THE USE OF VIRTUAL REALITY TO INCREASE EFFICIENCY AND PROFITABILITY IN DIFFERENT INDUSTRIES AND FUNCTIONS

How head-mounted display can bring value to sectors with its competitive attributes

Riia-Leena Wallin

International Business
Bachelor's Thesis
Supervisor: Susan Grinsted
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ABSTRACT OF
BACHELOR'S THESIS

Author: Riia-Leena Wallin
Title of thesis: The Use of Virtual Reality to Increase Efficiency and Profitability in Different Industries and Functions

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Objectives

The main objectives of this study are to find how virtual reality (VR) used with head-mounted display is already used in industries, to discover the possible specific disadvantages and negative effects of using VR, and do they have influence on how open the market is for the change. In addition, this thesis aims to find what business functions could be improved by VR, and in what scale, and to analyze the competitiveness of VR, by comparing its prominence to other rival technologies, such as augmented reality. The final aim is to evaluate how wide-spread VR can become in the future, and which developments are needed to achieve this.

Summary

The thesis provides an overview of how VR could be used in business, by finding the most notable advantages and disadvantages of it, which industries and functions could benefit the most from using it, and what is the long-term value which it can bring to those businesses. In the process to find the answers, literature review considering the term, background, level of reality and acceptation of the platform is presented. In addition, primary data is gathered from brainstorming sessions and expert interviews. The findings are analyzed to evaluate different factors and feasible roles of VR.

Conclusions

The most notable advantages of VR are the immersiveness and thus substitution to real life, three-dimensional perception, and the wide availability to markets. Disadvantages include exclusion from the environment, the level of hardware and software development, and the overwhelming expectations. The functions to most benefit from virtual reality are training, design, and marketing, and example industries using those are building, retailing, and real estate. Virtual reality is facing some major hindrances, such as prejudices, unrealistic expectations, and the rise of augmented reality (AR). In the future, AR is likely to take market share from VR, but in general they will have different uses, and in long term mix together. Although, legislation is an issue to be addressed for widespread use of virtual environment.

Key words: virtual reality, VR, head-mounted display, HMD, technology, immersive, Finland, platform, industry, function, training, international business

Language: English

Grade:

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1. **INTRODUCTION**

Digitalization has made everyday life consist more of technology, including the emergence of smartphones as a common product, and different gadgets, such as health watches and smart TVs. As technology is more and more embraced to everyday life to increase the life quality and in general increase efficiency in basic tasks, the continuous development of the supply of these devices has increased. Among this new era with technology, virtual reality (VR) has developed from design software to a new platform for the entertainment industry. Especially after the release of Oculus Rift in 2016, the hype around virtual reality has grown and with it the amount of content and devices have increased tremendously. In addition, the possibilities of virtual reality to be applied in large scale in different industries outside entertainment are also promising. However, this type has not yet become widespread, so this area and its further implications should be researched more, which this thesis aims to do.

Virtual reality as a virtual environment has long history behind it, dating back to 1960s to a Sensorama-gaming machine. After that it has come a long way, including designing in virtual world and different simulators, but only recently it reached the level of immersion, which can be regarded as a milestone (Stein, 2016). The current level of development in its hardware and software has made head-mounted display (HMD) a considerable alternative to two-dimensional screens. In addition, the unique traits of virtual reality are competitive against other recently emergent technologies, such as augmented reality (AR).

Virtual reality has been through a lot of hype in recent years, and this will most likely continue as the technology and content develop further. From here also stems the reason why this research needs to be done, to more distinguish the real advantages and uses amongst the wide range of ideas and suggestions. In addition, the specific ways and the level of benefit which virtual reality can bring to the sectors and functions outside gaming need to be assessed. As the research done until now consist mainly of pilots of HMD application, or have different kind of virtual reality used, a comprehensive study focusing on large-scale implementation on the HMD-perspective is needed.

1.2. Research Problem

Even though virtual reality as a technology format has existed since 1960s and has been used in some sectors, only the recent development of hardware and software has made it possible for VR to become a commonly used platform. The level of immersion and interactivity is currently the most developed what is has ever been, and as the price of the novelty has levelled down for mass market to afford, without being classified as luxury product, virtual reality used with head-mounted display has the potential to become a new platform to aid in numerous tasks and performances, which are right now done for example with computers and televisions.

The hype around virtual reality began in 2016, after the release of Oculus Rift, and since that many other players have joined the industry, such as HTC Vive, Samsung, and Nokia. This shows how virtual reality is regarded to change aspects in everyday life, in both leisure and work. The literature for virtual reality in business is vast, but not so much from the current level of development, and with head-mounted displays. In addition, as the hype has built around virtual reality, many scenarios have been made of how it could affect digitalization, and in which level. This is the reason why it is important to investigate specifically in which fields and functions VR in its current form could be used, and what are its strongest advantages and greatest disadvantages, and how prominent it could be in the future, to narrow down its feasibility.

1.3. Research Questions

The research questions are created to answer the research problem discussed above. Their aim is to gain deeper insight on the problem, by considering different features of it. The evaluated features are implemented on the questions, and conclusion will consist of answering these key questions. These three questions are:

1. What are the biggest advantages and disadvantages of the attributes of virtual reality?
2. Which industries and functions can benefit the most from implementing VR?
3. What is the scale of long-term value which virtual reality can bring to those industries and functions?

1.4. Research Objectives

Furthermore, the way to achieve concrete answers to research questions is presented in the research objectives below. They are created based on the research questions and research problem. These five objectives are:

1. To find how VR itself is already used in industries
2. To discover the possible specific disadvantages and negative effects of using VR, and if they have influence on how open the market is for the new platform
3. To find what functions could be improved by VR, and in what scale
4. To analyze the competitiveness of VR, by comparing its prominence to other rival technologies, such as augmented reality
5. To evaluate how wide-spread VR can become in the future, and which developments are needed to achieve this

1.5. Definitions

Virtual reality (VR): computer-generated immersive surroundings where participants feel like they are part of the simulated world and can interact intuitively with on-screen objects, achieved with head-mounted display, such as the Oculus Rift (Adaption from the delineation of Lin et. al., 2014)

Augmented reality (AR): human–machine interaction that overlays virtual computer-generated information on a real world environment (Ong et al., 2008)

Head-mounted display (HMD): opaque displays that exclude the physical world and cover the entire field of view (Stein, 2016)

Hardware: the physical, tangible platform

Software: the content of the hardware, intangible

2. **LITERATURE REVIEW**

2.1. Introduction

The general content of the term ‘’Virtual Reality’’ (VR) has changed many times during the past decades in both consumer and industry markets, for example moving from computer aided design (CAD) to virtual simulators, such as Second life. Currently it is mostly associated with the head-mounted display glasses (HMD), as the consumer gaming industry set a new milestone to VR with Oculus Rift launch in 2016 (Stein, 2016 & Yucel & Edgell, 2015). In addition, virtual reality has long had a steady base and multiple means of use in the industry level, e.g. with virtual design programs and teaching simulations (Blümel et al., 2008). As the hardware and software keep developing, and digitalization continues to change the way we live our lives, virtual reality can extend its influence to both the consumer and industry businesses.

In international business setting, there exists plenty of research of the practice of teaching, designing, and offering experiences in industrial environment via virtual computer settings, but not as much for applying the HMD glasses as an instrument, for this is a relatively new phenomenon. To cover this gap in information, this literature review aims to define the term of the virtual reality used in the thesis, and go through the long-term development of VR. In addition, the further sections will regard what is the level of reality HMD can offer, and what are the essential factors to adopt HMD as a platform. Furthermore, significance to the research is evaluated, and conceptual framework presented.

2.2. Characteristics of Virtual Reality

2.2.1. Definitions

Virtual reality has been defined to be many aspects during the past, but most prevalently it has been determined with adjective ‘’immersive’’ (Sharples et. al., 2008; Lin et. al., 2014; Carulli et al., 2016; Noon et.al., 2016; Stein, 2016). Immersiveness can also be synonymous with ‘sense

of presence', and means in its basic form the feeling of being physically present in a virtual world (Grabowski & Jankowski, 2015; Rebenitsch & Owen, 2016). Furthermore, the 'virtual' part in this thesis connects to the use of technology in creating the 'reality'. On the other hand, the 'reality' is regarded as a virtual environment (VE), which is used with the delineation of Lin et. al. (2014) as 'computer-generated immersive surroundings where participants feel they are part of the simulated world and can interact intuitively with on-screen objects'. This way, the definition differentiates from those which do not act as immersive as is the focus point of this analysis.

