or a value proposition is only a very small portion of the enterprise's value creation process, albeit an important one. It does not matter how engaging an application is, if there is no method of delivering it to the customer. It is not only the existence of the delivery channel that is important, but that the delivery channel, just as any other building block of the business model canvas, is an opportunity for value creation. Therefore, especially with emerging technologies such as VR/AR, where business models are still exploratory, it is important to look at value creation process as a whole.

For example, with PsiousVR their initial product was a mental health self-treatment platform (Roig 2016). However, this did not work and what was required, was not product innovation, but business model innovation. It turned out that PsiousVR was targeting the wrong customer segment, patients, when it should have been targeting a more prominent customer segment, therapists and mental health enterprises (Roig 2016). The value proposition themes of Figure 22 are about what the technology can do, however, it is necessary

to connect them to the right business models and value creation processes. While therapists are the right customer segment for PsiousVR, they are usually not technologists. Therefore, it is important to have technical support as one of the key activities of the company.

This business model innovation can also be used for developing completely new ideas from existing products. For example, while the value propositions of the high-end technologies have large potential, availability and price of the devices on mass markets is one of the reasons why it is currently difficult the develop consumer solutions that can reach large customer segments. The question is: how to make the devices more available for customers? Would it be possible to sell HMDs and computers by leasing instead of a whole package? Would there be a need for VR/AR facilities, where consumers could come and utilize the devices for free or for a small fee?

One of the reasons behind this study was to create a separation between the facts, the heightened expectations and the hype concerning the technologies. During the making of this study, the technologies of VR/AR have taken big steps forward. The technologies are becoming more common and more available. New big players have entered the market, such as Apple with their release of the the ARKit (Apple Developers 2017) and Windows, in collaboration with Acer, with their release of Windows Mixed Reality headset (Acer 2017). The development indicates that VR/AR can become more commonplace faster than what the original forecasts of, for example, Gartner (2016) and IDC (2016) predicted. The technologies of VR/AR can be used to create new products and services, and to leverage existing ones. While the technologies are not yet ready for mass consumer markets, enterprises should begin to prepare themselves for the time when they do, as it will become a key source of competitive advantage for many.

7.2 Communicating value creation with the business model

The business model canvas provides one possible answer to the second part of the main research question “how this value can be communicated?”. As mentioned before, the method does not answer everything regarding how enterprises create value, however, with the method many important steps of value creation on an enterprise level can be modelled and discussed. In this study, the method’s main strength, and difficulty, was its simplicity. Even though the method is used in many research papers, there are not yet many studies of how to use the method. The original developers of the method seem to emphasize its role as a prototyping, development and a communication tool (Osterwalder and Pigneur 2010; Fritscher and Pigneur 2014) and, therefore, suggest designing it in a minimalistic way that supports creativity and communication (Osterwalder et al. 2014; Strategyzer 2017). However, in research, the method is often used in a very different way, for example, as a framework for gathering and presenting data, and there are no resources that discuss it as a written tool of communication. In this study, both approaches were

combined: the business model canvas was used as a framework for guiding the data collection and analysis process, while still following the design best practices from the more business oriented business model canvas resources. In addition, a methodology was designed that supports the use of the business model canvas as a written tool of communication and as a tool for describing enterprise value creation.

It was noted, that the business model canvases made using the design best practices collected from research and business resources worked better as verbal communication and analysis tool than the canvas models made without using the best practices. However, finding a way to present these canvas models in written form proved out to be a long process that requires a lot of testing and triangulation to ensure that all the reading parties understand the contents. In the validation sessions of this study, where the canvas models were presented orally, there were no problems building a comprehensive understanding of the models and what they depict. This was because, first, the models were presented in a narrative way, focusing on their most important parts and, second, when something was not understood, there was a possibility to discuss the subjects further. It should also be noted, that presenting the models often brought up a lot of discussion about single building blocks that revealed new insights. In writing, building this comprehensive understanding was more difficult due to the lack of interactivity. The ability to describe the business models in a sufficient way improved with each business model made. However, this also required going back to previous business models and the methodology multiple times, and improving them until the process was refined. Therefore, the current business models depicted in the study are the results of a long iterative process based on both learning and validation.

