

**ENHANCING TOURISM WITH
AUGMENTED AND VIRTUAL REALITY**



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Sandra Jenny

Degree Programme in Business Information Technology
Visamäki – Hämeenlinna – Finland

Author	Sandra Jenny	Year 2017
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Supervisor	Lasse Seppänen	

ABSTRACT

Augmented and virtual reality are on the advance. In the last twelve months, several interesting devices have entered the market. Since tourism is one of the fastest growing economic sectors in the world and has become one of the major players in international commerce, the aim of this thesis was to examine how tourism could be enhanced with augmented and virtual reality. The differences and functional principles of augmented and virtual reality were investigated, general uses were described and devices were examined, compared and selected. Interviews with travel experts combined with examination and trials of augmented and virtual reality applications, at the biggest travel fair in northern Europe, were done to investigate today's potential usage of AR/VR in tourism. The critical part states the appropriate devices to enhance tourism with its reasoning's. By reference to these findings, a business case was developed, the case study was specified and a suitable business model was designed. As the tourism market was considered a mass market and many people already own their own smartphones, the devices Samsung Gear VR, Google Cardboard or just a smartphone are recommended to enhance tourism with AR/VR. On that basis, the business idea JOIN THE VALK was created, a travel app which embraces the advantages of AR and VR. It guides the tourist with AR and provides information with AR, VR and audio. Furthermore, it provides riddles to get rewards like reduction on entrance fees for museums or discounts in restaurants. The app also helps to recognise other customers in the AR mode to meet and share recommendations or just improve language skills. This thesis is aimed at people who are interested in starting up a new business in the sector of tourism and travel using augmented and virtual reality.

Keywords Tourism, augmented reality, virtual reality

Pages 47 pages including appendices 7 pages

LIST OF ABBREVIATIONS

AR	Augmented Reality
GDP	Gross Domestic Product
fps	Frames per second
GPS	Global Positioning System
GPU	Graphics processing unit
HD	High definition
HMD	Head-mounted display
IPD	Interpupillary distance
PTSD	posttraumatic stress disorder
UNWTO	World Tourism Organisation
VR	Virtual Reality
WTTC	World Travel & Tourism Council

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1 INTRODUCTION

Tourism is one of the fastest growing economic sectors in the world. There certainly is a special fascination about traveling. Many facets explain this spell; discovering new places, tasting new food or drinks, learning about inspiring cultures and customs, getting to know about fauna and flora of a region, meeting people from all over the world, becoming acquainted with thrilling history and culture, listening to an enthralling foreign language, experiencing different climates and weather, marvelling at creative and diverse fashion, discovering foreign art, enjoying festivals and cultural events and last but not least indulging in a relaxing and amusing time.

Imagine adding to this joy with future-oriented technology by simplifying traveling aspects and enabling tourists to explore and experience more than is currently possible. Augmented and virtual reality technologies are advancing and several use cases could be of great interest within the tourism sector, for example:

- Showing the attraction at a different season (e.g. in winter time)
- Presenting the attraction from a different perspective (e.g. from an aerial view)
- Depicting buildings, rooms etc. which are not accessible
- Virtually rebuilding historic places (e.g. the Colosseum in Rome)
- Presenting a specific scenario (e.g. a battle)
- Offering further information (as text or audio)
- Guiding a tourist

Several goals shall be achieved in this thesis:

- Describe AR, VR and the differences between them
- Make an overview of relevant devices
- Point out general applications of AR/VR
- Examine and evaluate already implemented AR/VR technologies in tourism
- Create a case study for AR/VR in tourism

In this thesis, the efforts are focused on the following research questions:

- Which AR/VR technologies are suitable to enhance the tourism user experience?
- Which case study is appropriate to enhance tourism with AR/VR?
- Which business model is suitable for this case study?

2 RELEVANCE

“We all know that there’s no shortcut to success, and there’s no magic formula that can create the “perfect” startup, immune from the 90 percent death rate constantly looming over the heads of entrepreneurs. However, there’s one factor that rises above all others in importance: the timing of the business.” (DeMers, 2015)

Why enter the market now with the idea of AR/VR technologies? The idea of VR technologies is not new. In the beginning of the 1990s, virtual reality was already a big topic. Nintendo announced the first home VR system named virtual boy. Since they only had a few games available, lack of colour (only red and black) and the uncomfortable device, the consoles didn’t sell well. A few years passed without big news. Then in 2014 Oculus Rift put the topic of virtual reality back on the table, and companies around the world began to build their own VR headsets. Since spring 2016 several interesting products have been release and have now started to be produced in mass circulation. (Brown, 2017)

Virtual reality and augmented reality are an important topic. See the search statistic on web browser company Google (table 1).

Table 1 - Google search statistic (Google, 2017a) (Google, 2017b) (Google, 2017c)

Term	Hits on google
Virtual reality	341'000'000 hits
Augmented reality	26'600'000 hits
Kim Kardashian	52'100'000 hits

Combined, the terms AR and VR beat reality star Kim Kardashian - who is one of the most googled persons (McCluskey, 2015) - has seven times as much hits.

But as already stated, virtual reality is not a new topic and therefore could have had many hits in the past. Therefore, a google trend chart was created - from 01.01.2004 until 18.01.2017 (figure 1). The following chart shows that in Oktober 2015 the intrest of the topic virtual reality began to grow, until it reached a very high peak in December 2016. This shows that the sector is late-breaking.

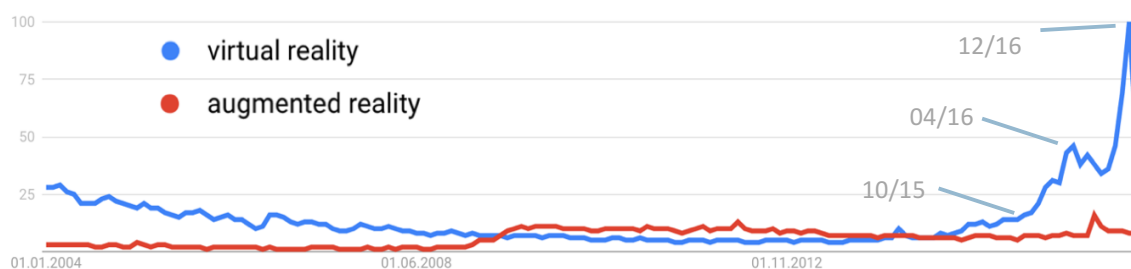


Figure 1 - Google trend – chronological trend of VR and AR (Google, 2017d)

The reason why to analyse AR/VR at this moment is because the crowd is now interested in these technologies. Furthermore, experts like Tim Merel (founder/CEO of Eyetouch Reality) - who are watching the market closely - state that the AR and VR are ready for the masses in 2017 (Merel, 2016). Merel also quotes AKQA founding Chairman Tom Bedecarre who said "New technology follows a familiar adoption curve, and it's easier to attract your first customers, innovators and early adopters. It's very hard to cross the chasm and attract the early majority and beyond".

Why of all possible market sectors choose the tourism market? According to the World Tourism Organisation UNWTO, nowadays the business volume of tourism matches or even exceeds that of automobiles, food products or oil exports. Tourism has become one of the major players in international commerce. One of the effects of the growth is an increasing diversification and competition between the destinations. (UNWTO, n.d.)

There is even more good news. The World Tourism Organisation UNWTO stated that tourism has shown extraordinary strength and resilience in the past few years and continues to grow strongly. So now, tourism is now one of the fastest growing economic sectors in the world. According to the latest UNWTO World Tourism Barometer, the international tourist arrival reached a total of 1'235 million, which was a growth of 3.9% or some 46 million more tourists (overnight visitors) compared to 2015. (Sobrinho, 2017) (UNWTO, n.d.)

But also from a longer-term perspective results are good. After the global financial crisis in 2009 there were seven years of sustained growth. This sequence of growth hasn't been seen since the 1960s. 2008 was the pre-crisis record for international tourist travellers. In 2016, 300 million more tourists travelled than in the record year 2008. The outlook for 2017 is also good: The UNWTO Panel of Experts and economic prospects expect an increase of 3% to 4% for international tourist arrivals worldwide. (Sobrinho, 2017)

Skift is a company which operates a business intelligence and marketing platform to provide insights to key sectors in travel. Rafat Ali and his team have extracted information from the Benchmarking Report 2015 from the World Travel & Tourism Council WTTC to compare travel and tourism to nine other sectors, which are comparable in expanse and global presence. They included 26 countries. Although the numbers are from 2014, figure 2 still shows that the travel and tourism gross domestic product (GDP) with around 2.4 trillion US dollars account for nearly 3.1 % of global GDP, and were even then larger than the automobile and chemical manufacturing industries. (Ali, 2015)










Industry	GDP (\$US billions)	% of Global GDP
 Automotive Manufacturing	\$914	1.2%
 Chemicals Manufacturing	\$1,590	2.1%
 Travel & Tourism	\$2,365	3.1%
 Banking	\$2,436	3.2%
 Education	\$2,605	3.4%
 Agriculture	\$3,111	4.0%
 Mining	\$3,897	5.1%
 Retail (without wholesale)	\$4,261	5.5%
 Financial Services	\$4,796	6.2%
Total	\$77,085	100%

Figure 2 - 2014 GDP comparison of eight different sectors (Ali, 2015)

On the basis of the Oxford Economics global industry model a forecast by industry was established (figure 3) which projects the travel and tourism GDP will grow 3.9 % per year from 2015 to 2025 (Ali, 2015).

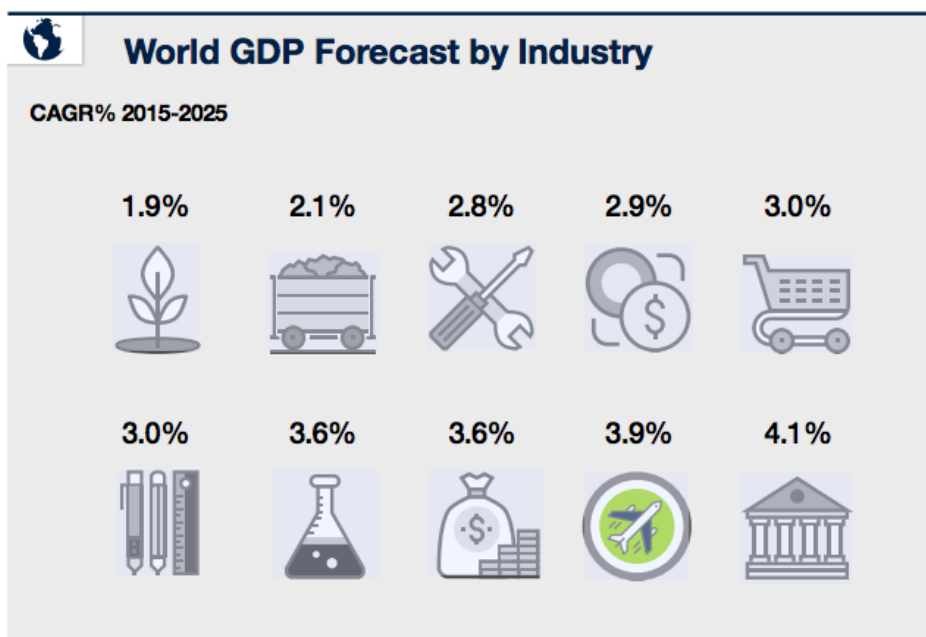


Figure 3 - World GDP forecast by industry for 2015 - 2025 (Ali, 2015)

To look deeper into the travel market, the largest spenders in international tourism globally were registered. Table 2 lists the top ten source markets during the first nine months of 2016.

Table 2 - Top 10 source markets 2016 (Sobrino, 2016)

Ranking	Country	Growth in spending
1	China	+19%
2	United States	+9%
3	Germany	+5%
4	United Kingdom	+10%
5	France	+3%
6	Australia	+9%
7	Republic of Korea	+9%
8	Italy	+3%
9	Russian Federation	-37%
10	Canada	-2%

To show the coherence between the top spenders in tourism and interested people in AR/VR technologies, the figures 4 and 5 illustrate which regions are showing the greatest interest in AR and VR technologies. The graphics are based on google trends, which analyses the interest by hits. The more people are interested in the topic of AR or VR, the darker the colour of the country. Because the interest in the topic began to grow in the beginning of November in 2014, the chosen time range is from 01.11.2014 to 17.01.2017.