When it comes to the head-mounted displays, the definition in this case includes the stereoscopic display, which presents two images from different viewpoints. In addition to this, the recent models of HMDs restrict the view outside the glasses, which is also a differentiating factor from other display devices (Rebenitsch & Owen, 2016). Head-mounted display is the main platform used in the further analysis, for it enhances the immersion of the experience (Najafipour et al., 2014; Stein, 2016).

2.2.2. Long-term Trend

Virtual Reality as a medium has expanded steadily during the recent decades (Mackenzie et al., 2013; Stein, 2016). The journey began in 1960s with the game 'Sensorama', which introduced multisensory driving experience to consumers (Najafipour et al., 2014; Stein, 2016). In the 1990s the interest to virtual reality grew in business setting, as the technology had developed enough to deliver useful simulators (Lin et al.,2014). However, the fundamental milestone to virtual reality was in 2016, as Oculus Rift was launched (Yucel & Edgell, 2015; Rebenitsch & Owen, 2016; Stein, 2016). Oculus Rift expanded the virtual reality experience to mass market, with higher quality than before (ibid). This can be regarded as a milestone, for before Oculus Rift many of the devices in the market were not as developed and thus not as appealing to the consumers (Rebenitsch & Owen, 2016; Stein, 2016). In addition, after the launch of Oculus Rift the software of creating the virtual environment has developed in great steps, which is an essential factor to sustain the growth of the platform (Noon et al., 2012). This

side improved after Oculus Rift for example launched Oculus Rift Development Kit in 2012, which offered a platform to everybody to test the best functions in VR with a reasonable price (Stein, 2016).

This innovation increased the quality of Virtual Reality experience, and made it more common to both consumers and business, at least as an idea (ibid). The high price of the device display set has been a hindrance to a larger expansion, and is generally seen as a disadvantage of virtual reality (Blümel et al. 2009; Germani et al., 2012; Xia et al., 2013; Grabowski & Jankowski, 2015; Stein, 2016). This also concerns Oculus Rift and other similar head-mounted display devices, whose price ranges from $599 to $999 in Oculus Rift (2017) and Vive store (2017), respectively. However, cheaper versions are also available, as Google Cardboard and Samsung Gear VR offer a display platform used with smartphone, price ranging from $5 to $99 (Google Cardboard, 2017; Oculus, 2017).

However, as the prevalent use of virtual reality within HMD started only in 2016 and the level of expected immersion changed, VR is still not as common as a medium to large population, as other mediums, such as smartphones and computers are. In many studies people experience VR in more immersive environment for the first time, and it is seen as a factor affecting the results in a negative way (Sharples et al., 2008; Germani et al., 2012; Grabowski & Jankowski, 2015; Sarangi & Shah, 2015). This is the cause of people not knowing how to cope with the display, such as in which position it would deliver the best experience, and it is also shown that when people are not habituated to the multisensory and responsive experience, various symptoms, such as eye strain and feelings of illness, increase (Sharples et al., 2008; Lin et al, 2014; Rebenitsch & Owen, 2016; Stein, 2016).

In industry level, as said before, virtual reality has been used more than in the consumer base, when the term expands to include for example computer aided design (CAD) and virtual simulators. CAD has been used in industry for many decades, starting from 2D and improving to 3D, and in the future the enhancements in display devices give it a new way to design products (Noon et al, 2012; Xia et al., 2013; Peng & Isaac, 2015). In addition, gaming industry

is often said to be the pioneer in developing and taking into use the innovations, which subsequently leads the way to the other industries use as well (Yucel & Edgell, 2015; Stein, 2016). For example, Ong et al. (2008) evaluate the prominence of augmented reality, which means implementing computer-generated information to real world environment, as a tool in industry design to be promising, as it overlays to the real world and sets the dimensions rightly, which is a factor cumbersome to achieve in VR. In addition, Ferguson et al. (2015) propose augmented reality and virtual reality used with gaming as a tool to increase the wellbeing of people, and the education in medical sector. Another factor to increase the prominent success of virtual reality is the trend of gamification, as in using element from games in non-game contexts (Sarangi & Shah, 2015). As virtual reality is now developed to a great level in gaming industry, some of the applications could be transferred with only slight modifications to other sectors, for example with soldier training.

2.2.3. The Level of Reality

To determine the scope in which HMD can affect in the future, the current level of how much virtual reality can substitute to the real experience must be evaluated. As said before, the distinguishable factor of virtual reality is the immersion, and this is achieved by multisensory environment. As head-mounted display covers the entire vision field and is often occupied with headphones, both sense of sight and hearing are used. In addition to this, Xia et al. (2013) emphasized the value of haptics interaction, in other words the sense of touch as in receiving the feeling of the virtual experience, for many training simulators require that to gain the real-like practice. This is demonstrated by the studies of Noon et al. (2012) and Grabowski and Jankowski (2015) regarding HMD and training collaboration. However, both studies admit that there exists a need for improvement to the sense of touch, as one needs a device, often cumbersome to wear, to execute this sense in the virtual environment. On the other hand, this issue can be developed by also developing the software, as Peng and Isaac (2015) accomplished by creating a haptic workspace moving algorithm to transfer the movement in real life to be more precise to the virtual world. Carulli et al. (2016) executed a study with olfactory device, which was adjoined to the head-mounted display device. Their study

concluded that the sense of smell increased the immersion, however the device to add scent is hard to add in mass production, to which follows that other senses than visual, haptic, and hearing are difficult to add to the encounter.

Nevertheless, multiple studies show that the subject people do not regard virtual reality as a real experience. Najafipour et al. (2014) refer to a study in tourist industry in which most of subjects did not want VR experience compared to real life. Lin et al. (2014) conducted a study comparing different display devices, in which HMD gave the worst result in both the experience and side-effects. In addition, Rebenitsch and Owen (2016) reinforce the symptoms level of HMD by referring to many cybersickness studies. However, these studies have relatively small subject groups, ranging from 10 to 31 (Respectively Lin et al., 2014; Najafipour et al. 2014). Furthermore, many of the research studying symptoms caused by virtual experience may have deliberately aimed to increase the negative response, to present valid results (Rebenitsch & Owen, 2016). Many of the studies have been conducted in the beginning of the 21st century, resulting in different hardware, software, and the opinion of people around the subject compared to the level of nowadays (Lin et al, 2014; Rebenitsch & Owen, 2016; Sacks, 2016).

However, many studies regard virtual reality as a useful tool for training, design, communication, and product development. Grabowski and Jankowski (2015) emphasize the immersion of HMD in the training of the dangerous aspects to underground coal miners, Germani et al. (2012) induce virtual reality to collaborative product design with the use of Avatars and web workplace, Sacks et al. (2015) enhance dialogue between designers and builders using virtual simulator, and Carulli et al. (2016) created a highly immersive test of using scent with HMD, resulting in product evaluation comparable to real life. Actually, in all of these studies, virtual simulation was found to be closely, if not fully, able to constitute the real life (ibid). In general, even though Virtual Reality may not now reach the full immersion, as the technology develops and innovations are made, with HMD it can reach a new level to contribute to a real-life experience.

2.2.4. Adoption as a Platform

Virtual reality has been around for many years, but as HMD is a recent phenomenon, the adoption as a principal medium using VR is depending on many factors. The technology acceptance model (TAM) created by Davis et al. (1989) evaluates the possibility of general user acceptance of a technical system. Basically the theory consists of Perceived Usefulness and Perceived Ease of Use, which affect the intention to use of people and in the end the amount of actual system use. The Perceived Usefulness is seen as a primary factor, which has been later on challenged by multiple authors, cited by Lala-Făd or (2014). Lala-Făd or (2014) analyzes in the paper the development of the model, bringing out the obscure assumptions that acting can be executed without limits, and also the data analyzing section, in which analyzed data was self-reported, not empirically gathered. However, the author (ibid) appraises the model as popular and working in some aspects, but the results should not be evaluated without criticism. Oh and Yoon (2014) used a developed TAM-model in their study in evaluating the possible future of Haptic Enabling Technology, referring to the interface between human and computer. As a result, they predict that devices enabling haptic information will increase, as realism and intuitive interaction are expected more by people. The study has some limitations to this aspect, as it mostly focused on haptic and not in multisensory environment, and the sample respondent's age in 20's – 30's is not a base for generalization to whole possible user base in both industry and consumer level. However, the study indicates that there is a growing demand for more immersive and realistic experiences, which HMD can deliver.