Therefore, it can be concluded that the business model canvas is a good tool for communicating and discussing enterprise value creation, and thus it can be used as both: a practical business tool and a research tool. The way the method is used in sections 5.1-5.5 supports the visualization of the different building blocks of the business models, and the way it is used in section 7.1 (Figure 22) supports presenting overviewing information about larger concepts. The simplicity of the business model canvas also enables using the methodology together with other tools, such as the value proposition canvas and the five forces mentioned in section 3.4. However, it should be noted that while the method itself is simple, its value is diminished by the obscure ways it is often used. This study identifies that presenting too much information at the same time, not using colours or having a narrative behind the business model makes it difficult to see the connections between the different building blocks. Therefore, having clear design rules for the canvas models that support the method's usage as a communication and a collaboration tool can often immensely increase the results it can provide.

However, it is still unclear what these design rules should be, especially when the business model canvas is used as a research method. This study is only a single example of how the method can be used, for example, for benchmarking or analysing value in business

context. While the methodology used was found to be beneficial in this context, it is unclear in what kind of scenario a similar method should be utilized. However, it is clear that there is a gap in the research related to the business model canvas and how it should be used that should be addressed in order to increase its value in both business and research.

7.3 Theoretical implications

The theoretical concepts of this study, value, value creation and business models have clear connections between each other, however, they are not directly linked together in any publications. In addition, many theoretical concepts, such as terminologies and definitions are still subject to change, as the theoretical subjects are still highly debated in business and management research. Therefore, the placement of this study is difficult. However, examining the scientific discussion of the theoretical concepts and the implication of a connection between the theories of value, value creation and business models is important in itself. Many of the current conceptualizations of value and value creation state that value creation is an all-encompassing process between all the stakeholders of an enterprise (Grönroos and Voima, 2013; Vargo and Lusch, 2016). At the same time, many of the current conceptualizations of business models bring up value creation as the core process of a business model. However, these conceptualizations of business models do not seem to link them to any specific frameworks or approaches of value creation.

This study identifies that as a theoretical concept, business models are more complex than the nine-block process outlined by the business model canvas. However, the simplicity of the business model canvas has its advantages, and one key finding relating to the method and the theoretical concepts of value creation is that the method enables analyzing the value creation of multiple stakeholders at the same time. This fits well with the subjective nature of value and the current conceptualizations of value creation, which highlight the importance of the network nature of value.

The framework proposed by Grönroos and Voima (2013) introduced in section 3.2 has its problems, since it only has two dimensions: the value provider and beneficiary. This is because value creation process can often have multiple stakeholders who are creating value for each other simultaneously. However, it should be noted that Grönroos and Voima (2013) works well as a framework for analyzing the relationship between the enterprise and a specific stakeholder, for example, the customer. While the business model canvas cannot be clearly separated into different spheres of value manufacturing, co-creation and independent value creation, this thinking model, where some parts of value creation can be affected by the focal company, and some cannot, was found to be advantageous in many stages of the business model canvas formation. For example, in the synthesis stage, where multiple canvas models were summarized into a single canvas model, “co-creation” processes, such as user communities and personalization, were often found

to be key parts of the business model. This is because co-creation processes offer enterprises a chance to affect the value creation process with factors that might not be related to the product itself. It should also be noted, that this kind of thinking can be used to develop business models, as companies can identify which parts of the value creation process they can affect, and should be a part of, or vice versa.

However, there are still open questions, for example, how do the concepts of value delivery and value capture fit the context of service-dominant logic, and how do the different conceptualizations such as the different spheres of value creation (Grönroos and Voima 2013) relate to each respective building block of the business model canvas. In addition, it should be noted that while the framework by Grönroos and Voima (2013) was found to be the most advantageous model for thinking when analyzing the canvas models, it has its problems and does not necessarily fit the current conceptualizations of value creation such as the new service-dominant logic conceptualization by Vargo and Lusch (2016). However, it can be argued that according to this study the framework by Grönroos and Voima (2013) has its advantages. Therefore, it is possible that the framework could be reworked according to the more recent conceptualization to better fit the multi-dimensional nature of value.

7.4 Evaluation of the study

The goal of the study was to provide an overview of the value potential of the technologies of VR/AR, analyse them objectively and separate the "hype" from the reality. From the pragmatic point-of-view, the study managed to answer these goals and provide answers to both parts of the research question. One difficulty was to remain objective while analysing the various business model cases. However, constant triangulation and validation with both research colleagues and industry professionals aided in separating between claims and hypothesis. In the end, the identified themes of value creation seem to match with the current VR/AR solutions and provide important insights for future business developments. The business model canvas can be used as a method for communicating this value, and, in addition, it can be used for innovating new VR/AR business models and/or improving existing ones.

