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MASTER'S THESIS

**INNOVATION OF 3D TECHNOLOGY IN SLOVENIA: INDUSTRY
DEVELOPMENT AND CONSUMER ATTITUDES**

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LIST OF ABBREVIATIONS

sl. – Slovene

3D – (sl. Tridimenzionalno); Three-Dimensional

2D – (sl. Dvodimenzionalno); Two-Dimensional

AV – (sl. Avdiovizualno); Audiovisual

Pro-AV – (sl. Strokovno Avdiovizualno); Professional Audiovisual

AVIXA – (sl. Združenje za Mednarodno Trgovinsko Avdiovizualno Industrijo); International Trade Association for the Audiovisual Industry

VR – (sl. Virtualni Resničnost); Virtual Reality

S3D – (sl. Stereoskopska 3D); Stereoscopic 3D

FPS – (sl. Okviri na Sekundo); Frames per Second

HD – (sl. Visoka Ločljivost); High Definition

DLP – (sl. Digitalna Obdelava Svetlobe); Digital Light Processing

HHI – (sl. Herfindahl - Hirschmanov Indeks); Herfindahl - Hirschman Index

EMEA – (sl. Evropa, Bližnji vzhod in Afrika); Europe, Middle East, and Africa

POS – (sl. Prodajna Točka); Point of Sales

C-3D – (sl. Učilnica 3D); Classroom 3D

CVEs – (sl. Sodelovalno Virtualno Okolje); Collaborative Virtual Environment

CAD/CAM – (sl. Računalniško Podprto Načrtovanje in Proizvodnja); Computer-Aided Design and Manufacturing

VM – (sl. Virtualni Model); Virtual Model

FAANG – Facebook, Amazon, Apple, Netflix, and Google

AR – (sl. Povečani Resničnost); Augmented Reality

INTRODUCTION

3D (three-dimensional) cinema business reached to the historical peak during 2009-10. However, this rise could not stay longer and after a couple of years, the entire industry together with 3D equipment manufacturers and the cinemas had to face a recession. This thesis addresses and identifies the key moments and tentative reasons of the market fluctuation thru history exploration, secondary information analysis, presentation of previous figures, and the assessment of the consumer attitudes. In this thesis, I briefly discuss a unique product, which is a 3D equipment (3D stereoscopic glasses, projection tools and the display). There are two types of consumers in the 3D market, domestic users/home entertainment/leisure (3D video games, 3D TV users) and commercial users, the cinema attendance.

From the sales perspective, overall 3D market splits into two groups, Retail Market and Corporate Market. Retail 3D market is not the center of concentration for the professional 3D manufacturers/sellers because of its small size. Corporate 3D market (cinemas) has a larger exposure; hence, this is the core of business for the 3D appliances manufacturers. Based upon the reliable preceding eight years' secondary information (2009-2016), I believe that the Slovenian cinema industry confronted quiet fluctuation. Cinema attendance was steadily increasing from the year 2010, however later in 2012, the market gradually moved towards the recession period. Next two years 2013 and 2014 proved the worst period of the decade. While cross checking this information from another source at the global level, it revealed that overall business of 3D cinemas confronted the same momentum of deviation in these years. This thesis elaborates the tentative reasons of such market fluctuations with the help of the secondary and the primary data analysis.

For the purpose to accomplish the aim of the thesis, exploratory research offers the grounds to measure certain facts and descriptive statistics. In the start of this research, I received some preliminary information about the 3D industry by writing emails to the companies. This information provided a possible ground to study a business dilemma of a specific entertainment industry. Meanwhile, I conducted a skype interview of a 3D cinema professional from the US who provided some useful global 3D industrial information and the guidance to source the secondary data. With the help of Slovenian database (www.bizi.si), I was able to contact a largest film distributor *FIVIA/CENEX*. This company provided me the sales records of Slovenian theatres from 2009-16. In the meantime, an analytics company *IHS Markit* from London cooperated and sent me the global 3D business dynamics data. Based upon this handy secondary data, I developed some research questions. Strong coordination with the mentor lead me to develop the research hypothesis. To get the vivid answers to the research questions, I studied and analyzed the secondary data of Slovenian 3D industry that provided a significant support to conduct the primary research of consumer attitudes. The results of primary research elaborate the flaws and recommendations for 3D products that could be the managerial implication of this research.

The research model comprises three research questions and five hypotheses to achieve the goal of this thesis:

Research Question 1: What are the trends in the development of 3D technology?

H1: Pro-AV industry is sensitive and highly correlated to the innovation.

H2: 3D technology is versatile and having different trends.

Research Question 2: What are consumers' attitudes towards 3D cinema in Slovenia?

H3: Consumer attitude towards 3D movies is less favorable than 2D movies.

H4: Technological adoption among the cinema audience is rare.

Research Question 3: Is there any business feasibility of VR (Virtual Reality) and its potential effects over 3D Industry?

H5: VR Cinemas have a likelihood to replace 3D cinemas.

First research question addresses the trends of the 3D products and the industry. Two hypothesis H1 and H2 supports the first research question. First hypothesis H1 describes the effects of innovation over the 3D industry. In this regard, I rely upon the web/online articles from the media agencies and summarize the fascinating information about the industry. There are a variety of usage of 3D technology; I discovered four unique uses of 3D products (beyond 3D cinemas) to support the second hypothesis H2.

To perceive how and why consumers stopped visiting 3D cinemas, I designed the second research question. From the consumer's point of view, this research question explicitly addresses the pitfall of the 3D industry. In order to answer my second research question, I developed subsequent two hypothesis H3 and H4. The third hypothesis H3 is about the study of consumer attitudes towards the 3D cinemas. In order to study the consumer attitudes, I accumulated the fundamental information thru online survey. Based upon the collected information, I analyzed the descriptive outcomes of the variables. With the help of my fourth hypothesis H4, I tried to discover further reasons for the decline of the 3D influx in the cinemas. For this purpose, I approached the developers of 3D products with a questionnaire and conducted their brief inputs to verify how much 3D products are user-friendly.

To foresee the future of 3D, I designed a third research question about the assessment of Virtual Reality (VR) and its future impacts over 3D as the contemporary technological enhancements are often replacing the preceding consumer products. Present global statistics indicate the soaring figures of VR retail sales. VR is slowly taking the first place in the home entertainment nowadays. As VR is an advanced degree of 3D technology, my H5 addresses the feasibility and the evaluation of VR cinemas to answer the third research question.

The thesis structure consists of four important chapters, besides the introductory chapter. The first chapter describes the background of the 3D industry and the understanding of 3D products. This chapter introduces the types of 3D products, represents the market competition analysis, and summarizes the Porter's five forces analysis.

Second chapter addresses the core of narrative study. It includes the various usage of 3D technology, introduction to the Virtual Reality and its history. There are global as well as Slovenian 3D industry dynamics of previous decade that elaborate the decline in the 3D industry. The third chapter outlines the methodology of this thesis, comprises upon the data collection techniques, research methods, research model, and the ethical consideration to conduct research. The fourth chapter presents the analysis of the primary data collected from the survey and the questionnaires. The analysis chapter also describes the consumers' adoption of 3D technology and their critical views about the 3D experience at the cinemas. This chapter confines the research outcomes, analytical figures, and the primary data figures acquired from the survey about 3D consumers in Slovenia. The additional section in this chapter is an evaluation of VR and the future of 3D. Thesis conclusion, references, and the appendixes are in the last section.

1 BACKGROUND OF PRO-AV (3D) INDUSTRY

I will briefly discuss here a 3D (three-dimensional) visual eyewear that we use to watch a three-dimensional video or content. For the simplicity, an example is a 3D pair of eyeglasses to view a film in 3D mode in the cinema foyer. According to the definitions by WTO (1998), 3D products and services fall in the category of the Audiovisual Services Industry (article S/C/W/310 of WTO).

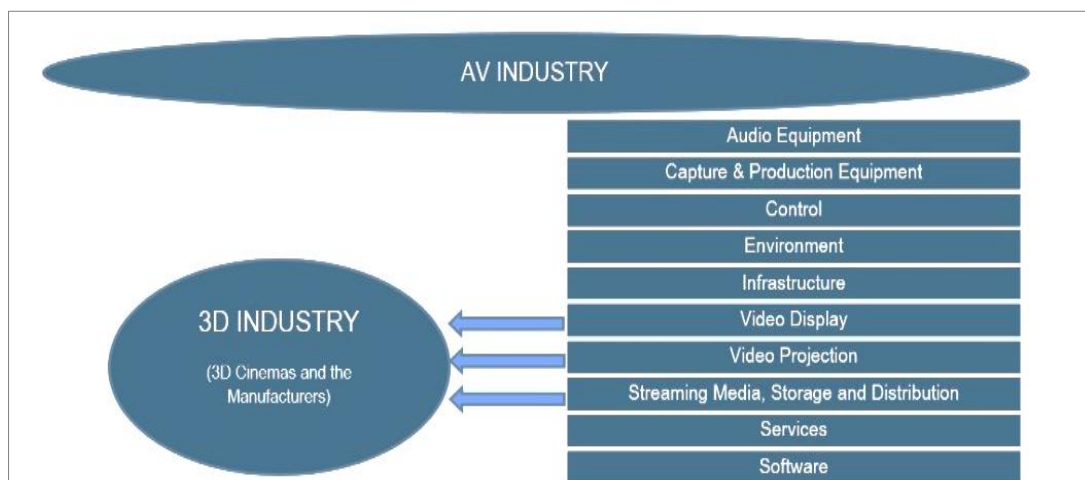
The market experts consider 3D industry as a niche market as it deals with the specific consumers whose center of interest is only 3D movies. As Parrish (2010, p. 554) defined, niche marketing strategy focuses a specialized consumer segment or the market. The professional 3D manufacturer companies are focusing only the 3D cinema audience; such companies even exclude the home 3D TV users from their target market. The industry comprised of the sub-sectors like Motion Pictures Projection, production and distribution of video, broadcasting and transmission, and other correspondence and services in connection with the Motion Pictures. According to a statistical review of WTO (2016), the value of global audiovisual products and services exports and imports reached up to \$20.62 billion and \$25 billion respectively in the year 2014.