The ease of use factor of TAM is also prevalent in the current situation, as the expectations for software and hardware of HMD increase. The hardware of head-mounted display is in good level currently, as with the appearance of Oculus rift et cetera in 2016 (Yucel & Edgell, 2015; Stein, 2016). The setting will also most likely develop in the coming years by including more immersive experience, following the scent adding study of Carulli et al. (2016). However, the expectations for software seem to be currently more than the reality can offer, because many factors depend on it, such as the immersion level and the possibility of side-effects. In basics, the programming of software takes time and effort to reach the best possible result, and often even then the result is not as satisfying as anticipated, which is seen as an effective setback

(Noon et al., 2012; Sacks et al., 2015; Yucel & Edgell, 2015; Rebenitsch & Owen, 2016; Stein, 2016;). Ong et al. (2008) specifically regard software modelling as a major limitation to the success of virtual reality, for it is not easy to model a fully accurate and working environment. On the other hand, some breakthroughs have been done, such as the development of Noon et al. (2012) of the Advanced Systems Design Suite (ASDS). ASDS combines virtual reality used with HMD and 3D computer aided modelling to better evaluate large scale objects (ibid). The main objective of the system is to combine the advantages of them both, as in designing the object both in the 3D CAD and using the HMD with gamepad controller, in real-time (ibid).

Furthermore, Yucel and Edgell (2015) emphasize that the prospective use of HMD can increase if the content producers and device producers share their knowledge, resulting in devices supporting the content and content taking advantage of the system the device can offer. They place three conditions to the success of HMD, and those are meaningful and immersive experiences, the openness of firm-level knowledge, and amount of competition. As the research is secondary and more focuses on the entertainment industry, it cannot be fully implemented to business level, but same factors affect at least on some level also in there. Experiences are being developed within software and simulators, Oculus has been relatively active in sharing toolkits for the developers, and the amount of competition is still relatively small, as not many other devices offer as immersive an experience (MacKenzie et al., 2013; Najafipour et al., 2014; Oh & Yoon, 2014; Ferguson et al., 2015; Yucel & Edgell, 2015; Stein; 2016).

However, one main factor can affect greatly the adoption of HMD as a platform. As HMD is a novelty and people have not that many experiences of it, only a few bad experiences may affect the whole perception of the product (Lin et al., 2014; Sarangi & Shah, 2015; Rebenitsch & Owen, 2016; Stein, 2016). In the case of Virtual Reality Induced Symptoms and Effects (VRISE), many studies have found that HMD gives the worst results in multiple aspects (Sharples et al., 2008; Lin et al., 2014; Rebenitsch & Owen, 2016). Factors affecting this are immersion, loss of control and navigation of the environment and preventing seeing the surrounding environment (ibid). However, for example the study of Lin et al. (2014) used only 10 participants, and by comparing three devices, of which two were one projection-based and

HMD was the only fully immersive, the study may be seen to provoke the HMD induced symptoms. Rebenitsch and Owen (2016) refer to many studies of HMD bringing the worst symptoms, but also acknowledge the improvement of the situation, such as habituation and decreasing the speed of navigation available. Overall, the symptoms are present in HMD and will not likely decrease much in the near future (Rebenitsch and Owen, 2016), but as people get more used to the stereoscopic view, and more user-friendly hardware and software continue developing, the symptoms can decrease (Sharples et al., 2008; Yucel & Edgell, 2015; Stein, 2016).

2.3. The Importance and Significance of the Research

Virtual Reality has been used in industries for a long time, for example by designing 3D-models on computers (CAD, Computer Aided Design), and thus plenty of research has been done about the general subject. However, Virtual Reality used with headsets (e.g. Facebook's Oculus Rift) has only recently emerged to the knowledge of common consumers, and has since that trended on gaming industry. As the development of the Head Mounted Display (HMD) continues to evolve, it becomes even more an option for other than gaming industries to use in many business departments. Thus, as many sectors already use virtual reality in some format, it should be studied how the business could become more efficient and profitable by applying the use of headsets within it.

In general, the main focus of the study is to explore the most useful traits of virtual reality's HMD-element, and how those could be used in other than gaming industries to increase the business. The findings of the study will indicate to the industries whether to invest in the virtual reality technology or not, and will also give insight to in general how the world in our future can look like, regarding to working and consuming environment.

2.4. Conceptual Framework

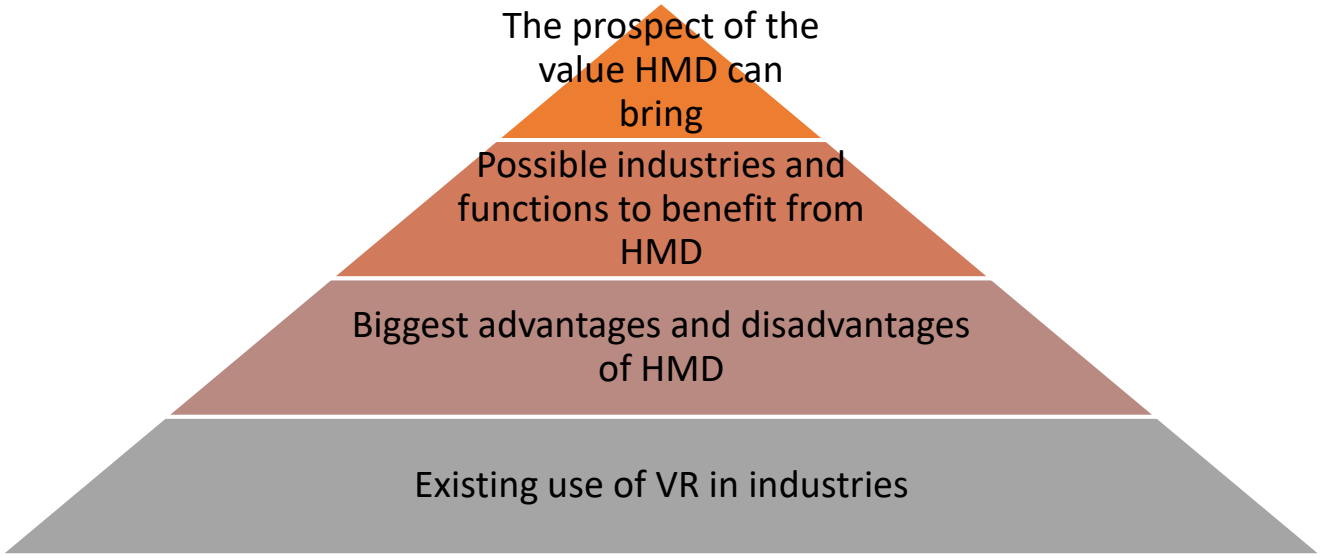

Figure 1: Conceptual framework

The conceptual framework (See Figure 1) presents a theoretical framework, and expresses the structure of further parts of this paper. First the general use of virtual reality (VR) in industries outside of gaming industry are covered. Second, the differentiating factors of head-mounted display (HMD) are revealed by comparing to the general of VR and its other dimensions, mainly computer aided design (CAD) and augmented reality (AR). Following comes the analyzing part of those factors, for what should be improved in the future for best benefit. Next research theme is the possible industries and functions, which would specifically benefit from HMD, and can be the ones in the first part, but in more future-perspective. In final step the amount of value HMD can bring is analyzed, combining all the aspects of the conceptual pyramid.

3. **METHODOLOGY**

The material for this thesis is gathered by using a combination of secondary and primary qualitative methods of research. The secondary research, literature review, aims to collect the secondary sources and from them find the relevant ones, to offer background and insight on the different attributes of virtual reality. Conceptual framework is presented in the end of literature review, shaping the structure of primary research. The primary research gathered information with brainstorming session and semi-structured expert interviews, and the results aim to answer the research questions.

3.1. Literature Review

The literature review is used to define more thoroughly the virtual reality-term, and how it has developed in the long-term trend. In addition, the level of how much virtual reality can substitute the real-life experience is evaluated, and also which are the factors enabling this level of immersion. Furthermore, by applying the Technology Acceptance Model (TAM) and reviewing it, the possible future demand and acceptance for VR as a platform is examined. Under the same subject both the development of hardware and software, and the effect of experiences to the perception of VR, are scrutinized. Additionally, the literature review offers a section analyzing the importance and significance of the research, furthermore emphasizing what is the need for creating this thesis. In addition, conceptual framework is presented, which leads the structure of Findings.