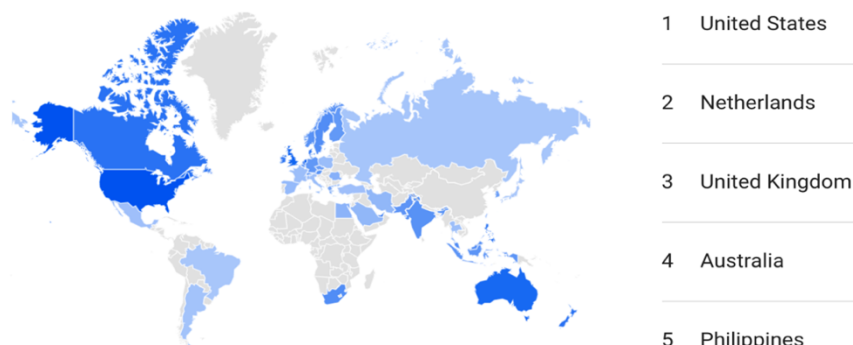


Figure 4 - Interest by region - virtual reality (Google, 2017d)

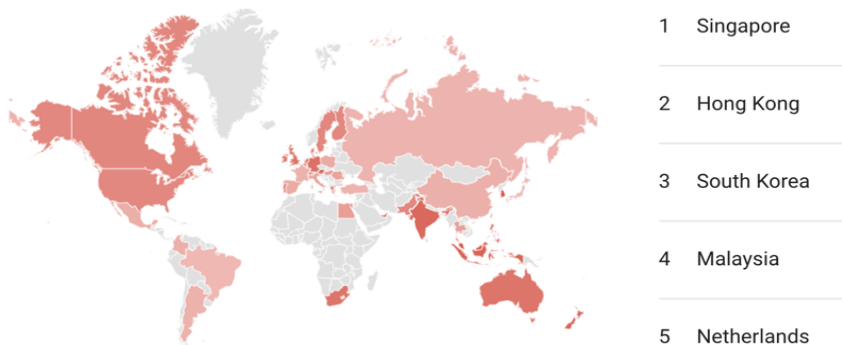


Figure 5 - Interest by region - augmented reality (Google, 2017d)

As the figures reveal, all the top ten tourism source markets show some interest in AR/VR technologies. The United States, the United Kingdom, Australia and South Korea are in the top ten tourist source markets (table 2) and in the top five of interested regions for virtual or augmented reality (figure 4 and 5). Figure 6 shows the coherence between this information.

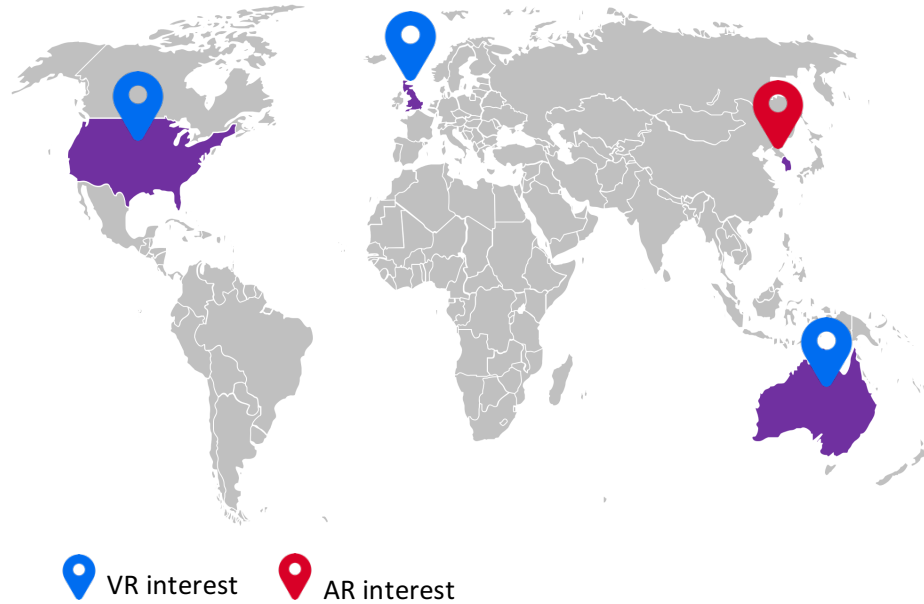


Figure 6 - Coherence between top 5 interest by region and top 10 source markets 2016

3 VIRTUAL AND AUGMENTED REALITY

This chapter aims to describe virtual reality and augmented reality, emphasizes the differences between the two realities, states the functional principles and gives an overview of which AR/VR technologies are available on the market.

3.1 Virtual reality

The goal is to immerse the user in an emulated reality – a version of reality that isn't there, but should be perceived as real as possible. We perceive reality with our senses: smell, taste, touch, sight and hearing. But also, other sensory inputs like balance are important to create an immersive experience. To achieve a plausible virtual reality, our senses are presented with a three-dimensional virtual environment. The more senses are addressed, the better the immersive real life simulation. To experience virtual reality, the user wears a head-mounted display (HMD). Headphones provide sound effects and cancel unwanted ambient sound. Handheld controllers, motion trackers on objects and sensors allow the user to become part of the virtual world and enable interaction like manipulating objects or performing a series of actions. Products like FEELREAL take it even further – FEELREAL created a mask which adds wind flow, hot air, vibration, water mist, and odor to the virtual experience. (Virtual Reality Society, 2016) (FEELREAL, n.d.)

There is also the problem of the definition of VR. It is possible to watch a 360 degree video of a real-world scene which was shot with cameras filming every direction at the same time. The terminology of virtual reality is not clear enough and so it is said that 360° videos are not real VR, only computer-generated VR (CG VR) is real VR. But since the same HMDs are used and it is also about the total immersion of the user, it can be said that the 360° videos are just a further type of VR. (Foundry, n.d.)

3.2 Augmented reality

The physical environment is enhanced/overlaid in real-time with virtual elements, so that the real world is enriched with further information. This digital information can be text, images, video, sound or GPS data. The goal is to enhance what already exists. There are several different ways a user can experience AR: mobile devices like smartphones or tablets, head mounted displays, glasses, lenses or PCs/TVs connected with a webcam (Emspak, 2016) (Augment, n.d.)

There is also much debate about the definition because there is also the term *mix reality (MR)*. Since the distinction isn't clear enough yet and the terms are currently used interchangeably, mix reality will not be examined further, because the term AR is used more often. (Foundry, n.d.)

3.3 Differences between AR and VR

“Augmented and virtual reality have one big thing in common. They both have the remarkable ability to alter our perception of the world. Where they differ, is the perception of our presence.” (Ronzio, n.d.)

Table 3 aims to describe the differences between AR and VR and figure 7 depicts the differences between the physical, augmented and virtual reality.

Table 3 - AR versus VR

	Augmented reality	Virtual reality
Extent	Enhanced real life	Total immersion
Visual	User can see real world and virtual objects at the same time	Real world is blocked out; only digital world can be seen
Scene	The user is at the location of the experienced reality	The virtual experience can take the user anywhere
Field of view	Small field of view	Wide field of view, 360 degree view possible
Movement	The user can physically move in the environment	Only limited movement is possible
Weight of device	AR specs are quite light and comfortable and more likely to be wireless	VR HMD are quite heavy, some have cables

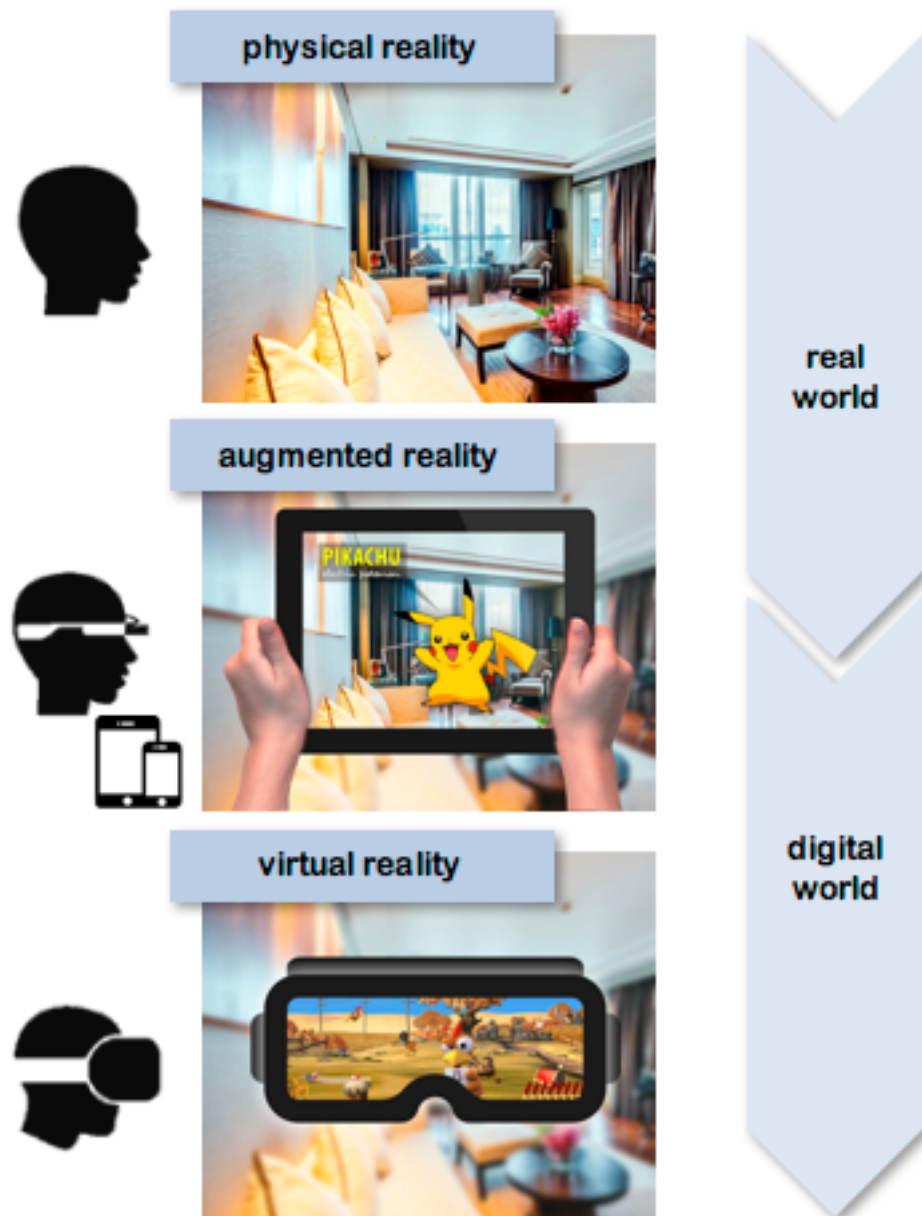


Figure 7 - Depiction physical/augmented/virtual reality (Eliáš, Z., 2017)

3.4 Functional principle AR/VR

This chapter describes what components are needed to operate AR/VR and states the functional principles of AR and VR.

3.4.1 Key components

AR and VR are complex entities with many different components (figure 8). There is the computing platform which is essential to power the applications with high-end CPUs and graphic cards. HMDs, tracking devices and control inputs allow to interact with AR/VR and to experience content like films, games or virtual objects.