Manufacturers of 3D equipment like 3D glasses, projection support devices and some other special electronics products are the key players of the industry. Several companies are forward integrated, i.e. they have the core business in 3D equipment manufacturing and their own 3D cinemas as well. This integration provides the in-house facilities to the research and

development department to test their new products and prototypes at actual scale. Such companies carry the competitive advantage of confidentiality, as they do not need to approach the test centers.

AVIXA (Audiovisual and Integrated Experience Association) provides a platform of industry analysis and reports. There are two orientations of the audiovisual (AV) industry. The vertical markets for AV industry includes Cinemas, Corporate level Projection, Education supporting Visuals, Energy and Utilities, and Healthcare. While the horizontal markets consist of the products and services like Audio and Video Equipment, Production Equipment, Video Displays, and Visual Software (AVIXA, 2017).

Figure 1: AV and 3D Industry Relationship



Source: Adapted from AVIXA (2017).

AV industry is a spectrum of home entertainment and consumer electronics, while 3D industry is a sub-sector of AV industry that deals only with the displays, projection and streaming, as shown in Figure 1. The customers of 3D manufactures are primarily cinemas while the end users of 3D products are the cinema customers. Hence, the cinemas are the intermediary between the 3D manufacturers and the end users. Amusement and event management companies, electronics retailers, trade show organizers, and the home users are also the customers of this industry. Cinema is the platform for the end-users of 3D products; hence, the study and analysis of the cinema business reveal the development of the 3D industry. Cinema has a key role to maintain the influx of consumers by providing their demanded video contents/movies.

1.1 3D Products

3D movies started in early twentieth century, when the Lumiere brothers presented a short movie in France. The commercial release of a 3D silent movie appeared in 1922 at a theatre in Los Angeles, people watched this movie with anaglyph lens glasses. Arch Oboler released

the first technically complete 3D movie *Bwana Devil* with sound and colors in 1952 (Schedeen, 2010). 3D is a mode of watching a display where view becomes or feels real. The feelings of watching a good 3D scene make the pleasant impression on the viewer and give a mental involvement into the scene. Elsaesser (2015, p. 253) explained that 3D movies are an example of immersion. This 3D immersion enables the viewer to differentiate the distance of the displayed object.

The stereoscopic 3D image consists of two images (left and right) which represents the view from the left and right eye. For the each view, there is a depth map that produces the illusion of depth perception and creates a third dimension (Northam, Asente, & Kaplan, 2013). Kim, Nam, Baek, Son, and Hong (2003, p. 686) stated that the user or the viewer need the special 3D viewing device, which composes of stereoscopic eyewear, or a pair of 3D glasses. The latest technologies made stereoscopic 3D (S3D) displays more accessible for the consumers (Hands & Read, 2017, p. 35).

According to Connolly and Billingsley (2006, p. 266), stereopsis are two simultaneous viewpoints, but our brain automatically generates the depth information and that is how the distance is visible through human eyes. During the production of movies in 1950, Hollywood was using stereo cameras, i.e. a pair of cameras to generate 3D contents (Connolly & Billingsley, 2006, p. 267). According to Jonathan (2009), a 3D system is made of three major equipment:

- Digital Screen
- 3D Signal Emitter
- 3D Pair of Glasses

The digital screen can be a 3D TV (a built-in feature to show the content in 3D mode) or a Cinema Screen (the 3D projector is a separate unit in the cinemas). The screen of cinema does not have any capability to develop the display, but it is a platform where the projector creates the image. The cinema projectors have the capability to show the display in 2D format or 3D format. The content or the movie is available in two different formats, i.e. 2D and 3D. If the content is not available in 3D format, the projector itself cannot display into 3D. A synchronization module calls “Emitter” that controls the signal output from the 3D Player or Cinema Projector. This emitter sends the infrared signals to the 3D glasses to respond according to the display output of the TV/Projector. Electronically controlled pair of 3D glasses, which flick at a specified frequency and synchronize with the frame rate (moving frames per second) of the video. The lens of the glasses (left and right) will close and open quickly, this process calls “shuttering”. One lens will open and other will close, the operation repeats as the 3D TV or Projector displays the 3D video.

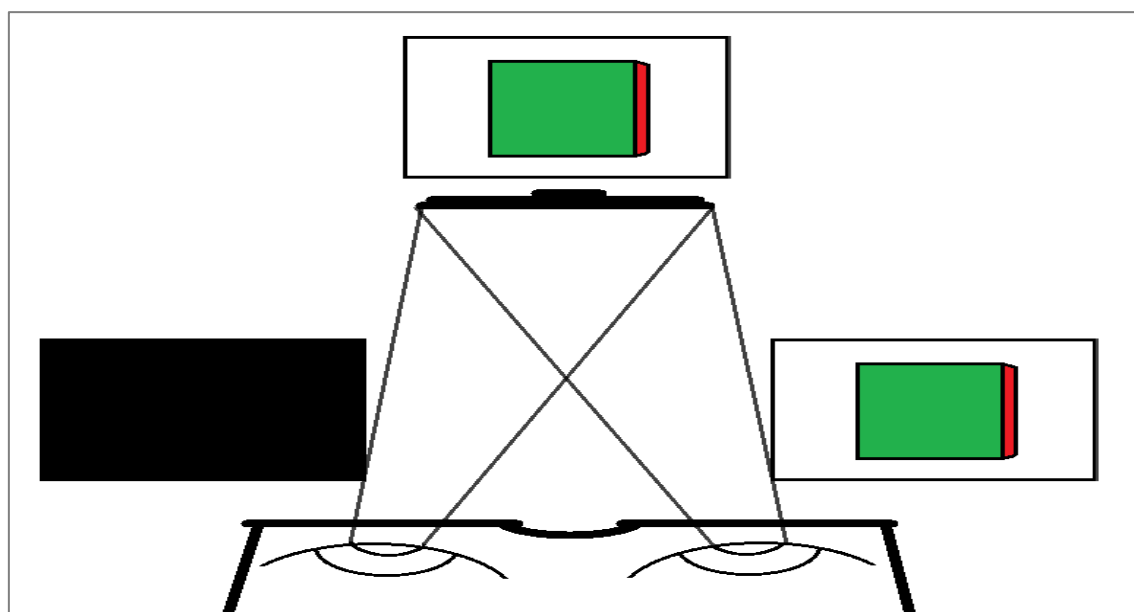
The screen must have the ability to play 3D format, but before the display, the content (movie) must have an option of 3D version that require highly technical graphics and stereo camera work. According to Shin (2012), many companies like LG, Samsung, Panasonic, and

Sony are manufacturing 3D TVs with the same momentum of growth as the 3D games and the contents are coming into the market. While explaining the role of 3D TV in the home entertainment he states “Projections for consumer spending on 3DTVs are \$17 billion by 2018” (Shin, 2012, p. 56).

“When photographed from two positions in the air and fused stereoscopically – scenes that showed little when viewed in two dimensions with one eye alone would reveal hidden images when seen binocularly in a true stereo 3D experience” (Holbrook, 1998, p. 301). The content shows three-dimensional images at the same point, the first image is on the left side, and the second image is on the right side. The middle image is the combination or the immersion image of the left and right image.

The pair of 3D glasses are able to flick the lenses, at one moment, one lens is shutter-off and other lens is open (left lens is shutter-off/black and the right lens is ON in the below figure). The flick rate is fast enough to catch the frame rate of the movie, this process calls “synchronization”. The below Figure 2 shows the red and green side of the screen image and at the same time the right side of the 3D glasses is open i.e. Red and green. Meanwhile the left side of the glasses is close i.e. Black.

Figure 2: Working Mechanism of 3D



Source: Cedric and Mehdi (2017).

Strickland (2009) states that the key feature of 3D TV is to show the same image in two different locations (i.e. Left and right side). This trick forces the brain to assume the image with depth and hence the image becomes like real. There are two categories of 3D products:

- Active 3D systems
- Passive 3D Systems

Active 3D Systems control the active 3D glasses, which flicks with the frequency of the project or moving display. The controlling device is a digital emitter that emits the radiation signals to command 3D glasses to flick according to the FPS (Frames Per Second) of the display. Here the compatibility matters where the 3D projector or TV should match the frequency of this emitter.