Limitations to the literature review include the few number of scholarly research addressing specifically head-mounted display type of virtual reality. Thus, other virtual reality sources, such as computer aided design and virtual simulators, are evaluated as sources, with different factors emphasized. In addition, the objectivity of the research is limited, for the sources are chosen by one person, and all the research found on the subject cannot be evaluated due to time restraints.

3.2. Primary Research

To conduct primary research for this thesis, a brainstorming session and semi-structured interviews were held during March, 2017. Brainstorming was arranged to gather ideas of possible uses of virtual reality, and to find out common opinion of the novelty. Ideas were collected primarily from university students, from different fields, and both verbally and in written format (See Appendix C). Before starting the sessions, the topic of thesis was introduced, and essential terms explained. It was also emphasized that any ideas, such as outside the business-setting, were welcome, and that there is no such thing as bad ideas. Providing concrete examples and scenarios was encouraged. The brainstorming results in this thesis are handled anonymously.

It must be noted that the number of participants in these sessions is 11, so the opinions cannot be generalized to large population. This is the reason why these brainstormings were more to generate ideas and evaluate how virtual reality could be used in the wildest scenarios. As virtual reality as a platform is still a relatively new concept with less concrete examples than, for example, computers, the possible ways to use it do not face as many tangible limitations.

The major advantages, disadvantages, and limitations, and the predominant and realistic future use of virtual reality were more addressed in the semi-structured interviews. The interviews were with experts from different sectors, organizations, and universities. The questions were sent out as an attached file with an e-mail, and can be found in Appendices A and B. In total 14 experts were contacted, from which 6 participated in the interview. The demographics of the six interviewees are presented in the Table 1, in the order in which the interviews were conducted. The selection of these experts was based on their perceived knowledge of virtual reality. In addition, the selection aimed to widen the range of viewpoints in the discussion by contacting different sectors.

Name	Gender	Age	Sector
Saara Murtovaara	Female	51	Real estate
Osma Ovaskainen	Male	18	Programming/Student
Joel Holmén	Male	29	Medical
Expert A	Male		
Mikko Lampi	Male	31	Research and Development
Emmi Teräs	Female	35	Traveling

Table 1: Demographics of Interviewees

The interviews were held in Finnish, two in written, and four in verbal format, and the verbal interviews lasted approximately 29 minutes. The translation of the interview to English is done by the author. Before the interview, the topic of thesis was explained, as well as key terms. Five of the interviewees agreed for their names, ages, gender, and sector to be released. One wished to remain anonymous, and thus is furthermore regarded as Expert A. It should be noted, that the interviewees represent their personal knowledge and opinion, and the answers should not be linked directly to other factors, or be generalized to the whole profession view. In addition, as all the interviewees are from Finland, the presented picture of virtual reality cannot be entirely generalized to address the global environment.

An initial interview base was created, but the interviews aimed to be semi-structured. Therefore, the questions acted as leading the conversation, but the structure was kept open for additional questions and inquiries when required and prompted. The interview base is presented in the Appendices A and B in Finnish and in English.

4. **FINDINGS**

This section will present the gathered knowledge from the brainstorming sessions and the semi-structured interviews, providing insight to the levels of previously structured conceptual framework.

4.1. Existing Use of VR in Industries

To avoid overlapping with the possible ideas, the existing use of virtual reality must be presented. However, the examples provided do not represent the whole scope of utilizing virtual reality, for often the knowledge is limited by a person's career or interest specialization. In addition, most of the secondary literature conducted for this thesis are pilot tests to see the effects of virtual reality on some specific functions, so they cannot be applied as examples of existing use.

The participants in brainstorming sessions predominantly mentioned game industry to be the most significant in the virtual reality field. Other examples presented are museum exhibits and real estate firms, which utilize VR to offer a chance to go to see the event, place, or premises without physically going there. In addition, HMD is used in psychology in various examinations, for example to scrutinize different cognitive performances, such as visual and hearing stimuli. A reason for this is said to be that ecological validity, the ability to generalize research results to real world, is high in virtual reality.

The existing use of virtual reality from the experts' experience included examples from health and real estate industry, and from design and training functions. Both Expert A and Holmén offer a couple of examples from health industry, both mentioning exposure therapy, which has been considered to resemble real-life well enough to have positive effect on the therapy. There also exists further evidence that the use of virtual reality can decrease the sensation of pain in notable levels, which helps for example in rehabilitation. In addition, they both mention that virtual reality has also been used in training simulations, such as operating in surgery. Another

mentioned example is how the PT- and MRI-pictures can be turned into 3D-models, and thus can be used to plan surgery or see formations. As these models are already being built in 3D, they could be easier to transfer to the head-mounted display view, than flat 2D-pictures. The second industry more thoroughly mentioned is brokerage, from where Murtovaara brings insight. She mentions that VR is used to present apartments which are yet unbuilt, for it is an easy way to demonstrate the property. In addition, both Murtovaara and Teräs bring out that virtual reality is used to organize showings for different properties.

The current functions mentioned in the interviews are visualizing and training. Expert A states that VR is used in scientific visualization, and Lampi finds virtual reality being very suitable for the visualizing of some concepts, or demonstrating a physical place. Teräs supports this by mentioning that architecture has utilized VR also in simulations of the products. Another function, training, is regarded as the original use of virtual reality in industries by Expert A, for example with different devices, such as forest harvesters. Lampi as well discusses of trainings and simulations as the existing use of virtual reality. He also mentions the availability of other entertainment content outside gaming industry, such as virtual movies and streaming.

In conclusion, currently the HMD platform in virtual reality is not very widespread in the business world. However, some examples rose from the interviews, such as medical and real estate sectors, and visualizing and training functions.

4.2. Biggest Advantages and Disadvantages of HMD

The most notable advantages and disadvantages are also the ones, that differentiate virtual reality from other technological platforms, such as computers and television screens. Predominantly the discussed advantages are as well the factors, that can bring most value to the possible sectors and functions. However, the disadvantages are the ones that need to be considered while evaluating the feasibility of the implementation of VR.

4.2.1. Advantages

To begin with, the trait of immersion and real-feeling was often mentioned in both the brainstorming session and the interviews. For brainstorming specifically, the opportunity to experience things which one would not necessarily otherwise experience, was emphasized. This includes, for example, the chance of going to space, but also the opportunity to train in risky situations, which could not be executed in real life due their dangerous effects. In addition, the ability to immerse oneself was mentioned to be one of the key factors, which could allow for instance more feasible, but just as effective virtual tolerance. Furthermore, the decreasing price of the virtual reality headset was noted.

When it comes to the interviews, same topics arise. All of the experts acknowledge the immersiveness and how virtual reality substitutes closely to the real experience. Furthermore, Lampi presents that eyes experience even crude visual experiences very authentic, which moreover supports the immersiveness of HMD. Also, Teräs mentions that physical doing teaches more than viewing from aside, and as HMD content is often from the viewpoint of the using person, this increases the effect of substitution. As for the available hardware, Lampi states that the most notable factor for VR is that it distinguishes the reality and virtuality, by removing the field of vision and the existing world, and thus creating a completely new environment. Both Lampi and Expert A present that VR is most suitable when the action needs to be done in new context, as in other than the surrounding environment. Other advantage is that virtual environment can be extremely customized, as Holmén, Expert A and Lampi bring out.

VR is also compared to the 2D computer screens, Ovaskainen stating that one of the strengths is that in the immersive reality you can intuitively examine the object from many different angles. This is also brought up by Holmén, who evaluates the three-dimensional perception to be a notable positive factor differentiating VR from basic computer screens e.g. in training and design functions. Expert A adds that the lack of stereovision is indeed a weakness of screens, other having lesser feeling of immersion than VR. In addition, Teräs mentions that virtual reality

offers a stronger experience than moving pictures, and with it strong emotions can be evoked, which support Murtovaara's comment of good marketing potentials of VR.

Furthermore, virtual reality is regarded as having right now an edge against the other recently emerged technologies, such as augmented reality. Ovaskainen mentions the reason also being the high price of the AR-glasses, which Lampi also states, mentioning also the inexpensive price of HMD glasses especially compared to AR and to the past prices. In addition, Expert A, Holmén, and Lampi say that the technological development is currently above that of augmented reality. The factors of the development of the virtual reality include the emergence of Oculus Rift, but before that the prices of components, such as gyroscopes and batteries, decreased, and the resolution of screens and in overall process power and tracking accuracy developed, as is stated by many interviewees. However, as the leader position of VR is primarily from technological factors which continue developing, AR can follow its steps and develop more in coming years. This is expected by many, as Expert A states.