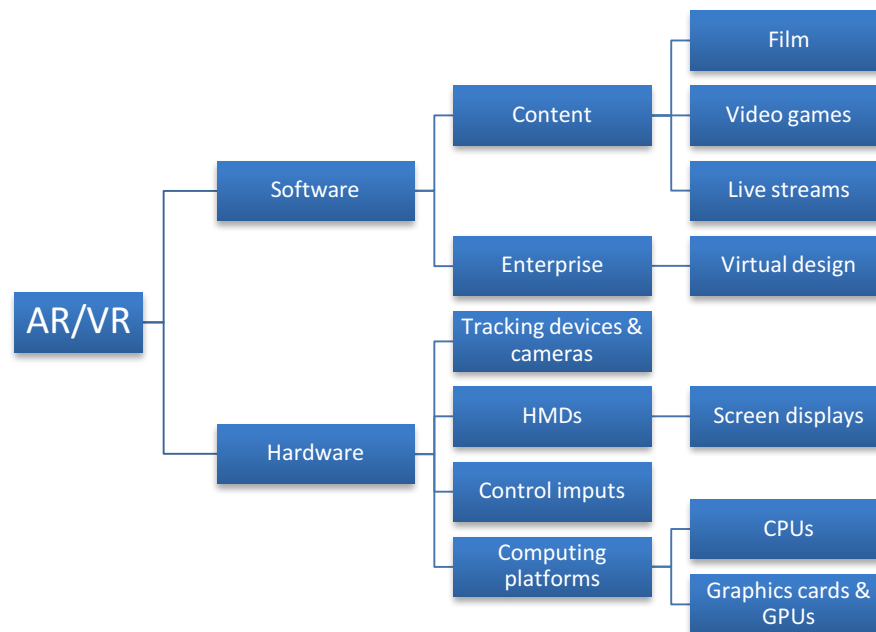


Figure 8 - AR/VR platform components (VR/AR Association, 2016)

3.4.2 VR functional principle

Figure 9 depicts the functional principles of VR with the included actuators, senses and devices. The aim of the hardware devices is to create a life size, 3D environment without the boundaries of TV or computer screens, so that the screen which is mounted to the face will follow the users to whichever direction they look. To achieve that, a HMD and a power source (PC, mobile device or video game console) are crucial. Additionally, inputs like head tracking, positional tracking, motion controllers, voice commands, on-device buttons or trackpads are needed to generate the VR experience. (Charara, 2017)

Head tracking means that the picture will shift to where the user is looking at. Gyroscope, accelerometer and a magnetometer are used to conduct head tracking, but there is also the positional tracking which tracks if the user is moving or leaning and moves or leans the virtual world with the action of the user. Motion controllers are the way to give the users virtual hands so the users can interact with the virtual world. These can be handheld devices or gloves with several sensors, trackpads and haptic feedback. Motion controller tracking devices can be placed on any real-world object (for example baseball bat, golf club, fake sword or guns) to bring these objects into the virtual world. Positional tracking systems are used to track the physical position of the user within a room through different sensors to enable the user to walk and move in the room and therefore also in the virtual world. Room scale boundaries prevent that the users bump into a wall or other obstacles. A virtual wall or a boundary line will signal the edge of the designated moving space. (Charara, 2017) (Shanklin, 2016)

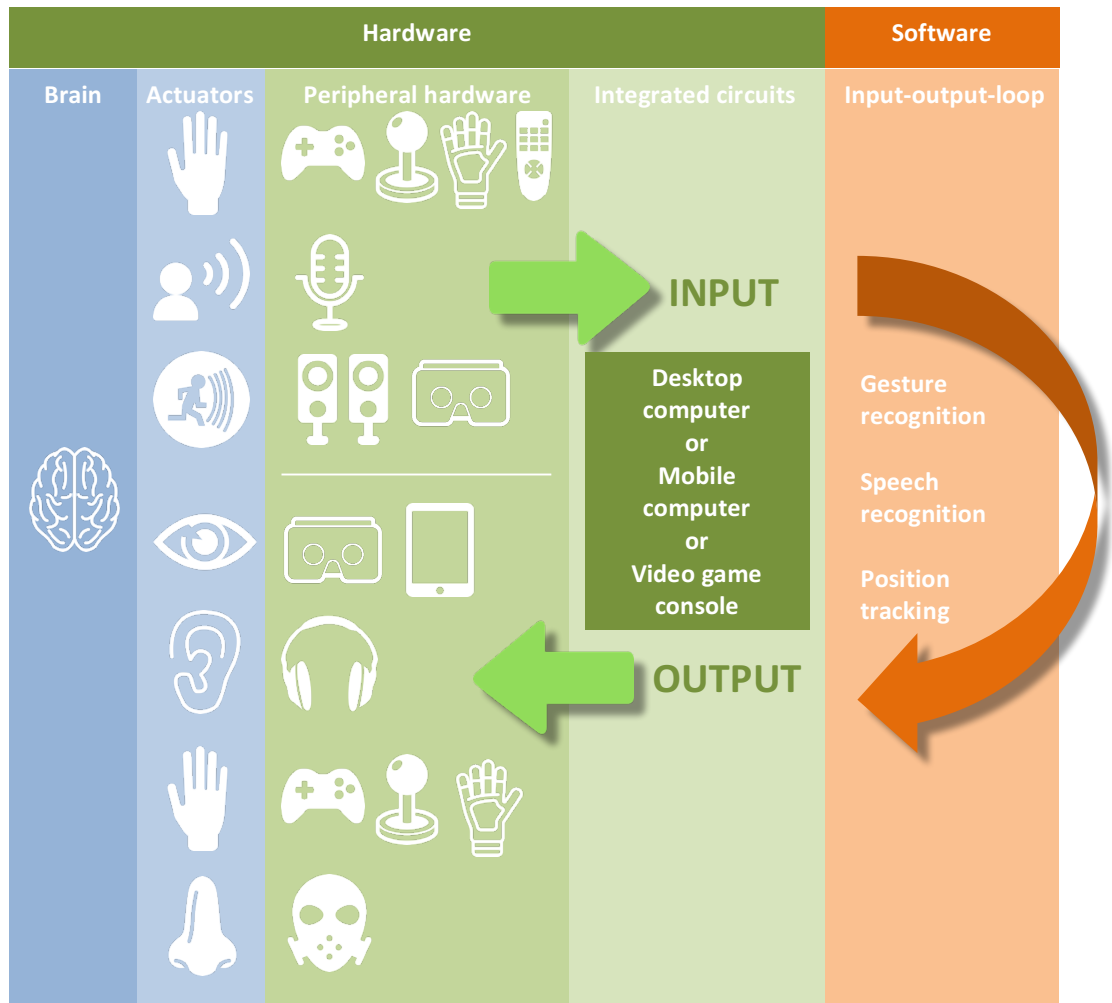


Figure 9 - VR functional principle (Traian, 2014)

VR needs these different inputs that are triggered by different actuators: speech, movement or handling a controller. Different peripheral hardware pick these inputs up and send them to the base station. This can be a desktop computer, a mobile computer (smartphone or tablet) or a video game console. The software responsible for the input-output-loop processes the different data sources and delivers visual, audio, haptic or even scent output to trick the brain into thinking that the user is in another world.

3.4.3 AR functional principle

Generally, there are two basic steps to generate AR: detection and overlay. First the camera needs to detect the object or reference point which indicates that AR should be applied. In a second step the virtual content will be overlaid on the camera feed according to the detected reference point(s). (Parker, n.d.)

Normal information needs to be triggered manually. The advantage of AR information is that the information is displayed automatically. But therefore, the AR device needs to know where the users are and what they

are looking at. The detection problem is known as tracking and can be split in two categories: marker-based and markerless. Marker-based systems use physical-world symbols as a reference point. These can be two-dimensional printed markers like barcodes or data-matrix codes which the user can scan with the camera so the computer can interpret the symbol and overlay virtual objects or get positioning data without GPS. Markerless systems use a combination of GPS, compass and accelerometer to determine the position in the physical world, the way the device is pointing and on which axis the device is operating. The data gathered from these resources can be compared to a database to identify what the device is looking at and provide the appropriate information or graphics to be shown on the display. Figure 10 shows the functional principle of AR in process form. (Woodford, 2017) (Dale, 2010)

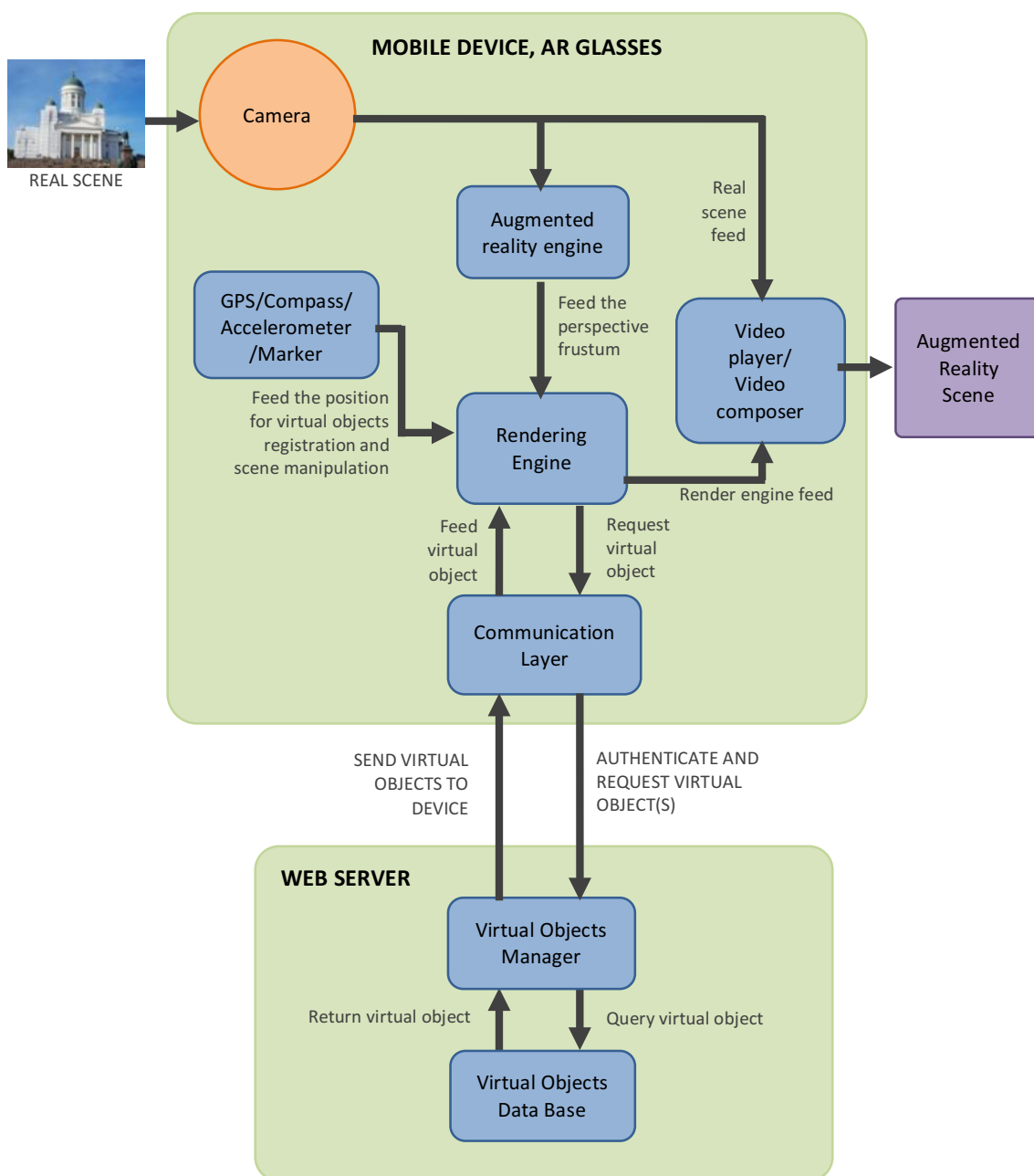


Figure 10 - AR function principle (Parker, n.d.)

3.5 VR devices

There are several VR products on the market. To present every product would go beyond the scope of this thesis. The reasons why certain products are included or excluded in the product description are stated. Four different devices will be presented.

3.5.1 Product selection

The PlayStation VR and the Daydream View weren't considered in this overview, since the PlayStation VR was developed for gaming experiences and is based on the PS4. The Daydream View wasn't included because it works only with five phones: Pixel, Pixel XL, Moto Z, Moto Z Droid and Moto Z Force Droid. Furthermore, the big players like Samsung or Apple weren't announced to be daydream-ready. Because there is no release date or price for the Huawei VR headset, this device wasn't considered either. (Google VR, n.d. a) (Hall & Betters, 2017)

To decide further which devices should be included in the abstract, a statistic about the worldwide sales of VR headsets was utilized (figure 11). Because the statistic for the actual sales in 2016 is not yet ready, the projected worldwide sales of VR headset for 2016 were used.

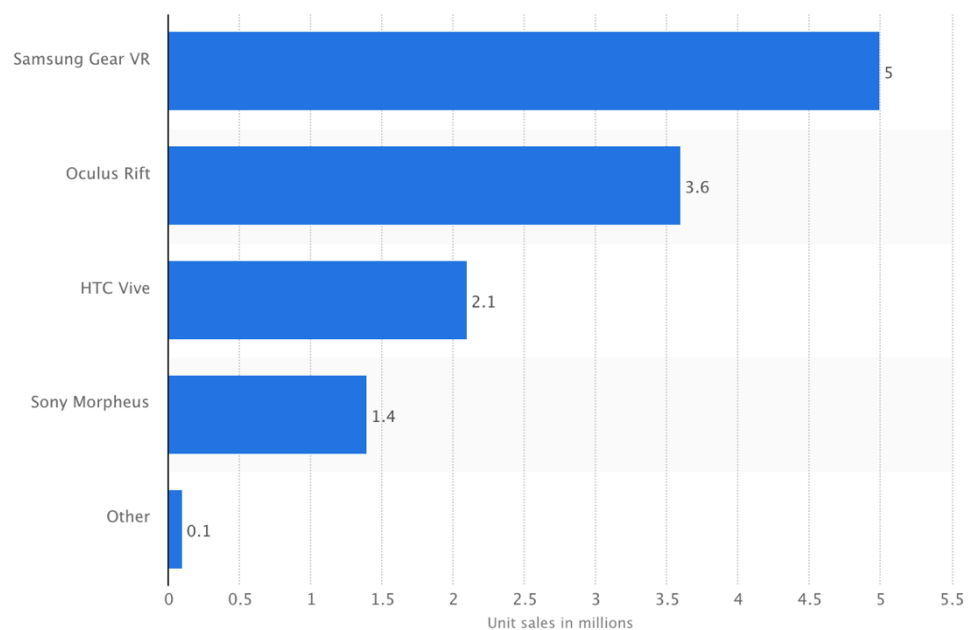


Figure 11 - Projected VR headsets unit sales worldwide in 2016 (in million), by device (Statista, n.d. a)

It is apparent that there are four big players: Samsung Gear VR, Oculus Rift, HTC Vive and Sony Morpheus. Project Morpheus was the codename of the PlayStation VR during development. This VR device was already excluded from the abstract due to an unsuitable field of application.