Emitter commands the glasses to flick (open and shut) at the same velocity as the presentation FPS. An Active 3D pair of eyeglasses is an electronically controlled device that is standalone and contains a battery cell to provide the power for the electronics components inside the chassis.

A red device is an emitter, and the black device is a distribution module, as shown in Figure 3. A distribution module works as a bridge between the multiple displays (Projectors/TVs) and the emitter. The emitter connects with the projector/TV and controls the 3D glasses with radiation or infrared. In order to control the glasses, the emitter emits the radio frequency in the surroundings, if the 3D glasses are within the range of this frequency they will connect and respond according to the commands of this emitter. In order to cover larger halls like cinema and exhibitions where people are using the 3D glasses from a large distance, more emitters are required to make the larger field range. In order to work properly, 3D glasses must be within the radius of emitter's frequency.

Figure 3: Active 3D System



Source: Xpand Vision (2017a).

Passive 3D Systems control a 3D polarized pair of glasses, which synchronize along the projector. The passive 3D glasses contain flat lens without any electronics components or battery neither feature of flicking. Since the Passive 3D glasses are without any electronics features so they are less expensive. However, certainly it does not mean that the Passive 3D projection is cheaper than the Active one. The screen for the commercial use (Cinema Level) is called Silver Screen which is way expensive than the normal screen. *Passive 3D System* does not support the normal screen.

Here is a demonstration of *Passive 3D System*; a polarized conversion module that fits in front of the projector. This module converts the display rays into polarized 3D display; the simple glasses shown in Figure 4 are Passive 3D glasses.

Figure 4: Passive 3D System



Source: RealD Inc. (2017).

The passive 3D glasses have less life span than the active 3D glasses. Cedric and Mehdi (2017) state that the choice is always from the customers, but the Active 3D is more preferable because of the full HD (High Definition) resolution. According to Fielding (2012, p. 4), passive 3D projection requires the silver screen, the rise of 3D movies brought back the trend of the aluminized screen.

1.2 Industry in Brief

The industry consists of few 3D companies. Based upon the number of companies in the industry, it is easy to evaluate that the industry is highly concentrated but from the geographic perspective, market share shows a different picture which I discuss in the subsequent Competition Analysis.

1.2.1 Operation Strategies of 3D Companies

The story of the available products within the industry starts from their own headquarters with the ideas and the product development. Once a company develops the product, it acquires the mass production facility in Fareast with the same mechanism as the tech giants like Samsung and Apple do. 3D companies finalize the design and development with the in-house resources, meanwhile to achieve the economy of scale, production moves to China, Malaysia, and Singapore. Companies perform the product finalization process within the organization. Once they receive the semi-finished goods from the production facilities, in-house production centers of the company perform the software installation and final touch process. Most of the companies are US-based and covering the global reach with their regional sales and support offices.

Salespersons/distributors have multiple products from different 3D manufacturers. For the smaller markets like South Africa, Brazil, India, and Middle East, the freelance salespersons are working with multiple 3D companies. Large markets consist of the regions, for example, European regions are Scandinavia, the UK, Central Europe and Southern Europe. Japan and South Korea control the Fareast while US based offices control Canada and South America. There are 39,783 cinemas in the US and 29,958 in the Europe in 2013 which is the market size for the 3D companies (Simon, Benghozi, & Salvador, 2015).

1.2.2 Market Players

On the commercial level, there are four large professional and specialized companies in the 3D market:

- Real-D Inc.
- Master Image
- IMAX 3D
- XpanD 3D/Xpand Vision

Retail electronics companies like Sony, Samsung, Panasonic, Acer, LG and many more are also providing 3D products. The niche marketing strategy is to differentiate the customers on their demographics, lifestyle, size, and color (Parrish, 2010, p. 554). Since the commercial 3D manufacturer companies are focusing only cinema customers, it is obvious to state that their strategy includes business-to-business customers. The retail 3D manufacturers are mostly focused upon the home users. I exclude the retail 3D companies from the cinema 3D companies. “Since a niche market is small compared with the large main market, there are fewer competitors” (Toften & Hammervoll, 2009, p. 1380). Niche firms often lack of resources like human resources and the market information (Toften & Hammervoll, 2009). “Niche marketing, or nichemanship, is the process of carving out a small part of the market whose needs are not fulfilled” (Shani & Chalasani, 1992, p. 44).

1.2.2.1 Real-D Inc.

Real-D started in 2003 covering the US market with 8,600 cinema screens, completely forward and backward integrated company having their head office in California, USA (Idelson, 2011). “Real-D is an innovator and licensor of stereoscopic (3D) and other visual technologies for use in the cinema and on consumer electronic devices. Real-D has the world's largest 3D cinema platform with over 26,500 screens in 72 countries. Since 2005, over 1.5 billion people have enjoyed more than 200 blockbuster movies in Real-D 3D” (RealD Inc., 2017). According to the website of Real-D, the company is sole manufacturer of their own 3D equipment (3D Glasses, 3D Emitters and the Cinema Projection tools).

Presently, Real-D is sponsoring the Hollywood (Marked posters: *Watch in Real-D Theatres*). This marketing strategy is an effective way to communicate with the customers. As E.-J. Lee, Lee, and Schumann (2002, p. 21) conclude that the successful way of communication could affect the consumer adoption of technology. As the cinema customers come across the advertisement of the movie with the option of 3D, it influences them to decide between 3D movie and 2D movie. If the poster or the advertisement of the movie does not show the 3D availability, customer will not even think about it. Real-D acquired Master Image in 2017; the details are presented in Market Competition Analysis.

1.2.2.2 IMAX 3D

IMAX is having the long history of the development of immersion since 1968, the headquarter is in Ontario, Canada (IMAX, 2017). There are four major players in North American 3D market; Dolby 3D, Real-D, MasterImage and XpanD, while IMAX 3D is too expensive to include in the competition. They are having the largest market share in the Canada (Bragée, 2010, p. 2). IMAX uses dual projection that is highly expensive (Fernandez, 2013). The difference of the technology is that IMAX is using two projectors; each projector creates images on the screen that increases the cost of the cinemas, as shown in Table 1. Due to this unique standard, IMAX claims their differentiation in the 3D market at the higher price.

Table 1: 3D Technology Comparison

	IMAX 3D	Real-D 3D
3D technology	Linear polarizing	Circular polarizing
Projector	Dual projectors*	Single projector (with 3D lens)
Screen	Silver coated	Silver coated
3D glasses	Large format (for larger screen)	Standard size
Audio	Uncompressed	Varies by theater

Source: Fernandez (2013).

1.2.2.3 XpanD 3D/Xpand Vision

XpanD develops 3D eyewear products and 3D theater solutions, established in 2008. XpanD incorporated in 2008 from Nu-Vision in Beaverton, Oregon USA. “XpanD Inc. operates as a subsidiary of X6D Limited” (Bloomberg Inc., 2017). X6D Limited is a Slovenian company with the headquarter in Ljubljana. The present name of XpanD is Xpand Vision. This company has a long history since 2005 when Boyd McNaughton (owner of Nu-Vision Company) was working on a liquid crystal shutter lens glasses (Ray, 2012, p. 257). XpanD 3D was working along with X6D Limited Slovenia and it merged in 2009.

Xpand Vision has a competitive advantage in quality and the brand image by using DLP (Digital Light Processing) technology in their 3D glasses lens (Texas Instruments, 2017). This company has a strong technical background to manufacture the lightweight lenses for the *Active 3D Systems* (Andreas, 2008). They are also covering the market share in *Passive 3D Systems* gradually. Having the geographical advantage, Xpand Vision is approaching Asia and Europe simultaneously. France is the largest place of cinema screens in the Europe and Xpand Vision has a strong goodwill there. Moreover, the company is well related-diversified in the market segmentation. They are increasing the market share by integrating with the event management, theme parks, medical, and other complimentary products.

Active 3D glasses are reusable with built-in electronics frame and the projection is less complex. They claim the good 3D quality for the customers. “XpanD already dominates Japanese 3D exhibition and rivals Real-D in European market share” (DiOrio, 2010). There is no need of *the Silver Screen* to convert a theatre into 3D, theatres can also play 2D movies and 3D movies (DiOrio, 2010). A *Silver Screen* supports only *Passive 3D Systems* while a normal cinema screen (*for example Perlux Digital*) supports *Active 3D Systems* as well as it can also display 2D movies (Screens, 2017).

1.2.2.4 Small Market Players

Dolby 3D has a good historical background and they entered into the market with *Passive 3D Systems* but more expensive and reusable glasses (Idelson, 2011). While exploring the US 3D market shares, Idelson (2011) discovered that Master Image uses the same techniques as Real-D because of their corporate relationships. Panavision is another 3D company, but they own only 50 screens in the US and South America. Technicolor tried to enter the market with the lower 3D conversion cost strategy. Technicolor can convert a normal 2D theatre into 3D theater at the lowest possible cost. They have also their own products, but mostly working in *Passive 3D Systems*. These small players are still trying to exploit the market share with the differentiation or somehow cost efficiency, but strong competitors are giving them a tough time.