However, even though the study began from a highly practical stance and had highly practical goals, the value of its theoretical implications should not be underrated. Developing and improving the business model canvas as a methodology was not originally a goal in the research. However, as the research progressed and the theoretical concepts of the study became clearer, it was evident that there was a need for a more clarified usage of the business model canvas. The way the business model canvas is used in this study, supports its usage in both business and research. Therefore, perhaps the most important findings of this study after the findings related to the value of VR/AR are related to the business model canvas, how the method should be used and how it could be improved for

future usage. Finding connections between the theoretical discussions of value, value creation and business models was also an unexpected finding, however, an important one.

The most substantial problem of the study, was its schedule. As mentioned before, developing a methodology for using the business model canvas was not originally a research agenda. In addition, the time required for presenting all the 10 business model cases in a comprehensive way and gathering insights about all of them together was largely underrated. Therefore, the study exceeded its original time related constraints. This problem could have been diminished by cutting the amount of business model cases or by, for example, moving some of the research agendas for future research. However, the end results of this study would not have been as comprehensive as they are and perhaps some of the key findings could have not been made. Therefore, in this case, the late schedule enabled validating the research once more and giving a better answer to the research question.

7.5 Limitations and future research

Value creation is a complex subject, and perhaps the most substantial difficulty of this study was keeping it within its pre-ordained scope. Every business model analyzed revealed new interesting facts of value creation and its mechanisms on a business model level. The key limitations of this study were:

1) The focus of the study
2) Data collection and analysis method
3) Subjective nature of the analysis
4) The state of value, value creation and business model literature

First, the value analysis in this study was deliberately set to the level of enterprises and the analysis was further limited by the nine different building blocks of the business model canvas as well as the way the method was used. While this made it possible to create an overview of the VR/AR industry, it also limited the study. For example, each one of the value creation themes identified in this study could be a research agenda on its own. Engagement is a recurring concept in VR/AR related value creation, however, it is still unclear what this engagement means. From a practical sense, it is easy to understand why virtual journeys to historic locations would be a more engaging learning experience for students than reading a history book. However, is the experience more engaging than watching documentary about the location, and if so, why?

Second, while critical assessment and triangulation played a key role in the business model building process, the data collected and analyzed for the models was from public sources. Because of this the presented results represent in many cases how companies want themselves to be perceived and what value they think they can provide. This presents a problem: what if the companies are wrong and do not understand their customers?

In addition, in many cases it was difficult to determine whether a resource or an activity could be considered a key building block and whether the segments about them reflect the reality, since determining key resources and key activities was mostly based on critical assessment.

Third, this research is inherently subjective and based around the researcher's critical assessment of what is important. To understand value, it is required to understand the beneficiary who the value is being created for. The results of this study are a collection of interpretations and therefore should be viewed critically.

Fourth, the subjects of value, value creation and business model literature are still exploratory. This study identified clear connections between the theoretical concepts, however, without a clear theoretical framework, the placement of this study is difficult.

However, the first three limitations of this study are self-imposed and they are what enabled providing a large overview of value creation in VR/AR industry. In addition, they can be used for identifying future research subjects. For example, the first limitation is related to the framework used for data collection and analysis, the business model canvas. Therefore, a good future research subject would be to use other methods (such as customer interviews, ethnography, qualitative content analysis) to further validate and research the themes identified by this study. Other possibility would be to use the themes as a baseline for practical innovations or developing the whole industry of VR/AR, by for example, figuring out how to fix the current problems of the technology, like its availability. The same applies to the fourth limitation of this study, as it identifies a connection in the concepts of value, value creation and business models. However, while there is clearly a link between the business model canvas and the network-like concept of value where stakeholders are creating value for each other, however, there are not yet studies that would connect the theoretical frameworks together properly. Therefore, making clear connections between the different theoretical concepts of this study has potential for future research.

It should also be noted that the method itself, the business model canvas, is still a research agenda. The method has been used increasingly as a tool in both business and research ever since the release of the "Business Model Generation: a Handbook for Visionaries" (Osterwalder and Pigneur 2010). In business context, there has been a collective for gathering best practices on how to use the method, mainly due to the efforts by the business model canvas centric company, Strategyzer (see Garner, 2015). However, in research context, studies regarding how to use the methodology, and in what context, are rare. Therefore, more studies of how to use the methodology in different cases would increase its ability as a both analytical and visualization tool. Important questions are, for example, how to build the canvas models? What different ways are there to use the method? How the canvas models should be presented? It should also be noted, that the business model canvas constrained the analysis to the nine different building blocks and in many cases

there were also “outside” factors, such as competition or laws, that could affect the value creation processes of the enterprises. Therefore, another interesting future research subject would be to analyze what methods could be utilized together with the business model canvas in order to gain insight about value creation forces “outside” business.

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