Based on several articles, currently the best VR devices were chosen. To get an overview from simple to high-end gear, the included VR products

are Google Cardboard, Samsung Gear VR, Oculus Rift and HTC Vive. (Greenwald, 2017) (Porter, 2016) (Hall & Betters, 2017)

3.5.2 Product description

By reference to the product selection, the four chosen products are described in table 4. Prices were located at the main supplier site. Because some websites indicated the prices in US dollars only, all prices are quoted in US dollars to guarantee comparability.

Table 4 - VR product overview (Shanklin, 2016) (Google VR, n.d. b) (AliExpress, n.d.) (Oculus, n.d. a) (Samsung, n.d. a) (Rift, n.d.) (Davies, 2016) (Vive, n.d. a) (Porter, 2016)

	Google Cardboard	Gear VR	Oculus Rift	HTC Vive
Device	 <i>Figure 12 - Google cardboard (Wikipedia, 2017a)</i>	 <i>Figure 13 - Gear VR (The Digeon, 2015)</i>	 <i>Figure 14 - Oculus Rift (Wikipedia, 2017b)</i>	 <i>Figure 15 - HTC Vive (Wikipedia, 2016a)</i>
Description	VR device made from cardboard, lenses and sometimes velcro to fit smartphones of different sizes.	Different Samsung GALAXY smartphones can be snapped into Gear VR HMD	Virtual reality headset with integrated VR audio system	Virtual reality headset
Base station	Smartphone	Galaxy smartphone	PC	PC
Requirements	Smartphone with screen size up to 15 cm	Galaxy S7, S7 edge, Galaxy S6, S6 edge, S6 edge +, Galaxy Note5	A PC is the engine that powers Rift. Certain minimum specifications must be fulfilled.	High-end GPU
Starting price	15 \$	99.99 \$	599 \$	799 \$
Head tracking	✓	✓	✓	✓
Positional tracking	✗	✗	✓	✓
Motion controllers	✗	✗	✓	✓

Motion controllers price	–	–	199 \$	bundled
Tracking system	–	–	optical	Lighthouse
Tracking system price	–	–	79 \$	bundled
Room-scale boundaries	✗	✗	✓	✓
Built-in camera	✗	✓	✗	✓
Display resolution	?	1440 x 1280 per eye	1200 x 1080 per eye	1200 x 1080 per eye
Field of view	?	~101°	~110°	110°
Refresh rate	?	60 Hz	90 Hz	90 Hz
Wireless	✓	✓	✗	✗
Focus adjustment	✗	✓	✗	✗
Built-in headphones	✗	✗	✓	✗
Dimension	14.5 x 10 x 8 cm	20.7 x 12.3 x 9.9 cm	~21.6 x ~10.2 cm (W (including headphones) x D)	~19 x ~12.7 x ~89 cm
Weight	54 g (only cardboard)	345 g / 312 g without front cover	470g (excluding cable)	563g (excluding cable)
Total starting price	15 \$ ~ (564 \$ with smartphone)	~649 \$	~1376 \$	~1599 \$
Release	June 2014	August 2016	March 2016	April 2016
Remarks	Cheaper viewers are sold. Even do-it-yourself instructions are available. Although the quality and functionality are limited.	–	Includes: headset, sensor, remote, cables, Xbox One controller	Includes: headset, two wireless controllers, two base stations, link box, earbuds

The total starting price includes a headset, base station (PC, console or smartphone at full retail cost), motion controls and tracking system. These prices should be understood as rough indicative prices.

All the devices are capable of head tracking, but only the high-end HMDs (Oculus Rift and HTC Vive) are capable of positional tracking. Also, the mobile VR (Google Cardboard and Gear VR) doesn't have real motion controls. Although the display resolution of the Gear VR is better than those of Oculus Rift and HTC Vive, that doesn't mean it has better-looking visuals, because the crucial factor are the graphic cards which are more powerful in the PC base stations. The human eyes' field of view is 180 degrees. The wider the range of a device, the closer it gets to normal vision. None of the devices comes close to 180 degrees. But already a 100 to 110 degrees' field of view is sufficient to generate a good immersion. The refresh rate is important to perceive the virtual world visually. 90 fps are nowadays considered the minimum value for high-quality VR. Only the Oculus Rift and HTC Vive fulfil these standards. Although a minimum frame rate of 60 fps is needed to avoid stuttering and prevent the users of feeling sick. All devices allow the user to wear glasses while using them, but only the Gear VR has focus adjustment so the glasses aren't necessary to enjoy the VR experience. Only the Oculus Rift has built-in headphones. The others only have ports to connect external earphones. The two advantages of the mobile VR headsets (Google Cardboard and Gear VR) are pricing and that they go completely wireless. (Shanklin, 2016)

It is important to notice that there also are hardware devices which are not only for the consumption of VR content, but also for the VR content production. Cameras with twin lenses shoot 360 degree photos and videos in full HD or near-4K quality, which can be used without extensive post processing. To give a quick impression, the Ricoh Theta S (table 5) and the Samsung Gear 360 (table 6) cameras will be introduced.

Table 5 - Ricoh Theta S (Ricoh, n.d.) (Tomkins, 2015) (B&H, n.d.)

Ricoh Theta S	
Description	This camera shoots 360° spherical photos and videos using a twin fisheye lens system, to produce a 14 megapixel output and full HD videos at 30fps.
Requirements	—
Dimension	44 x 130 x 23 mm, 125 g incl. batteries, 8GB internal memory
Price	349.95 \$
Remarks	Storage and battery can't be replaced or upgraded. Live view image, adjusting camera settings and wireless transfer of photos or videos for instant online sharing is enabled trough Wi-Fi.



Figure 16 - Ricoh Theta S (Wikipedia, 2017c)

Table 6 - Samsung Gear 360 (Samsung, n.d. b)

Samsung Gear 360	
Description	Two 180° wide-angle lenses take shots simultaneously and capture 360 degree videos and photos. The camera shoots near-4K videos and 30MP photos.
Requirements	Compatible Galaxy smartphone or PC
Dimension	66.7 x 56.2 x 60 mm – 145 g incl. battery
Price	349.99 \$ + memory card (39.99\$ - 32GB, 69.99\$ – 64GB, 129.99\$ – 128GB)
Remarks	Wi-Fi, NFC enabled, dust and water resistant, Bluetooth



Figure 17 - Gear 360 (The Digeon, n.d.)

3.6 General application of VR

The list of use cases for virtual reality seems endless: healthcare/surgery, entertainment, architecture, military, education, business, media, sport, rehabilitation or treatment of phobias – just to name a few. It is generally expected that there will even be more applications for VR in the future. To get a better understanding of VR application, already applied examples are listed below:

One of the biggest adopter of VR technology is the healthcare industry. Same as the training of pilots, critical and possible deadly situation can be performed with simulation technology. The NeuroTouch Cranio is such a surgery simulation technology developed especially for brain surgery. Cadavers and synthetic phantoms have a lack of realism like the absence of disease-related pathology or no bleeding. While the screen depicts a tumor, the doctor holds surgical tools. So, the simulation allows haptic feedback and visual and tactile reality. (Howell, 2013) (CMS Made Simple, n.d.)

Entertainment - especially gaming - is one of the primary uses of VR technology. Games like *Keep Talking and Nobody Explodes* immerses one player in a room in which a bomb must be diffused while the other players (so called experts) support him by giving him instruction from the manual. The catch: The player doesn't see the manual and the experts can't see the bomb. But it is also possible to watch 360 movies, view live sports with *VR stadium* or attending a cirque du Soleil performance. (Steel Crate Games, n.d.) (Gaudiosi, 2015) (Giardina, 2017)

The education sector has found it use in VR too. The goal of the TeenDrive365 simulator is to raise awareness how dangerous distracted driving can be. Dangers like traffic noises, text messages and virtual friends

in the car will challenge the people wearing an Oculus Rift HMD. (Dredge, 2015)

Even Psychological treatment is possible with VR. A common way to treat the patient is the exposure therapy, where the patient must repeatedly confront and process the trauma to reduce the anxiety level and response to the trauma. The simulation of the University of Southern California Institute of Creative Technologies immerses patients in the environment of the traumatic experience and the brain fills in the blanks. Like that memories can be unlocked while the patients recount what they see meanwhile the clinician can influence the virtual environment. (Quart, 2016)

3.7 Issues with VR devices

First-class devices like Oculus Rift and HTC Vive are powered by costly high-end computers, which need advanced graphical capabilities. According to the research company Gartner, less than one percent of PCs will be capable to support these systems, which means for most of the possible customers the technology is inaccessible with their standard PCs. Oculus Rift owners are recommended to buy at least a NVidia GeForce 970 or AMD Radeon 290 graphics card, which is about \$280. Furthermore, an Intel i5-class processor, more than 8 GB of memory and two USB 3.0 ports are required. For our brain to perceives images as real, VR needs to achieve 90 fps, whereas standard PCs run at 30 fps. PCs which complies with these requirements are costly. Additionally, there is the price of the device itself - 599 \$ for the Oculus Rift or 799 \$ for the HTC Vive. (King, 2015) (Matthews, 2016)

Furthermore, it is still unknown how the health may be affected. Although it is the general believe that side effects are only temporary, long-term studies are scarce. One of the biggest problems is eye-strain which is triggered by the vergence-accommodation conflict (Davis, 2016). Eighteen possible discomfort symptoms are stated in the health and safety documentation of Oculus Rift, among them are for example dizziness, seizures and disorientation (Oculus, n.d. b). But of course, Oculus also listed these as protective measures against possible lawsuits. There are side effects, the question is if they are harmful. Future comprehensive long-term studies will provide answers to these questions.

3.8 AR devices

There are several AR products on the market with varying emphases. The reasons for the product selection are stated and three different devices will be described further.

3.8.1 Product selection




Excluded from the overview are the Solos AR and the Recon Jet smart glasses because they are designed for smart cycling. CastAR and the Vuzix M300 aren't included in the overview because they were designed specifically for gaming respectively enterprise use. Meta AR wasn't analysed because the device isn't wireless. For the product Magic Leap, there is not enough information to include it in the oversight. (Linda, 2016)

Devices included in the abstract are the Microsoft HoloLens which was designed for commercial application, but also for enterprises to integrate it in their product development process. Due to the Microsoft brand, it is anticipated that it will be the most widespread commercial device. The Moverio BT-300 targets business and entertainment customers. Furthermore, Epson promotes the BT-300 as the smallest, most comfortable and most affordable smart eyewear on the market. After the great success of Pokémon GO, it is important to include smartphones and tablets in the abstract. Because Samsung was the leading smartphone vendor in 2016 with 21.25 % global market share, their latest smartphone has been chosen for the overview. (Hemmer, 2016) (Epson, n.d. a) (de Looper, 2016) (Statista, n.d. b)

3.8.2 Product description

Based on the product selection, three different devices are presented in table 7. Prices were located at the main supplier site. Because some websites indicated the prices in US dollars only, all prices are quoted in US dollars to guarantee comparability.