1.3 Market Competition Analysis

Real-D has acquired Master Image including all the assets, technology, inventory, accounts and premises in February 2017 (CJ Wire, 2017). There was a lawsuit between both parties about the conflict of several patents, which Real-D won. After this acquisition, the US 3D market became more concentrated and Real-D is a monopolist. Even in 2013, Real-D was carrying most of the market share, “Real-D is the undisputed frontrunner, with greater than 85% market share in the US” (Peddie, 2013).

I analyze the market concentration through the Herfindahl - Hirschman Index (HHI) (Investopedia, 2017). The method is to square each market participant’s market share and make the sum of those numbers. The result will range minimum from zeros to maximum 10,000. If the number is closer to 10,000, the market is highly concentrated and monopolistic. If the result is closer to zeros, then the market is competitive.

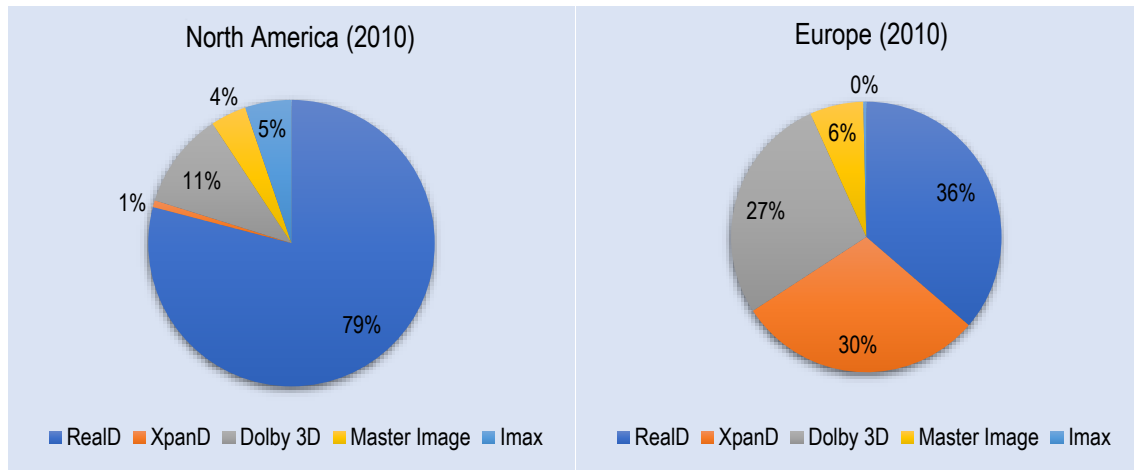
$$HHI_{i...n} = \sum_{i=1}^n S_i^2 \quad (1)$$

According to the above equation, I squared the market share of each participant and divided by the total market share. Market shares of five competitors in the US and the European market are shown in the below Figure 5, I took these figures from the year 2010. Real-D has 79% market share in the US and 36% in Europe. Dolby 3D is a second market leader in the US with 11% and third in Europe with a 27 % market share. While Xpand Vision is the second market leader in the Europe with 30%, and carries the minimum market share in the US with the last rank. Master Image carries 6% and 4% market shares in European and the US market respectively. IMAX, the Canadian company, almost not visible in the European market, but has 5% market share in the US.

According to the database from IHS Markit (2010), I calculated the HHI Index of the both markets. The market shares of all five companies in the North America (US Only) give us the HHI Index of 6,404 points. The HHI Index for the Europe reveals the figures of 2,961 points. Hence proves the US market was more concentrated in 2010. Real-D owns 79% of the market share proves them monopolistic in the year 2010 while the European market is more competitive.

Since the recent data for the market shares are not available, I kept the figures of the year 2010 and added up the market shares of Real-D and Master Image (since they merged in 2017). It gives the US market HHI index 7,036 points and Real-D clean sweeps the market share by holding an 83% share. Recent figures concretes the monopoly of Real-D, “In North America, Real-D has 91% market share among 3D theaters, with more than 13,700 screens, and 36% of 3D screens worldwide use the Real-D system” (Idelson, 2016).

Figure 5: Market Shares of 3D Companies in 2010



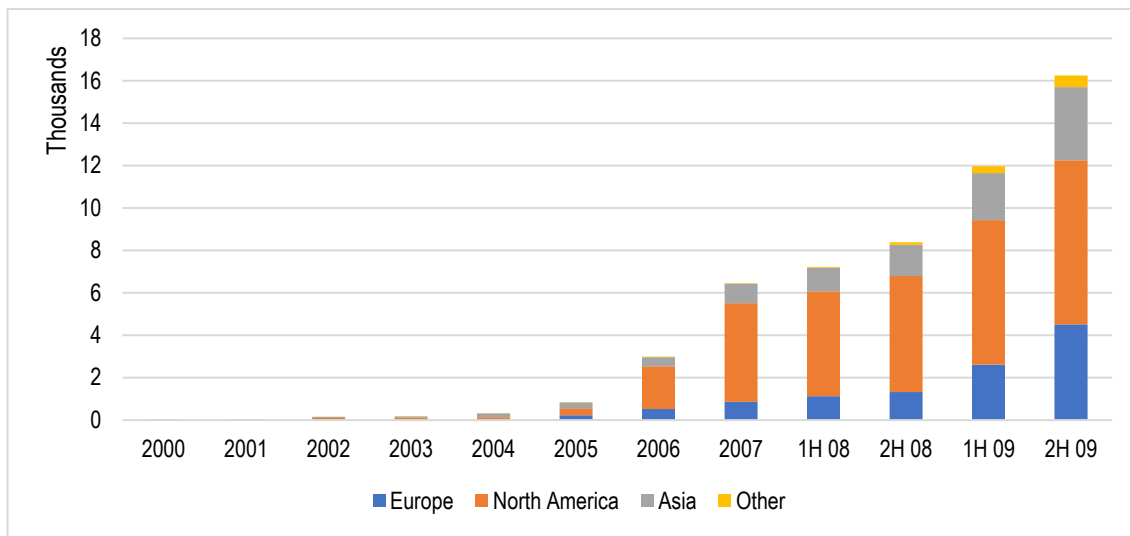
Source: IHS Markit (2010).

1.4 Industry Dynamics

Warner Bros released a sci-fi movie *Journey to the Center of the Earth* in 2008. At the worldwide level, this movie generated 3.7 times more business in 3D format than 2D format (Mead, 2008). This was the year when 3D industry set foot in the boom phase. Early 2009 brought *Ice Age 3: Dawn of the Dinosaurs* and the most awaiting *Avatar* came to the cinemas in December 2009. As shown in Figure 6, both movies made their unusual 3D business and gave a rebirth to 3D cinemas. There was a magnificent investment rise in the 3D cinemas during 2008-09. The graph bars of 2008 and 2009 divide into six months split to compact the figure.

There were around 7,000 worldwide 3D cinema screens in the first half of the year 2008. During the second half of 2008, it crossed over 8,000. The European and the US markets grew at this time. There were 12,000 3D cinemas in the first half of 2009 while during the second half of 2009, 4,000 new 3D cinemas appeared in the market. The second half of 2009 represents a tremendous growth of 3D cinemas. Since 2006, European and the US markets are gradually growing while Asia and the other markets have steady growth with a slight of deviation. Outrageous growth in 3D business during 2008 and 2009 represents the historical era when people were really talking about the 3D cinemas.

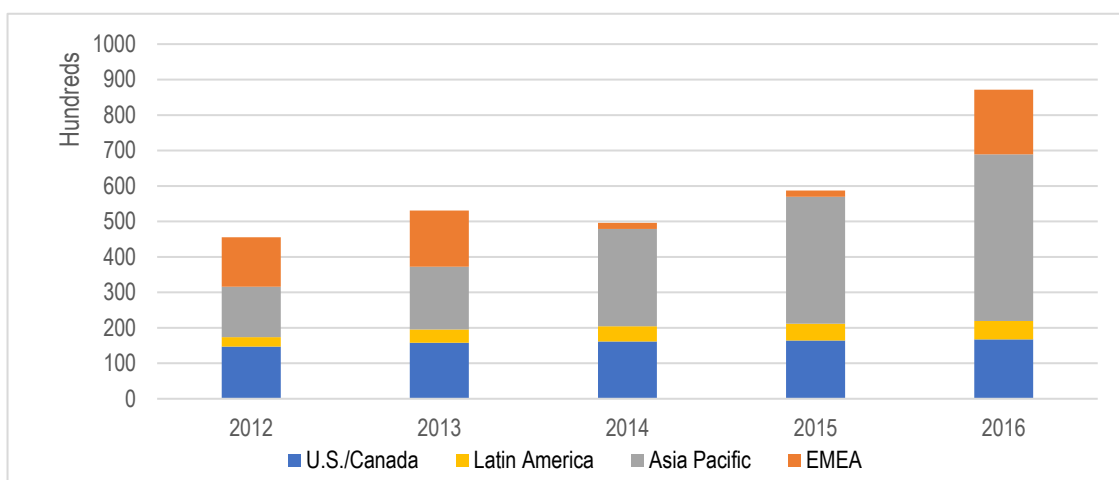
Figure 6: Worldwide Number of 3D Cinemas (1)



Source: IHS Markit (2010).