Nevertheless, virtual reality has attained more awareness than AR specifically via Oculus Rift, which drew the big players, such as Google and Facebook, to invest in it. The notable results of this occurrence are expected to be more visible in the coming years, as Expert A presents. He also says that the hype around virtual reality began via Oculus, and for example Lampi brings out that due the hype, it can be easier for VR-projects to find money and partners. In addition, he declares that the hype has established a supply of development tools and knowhow. However, Expert A, Holmén, Lampi and Ovaskainen state that the significant factor for the future of virtual reality is its availability for all target groups and in all price categories. This continues to increase the awareness, and at present has made the product closer to the consumers.

4.2.2. Disadvantages

When it comes to the disadvantages of virtual reality, three subjects are pointed out in the brainstorming sessions. First of them is the affordability, for as said in the literature review, the

price of Oculus Rift and other similar head-mounted display devices, can range from $599 to $999, which is relatively high for average income to afford. There exists also the cheaper versions, which utilize the screen of smartphones, but from there rises the second matter: the content is often clumsy and can be poorly made, and so the experience is not as immersive as it could be. In addition, it was seen that the volatile quality of the software limits also the spreading to different sectors. This is because the content must develop to be more precise, to stimulate small and detailed movements, such as in surgery training. The third subject is closely linked to the advantage of taking over the senses effectively, but it was also considered that too extreme immersion can be even traumatizing. In addition, as the head-set covers the field of vision, physical harm can also be caused for bumping into objectives or other people around. A concern for motion sickness was also mentioned.

The content of interviews also emphasized the limitations to field of visions. Both Holmén and Murtovaara state that the fact that you have to exclude yourself from the environment is an disadvantage against the other platforms available. Teräs finds this also as a disadvantage, as in the current trend of sociability, the antisocial nature of HMD does not stand out as a positive factor. Ovaskainen adds to this other limitation, that if one wants to show the content to other people, more glasses are needed. In addition, Teräs mentions that the making of VR is expensive and time-consuming, and that it is hard to find proper workmanship.

As for hardware, Murtovaara evaluates that the HMD are still in the testing and the initial phase, both in appearance and the usage, which results into a bit clumsy use. Ovaskainen also mentions that the glasses work a bit different way than the eyes see naturally, as in blur of image when moving head, so the initial phase should be developed to offer more enjoyable and realistic experience. The more specific technological weaknesses for HMD include, in Expert A’s opinion, design, size, and weight. Lampi emphasizes that the comfort and usability are not at the level so that HMD could be used in all conditions, for there is lots of cables and camera adjusting, and you have to reserve place for the activity. In addition, Teräs states that the resolution has been relatively poor in mobile devices, which has even prevented investments from the firms.

Continuing with the technological perspective, Murtovaara points out that connecting your phone to glasses already feels outdated in the field. She presents Bluetooth as a solution to make it more functional. In addition, Holmén regards the need for powerful computer to function as a disadvantage. Mobile displays offer an alternative without wires and need for powerful computer, but their performance is weaker and they also have the battery issues, as Lampi and Expert A state.

As to the software of the virtual reality, Murtovaara affirms that the glasses can cause nausea and dizziness to person trying it first time, although generally these feelings can go over after couple times of use. However, Expert A states that motion sickness is a notable feature in HMD. The one caused by devices has decreased, but the one caused by software still exists. He presents that some people just feel ill when there is virtual but not real movement, and Lampi affirms that for some the motion sickness is a great barrier for using VR. Still, Expert A acknowledges that with good hardware and suitable software, even the most sensitive people can use VR.

However, Lampi brings out that as virtual reality was developed technology first, the level of content is less than it ought to be. Ovaskainen agrees that there is no terribly good content for the VR currently. Expert A elaborates this with that VR does not yet have such a ‘’killer-app’’ that would boost the sales and pay back the invested money. Teräs states that VR material must be very intuitive, otherwise the person may not enjoy the experience and can even have negative feelings about it. Holmén also brings out the concern that there exists no thoroughly researched proof how the longer period of usage can affect the person. In addition, even though VR could be used as alternative platform for computers, Ovaskainen states that there has not yet been invented good ways of how VR would be better than the computers, for the use of VR is slower and tougher, as people are not yet accustomed to it. Lampi also mentions that with glasses you cannot really get anything from the VR experience, as they rarely fit inside the HMD.

Other disadvantages of virtual reality are actually the hype around it, and also the competition, primarily AR. Lampi states that the huge hype is actually the biggest disadvantage, for it is

usually marketed as the best solution for a problem, which it often is not. He elaborates that often the developers should focus on the context, the need, and what value VR brings to it. In addition, if HMD does not meet the expectations, in either consumer or business market, the virtual industry may experience breakdown. The disappointment can be caused by many variables, such as the unanticipated consumption of time, or simply, if the initial experience is not as immersive as marketed, which can be the case with cheaper HMDs. In addition, the competition in the virtual field will most likely increase in the future, as Expert A predicts that AR will develop over VR in 5 to 10 years. AR is seen as more feasible in different functions by many interviewees, especially as it can even be a substitute for a smartphone. but Lampi also states that it depends on the development of technology how the roles of the two realities will distribute.

4.3. Possible Industries and Functions to Benefit from HMD

The range of ideas to implement virtual reality into business is very wide in both the brainstorming sessions, and the interviews. The brainstorming sessions included for example medical field in many aspects, such with therapeutic purposes, as in rehabilitation applications, and to help to tolerate to phobias e.g. In addition, the opportunity to create 3D-models of the human body was presented, as well as doctors practicing realistic situations in medical school and in the work life. Other applications of training were simulators, such as in driving school, and in general no restrictions to training in simulated environments were raised. A more business related view for this was the viewpoint of middleman companies, which specialize in training employees for corporations. These could utilize VR for its wide content, and offer whatever training is needed. In addition, managers could familiarize themselves on the field-of-work, and practice for possible crisis situations.

Virtual reality was also seen to affect entertainment industry outside gaming, by for example establishing new kind of escape rooms, and offering amusement simulators, like flying. Furthermore, a way to participate in concerts while staying at home was presented, as with content filmed with 360-degrees live. VR was also proposed to offer more interactive running

simulators for example in the treadmill, which could also spark interest for exercising if it was lacking before, for the focus would be more on the virtual environment.

Functions more closely linked to working inside the industry were in design and architecture. It was acknowledged that any sector requiring 3D-modeling, such as the building, architecture, and real-estate industries, could benefit very much from VR-technology. Reasons behind this were that it offers multiple points of view and an insight on how the final layout would look like. The opportunity to allow customers to experience the house before building it, affecting the décor and elements in it while going to the virtual world, was seen as powerful way to engage customers into buying the final product. This is a part of marketing, to which other approaches were also presented, such as interactive brand storytelling and advertisements, and for example in retailing making people see the possible clothes on themselves. The chance to review the travel destination was also mentioned a couple of times.

The scope of ideas for interviews reflect both the interviewees sectors and personal interest, giving a variety of examples. For example, Ovaskainen presents how actually all the programs in normal computer can be replaced with VR, essentially meaning that multiple windows could be replaced with one wide screen, inside the headset. This basically means having head-mounted glasses as a new platform for accessing different types of programs. Holmén also comments on the function of environmental perception, as currently the pictures taken for surgeries are viewed from three screens, they could be shown in the virtual reality, where the place of what to study more can be viewed more intuitively and from many perspectives.

Furthermore, the teaching and training function is mentioned in all six interviews. Regarding medical field, Murtovaara presents the use of VR in teaching for example for surgeries, Holmén proposes giving rehabilitating and physiotherapy instructions at home, acting as effective distance consultation. Lampi also mentions the distance care, especially when combining motion detection with it, as to provide more personalized service, for example in rehabilitation. Ovaskainen emphasizes that virtual environment would work in teaching much better than any other platform, for it is easy to build the simulation, and you do not need to have the physical tools etc. to practice it, such as in assembling a motor. Lampi and Expert A likewise believe

that training is the field which will benefit the most from the use of VR; Lampi sees that the ability to produce realistic virtual environments and simulate different scenarios are behind this development. Expert A regards that especially when expensive devices or dangerous situations are considered, VR will continue to be used and developed there. Teräs also states that VR has in any field's training use a big potential, giving examples of Armed Forces' refresher courses, part of driving school becoming virtual, and virtual manuals of complex household machines.