Table 7 - AR product overview (Graphiq, n.d.) (Epson, n.d. b) (Samsung, n.d. c) (PR Newswire, 2017)

	Microsoft HoloLens	Moverio BT-300	Samsung Galaxy S7
Device	 <p>Figure 18 - Microsoft HoloLens (Wikipedia, 2015)</p>	 <p>Figure 19 - Moverio BT-300 (The Digeon, 2016)</p>	 <p>Figure 20 - Samsung Galaxy S7 (Wikipedia, 2016b)</p>
Base station	Operates on built-in, battery-powered Microsoft 10 program	Operates on built-in, battery-powered Android 5.1	Operates on Android 6.0
Starting price	3000 \$	779 \$	570 \$
Positional tracking	✓	✓	✗

Built-in camera	✓	✓	✓
Display resolution	1268 x 720 per eye	1280 x 720 per eye	1440 x 2560
Field of view	20°	23°	?
Refresh rate	60 Hz	30 Hz	60 Hz
Wireless	✓	✓	✓
Built-in head-phones	✓	✗	✗
Weight	579 g	69 g	152 g
Release	March 2016	January 2017	March 2016
Remarks	Developer Edition	Developer Edition	–

3.9 General application of AR

Same as with VR there are many use cases for augmented reality in different fields like telepresence, government and military, transportation, education and many more. The range of fields will broaden with the improvement of technology and the increased awareness in the general population. To get a sense of AR applications, in the following some already operational AR implementation will be described:

In the sport sector, the Solos Smart Cycling glasses helped US cyclists during the 2016 Rio Olympics to keep track of their performance without pausing, because it displayed real time activity data (Linda, 2016).

AR applications are also used in the shopping industry. For example, the furniture retailer IKEA uses AR to help customers visualize how selected furniture fit in their own rooms (IKEA, 2013). With the Ray-Ban Virtual Mirror the customer can try on the sunglasses or eyeglasses in real time in front of the computer (O'Brien, n.d.).

In the healthcare sector, AccuVein helps the doctors and nurses at finding a vein on the first attempt. A scanner which is projected over the skin, shows the location of veins, vales and bifurcations in the patient's body. (Ratcliff, 2016)

Of course, also AR found its use in the gaming industry. With Pokémon GO the user can find, catch and battle little monsters that are displayed on the screen, inserted in the actual surrounding captured by the mobile device's camera (Pokémon, n.d.).

An example for AR in industry is delivered by Scope AR. This company created Worklink to provide smart instructions trough AR. The instructions (information in text or graphic) are layered over the physical pieces in real time, so the employees' hands are free to work. Caterpillar uses Worklink for remote assistance for their heavy machinery. (Scope AR, 2016)

AR could improve telecommunication. Through Microsoft's HoloLens and several cameras filming from different angles, a holographic representation could be "teleported" into the same room with another user. There the holographic representations could talk to the other user, interact and even walk around in the room. (Novet, 2016)

3.10 Issues with AR devices

Googles pioneer work in face-mounted computing didn't go well. In January 2015, the media reported that Google ended the sale of Google Glass. There were some general problems like the quality of the camera, the battery life which lasted only 45 minutes, a small display with low resolution, the aesthetically unappealing design and uncertain intended purpose. The unclear purpose of the device went so far that even the developers didn't agree on whether the device should be worn all the time or only in specific situations. (Rowinski, 2016)

But there were also health concerns: "Not everyone was comfortable with the idea of having a gadget that constantly emits carcinogenic radiation so close to the head. While other mobile devices such as an iPhone or a Samsung Galaxy also emit harmful radiation, they don't have to be in direct contact with your skin all the time." (Doyle, 2016)

Augmented reality gear could also compromise the safety of the users. They could misjudge the speed of an oncoming car, underestimate the reaction time and inadvertently overlook the hazards (like a road hole) in the real world. A way to address these safety shortcomings is that GPS signals embedded in the devices detect the speed of motion and stop the flow of information. However, it is doubtful whether this solution will be used, because the user wants to stay connected and not being patronized. (Sabelman & Lam, 2015)

One of the main problems were privacy concerns. People were afraid that the device was recording all the time, which it didn't. When a photo or video is taken with a smartphone, the bystanders will see the photographer lift the smartphone and holding it in place and therefore know when a picture is taken. With Google Glass a spoken command or a physical action started the recording. But the bystanders didn't know if the commands were already issued and the lack of understanding that the screen was illuminating when recording didn't help. As result some restaurants and bars banned the device because customers didn't feel comfortable with other people wearing it. Cinemas prohibited the smart glasses too, because they were afraid of illegal filming of the movies. Users have had a hard time to figure out where the devices were welcome. (Gross, 2014)

Rowinski asked why other companies will win where Google Glass failed and quoted Robert Scoble – who wore the Google Glass for one year

without taking it off – who stated four reasons: depth, immersion, utility and functionality (Rowinski, 2016).

All in all, augmented reality is a new and exciting technology but is also still in its infancy. Even observers of the scene say it is difficult to pick a company or even a technology which will prevail (Mainelli, 2016).

3.11 AR/VR suppliers

Besides suppliers known for their hardware like Oculus, HTC Vive or Microsoft HoloLens there are other AR/VR suppliers. Figure 21 depicts some important suppliers with their field of activity.

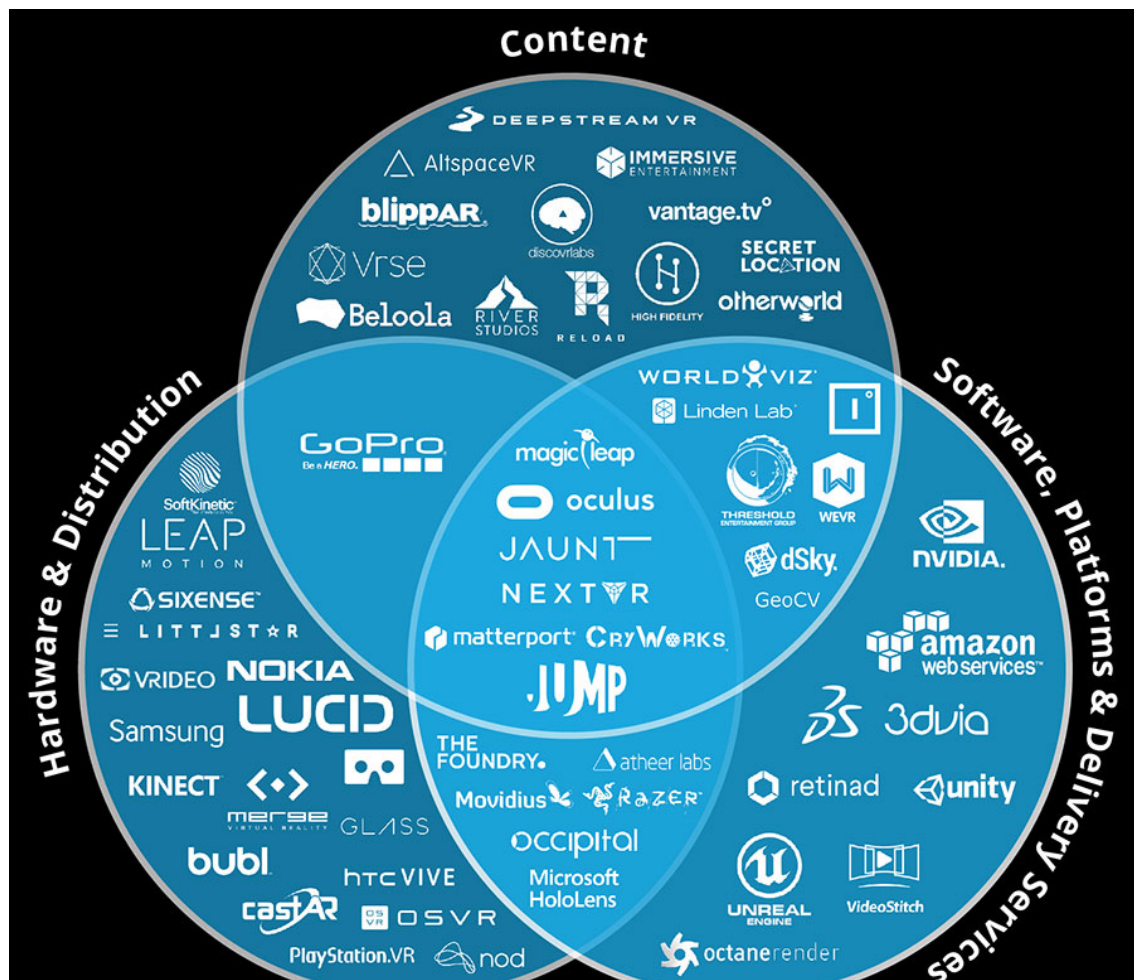


Figure 21 - AR/VR suppliers (Saini, 2016)

To describe all the different suppliers would go beyond the scope of this thesis. To give an impression of their field of work, four suppliers from different fields are presented.

3.11.1 WorldViz

WorldViz is a virtual reality company which aims to empower businesses with new visualization techniques with 3D interactive and immersive visualization and simulation solutions. They claim to have the world's only immersion-ready VR system for academic and professional use. Furthermore, they provide a VR application to create sophisticated 3D content, a high-precision motion tracking system and offer art design and custom application development services. (worldviz, n.d.)

3.11.2 NVIDIA

NVIDIA is a technology company which among other things produces their primary GPU product line *GeForce* and claim to build the fastest GPUs for VR. GeForce GPUs drive PCs but also VR-ready notebooks and the Oculus Rift headset. Furthermore, they are offering the VR development community new tools to increase graphic performance. (Burke, 2016)

3.11.3 Immersive Entertainment

Immersive Entertainment develops and publishes fully immersive virtual reality technology and content for medical, training, educational and enterprise use. Among other things they offer developer technologies as well as Solo and Shared Virtual Reality Experiences (VREs) which were designed for Oculus Rift and HTC Vive. Their products are aimed at consumers and developers. (EvoNexus, n.d.)

3.11.4 Magic Leap

Magic Leap states that they are developing the next computing platform that will allow to seamlessly combine and experience the digital and physical worlds. Otherwise there is not much information on the official website because the company is quite secretive and hasn't launched their first product yet (Abovitz, 2017).

Andy Patrizio describes the Magic Leap as follows: "Magic Leap makes a head-mounted virtual retinal display, which superimposes 3D computer-generated imagery over real world objects by projecting a digital light field into the user's eye. This allows for placing 3D objects in the user's field of vision of the real world instead of a 100% virtual vision like other headsets." (Patrizio, 2016)

Patrizio further states that Magic Leap has raised a record-breaking amount of money for a VR company. In December 2015, they racked up \$827 million. In February 2016 Magic Leap announced \$793.5 million in new founding. Among the investors are Alibaba Group, Google, Qualcomm Ventures, Warner Bros., J.P. Morgan Investment Management and

Morgan Stanley Investment Management. According to Patrizio this is the largest amount of funding for a startup ever raised. (Beach, 2016) (Patrizio, 2016)

Although Magic Leap hasn't launched their first product yet and not much information is available, they gathered a vast amount of money from big players. It is reasonable to keep a close eye to further development.

4 BUSINESS PLAN AND BUSINESS MODEL

In this chapter a short description of a business plan and the Business Model Canvas with its advantages are presented.

4.1 Business plan

The business plan is a written description of the future of a business, characterizing the rationale of how an organization creates, delivers, and captures value to make the business a success. Scope and content of a business plan differs, depending on different authors. But in general, following points are addressed: management summary, product and services, vision and strategy, competitive advantages and market, management team and key employees and the financing needs. (Entrepreneur, 2014)

4.2 Business Model Canvas

The Business Model Canvas helps to understand and use the concept of a business model and can act as a shared language for describing, visualizing and assessing a business model. It allows to map out the business and create, offer and capture the values related to the business and develop an innovative business model.

The description of a business model with the Canvas can be described through nine basic building blocks. These basic building blocks point out how a company intends to make money. The nine blocks cover the four most important areas of business: customers, offer, infrastructure and financial viability.

The nine basic building blocks are: customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partners and cost structure (figure 22).

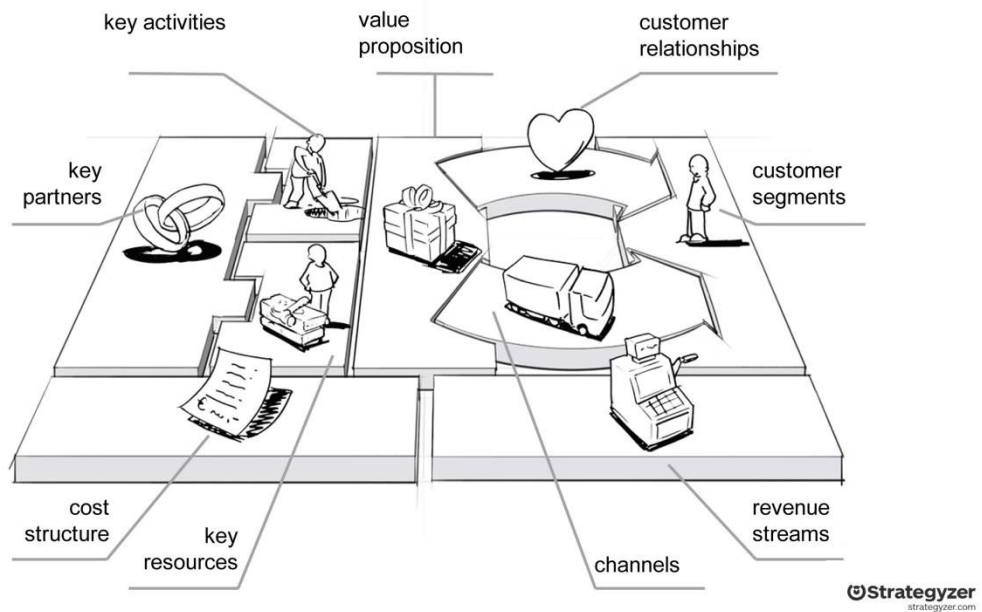


Figure 22 - Business Model Canvas (Strategyzer, n.d.)