The information from 2009 was not available from the same source, but I made the second chart from another source that is Figure 7, which shows the data from 2012-16. During the year 2012, there were more than 400,000 3D cinemas around the world. The year 2013 also shows some growth, but 2014 reflects the recession period, for sure in this year 3D cinemas converted into the 2D cinemas again. This was not a good year for the 3D cinemas, only the US shows some growth in 2015 and 2016. EMEA (Europe, Middle East, and Africa) shows a noticeable fluctuation in 3D cinemas. There is a difference in the US and European market for the 3D theatres. The statistics represent the fact that EMEA stopped playing 3D films during 2012-16 (Motion Pictures Association of America, 2016). While the number of 3D theatres gradually increased in the US and South America. The chart of Asia shows the sudden growth in 3D theatres during the year 2016.

Figure 7: Worldwide Number of 3D Cinemas (2)

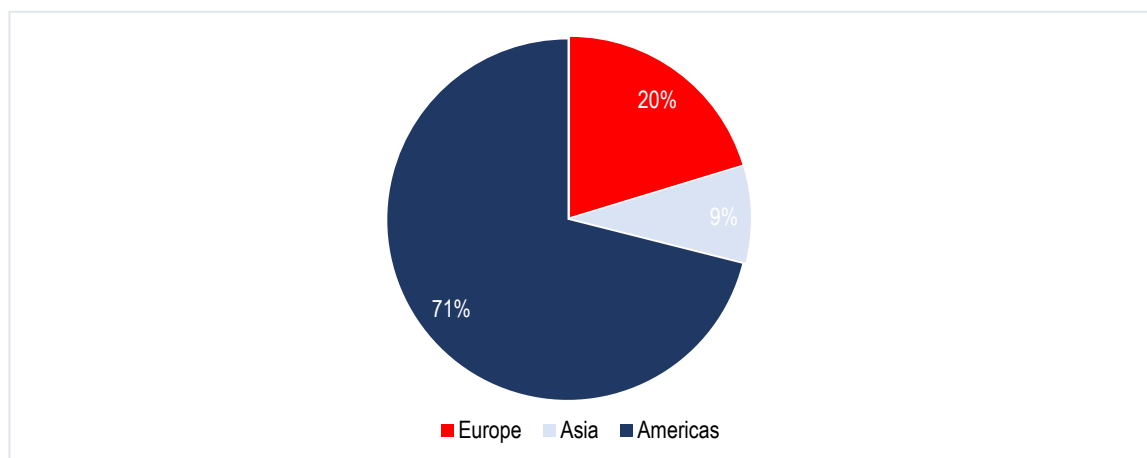


Source: Motion Pictures Association of America (2016).

Cost management is problematic for the cinema owners. In the US market, movie distributors are covering the cost of 3D glasses. They include the appropriate quantity of 3D glasses in the price of a 3D movie (Macnab, 2009). Nevertheless, the European cinema owners are afraid of loss. Studios are responsible only for the content, while the distributors are not interested to cooperate with the cost of equipment as they practice in the US. “One reason expressed for US success in movie exports is a comparative advantage from economies of scale” (Marvasti, 2000, p. 100). The reason of decline in the 3D screens in the Europe seems the lower market share in the film production. Growth of 3D Cinemas has been declining since 2011 because of the increased proportion of 2D installed screens (Motion Pictures Association of America, 2011).

Since Hollywood is in the US, it is easier for the movie distributors to influence 3D trend among the cinema owners and the audience, as shown in Figure 8. Europe has a language barrier, cinema audience usually prefer to watch the domestic production movies. Just top ten Hollywood movies show up in the European cinemas. Almost all the European theatres provide the local language subtitles for the Hollywood movies. The UK film production houses normally work with Hollywood while other European countries have their own domestic production companies. France and Germany are some of the largest movie production houses in the Europe. France released 272 movies in the year 2011 with the total spending of €1.4 billion. The production of 207 movies was entirely French while the remaining was co-production (Leffler, 2012). Another tentative reason of Real-D’s larger market share in the US could be the relationship marketing strategy. Relationship marketing helps to develop the relationship with the customers and build the network for mutual benefits (Shani & Chalasani, 1992, p. 44). Being geographically in the same country, Real-D could conveniently build networks with the film producers, distributors as well as with the cinemas.

Figure 8: Worldwide Market Share of Film Production



Source: IHS Markit (2010).

IHS Markit (2011) uncovers the revenue analysis; during 2010, 3D cinemas generated \$6.1 billion while this figure was \$2.5 billion in 2009. This exceptional surge in the market resulted the establishment of 30,000 new 3D cinemas worldwide by the end of June 2011. The US and the Canadian 3D markets grew by 36% in the year 2010 from preceding year's revenues.

As Table 2 describes, the US market revenues from 3D market was \$1979 million. Japan standalone generated \$471 million revenues from the 3D cinemas in the year 2010 while the UK stood third largest territory in the 3D market with \$336 million. Brazil was a largest 3D market in the South America while Mexico was the second one. Slovenia* is the small 3D market on the 25th rank, yet made \$3.5 million business from the 3D cinemas during the year 2010. During 2010, 3D industry recorded the highest growth rate in Columbia and Argentina, 35.6% and 26% respectively. China and Mexico accounted the highest profit margin for 3D films in the year 2010.

Table 2: Worldwide Revenues of 3D Movies in 2010

Rank	Country	Revenue (Million \$)
1	USA	\$1979.5
2	Japan	\$471.0
3	UK	\$427.6
4	France	\$364.7
5	Russia	\$336.5
6	China	\$289.5
7	Germany	\$280.1
8	Australia	\$236.4
9	Italy	\$216.9
10	Canada	\$194.9
25*	Slovenia	\$3.5

Source: IHS Markit (2011).

1.5 Porter's Five Forces Analysis

While communicating with the companies for the information regarding their internal process, it was difficult for them to cooperate. Therefore, I collected the information from their newsletters and the websites. To reach the depth of industry analysis, I followed the Porter's five forces model. I used the preliminary information from the selected companies via Skype. I collected the product description by analyzing the insight of the equipment and studied the electronics components by disassembling them.

1.5.1 Supplier Power

For the manufacturing of 3D equipment, the companies usually require two types of core components; Electronics components and Mechanical components.

The electronic components are available at several POS (Point of Sales). The material is available mostly on the websites and online stores. Each component has the category and description, which makes the process of sourcing the material quite easy and simple. Some of the electronics components manufacturer companies are Farnell (2017), Microchip (2017), Mouser (2017), Digi Key (2017), RS Components (2017), Robot Shop (2017), and 4D Systems (2017). Each company has region wise decentralized warehouses and web shops. Mouser Electronics is an American company but decentralized into the regions. For the Europeans, they have two or three big warehouses where different categories of stock are available for the quick access. The head of inward and outwards is in Germany (Frankfurt) while in Slovakia and Czech Republic they have the storage facilities. As the customer approaches the web store, the website directs to the local region (for example, www.mouser.com for the US and www.eu.mouser.com for the Europe). In case of the unavailability of the product in the region store, the product travels from the United States (delivery charges depend upon the size of the orders).

I came across a managerial dilemma regarding the global production and standards. European and the US measurement systems are different that gives a challenging situation for the production houses. If a 3D company wants to make their product globally integrated and easy to install, it needs to be flexible in terms of use. Metric system (Meters, Kilograms) prevails in the European market while the US has an Imperial system (Feet, Pounds). A production house in Europe will have the difficulty to source the components and raw material in imperial measures while a production house in the US is not able to find the war material parts in metric measures. The US designed product contains the imperial measure parts while European products are made on the metric system measures. Hence, in this case the companies have to import the material from another region.

The mechanical products relate to the outer core of the products (i.e. covers and casings). More than 70% of mechanical goods are available from the same sources of electronics material vendors. 3D companies, mostly rely upon the local vendors regarding the accessories and outer mechanical parts because they want to keep their products different and less modifiable. Even after the complex material and specialized components demand, I consider the lower supplier power in the industry. The core of the product depends upon the electronics components, while the availability is quite common. The cost of the components is some cents, which decreases relevantly as the volume increases. The chances of defect raw material are lower as the manufacturing of such components has the technological efficient plants in the Far East and the US.

1.5.2 Buyer Power

The buyers of 3D products split into two major categories: Individual Users and Corporate. The next section about the versatility of 3D explains the details of the corporate use. Individual users are commonly using the products related to the Home Entertainment like

3D Video Games, 3D TVs, and small projections. The Corporate level users are not the end users, but the Business-to-Business entities, which provide the entertainment facilities of visual services like Cinemas, Theme Parks, and Educational Institutions. The experience goods are those whose qualities cannot be identified before the purchase (S. L. Arthur, 2005, p. 45). Furthermore, “The market area for search goods is wider than the market area for experience goods” (S. L. Arthur, 2005, p. 46).