Other possible uses for virtual reality are demonstrations of products and design. Teräs offers an example how Finnair displays their long-distance flights, as in what kind of travelling experience you get with new airplane. Lampi also acknowledges the industries which make big projects, such as physical buildings or ships, and how the demonstration of those products can have tangible benefits. Expert A tells an example of how visual prototypes could be done for example of cars, which would be cheaper than the current custom of using clay. He also mentions the retail industry, as with virtual shops, in which you can inspect the product and make the purchase decision virtually. This is already used in some level in house showings, but could be used in house buying with telepresence. However, Lampi recognizes that currently VR is mostly used with experiments, but as the use will expand in the future, the use of HMD will be for the value it creates, not for the fun of it.

As for telepresence, both Expert A and Lampi mention holding meetings in virtual space: Lampi proposes an example of holding the meeting in the designed place, as to demonstrate the decision makers how the result would look like. Expert A divines that social VR is going to be a big thing, and an example of this is the virtual meeting. Murtovaara combines also social media aspect in how tourism industry could utilize VR in presenting hotel rooms and other hotel facilities: as camera technique and phone applications develop enough, shareable virtual immersive travel videos to friends could be executed. Both Expert A and Lampi also see that entertainment industry outside gaming could have applications of VR, such as with VR-films, or serious games, as in teaching and such.

In general, the range of possible industries and functions that could utilize virtual reality is wide, from entertainment to training, and from marketing to design. In a sense, these comments and visions represent a demand, as virtual reality is seen to improve the subjects discussed above. The supply itself is not right now as great (See section 4.1.), but is growing constantly, even more when the demand for more intuitive and realistic experiences increases.

4.4. The Scale of Value HMD Can Bring in the Future Perspective

For evaluating how much value HMD can bring to the industries, the prospects of virtual reality are evaluated. The average opinion in brainstorming sessions was that virtual reality is in rise, and will develop more in the future and thus become more prevalent platform in everyday life. However, some opinions remained skeptical of virtual reality, such as it should not be mixed with working or studying in a large scale, and should more focus on the gaming industry.

In general, the interviewees did not report this strong level of hindrance to virtual reality, but multiple other factors were pointed out. Ovaskainen states, that as it is not yet known what are the effects of screen being so close to the eyes, the uncertainty can affect the attitudes of market. Holmén also has noticed that prejudices have an effect, so that it requires one brave person to experiment so that others dare to try also. One reason for this can be the newness of the technology and that people are not used to it yet, but Holmén states that as time goes by the practical benefits of virtual reality speak for themselves. Expert A has also experienced that some just do not want to use digital devices. Lampi in his experience has seen that the expectation around VR is often about entertainment, which is not surprising as games and such have been most visible in the market yet, which can decrease the interest to try other uses of VR.

Other factors for VR to consider to expand, are that the hardware should developed more to meet the demand as Expert A states, while Lampi emphasizes the role of developing the content. He also sees that the overflowing expectations are a hindrance, for they can deflate the rise even in its beginning if many disappointments arise. Teräs sees that the overall

subjective nature and the relative expensiveness of HMD can limit its future prevalence. Another hindrance for VR is the progressive development of AR, as Expert A states, and this may lead to that companies prefer to invest in that technology instead.

For short term development, a couple of years forward, Ovaskainen anticipates virtual reality to become a lot more common, if there is willingness to develop further. This seems likely, as large companies have started to invest in VR, as stated earlier. Expert A however suspects that there would be significant increase in the demand, as at the moment there is no superior app for VR in the consumer market, which would encourage people to buy it, and also rise the visibility of VR in other sectors. However, he does neither believe that the boom around virtual reality is just going to disappear, and at least in business-to-business there will be demand for it.

Software will also develop in the near future, mentioned by Holmén and Lampi. Ovaskainen also emphasizes that the problem currently lies more in the quality of the software, not that much in the hardware of virtual reality. Expert A supports this, as he concerns that consumers could abandon virtual reality for the lack of adequate content, and Lampi also sees the level of content as key issue for wide use. He emphasizes alongside that software should not be only focusing in quality, but it should also aim to answer the need of target group, for VR to be successful. As for the specific aspects where content would develop are the interactive environment, said by Holmén, and the overall game worlds and immersiveness, said by Lampi. All interviewees also see that the hardware will develop in the following years, starting from basic things such as better quality in screens, lighter devices, and improvement in the performance. Expert A mentions that the next version of Oculus Rift or Vive may come in two years, and certainly other manufactures will start to supply HMD. He sees that mainly the devices will develop, and not in any major way, but also that the HMD will experiment more features, and offer additional equipment, such as different motion controllers. In addition, the tracking of head position, especially in mobile HMD, and of facial expressions is regarded to improve.

As the device is prone to improve, the subsequent feature of decrease in price is present in the interview of Teräs. She states that this leads to consumers being more encouraged to buy the devices, and thus increase the sales. Lampi sees the improvement to as well rise the visibility and availability, increasing the demand, and thus the amount of knowledge of making VR would rise. Following this, the supply for adequate content would also rise. Teräs perceives the visibility in coming years to especially rise as companies increase their presence with virtual product introductions. Holmén furthermore emphasizes that awareness is a key issue for VR to become widely used.

As for the long-term development, Murtovaara and Lampi predict that head-mounted display will become even lighter and smaller, increasing the usability and thus visibility. Lampi accentuates the usability and the quality of experience, as he holds them as key factors for VR to succeed. Murtovaara also anticipates mobile HMD to operate without placing the phone in the device as a viewing screen, which is seen as essential if wanted to have a large audience using VR actively. She is positive that a version of Bluetooth-enabled contact lenses would be the best solution, if technically possible. In addition, Lampi mentions that the interaction to virtual environment is subject to great develop, for example via EGG sensors. Also, the feedback to the person is likely to improve, for example the haptic feedback. However, Expert A sees that the lack of haptic feedback is currently a big problem, as there is no simple solution to it even in long distance.

Even though the competition against virtual reality is not as high currently, in the long distance this is seen to change. Expert A particularly supports this, as he states that AR will become the bigger player in around 5 to 10 years, fitting many fields where VR would be used, which Holmén as well acknowledges. The advantages against virtual reality are that it can be applied more easily to everyday use, as it shows the real world, what Holmén also mention. However, the sectors for both AR and VR can differentiate from each other, especially if AR technology does not develop significantly, while VR improves. Lampi mentions that AR would work better in customer service and repairing, as it provides additional information, and VR would fit simulations and such. Expert A and Holmen see that virtual reality would have a strong foothold in the entertainment industry, given that content is developed enough. They both mentioning

gaming industry, Expert A emphasizing the role of ‘’killer-app’’, which would spark the interest of consumers. In addition, Murtovaara mentions the film industry, and Expert A adds to this the promising perspective of porn industry: in both the immersiveness and authentic feeling add value to the experience. However, Lampi brings out the uncertainty surrounding the demand for VR in entertainment, and offers that bigger growth could be more part of the training and work, in the above discussed examples.

In general, many of the interviewees see that AR and VR will get mixed at some point in the future, as to Mixed Reality. This term simply includes the merging of virtual and real worlds, and can be regarded as umbrella term for both VR and AR. This could be achieved with one glasses, which would offer the primary functions of AR and VR, as in overlaying digital data to real life, but also being able to exclude the person’s viewpoint and creating a whole new environment. However, Teräs points out, that the legislation lags behind in the whole matter of virtuality. For example, majority of the industries’ legislations, and the Act do not yet recognize that physical learning can take place virtually. This is a major issue to be recognized, as the lack of this admission can greatly limit the prevalence of mixed reality.

As a conclusion, there seems to be a few restrictions for virtual reality to become commonly used platform, such as negative attitudes, overwhelming expectations, and rising competition. In short-term VR development would be in the basics, such as in the quality of content and level of device usability. The development of software is emphasized, but there will also be new and better devices coming to the market. In overall, as the visibility increases, the demand is subject to rise, but not likely in great levels. In the long-term VR is seen to develop even more, but also AR will rise as its serious competitor. AR will likely take market share from VR, but they will also have different functions. They can also get mixed, and thus all functions could be achieved with one glasses. However, as the legislation lags behind, the utilization can decrease to what it could be at best.

5. **DISCUSSION AND ANALYSIS**

The three research questions (See section 1.3.) present a way to see the prominence of virtual reality in business setting. The gathered information from brainstorming and interviews are further discussed below, in order to find answers to the questions.