The advantages of the Business Model Canvas are that it forces the creators to think about various key aspects and focus on the strategic elements that are most important and will have the largest impact on driving growth. Furthermore, it is possible to tell at one glance if a part is missing, where more effort is needed, and how the functions, activities and processes are interlocked. (Webb, 2014)

5 METHODOLOGY

5.1 Scope and limitations

5.1.1 Research questions

Various research questions in the field of AR and VR can be raised. The following questions are considered the most appropriate to analyse the goal achievement of this thesis.

- Which AR/VR technologies are suitable to enhance the tourism user experience?
 - Where are the weak spots in the AR/VR technologies? (Sound/image correlation, interactivity, field of view, resolution...)
 - Security aspects (walking around with the AR/VR device, theft protection)
 - Comfort aspects (fitting of the devices, weight, easy handling)
- Which case study is appropriate to enhance tourism with AR/VR?
 - Which problems shall be addressed?
 - What is the product?
 - What is the vision and mission?
 - Which are the marketing opportunities?
- Which business model is suitable for this case study?
 - Who is the customer?
 - Which value do we generate for the customer?
 - What are the revenue streams?

5.1.2 Limitations of the research

Due to lack of time and access possibilities, it wasn't possible to examine and try all the AR/VR devices mentioned in the product selection.

5.2 Rationale

This is a research thesis without own development or experiments. There are several reasons for this decision:

- Scope: Determine the demand and suitable technologies before developing a service/product on the wrong technologies
- Time: Limited time of eight weeks to conduct the thesis

- Costs: Microsoft HoloLens costs \$ 3'000, Oculus Rift and HTC Vive cost 599\$ respectively 799\$ without the powerful PC needed to supply the devices.

5.3 Implementation

The main goal was to get some own hands-on experiences with different devices to analyse which devices are appropriate for which use case from the point of view of the author. Further to get information which may not be included in a test report but which could be relevant for this thesis.

To gain insight and explore current uses of AR and VR in tourism, Matka 2017 –the biggest travel fair in northern Europe – was visited (n'Tradeshows, 2017). The fair was held from the 19th to the 22nd January in Helsinki and more than 1000 exhibitors from 80 different countries showcased products from travel and tourism industry. Especially the topics *Travel Technology/eTravel/Education* were in the scope of the visit. The goal of the visit was to capture the general sentiment about AR/VR in tourism, ask general questions about AR/VR, explore the market, try out some technologies and find interview partners. Following companies were visited at the Matka travel fair: Unicef, Finnair, Aurinko, Finnlines, Fazer, Virtual Traveller and Immersal.

Travel specialists have been interviewed to give more insight about different subjects. Therefore, a questionnaire has been prepared. The interview partners were informed about the purpose of the interview. The notes taken during the interview were afterwards rehashed. Relevant information was presented in the thesis.

6 EXPERIENCED AR AND VR EXAMPLES IN TOURISM AND TRAVELING

The Matka travel fair was visited to get a general understanding of the use of AR and VR in tourism up until now. Whereby the caption “AR and VR examples in tourism and traveling” also span exploring of cuisine and travelling virtually to off limited places. Hands on experiences made at different exhibition stands are put down in writing. A critical part examines the problems of the different AR and VR applications to answer the question which AR/VR technologies are suitable to enhance the tourism user experience.

6.1 Overcoming limited access

UNICEF used virtual reality to show a Syrian refugee camp in Jordan (figure 23). In the 360° film the Syrian child Sidra guided through different parts of the camp. The users were able to look around in Sidras home, get a general view of the camp, watch her and other girls at school and see them playing soccer. Because of security concerns, not everybody is allowed to enter the camp (unless with special authorization). The purpose of showing this video was to raise awareness and collect donations by taking the users to the camp to see the plight of the refugees and make the users feel like they are actually there. To create this immersed feeling, UNICEF used a custom camera rig and showed the 360° film with Samsung Gear VR. So the campaign could reach more people, UNICEF created the UNICEF 360° app, which is free and can be played with a smartphone and a cardboard viewer.



Figure 23 - UNICEF VR film

Fazer is a Finnish chocolate producer which has a newly built visitor centre where they offer an exhibition tour. Besides getting insight in Fazer's activities and product selection, most people are interested in how the products are manufactured. Due to hygiene regulations and the stream of visitors, it is not possible to enter the factories. To provide insight into the production, Fazer provides a 3D VR tour into their manufacturing facilities, production lines and even give an aerial view of the entire production site. The visitor can either use a Samsung Gear VR device or use a sphere hanging from the ceiling (figure 24) to explore the 3D photography of the sites.



Figure 24 - Fazer VR tour

6.2 Selection guide

The travel agency Aurinko showcased three different locations with 360° videos (figure 25). Within the videos the user got as much information as possible about the individual locations. Many different settings were shown with the Samsung Gear VR. There are several functions provided by these videos: First, the travel agency is put into spotlight by innovative marketing. Secondly, they give the user an overview and a foretaste of several possible destinations. The last and perhaps most important feature is to help the customer choose his destination with a lot of information and to act as a selection guide.



Figure 25 - Aurinko VR selection guide

6.3 Showcasing

Finnlines is a Finnish shipping operator which offers - among other services - different ferry trips. They renovated several vessels and put them through a significant facelift. To showcase the refurbished common area, gym, children's playroom, restaurant etc., they produced a 3D photographic tour through one of the vessels to attract customer attention and present their product in the best possible light.

Finnair is the largest airline in Finland and the first European airline to employ the new Airbus A350 XWB (Extra Wide Body). Since they advertise that the new airbus raises the bar for passenger comfort with a spacious cabin, wide seats, large panoramic view windows and the latest LED lighting technology to fit the ambiance, Finnair created an immersive and interactive visit to their latest acquisition (figure 26). With a HTC Vive HMD and controllers the plain could be virtually explored – opening/closing the window shades or adjusting the light with the controllers, walking around the cabin to perceive the dimensions of the cabin or even taking an exciting glimpse on top of the wing while the airplane was flying.



Figure 26 - Finnair VR showcase

6.4 Sharing travelling experiences

Virtual Traveller provides an app where 360° traveling videos can be accessed. The videos are shot by travellers which share their personal story. To shoot the videos, a handheld camera which creates full 360° videos is used. The target group are people with too little free time, not enough money or challenges like disabilities and the goal is to enable them to virtually experience the world. This can be done by using the smartphone and cardboards or VR glasses.

6.5 Locator / Navigation

Immersal developed an infotainment platform which was designed for large venues like an exhibition. The user can access this augmented reality by downloading an app and using his smartphone or tablet. The app locates booths, cafés, WCs etc. and helps to navigate to them by showing an arrow overlaid in the live picture taken by the smartphone/tablet (figure 27). Furthermore, a search feature helps to find shops/booths with certain search criteria. To entertain the user, virtual coin can be collected and afterwards traded for a cup of coffee in a certain café. The AR experience mode allows the user to watch AR objects e.g. a whale and write messages to it, which will also be shown in the AR mode. In addition,

there are also promotion AR objects to call attention to a certain product or booth.



Figure 27 - Immersal AR Locator / Navigation

6.6 Criticism

While trying out the different usages of VR/AR, several findings have emerged which will be stressed and the resulting sentiments are stated.

6.6.1 Experiences

Finnlines showcasing of the new refurbished vessels showed a slightly tiled image which also lagged and after a few seconds motion sickness already started to kick in. Furthermore, the resolution of the image seemed grainy and couldn't be manually focused by rotating the focus ring on the headgear. In the Finnlines VR pictures the stand of the camera was visible when the user looked down – this too reduced the feeling of immersion.

To showcase a room to get a feeling of space and layout, it is preferable to be able to walk around and see the room from different angles, which was done nicely by Finnair. To do that they had to create the surroundings and couldn't only film or photograph the space. The production of this approach is much more complex but also provides the opportunity to enhance the application in a fun and playful way (like standing on the wing while flying) to delight the user and associate additional positive feelings for the product.

The drawback was the heavy HTC Vive headgear. There was also a convenience issue with the AR app from Immersal. Since the app uses signs hanging from the ceiling for orientation, the user must track these signs in the camera focus. Over a long time, it is quite exhausting to hold the phone high enough to focus on the signs. Jufo Peltomaa (co-founder and head of special ops of Immersal) pointed out that they will enable to use the phone/tablet vertically, so that the camera can capture more height. At the moment, the app only operates on iPhones or iPads, but it is planned that android based smartphone and tablets can use the app too. No

personnel are needed to lend gear because the user already has his device (smartphone or tablet) and can download the app by himself. Therefore, a short intro or help for people who aren't digital natives would be helpful to ensure the user knows all features (like pressing a VR object on the screen may release coins).

Generally, people were quick to grasp the handling of the different VR applications, so that only one person was necessary to handle several users at the same time. The Finnair VR application needed more support because the user not only listened and looked but could also move around and move things with the handheld controllers. There constantly was one person watching and helping so the user wouldn't crash into the chair, stumble off the platform or get caught in the cables. The chaperone also pointed out different clues for how to access certain features. There were several disadvantages: Only one user at a time, more space and more personnel needed (one to guide the user and one to answer questions and instruct other people). But it may be expected that user will get more accustomed to use the devices and the handling will be more clear so that less support will be needed.

6.6.2 Sentiments about VR

In general, the VR technologies made a huge step in the past few years. High end gear like HTC Vive and Oculus Rift already allows to move and interact with the virtual environment through room scale boundaries and tracking systems. But still the space to move is quite limited because of the wires attached to the HMD. Also, the handheld devices didn't feel very natural and sometimes it was hard to estimate the distance to a virtual object, so the user had to try and grab it several times. These factors lessened the feeling of immersion.

There are still some problems to solve like the resolution quality of some images and the tilted angles - which lead to motion sickness - or the camera stand which was visible in the video. It must be emphasised that not only the HMD is crucial for the quality of the immersion. Different videos shown on the same Samsung Gear VR had a large contrast in quality. But in general, the field of view in all the VR devices was okay. The sound correlated well with the videos and Samsung Level On headphones provided satisfying sound quality.

With regard to the security most of the VR applications were quite safe to use. Just sit down in a chair, mount the VR device and look around. Only the HTC Vive interactive application required a constant chaperone. Concerning theft protection none wireless HMD (like Oculus Rift and HTC Vive) were a bit better secured than wireless HMD (like Samsung Gear VR) which could have just been snatched. Although the wires are not enough security because they can be unplugged. The only hindrance is the cable routing.

Comfort was a big aspect. Although the HTC Vive had several possibilities to adjust the gear, in the end it was just a bit too heavy to wear it for a longer time. And if the user is not used to the gear, a chaperone is needed to adjust the head straps. On the other side the Samsung Gear VR was easy to strap on and had a handy rotary control for focus adjustment. The handling of a Samsung Gear VR was easy because there were less challenging applications as with HTC Vive where the users had to use handheld controllers or abide by virtually set boundaries. Regarding maintenance aspects, it is difficult to provide unambiguous information because none of the exhibitors cleaned their gear before passing it on to the next user. Another maintenance aspect is the mending of a device, which was quite easily done. When a Samsung Gear VR didn't respond any more they just snapped another Samsung phone into the gear.

6.6.3 Sentiments about AR

Unfortunately, it wasn't possible to test any AR devices other than a smartphone. Apparently, AR HMD haven't pervasively entered the touristic market yet. Promising devices like Microsoft HoloLens are not yet officially available. When a smartphone is used as an AR device, there is no wire, which allows to walk freely. Obstacles like walls or lamppost will be seen through the AR view. Although through the limited field of view, a ledge or a pothole may be overlooked if the user is only staring at the screen. Theft protection same as cleaning/maintenance aspects can be omitted since the user brings his own device. The drawback is that lifting the smartphone over a longer time is quite exhausting. It is recommendable to use a smartphone instead of a tablet.