Since 3D products categorize as the experience goods, the quality or differentiation is the priority of the customer. Availability and the advertising is not much frequent as a grocery or search goods. Consumers’ demand is not frequent but once it arises, the purchasing decision depends upon the knowledge of the 3D product and the described features. The life of the product prolongs at least up to one year. The possibility of damage of the 3D eyewear is more than the other 3D equipment. Amazon (2017a) shows the retail price of Active 3D glasses vary from €35-80 approx., summarized in Table 3. These retail prices are for those customers who have already 3D system or a 3D built-in TV. The life of the battery depends upon the usage (from 100-250 hours). There is a problem with the Active 3D glasses, the customer is bounded in such a way that the switching cost is too high, the other way is to sacrifice the quality.

The experience goods have two characteristics, the actual value is determined after using and the social, political, and economic influence (Hawkins & Davis, 2012, p. 236). Here the corporate consumers’ switching cost increases as the influence of customer insists to adopt new technological goods (i.e. Cinema). The 3D glasses will support only the same manufacturer (i.e. Sony 3D will work only for Sony 3D TV). There are few products launched by some manufacturers to fill the market gap of retail sales. Some unknown brands from the Chinese manufacturers are available in the market, but there will be problem of synchronization. One of the biggest flaw that a consumer can face in 3D viewing is *ghosting*. If the 3-dimension image does not synchronize properly with the 3D glasses, there will be double image visible in the content. In simpler words, there will be a noticeable shadow of each object. Hence, the buyer has a less power as the switching cost is high.

Table 3: Retail Price Comparison of Active 3D Glasses

Company	Model	Specification	Prices \$
XpanD	X105	Active Shutter Glasses	\$54.99
Panasonic	TY-EW3D3ME	VIERA HDTV	\$81.20
Hi-Shock	Black Diamond	HDTV	\$49.90
Samsung	SSG-51002	3D Active Glasses	\$34.99

Source: Amazon (2017a).

Passive 3D glasses are available only from €5-10, which also depends upon the compatibility. “Passive 3D glasses are cheap, just a few pounds for each pair of glasses” (3D TV Technology, 2017). The corporate 3D buyer like cinema owners are stuck in the cage as it is a onetime investment. Hawkins and Davis (2012, p. 237) relate the experience goods

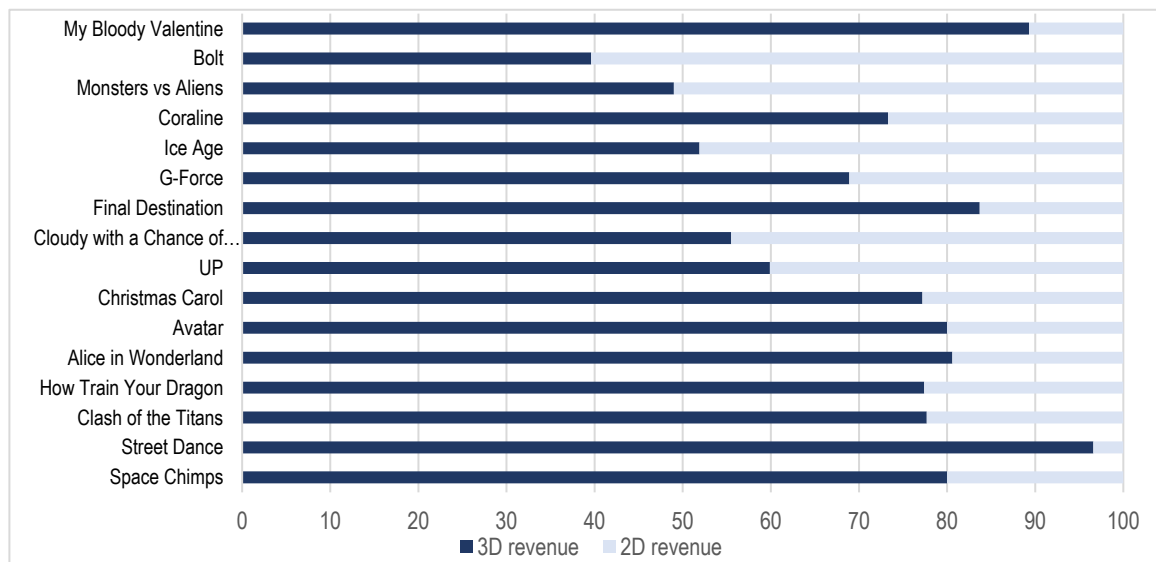
with the media, entertainment, and the lifestyle. Technological and non-technological innovations have large impact over the experience goods. Cinema or the corporate buyers of 3D products have high switching cost as well as the innovation impacts on the facilities and quality.

1.5.3 Threat of Substitutes

There are no substitutes for the 3D, there are tentative substitution of VR, but the technology is the same. Following section about the Virtual Reality describes the product and details of the technology. 3D itself is an upgrade of 2D visuals that we normally view on each TV or display set. There are no substitutes so I can state that the product itself has the strength of differentiation. On the other hand, the 3D product depends upon the content (3D based movie). The contents/movies are compliment goods and without compliment, the product itself is useless.

The reason for the massive 3D business during 2009-10 was due to the good Hollywood movies (Figure 9). “Disruptive technologies, like the spread of 3D in films, brought to market changes. Eight of the ten top grossing films in 2009 had a strong visual effects component” (Simon et al., 2015, p. 102). However, the availability of compliment can influence the market; 3D is a compliment driven product highly sensitive and correlated to the production of 3D movies and video games.

Figure 9: 3D Content as the Compliment of 3D Cinema (2009-10)



Source: IHS Markit (2010).

1.5.4 Competitive Rivalry

Since the industry directly related to the innovation and high end technological products, there are less chances of collaboration. Competitive rivalry among the companies is highly intense. Each company is trying to keep its competitive advantage safe and strong.

There are competitive companies from Far East trying to catch up the quality, but the forward integration in the US and the sponsorship with the Hollywood is keeping the US based companies strong. However, there is a separate market for the cinemas in Middle Eastern countries, but the culture and the language of the movies split apart these two markets. Having few key players shows the high market concentration. As the technological information and the specialty of the product is involved, companies are strict rivals to each other.

1.5.5 Threat of New Entrants

There are several barriers for the new entrants; existing giant companies like Samsung, Sony, Panasonic, and LG are not interested in the 3D industry at the corporate level but they are making 3D glasses for their retail 3D TV users. To open a corporate level 3D business requires a huge diversification, since there are future challenges and fruitful profitability in the smart phone business so these companies are busy enough. At the corporate level market, there are many gaps, but a large investment required to enter as a 3D manufacturer or start a 3D cinema chain. Existing 3D companies have already built their huge walls of brand image that the new entrant need to be extraordinary to cross them, while goodwill is another part of the game. The acquisition of Master Image by Real-D increased the power of US market and now certainly small players will face tough times. Existing 3D companies have already taken the market share so there are barriers to the new entrants. The European market is competitive while the US market is monopolistic. Asia could be a center of interest for the new entrants as the Industry Dynamics showed a rise of Asian 3D market during the present years.

2 TRENDS OF 3D TECHNOLOGY AND INNOVATION

This chapter comprises upon the 3D cinemas' dynamics of Slovenia from year 2009-2016. By continuing from Slovenian 3D cinemas, I discuss the global various trends and other uses of 3D technology. Subsequently, I move towards the innovation of the 3D technology with tentative movements and diversification of the tech giant companies. Virtual reality is the second type of 3D that I discuss in the last part of this chapter with its history and future influence on the customers. VR is an advanced 3D and a hot cake product since last couple of years. VR technology has a faded history from the eighties, but present integration with the smartphones brought back this technology into the limelight.

2.1 Dynamics of Slovenian 3D Market

Slovenia is geographically small country with plenty of interesting facts and awards. XpanD belongs to this country, which is one of the leading 3D brand in the world. Cinema trend is quite popular among the people. The previous five years data of Slovenian theatres show interesting figures regarding the 3D and 2D movie viewers. The 3D trend arose among the Slovenian cinema fans in 2009 as blockbuster movie *Avatar* hit the local theatres. Producers and directors developed new technologies to reach for the new level of visual effects in this movie (Simon et al., 2015, p. 103).

The previous chapter described the story of 3D at the worldwide level; the data from Slovenian 3D cinemas also represent the same resemblance of deviation. I collected a raw data on sales figures from Fivia (2017), which is the largest distributor of movies in Slovenia. Apart from the distribution of the content, this company also provides the specific and customized analysis of the industry to the owners of Slovenian cinemas. Since 3D boom also influenced the 3D cinemas of Slovenia, the company was maintaining the figures of 3D and 2D separately from 2010-2013 to focus upon two different sections of cinemas. As the 3D declined after 2013 in Slovenia, the company stopped collecting and managing the data separately and piled the 3D and 2D movie figures collectively. Based upon this database, I tried to establish an adequate answer that supports our third hypothesis H3: The consumer attitude towards 3D movies is less favorable than 2D movies.