5.1. The Most Notable Advantages and Disadvantages of Virtual Reality

The noteworthy advantages and disadvantages are also the ones, that differentiate virtual reality as a platform most from the others. The core advantage which virtual reality possesses is the immersiveness, which allows it to offer a whole new dimension to the task at hand. This is a primary trait for virtual reality also in that sense, that it substitutes closely to the real experience, which makes the results evoke stronger experiences than that of 2D, and for example training comparable to real life. The virtual environment itself is not as unique an advantage, for computers can reach the same level of customization, but more importantly the three-dimensional perception, which virtual reality offers to perceive the customizable environment and interact naturally in it, is an exclusive trait for the platform. The recent breakthrough for virtual reality can be found in the decrease in price and increase in quality, which made it available and appealing to the vast market of private consumers. Due to this, and the continuing development, and in general the awareness and hype around VR, it also has currently an edge against other new technologies, such as AR.

As for the disadvantages, the most notable one is the one also used to gain the immersion: the fact that you must exclude yourself from the environment. This differentiates it from other platforms, and as it also enhances the immersion, it can also cause accidents etc. for not seeing around. In addition, the caused antisocial nature does not fit the current trend of sociability, as also the sharing of content without multiple glasses is difficult. Another disadvantage leading from the immersion is the motion sickness, mainly caused by virtual movement in the software, when in reality there is none. For some people this can be a major barrier for using HMD. However, this feature can be developed, but it shows that currently the technological problems

of VR are notable. As virtual reality is a novelty and thus the development has not refined it to its best form yet, there is clumsiness in hardware, in both appearance and the usability. For example, the size and weight of it are cumbersome in long use, and also the presence of cables decrease the enjoyment. In addition, the resolution of the screen is not the best, and mobile HMDs requiring physical phone already are regarded outdated.

As there is clumsiness in hardware, also software lacks in quality. Not only that, it is also expensive to make and currently the skill needed for making is hard to find. In addition, to reach the immersion advantage, it must be very intuitive, otherwise negative feelings, as embarrassment or disappointment can evoke. Amongst all the hype around VR, these experiences can decrease its desirability, which gives more competitivity to AR, which is also seen to develop over VR in long term. The last disadvantage is the lack of thorough research of the medical effects of virtual reality, as in what this new short distance away from the screen can affect. In addition, the mental effects of the content are neither widely tested, and as the production of the software is not widely regulated, the worst cases may still to be seen.

5.2. Industries and Functions Benefitting the Most from Virtual Reality

The industries and functions best benefitting from virtual reality are difficult in a sense to evaluate, for the platform is a novelty and the feasibility is yet to be seen. However, some can be evaluated based on previously analyzed advantages and disadvantages, by seeing which would benefit the most from those traits compared to current situation. The function where virtual reality could be most utilized is training and teaching, for the results acquired in simulations represent those of real-life. An additional positive factor for this is that the tools needed in reality to perform the task, such as hammer and knife, are not needed for the usage of hand- and other trackers. This could be utilized in many industries, such as medical and driving school, but in general more value can be added as VR allows to practice actions which would be hazardous in real life or involve expensive devices, such as mining environments and evaluating mistakes in surgery.

The second function would be design, for the multiple viewpoints-approach suits it better than the currently used two-dimensional screens. In addition, the recent inclusion in the form of hand- and other trackers increase the possibility to design inside the virtual experience, allowing more intuitive approach to it. This improvement would most benefit the building industry, for the design could be adjusted in a realistic environment, and it could also be showed to multiple different people to gain insight on the matter and furthermore improve the blueprint. In addition, as the presence in the virtuality improves, also telepresence meetings could be held.

The third function to be enhanced via virtual reality is marketing and retail, both in business-to-business and business-to-consumers. An example is shown above in showing blueprint how the product looks like, but this time to investors e.g. who would be interested. Likewise, the demonstrations of new products could be in the new dimension, as clay model etc. would not be needed anymore. In addition, business-to-consumers approach could be used while showing the house still in construction to possible buyers in real estate business, where consumers could decorate the home to their taste and see how it fits their needs. Virtual reality also offers an engaging approach for marketing, as do advertisements and brand storytelling, which with interactivity can offer consumers a closer relationship to the company than before. In addition, especially travel industry would benefit from this, as the most important aspects of the destination can be reviewed beforehand, such as the hotel, beach or tourist attractions. Other business-to-consumers function could be entertainment outside gaming, such as virtual movies and ‘’serious games’’, such as treadmill running applications or teaching in general.

5.3. Future Value of Virtual Reality

Even though virtual reality has unique traits, and promising industries and functions to be implemented in, the investments are not worth doing if VR cannot provide value in both short- and long-term. In general, virtual reality does face some hindrances to spread widely, such as prejudices regarding the use, or in general towards digital devices. These are subject to change, as the benefits start to speak for themselves, and as there are influential people to lead

the way by experiencing VR. In addition, the overflowing expectation surrounding VR can lead to disappointments, which can deflate the sales. Also some people may want to stay aside and wait for augmented reality to develop better, as some perceive it as the one to develop over VR.

In the short term, the hardware and software of head-mounted display is expected to improve, price to decrease, and supply of knowledge to grow. Alongside those the visibility is subject to grow, leading to increase in demand. The emphasis should be on the content especially, for right now it does not reach the level of development which hardware has. The content is also important for it facilitates the most unique trait of virtual reality, the immersion. However, major development in the field is not expected, more it is going to focus on basic matters, such as better quality in the content and lighter devices. In addition, Oculus and other major players are expected to come up with new devices, with better functionality and new experimental features.

For the long-term view of virtual reality, the technology keeps on advancing, probably improving the head-mounted display to smaller and lighter versions, still enclosing the field of vision but increasing the usability and the quality of experience. In addition, the immersiveness is likely to improve, as the interaction to the virtual environment may develop, as now the lack of haptic feedback is a major problem for the full immersion cannot be reached fully without it. Another long-term factor for the value of virtual reality is the increasing competition, especially from augmented reality. Even though augmented reality is not right now as developed as virtual reality, it most likely will develop to at least same level as technologies improve. It is not yet sure how, and if, the platform would differentiate from each other, but both have unique advantages to answer different needs. AR would provide additional information in everyday life, and VR would offer a new environment to implement actions in.

Nevertheless, it is highly likely that the both realities will get mixed at some point in the future, as to Mixed reality, and thus e.g. with one glasses both functions could be utilized. However, the lagging legislation is a major issue to be recognized in this matter, as if it does not recognize the virtual training etc. as substitute to physical training, many of the functions mentioned above face limitations of usage.

6. **CONCLUSIONS**

This section summarizes the main findings gathered from the data and the main points from the Discussion, and provides an overview of the key aspects to be considered in International Business and the business developing virtual reality. In addition, suggestions are made for further research .

6.1. Main Findings

The main findings revolve around the three research questions. To begin with, the first most notable advantage of virtual reality is its immersiveness, and thus the ability to substitute closely the real life. Second is the three-dimensional perception which VR offers, and thus multiple viewpoints which are not attained in current two-dimensional screens. The last discussed advantage is that currently HMD are available to all target groups and in all price categories, which was created by decrease in price and increase in quality. For the disadvantages, first is the drawback of immersion, the required exclusion from the environment, which increases the risk of damage to the environment and decreases the social side of VR. The second disadvantage is the current level of technology, for the hardware is only in its initial state and thus a bit clumsy to use, and software does not support full immersion in its current state. These can underwhelm the experience, and thus affect demand negatively. This is especially due to another disadvantage, the overwhelming expectations around VR. In addition, the virtual reality induced symptoms, especially motion sickness, can prohibit people from using HMD. Similar drawback is that this aspect has not been studied publicly, for example the long-term use or possible mental effects, and negative occurrences may also affect negatively the demand. The last disadvantage is the rising role of AR, and the uncertainty around how the roles will distribute in the future between these two technologies.

As for the most likely industries and functions to benefit from virtual reality's traits, first discussed is the training function, for the simulations can substitute the real experience, and as it provides a new environment, it can be basically applied to any kind of teaching. It neither

requires tools to be used, and is of most value in situations where practicing in real setting would be too hazardous or the device too expensive. Sectors to utilize from this would range from medical field to army's refresher courses. The second aspect is the design function and demonstrations of products, which derives from the multiple viewpoint characteristic. This can be used in the building industry, for example allowing the cut of costs when doing it in virtuality instead of e.g. clay. The third function is marketing, in both B2B- and B2C-settings, by offering interactive approach to both consumers and shareholders, for example with effective advertisements or simply by demonstrating the good. Sectors using this would be retail and travel industry, for example with house showings and advertising the destinations.