6.7 Suitable AR/VR technologies for tourism

To answer the question which AR/VR technologies are suitable to enhance tourism user experience, various aspects must be considered. Most AR devices have a specific purpose and are not (yet) designed for the touristic market. There are several good VR devices on the market. For tourism two important aspects must be taken into account; Mobility and how many users can be served at once. The touristic market is still one of masses. If only a few persons can be provided with a service at once (e.g. to experience a complex and interactive room scale scenario), the tourist needs to book an appointment. This is an annoyance since the whole day or even trip must be scheduled around this appointment. And of course, having less customers results in higher prices for a service which is also a drawback. Normally, tourists want to visit and move in the city or countryside they stay in. So, although some devices have superior technical functions, the selection criteria encompass which devices are suitable AR/VR technologies for tourism. Table 8 shows the criteria and statements.

Table 8 - Selection criteria

Selection criteria	
Readiness	AR devices like Microsoft HoloLens and Moverio BT-300 are future-oriented products, but not ready for the mass market yet because they are still developer editions.
Acceptance	Google Glass failed because of privacy concerns. People were concerned they were constantly filmed. It isn't certain how people would react to tourist moving through cities and landsides with AR glasses like Microsoft HoloLens and Moverio BT-300. Therefore, it is advisable to let society become acquainted with these devices first.
Costs	HTC Vive and Oculus Rift need some expensive PCs to power them, so they will cost about 1500 US dollars. But the Microsoft HoloLens is even more expensive. The devices cost 3000 US dollars.
Mobility	The high-end VR gear like HTC Vive or Oculus Rift are not wireless and powered by PCs and therefore not ideal considering the aspect of moving around and exploring a city.
Convenience	High-end gear like HTC Vive or Oculus Rift are quite heavy and after a few minutes can become a bit of an encumbrance, while the other gear is quite light and comfortable to wear or carry around in a bag especially over a longer period of time.
Simplicity	If there is a complex VR room scale scenario with HTC Vive or Oculus Rift devices, a chaperone must oversee the whole session to give advice and to guard the inexperienced user from bumping into obstacles. Whereas devices powered by smartphones are self-explanatory and can be used easily by the user.
Dissemination	Only 1 % off all PCs are VR ready. On the other hand, a lot of people have smartphones or tablet that are VR and AR ready.

Due to these criteria and reasons in table 8, the smartphone driven like devices like Samsung Gear VR, Google Cardboard or a simple smartphone/tablet itself are recommended to enhance tourism with AR/VR (table 9).

Table 9 - Selected devices

Google Cardboard	Samsung Gear VR	Smartphone/Tablet
 <p>Figure 28 - Google cardboard (Wikipedia, 2017a)</p>	 <p>Figure 29 - Gear VR (The Digeon, 2015)</p>	 <p>Figure 30 - Samsung Galaxy S7 (Wikipedia, 2016b)</p>

7 BUSINESS PLAN

In this chapter the business idea and concept will be presented in a tailored form. Important aspects that are relevant for AR/VR were emphasised.

The feedback from the travel experts about which technologies – AR or VR – respectively which devices – Microsoft HoloLens, Oculus Rift or Google Cardboard – are better suited to enhance tourism was mixed. With the experiences from the Matka travel fair, it was decided to embrace the advantages of both technologies, meaning immersion of VR and free movement of AR.

7.1 Background and problems

Moving in a foreign city is fun but also has its back draws. The tourist must choose what to visit, find the way to go there and look up information when it is not provided on the spot. Furthermore, some sites can't be accessed or certain events happen only once a year. And for some travellers it is fun to get in contact with other travellers but they don't know who else also is a tourist and if the person is interested in getting into touch.

7.2 Product outline

The app JOIN THE VALK shall address these problems. To reach out to as many customers as possible, the app will be created for smartphones and tablets. There will be several aspects of the app which shall help the customers.

The app proposes different routes with certain aspects: history, architecture, food, art, fauna/flora or top 10 things to see. The route will be visualized in a normal map for a better overview or as an augmented map. While walking with the AR mode, other interesting sites will be signalized. Once arrived at a destination, further information will be provided in the form of audio, AR content like text or even VR 360 degree videos. To add some fun into using JOIN THE VALK riddles hidden in the AR or VR content can be solved to gather points which can be exchanged for reductions in selected restaurants, museums or exhibitions. To get in touch with other travellers, the AR mode of the app will show other customers who are using the app. Recommendations and ratings can be exchanged. A simple and understandable menu will guide the user through the app (figure 31).

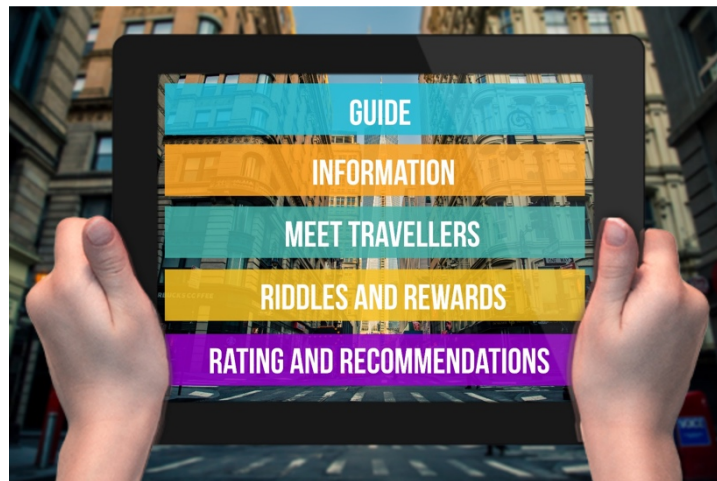


Figure 31 - Home screen example (Eliáš, Z., 2017)

7.2.1 Guide

The app provides two different ways to guide the tourist. The classical view helps to grasp the general location on the route from an aerial view and shows all the spots that are on the tour. With the augmented view the camera shows the surroundings on the phone while providing information about the directions (figure 32).

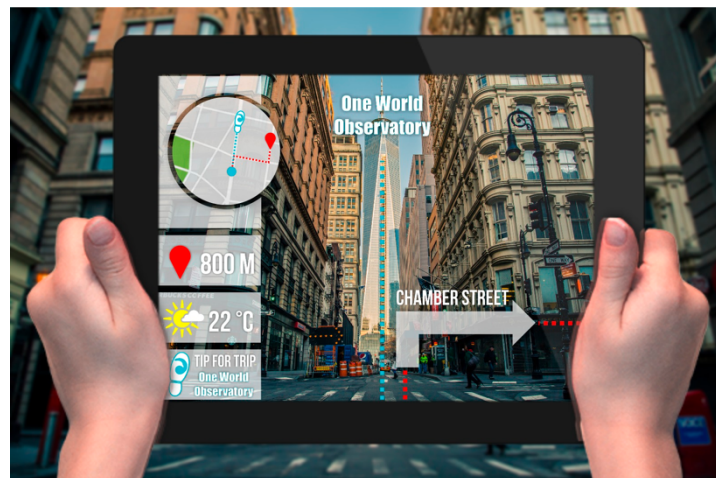


Figure 32 - AR guide example (Eliáš, Z., 2017)

While walking, the augmented view pinpoints objects which are passed, even if a monument isn't on the tour route. Because the app operates on a markerless system, it isn't necessary that the camera focuses on an object because GPS, compass and accelerometer data provides the information of objects which could be hidden in an interior courtyard. This function is perfect for tourists who like to scout the surroundings or just want to go for a little stroll but still want to be aware what possible treasures they are passing so they don't miss an interesting sight. To prevent a cluttered screen in bigger cities, a filter provides the functionality to show the pinpoints by interest like history, architecture, food, art, fauna/flora or top 10 things to see.

7.2.2 Providing information

Once arrived at the destination, further information can be accessed through the app (figure 33). Depending on the monument, different forms of information can be provided. In the AR view, text can be layered over the real object, for example the height of a TV tower. This is particularly helpful to point out an interesting detail on an object like a special ornament on a building. Some of the biggest providers of insight into different cultures are celebrations and events like carnival, official receptions, demonstrations, national days and music/theatre/art festivals. Unfortunately, it is nearly impossible to experience all these different celebrations and events in one trip. To provide the visitor with an unforgettable memory, the app offers the opportunity to watch 360 degree videos of these events while the customer is standing in the spot where the film was actually shot. It is also possible to show a park in bloom or the snow-covered mountains and surroundings while the tourists are visiting in the hot and dry summer time. In addition, it is also possible to present a view from a different perspective like an aerial view of a location. Audio can give further information about the history of a sight.



Figure 33 - Information example (Eliáš, Z., 2017)

To benefit from the immersed feeling of VR, the customers can snap their smartphones in a cardboard similar to Google Cardboard and enjoy the experience with a light and cheap device which furthermore contribute to the convenience through relieved arms, because the device can be tied to the head with a velcro strap. Figure 34 shows an example cardboard with the logo of JOIN THE VALK in the front which will be sold at partner stores. Furthermore, it will be a good marketing tool if other travelers see a customer exploring a different world on a central touristic spot with this cardboard. On the side of the cardboard will therefore be a QR code which can be scanned by interest tourist and links them to further information about JOIN THE VALK. But it will also be a nice reminder of the tour and the foldable, robust and lightweight design allows the customer to take it

back home where it may inspire relatives and friends to experience JOIN THE VALK.



Figure 34 - JOIN THE VALK cardboard example (Eliáš, Z., 2017)

7.2.3 Solve riddles and get rewards

Different clues are hidden in the information using the AR or VR mode. These could be a crest of a marching band shown in a VR video or a question about the eating habits that were narrated in the audio. Multiple choice questions (each with four possible answers) help the customer to find the right answer (figure 35). Furthermore, the AR view shows AR objects in different places. The goal is to display AR objects that are well known for that country or place. For example, in the US various Simpson characters will hide on the tour while in Finland Moomins could be hiding. In the end of the tour, the customers will be asked which AR objects (e.g. Simpson characters) they have discovered. The customer can select the spotted AR objects in an image with different depictions of them. The score of the riddles can be posted on social networks to let friends and family now about their achievement.



Figure 35 - Riddle example (Eliáš, Z., 2017)

The benefits for the customers are to get rewards like reduced entrance tickets for a chosen museums and exhibitions or a discount in restaurants. If they got curious about the displayed AR objects – for example the Moomins or Simpson characters – they can benefit of reductions in selected souvenir shops and book stores.

The benefit for partners like restaurants and museums is that the customer is made aware of them through the discounts and furthermore they will also be specially pinpointed in the AR view.

The benefit for JOIN THE VALK is that information will remain longer lasting in memory by a playful approach and hopefully the stroll with JOIN THE VALK too, so that the customers will recommend the app and use it again in another city. It is also a goal to attract families with kids with these playful elements because the app is not only a dry and boring information app. The score posted on social networks has also marketing and promotional purposes.

7.2.4 Meet travellers

Sometimes it is fun to meet other travellers, especially if you are alone on the track. Or maybe you want to meet other families with kids to join you on a walk. But at times it is not easy to discern who is a traveller and who wants to get in contact with other people. The app provides the opportunity to be “visible” to other app customers in the AR mode, so that a “visible” customer will be shown in the AR view (figure 36). Sometimes language barriers prevent contact with other travellers and hamper communication. So, the customers can choose if they want to supply information about themselves like nationalities and spoken languages. This is helpful if the customer wants to ask a bit more complicated questions or wishes to speak in certain language with other travellers, for example to improve the skill in a particular language.



Figure 36 - Meet and recommendation example (Eliáš, Z., 2017)

7.2.5 Rate and share recommendations

In the app JOIN THE VALK a rating system for each monument, sight, museum or restaurant on the tour is integrated. An easy 5-star touch rating system helps JOIN THE VALK to assess the customer interest and to assess which sights should be replaced by new ones. Furthermore, the customer can share these recommendations with travelers met on the walk (figure 37). A big advantage is that the customer knows that there is a real person giving the recommendation and not some ghost writer payed by some shady principals.



Figure 37 - Recommendation and sharing example (Eliáš, Z., 2017)

7.3 Vision and mission

The vision is to enable the customers to discover more than possible and experience new locations while gaining knowledge and having fun

The mission is to enable the customer to discover more in one visit in a convenient and fun way with the possibility to recognize other contact seeking travelers and share recommendations. JOIN THE VALK strives to create a fully integrated touristic exploring app with a worldwide dissemination.