2.1.1 Analysis of 3D vs 2D Movies in Slovenian Cinemas (2010-13)

I extracted the sales figures of best five 3D movies of the year (the most watched 3D titles in the cinemas of Slovenia) and tried compare with the same title in 2D format. The base year is the release year. In the category of *Animation* movies, the local cinemas offer four types of shows:

- Slovenian audio Synchronized (2D)
- Slovenian audio Synchronized (3D)
- With Slovenian Subtitles (2D)
- With Slovenian Subtitles (3D)

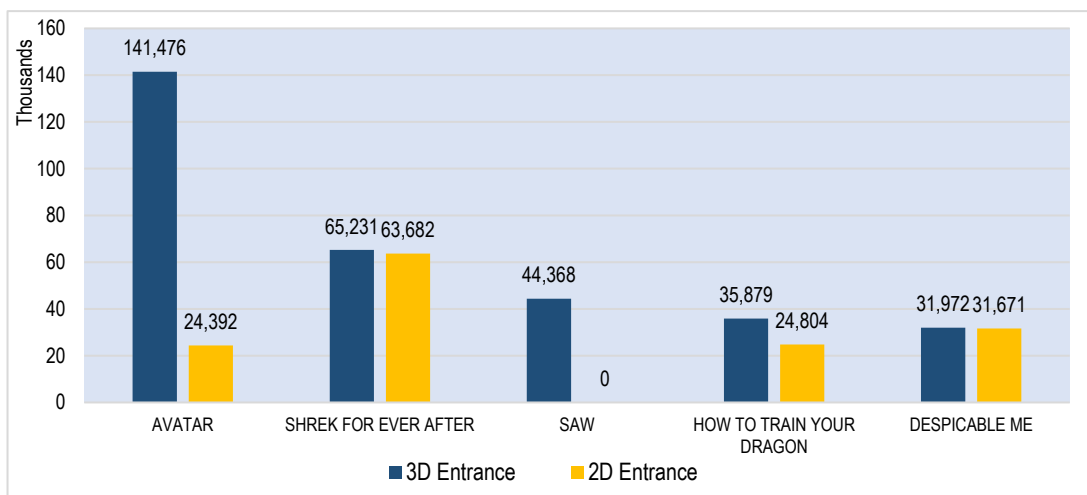
As the purpose is to analyze the difference between 2D and 3D inflows, so I submerged synchronized and subtitled movies together. The animated movies are mostly for the kids, so there is more attendance in Synchronized version. A movie can last longer than one calendar year. For example, *Avatar* released on December 17, 2009 in Slovenia and on the next day in USA. The movie kept running in the theatres for more than six months (i.e. Until June 2010). As the data for 2D movies and 3D movies was not available before the calendar year 2010 so I excluded the time from December 17 to December 31, 2009 in the case of *Avatar* and compared it from First January 2010 onwards.

There are total 45-50 cinemas in Slovenia while the number of screens are 90-95 (Fivia, 2017). Some additional cinemas have only seasonal openings during the annual movie festivals. Some of the cinemas are only dedicated for the 3D movies. Nevertheless, most of the cinemas are convertible and playing both 3D and 2D formats. Based upon the previous six year data (2010-2016), on average 2.37 million annual visits are recorded at the commercial cinemas of Slovenia (Fivia, 2017). For the previous six years, the business of the Slovenian cinemas is average €113 million per year.

The total number of people who watched *Avatar* in Slovenian cinemas were 165,868 and 85% people watched in 3D mode, as shown in Figure 10. This is the most 3D watched movie from 2010-2013 in Slovenia. There are plenty of reasons behind the 3D trend, however the management of cinemas told about the quality of content, storyline, and the marketing and advertising expenditures of the producers. Still, there are plenty of other blockbuster movies, which released in that four-year span, but none of them crossed 3D business of *Avatar* or even hit closer.

The remaining four 3D movies from the year 2010 also made their good business in 2D formats; the cinema attendance is equal for both formats except *How to Train Your Dragon* where 3D format again took an edge of almost 20% over 2D mode. *Saw* was available only in 3D format.

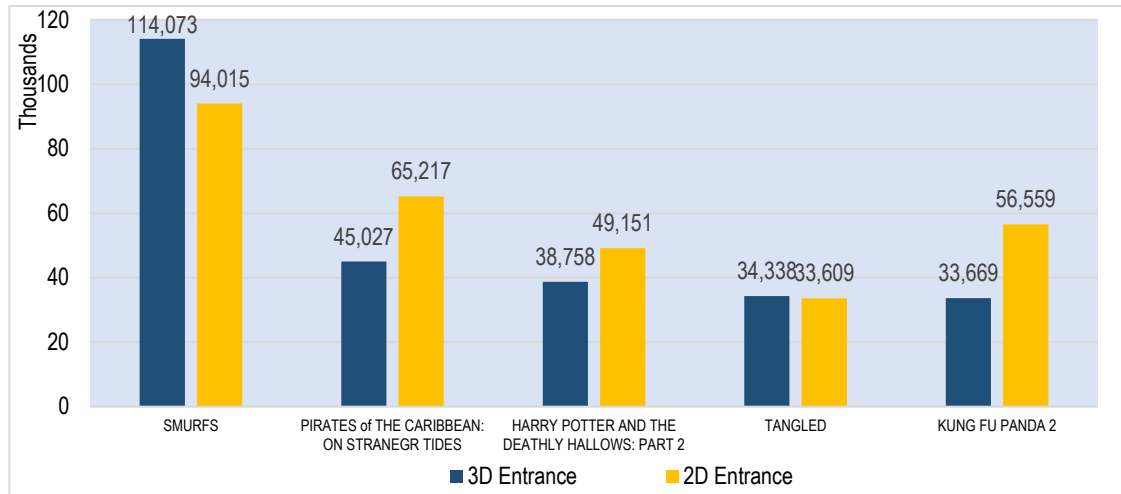
Figure 10: 3D Entrance at Slovenian Cinemas 2010 (the peak year)



Source: Fivia (2017).

We can observe a noticeable difference from 2011 data where only *The Smurfs* in 3D mode crossed over 2D mode, as shown in Figure 11. This was the animated cartoon movie, other than this; all of the remaining four movies' 2D mode attendance is higher than 3D mode. We can cross check the market effect here, as according to the Motion Pictures Association of America (2011) the 3D trend started declining during 2011 at worldwide level.

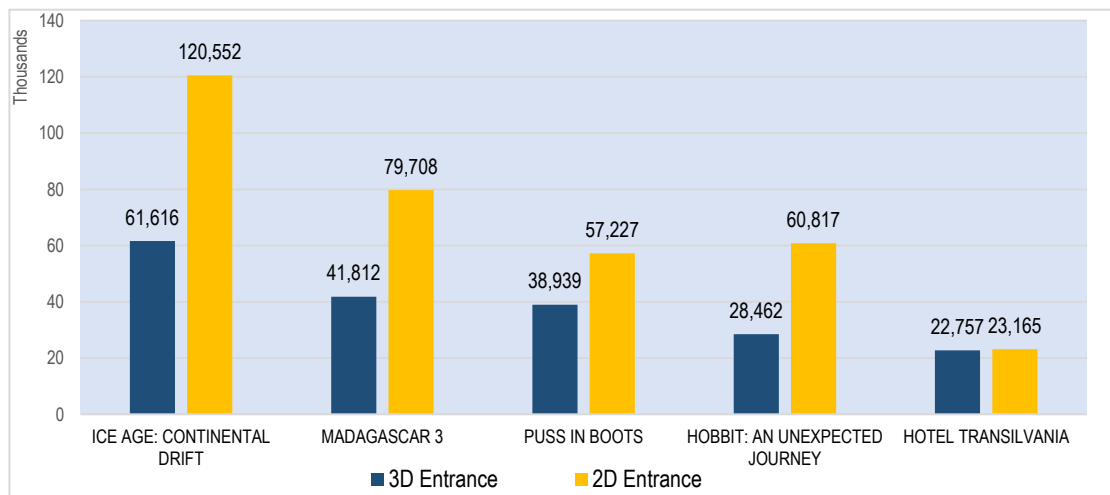
Figure 11: 3D Entrance at Slovenian Cinemas 2011



Source: Fivia (2017).

The graph of 2012 shows substantial depression of the 3D market in Slovenia, beow Figure 12. None of the best 3D movie could win against 2D; the charm of 3D among people went down. Most of the good 3D movies were animation in the year 2012. The entrance for the best 3D movie of the year could make only five-digit business, while during the preceding two years 3D movies were making six-digit business in Slovenia.

Figure 12: 3D Entrance at Slovenian Cinemas 2012 (decline period)

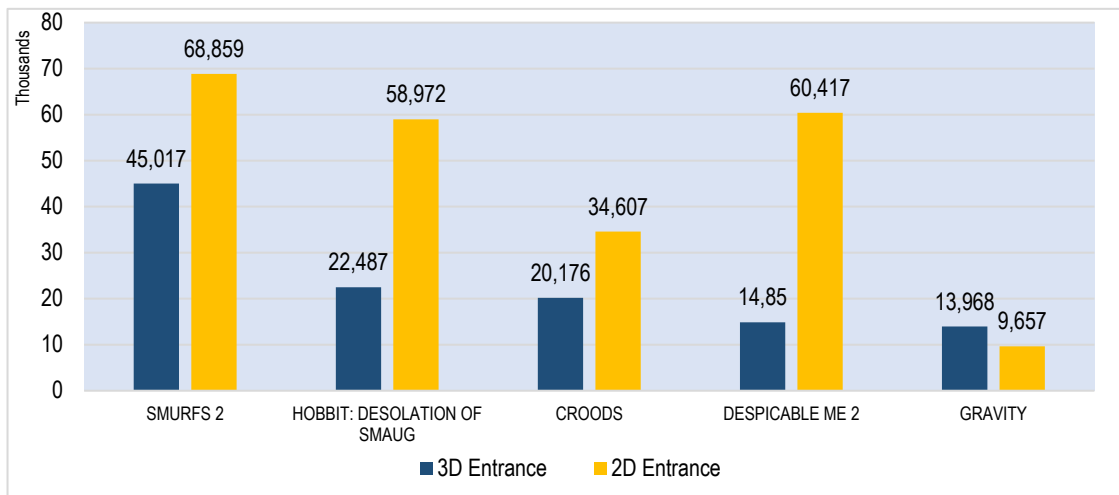


Source: Fivia (2017).