The future value of virtual reality seems promising, but it also has some hindrances to be assessed, for to spread widely. These are the prejudices around both VR and in general digital devices, and the overflowing expectations that can lead to disappointments and thus affect sales more negatively. In addition, AR is suspected to increase its role in the field, which can hold some shareholders from investing to VR. In the short-distance the technology will most likely develop in basic matters with new devices coming to the field, and the demand to keep growing steadily. For the long-distance the technology will answer the need for functionality and convenience factors. Also, the topic of augmented reality is important, and most likely in the future, when it has developed to same level as virtual reality, both will have their general applications to business, but in different functions. However, it is likely that they will mix together, resulting in one glasses providing the benefits of both. One major hindrance can affect the whole outcome, the legislation, as if it does not recognize virtual environment as substitute to real, then many of the applications can be delayed or cancelled from use.

Furthermore, by acknowledging the strengths and weaknesses of this novelty, suggesting sectors and functions to which it is most suitable, and analysing the prospects of it, this thesis contributes to the field by summarizing the scattered research, and utilizing both the ideas gathered from brainstorming, and the views of different experts, giving a report of the feasibility of VR.

6.2. Implications for Industries in International Business

As discussed in the previous sections, the advantages of virtual reality are unique, and in the long-run will overcome the disadvantages mostly revolving around the technical development. Multiple industries and functions are presented, where virtual reality can benefit international business, and increase efficiency and profitability. Even though augmented reality will likely develop to the level of virtual reality in the long term, the functions then will most likely differentiate to answer to their unique advantages. Moreover, the two technologies will most likely mix, and then benefits of both can be attained with one glasses. In addition, by implementing VR in the addressed functions in the short-term, notable benefits are already acquired.

6.3. Implications for Virtual Reality-Specific Business

Most of the prominent disadvantages for virtual reality can be fixed in the future by developing the technology of hardware and software. The clumsiness of hardware should be decreased to offer more enjoyable experience, and the software developed to present more interactive and immersive experience. Especially content should be improved, as to decrease the effect of disappointment by underwhelming experiences. Furthermore, the marketing around virtual reality should more focus on the need to be addressed, and not to offer VR as a general solution for problems. In addition, even though the hype revolves currently mainly around the entertainment industry, many other industries and functions would benefit from the use of virtual reality, in both B2B and B2C sectors.

6.4. Suggestions for Further Research

The limitations of this research are the scarcity of scholarly sources focusing on HMD, lack of proper focus group on consumer perspective, lack of global perspective, and the smallness of information provided on the role of augmented reality and other notable technologies. For more

accurate scholarly sources for this subject, more research concerning applications and examples of using e.g. Oculus Rift or another immersive HMD should be conducted. In addition, the consumer perspective could only be evaluated from small data, and for the further research a larger focus group could be used to gain information regarding the demand for VR. In addition, even though the secondary research has a global viewpoint, all the participants in brainstorming and interviews are Finnish, meaning that research revealing the global picture should be researched. Furthermore, the information on the possible competitive technologies which virtual reality may face in the future is lacking, and thus they need to be thoroughly compared in the future to distinguish more definitive traits and benefits.

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APPENDICES

Appendix A: Finnish Email Sent to Possible Interviewees

Arvoisa Haastateltava,

Olen Riia-Leena Wallin, ja opiskelen kansainvälistä liiketoimintaa Aalto-yliopiston kauppakorkeakoulun Mikkelin kampuksessa. Teen tällä hetkellä kandidaatintyötäni, jossa arvioin kuinka virtuaalitodellisuuslaseja voitaisiin käyttää eri toimialoilla ja yksiköissä tehokkuuden ja tulosten parantamiseksi. Haluaisin saada Teidän näkemyksenne seuraavalla sivulla oleviin kysymyksiin, joko vastaamalla kirjallisesti tai suullisesti (esim. Skypen kautta). Jos niin haluatte, haastattelussa käsitellyt asiat ovat luottamuksellisia, ja voitte esiintyä lopullisessa työssä anonyymisti.

Vaikka osa kysymyksistä vaikuttaisi laajoilta, toivon Teidän vastaavan niihin parhaimman tietonne mukaan, keskittyen mielestänne tärkeimpiin seikkoihin. Vastaan mielelläni, mikäli teillä on jotain kysyttävää tai kommentteja.

Ystävällisin terveisin,

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Virtuaalitodellisuus (Virtual reality, VR): teknisesti luotu immersiivinen ympäristö, missä osanottajat kokevat olevansa osa simuloitua maailmaa, ja voivat intuitiivisesti vuorovaikuttaa ympäristöön. Immersio luodaan virtuaalitodellisuuslaseilla, esimerkiksi Oculus Rift-laseilla.

1. Mitkä ominaisuudet mielestänne erottavat edellä kuvatun virtuaalitodellisuuden muista teknologisista alustoista, kuten lisätystä todellisuudesta (AR) ja tietokoneiden näytöistä?
    a. Mitkä ovat erityisiä vahvuuksia?
    b. Mitkä heikkouksia?
2. Onko Teidän mielestänne virtuaalitodellisuudella merkittäviä esim. teknologisia tai asenteista riippuvia esteitä tulla laajalti käytetyksi eri toimialoilla?
3. Oletteko nähneet virtuaalitodellisuutta käytettävän pelialan ulkopuolella?
    a. Jos kyllä, miten?
4. Edelliseen kysymykseen lisäten, millä tavoilla voisitte kuvitella virtuaalitodellisuutta käytettävän pelialan ulkopuolella?
5. Kuinka kuvailisitte virtuaalitodellisuuden merkittävimpiä kehitysaskeleita viimeisten viiden vuoden aikana?
6. Kuinka näette virtuaalitodellisuuden kehittyvän lyhyellä aikavälillä, noin yhden ja kahden vuoden aikana?
7. Mitä arvioisitte tapahtuvan virtuaalitodellisuudelle pitkällä aikavälillä?
8. Onko Teillä jotain muuta lisättävää aiheeseen?

9. Sukupuoli: Mies / Nainen / Muu
10. Ikä:
11. Kansalaisuus:
12. Toimiala:

Appendix B: English Email Sent to Possible Interviewees

Dear Interviewee,

My name is Riia-Leena Wallin, and I study International Business at Aalto University School of Business, Mikkeli campus. I am currently working on my Bachelor's thesis, in which I evaluate how virtual reality, used with head mounted display, can be used to increase efficiency and profitability in different industries and functions. I would like to have your insight on the following questions presented, either by answering them written or verbally (with Skype e.g.). If you wish, the interview will be kept confidential, and you will remain anonymous in the final work.

Even if some of the questions may seem broad, I wish you could answer them according to your best knowledge, focusing on the things you find most important. I will be pleased to answer to any questions or concerns.

Yours sincerely,

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Definition of virtual reality (VR): computer-generated immersive surroundings where participants feel like they are part of the simulated world and can interact intuitively with on-screen objects, achieved with head-mounted display, such as the Oculus Rift.

1. In your opinion, which attributes of VR, as described earlier, differentiate it from other technological platforms, such as augmented reality and computer screens?
    a. What are the strengths?
    b. What are the weaknesses?
2. Would you think that there are notable technological/prejudicial/etc. obstacles for VR to become widely used in different industries?
3. Have you seen VR being used outside gaming industry?
    a. If yes, how?
4. In addition to the previous question, which ways would you imagine VR being used in industries outside gaming?
5. How would you describe the major developments of VR in the past five years?
6. How do you perceive the future development of VR in a relatively short term (one to two years)?
7. What would you estimate to happen to VR in the long term?
8. Do you have anything else to add to the topic?

9. Gender: Man / Woman / Other
10. Age:
11. Nationality:
12. Industry in which working:

Appendix C: The Questions Asked in the Written Format of Brainstorming

1. Miltä VR sinusta vaikuttaa? (Olettaen, että katsoit esimerkkivideon)

2. Miten VR olisi voinut auttaa sinua eri tilanteissa aiemmin? (Uusi työpaikka, informaation etsintä..)

3. Millä aloilla olet kuullut käytettävän VR:ää, ja miten?

4. Mille aloille voisit kuvitella sen sopivan, ja miksi? Jos opiskelet tai tunnet jotain alaa, esimerkit suositeltavia!

5. Muita kommentteja/pohdintoja/kysymyksiä

In English:

1. How does VR seem like to you? (Presuming, that you watched the example video)

2. How would VR had helped you in different situations before? (New workplace, searching for information...)

3. In which fields have you heard of VR to be used, and how?

4. To which fields could you imagine it to be suitable, and why? If you study or know some sector, examples are recommended!

5. Other comments/thoughts/questions