7.4 Brand identity

The brand identity shows how a business wants to be perceived consumers. Therefore, the vision and mission are reflected and expressed in the brand identity of JOIN THE VALK. The name JOIN THE VALK is a wordplay. The customers enjoy the tours in a walk. The tour itself is enhanced with virtual and augmented reality. The first two letters of VALK build a reference to the enhancement by those technologies. Furthermore, valk is the Dutch word for falcon. This animal has an excellent sight which also refers to the vision of JOIN THE VALK: discover more than possible.

To create a high recognition value, a logo was created (figure 38) which incorporates the brand identity. A shoeprint symbolizes the walk, the falcon in the footprint allegorizes to the enhanced vision and the blue circle epitomizes the world.



Figure 38 - JOIN THE VALK logo (Eliáš, Z., 2017)

The slogan of JOIN THE VALK is: Discover more than possible – experience new locations while gaining knowledge and having fun.

7.5 Market

Interviews with travel experts have shown that not all countries have the same affinities to AR/VR technologies and that the market in some countries may not yet be ready. To launch the app in a first step, the US market will be targeted because the US are the second largest spender in tourism (table 2) and interests in VR technologies were high (figure 4). The app will also be aimed at domestic US tourists, which may be using the app in other cities or countries and therefore make it known in these markets too. The expectation is, that US tourist will raise awareness for the app with their open and outgoing manner. In a second step, the South Korean market may be targeted, because it is also known and especially mentioned by the travel experts for its technology affinity. In longer term, JOIN THE VALK shall target the international market.

7.6 Business model

The business model was created based on the Business Model Canvas from Alexander Osterwalder and Yves Pigneur (Osterwalder & Pigneur, 2009).

7.6.1 Customer segment

JOIN THE VALK targets the mass market of tourists and doesn't want to be established as a niche product. The main customer segment will be tourists traveling independently (not in guided groups). The segment contains women, men and children of all ages and nationalities prone to use smart technologies. Because models which are focused on the mass market don't

distinguish between different customer segments, the segments are not differentiated any further.

7.6.2 Value propositions

JOIN THE VALK delivers several value propositions to its customers which are listed in table 8.

Table 10 - Value propositions

Value propositions	
Convenience	Defined tours can be chosen (e.g. art, history or food tour) and the guide will show the customer the way. The app strives for optimum convenience for the customer, also by integrating several features in the same app.
Ease of use	Touch screen control, self-explanatory views (modes) and well-known menu icons guarantee the ease of use.
Enhanced customer experience	With AR and VR content the customer can experience more than normally possible and will be immersed in different seasons, festivities or perspectives which leads to an enhanced customer experience.
Gain knowledge	Gain knowledge about the visited location through different media like audio, video or AR information.
Socialize	The feature "Meet travellers" gives the customer the possibility to meet other contact-seeking tourists and to socialize.
Base of decision-making who to approach	To decide who the customer would like to approach, information about which country other customers are coming from and which languages they are speaking to either improve to language skills or have an easier mean of communication.
Trustworthy information	While socializing with other travellers, favourite sights and restaurants can be shared. The customers can gather trustworthy information directly recommended by a real person they see and assess and therefore be sure no fake information produced by ghost writers are obtained.
Price benefits	Collaboration with selected partners allows to offer price benefits like reduced entrance tickets for a chosen museums and exhibitions or a discount in restaurants, souvenir shops and books stores.
Fun	Having fun by solving riddles, answering questions and looking for different AR objects (for example the Simpsons characters).
Maintain social status	Maintain social status by posting the game score in social media (e.g. Facebook).

7.6.3 Key partners

JOIN THE VALK will build strategic alliances between non-competitors. The key partners are presented in table 9.

Table 11 - Key partners

Key partners	
Museums, exhibitions, restaurants, book stores, souvenir shops	Museums, exhibitions, restaurants, book stores and souvenir shops are working together with JOIN THE VALK to make their places known to more customers. In turn JOIN THE VALK can offer the customers reduced entrance fees, meal or product prices.
Governments	In times of socio-cultural unrest the governments will be interested to foster the understanding for the own culture and promote cultural exchange, mutual exchange of information and video footage. Video footage shot by JOIN THE VALK can be used by the government to attract more visitors.
Universities	Universities are interested in preservation and distribution of knowledge about culture like rituals, customs, celebrations and songs. Collaboration on different projects to provide the students with an assignment for their final dissertation.
Angel investors, venture capitalists	Angel investors and venture capitalist to raise capital to develop the app JOIN THE VALK. In return they gain a return on their new investment project.

Further partners are app stores (like App Store or Play Store) and owners of trademark law protected content so AR objects like Simpsons characters can be integrated in the app.

7.6.4 Channels

The customer can purchase the app in different app stores like Apple's App Store or Android's Play Store.

To raise awareness for JOIN THE VALK, social media channels like Facebook and Twitter will be utilized. Furthermore, key partners like museums, exhibitions, restaurants, book stores and souvenir shops can sell the JOIN THE VALK cardboards. It will help to advertise the app but also customers can get basic advice and post-purchase customer support from the partner personnel. Advertising leaflets will be placed at the different partner stores to attract further attention to JOIN THE VALK.

7.6.5 Customer relationships

There are two customer relationships which co-exists. Self-service, because no personnel from JOIN THE VALK is on-site, but also basic personal assistance through the key partners like museums, exhibitions, restaurants, book stores and souvenir shops.

Input like rating of the sites in JOIN THE VALK is important to gauge what the customer likes. Criticisms in app stores can be faced with direct feedback which allows to react to customer concerns.

7.6.6 Key activities

The main activity will be to develop the app JOIN THE VALK and fill the app with content – travel routes, riddles, videos and offers (from restaurants etc.) for the customer. Material like 360 degree videos of celebrations needs to be filmed. Building partnerships with key partners like museums, restaurants, books stores, souvenirs shops and universities is very essential too. Later, the contents need to be assessed by reference to the ratings in the app JOIN THE VALK and the feedback in the app stores to further improve the app.

7.6.7 Key resources

The main key resources are human resources. The most important are app developers to get the app up and running. Business advisors help to create a functioning business and to form strong relationships with key partners. History advisors assist in creating historically accurate content. Filmmakers deliver spectacular 360 degree videos. Translators ensure the correct and professional use of language. The most important physical resources are servers, but also 360 degree cameras and drones to shoot from aerial perspectives. The key intellectual resources are brands and copyrights to create VR objects (for example the Simpsons characters).

7.6.8 Cost structure

JOIN THE VALK focuses on minimizing the cost with maximum automation and outsourcing, which means the cost-driven business model will be applied. The most important costs are fixed costs like salaries, office space, computer equipment and IP licenses. Furthermore, there are variable marketing costs.

7.6.9 Revenue streams

JOIN THE VALK relies on multiple revenue streams:

Sale of the JOIN THE VALK app with a fixed list price in different app stores. The benefit of selling a product in an app store is the worldwide coverage and simple accessibility by the customers. Also, JOIN THE VALK cardboards and earphones are sold in partner stores.

But because many customers aren't willing to pay a lot of money for apps, the main revenue are advertising revenues from key partners like museums, exhibitions, restaurants, book stores and souvenir shops. This revenue stream will generate the most income.

Additional revenues are state subsidy to foster understanding for the culture and promote cultural exchange. The government can address the customer in the app in an own video. An advantage of this revenue stream is, that some subsidies can be requested before the product is finished and therefore are a fast way to get early revenues.

8 CONCLUSION AND OUTLOOK

There are several interesting devices on the market although the technology needs to mature further. One problem is the price of the high-end equipment which will slow down the process of market penetration. Since augmented and virtual reality are still a new topic, it is more important to create a business idea that brings real value to the customers and introduce it to the market as fast as possible to be ahead of the competitors and thereby secure a market share. Since many people already own advanced smartphones, it makes sense to use cheaper means like cardboard or similar devices to reach as many customers as possible. The most important thing for building a product or service is that it will bring real value to the customers, otherwise the clientele will lose interest fast. A business model which has its main revenue streams through key partners, assures an affordable service.

The app JOIN THE VALK was characterized as an integrated travel app. To generate even more value, there are several ideas which could be incorporated into the service. At the moment, only 360 degree videos are provided. Scenarios like a battle or a rebuild of former buildings/places through computer generated virtual reality could be integrated. Also, an intelligent decision guide could be helpful for the customers. Not only are the ratings from other customers shown. The intelligent decision guide checks the ratings of people who have the same kind of interests and therefore adapts the suggested travel routes or attractions. To respond quickly to customer wishes, feedback possibilities can be directly integrated in the app. A collaboration with the customers is the aim, so they can place their suggestions and feel involved. To assure as much comfort as possible while traveling, public transportation information like timetables, fares and nearest stations and exit stops could be provided.

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1. Additional VR devices
2. Questionnaire used at Matka travel fair

ADDITIONAL VR DEVICES

Oculus Touch (Rift, n.d.)	
Description	Touch controller
Requirements	Requires Oculus Rift
Price	199 \$
Remarks	–




Figure 39 - Oculus Touch (Wikipedia, 2017d)

Oculus Sensor (Rift, n.d.)	
Description	Constellation tracking system, with an external sensor that detects the infrared light that is in the headset.
Requirements	Requires Oculus Rift
Price	79 \$
Remarks	To enable 360 degree room scale tracking, at least three sensors are required. One comes with the Oculus Rift itself and one sensor comes with the Oculus Touch controllers. The third sensor can be bought separately. The store info includes a warning: “Please note: 360° and Room Scale tracking are experimental features—not all experiences may work as expected.”




Figure 40 - Oculus Sensor (Wikipedia, 2017e)

Vive Controller (Vive, n.d. b) (Lang, 2016)	
Description	The controller is the way to interact and play with the virtual world. It has 24 sensors, multi-function trackpad, dual-stage trigger, HD haptic feedback and a rechargeable battery and is completely wireless. The battery capacity is 960 mAh.
Requirements	HTC Vive
Price	129.99 \$
Remarks	Already new prototypes have been shown to public which are smaller and more ergonomical (Lang, 2016). But they are not yet mentioned in the accessories list in the Vive website.






Figure 41 - Vive controller (Appleros, 2016)

Vive Tracker (Vive, n.d. c)		
Description	Tracking device which brings any real-world object (for example baseball bat, golf club, fake sword) into the virtual world.	 <p>Figure 42 - Vive Tracker (Gomar, 2017)</p>
Requirements	HTC Vive	
Price	?	
Remarks	Coming soon	

Vive Deluxe Audio Strap (Vive, n.d. d) (James, 2017)		
Description	This strap replaces the original harness and is designed for more comfort (robust and adjustable head assembly) and comes with adjustable earphones.	 <p>Figure 43 - Vive Deluxe Audio Strap (afjv, 2017)</p>
Requirements	HTC Vive	
Price	?	
Remarks	Coming soon	

QUESTIONNAIRE

Company

Field

Preferred holiday type

Name

Email

Sex

Age

1.0 Do you know AR/VR technologies? If yes, which ones?

Yes No

2.0 Have you seen AR/VR technologies applied in tourism? If yes, how and where?

Yes No

3.0 Do you think AR/VR technologies could be useful in tourism? If yes, how / in which field?

Yes No

4.0 Do you think reviving a touristic spot (e.g. the Colosseum) would be interesting? If yes, how?

- Yes No

5.0 Which artificial reality would you implement? Why?

- Different season Different scenarios (e.g. battle)
 Different century Get more information through text
 Different perspective Get more information through video
 Different buildings Others: _____

6.0 Which technologies do you think would fit best? Why?

- Augmented reality – Microsoft HoloLens
 Virtual reality – Oculus Rift
 Virtual reality – Smartphone with Cardboard
 Others: _____

7.0 Is there any process which could be replaced with AR/VR (e.g. introduction process)? If yes, which one?

- Yes No

8.0 Do you think AR/VR technologies could replace the normal audio guides? If no, why?

- Yes No

9.0 Would you prefer to be guided by a person or by a AR/VR system? Why?

- Person
 AR/VR system

10.0 How important do you think interactivity is (e.g. swordfight)? Why?

- 1 2 3 4 5

11.0 How long should a tour/virtual experience be?

12.0 How much do you think would visitors pay for this experience? Why?

13.0 Which business model would be preferred by the service provider?

- Classical model – direct sale
- Low-cost model – pay more for audio, CD...
- Advertising model
- Others: _____

14.0 Where do you see risks/critical factors?

15.0 What do you think is the max weight/size for such a device? Do you think there are other criteria that a visitor will use/not use a device?



AR – Microsoft HoloLens



VR – Smartphone with cardboard



VR - Oculus Rift