The total appearance for *The Smurfs 2* in 2D is larger than 3D during the year 2013, as shown in Figure 13. The overall attendance (both 2D and 3D) in 2013 is also less than the first part of *The Smurfs* 2011. There were 208,088 people in cinemas for Smurfs in 2011, while for *The Smurfs 2*, only 113,876 people appeared, this time 94,212 kids did not show up in cinemas for their favorite movie. The remaining 3D movies of the year 2013 did not perform well. Other animated movie, *Despicable Me 2* was also the best 3D movie of the year, but

could not make good business in front of 2D format. The year 2013 also shows the decline favoritism of 3D among the kids. The last ranked good 3D movie of the year 2013 was *Gravity*. It was a sci-fi movie and we can see there were more people for 3D format, but overall, this movie could not make a good business. Probably the content was good enough to convince the audience to appear in 3D format as *Avatar* did.

Figure 13: 3D Entrance at Slovenian Cinemas 2013 (recession)



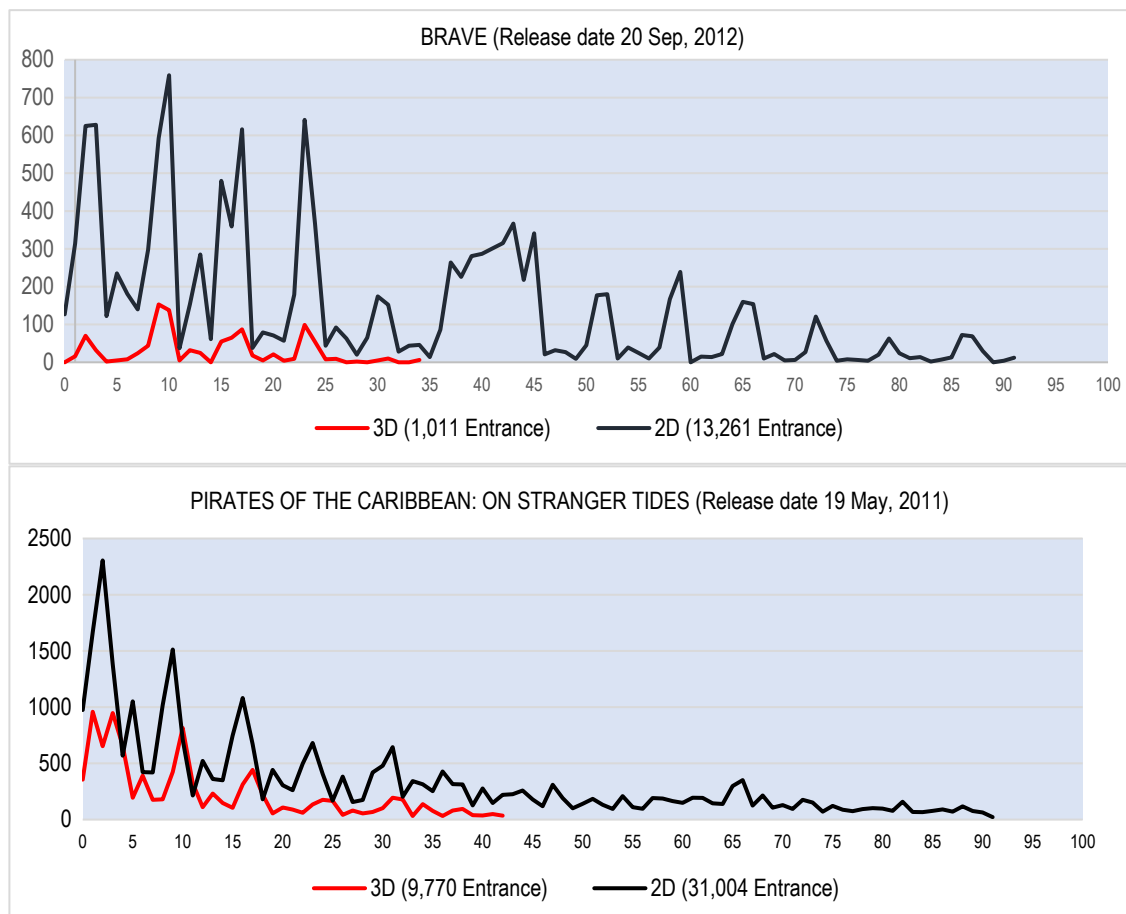
Source: Fivia (2017).

2.1.2 Timespan of a 3D Movie in Slovenia

I calculated the life span of a movie (2D vs 3D) in a Selected Theatre D.o.o. (2017) to ensure if people really do prefer 2D format more than the 3D format. As the results are shown in Figure 14, 2D format movie lasts more than twice than a 3D movie mode.

Here is the graph presenting the data of a selected cinema in Slovenia. *Brave* (animation, released on 20 Sep 2012), the 2D mode movie stayed in the theatre for 92 days while 3D mode movie eliminated just after 32 days of business as there were no more viewers coming to watch. Another example is in the second graph, there is an adventure-genre movie *Pirates of the Caribbean: On Stranger Tides* (released on 19 May 2011). I compared, the 3D format winded up after 42 days while the 2D movie kept running for 92 days. The graph of *Brave* shows that kids are more likely to appear in the cinemas during the weekends and the holidays. The graph of *Pirates of the Caribbean: On Stranger Tides* shows that adults have also the same behavior to visit the cinema on the weekends, but it is a slight consistent during the weekdays as well.

Figure 14: Life of a 3D Movie



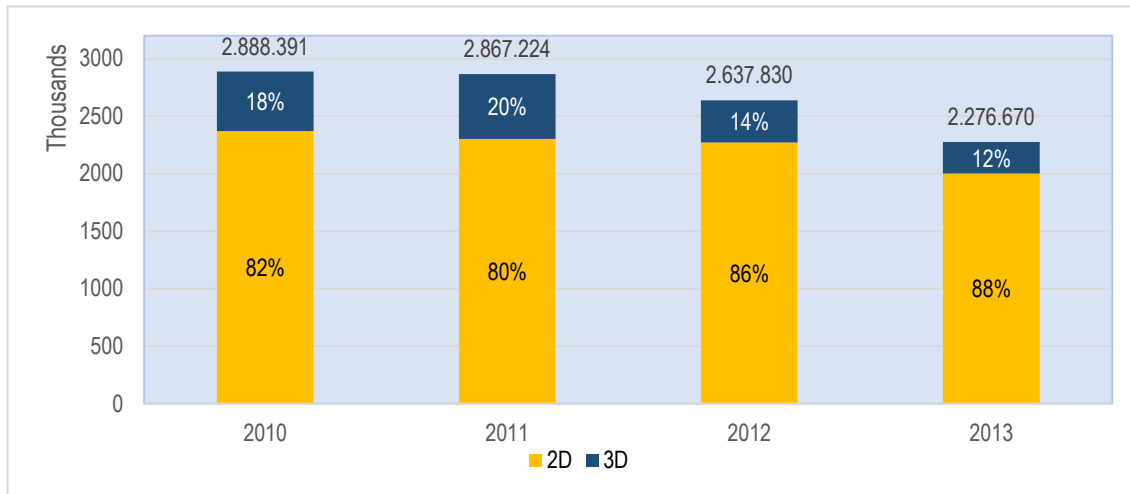
Source: *Selected Theatre D.o.o.* (2017).

2.1.3 An Overview of Slovenian Theatres (2009-16)

I split the all the entrance of Slovenian cinemas into the 2D and the 3D formats from 2010-13. The graph represents the increase of entrance in 2010, a little bit decline in 2011 and gradually decrease in 2012 and 2013, as shown in Figure 15.

The proportion of 3D viewers increased in the year 2011 by 2%, while the overall entrance was less than from the year 2010. From 20% in the year 2011 to 12% in the year 2012 is the noticeable decline in the 3D entrance. Despite the fact, 2D viewers were still gradually increasing in the year 2012. During the year 2013, both movie formats declined by 2%. Above figure represents the decline in 3D as well as in the 2D formats of the movies in the year 2014. This figure up to some extent shows the resemblance of the worldwide 3D cinemas from 2012-16 which is described in the Figure 7 on page 14.

Figure 15: 3D Cinema Trend in Slovenia (2010-13)

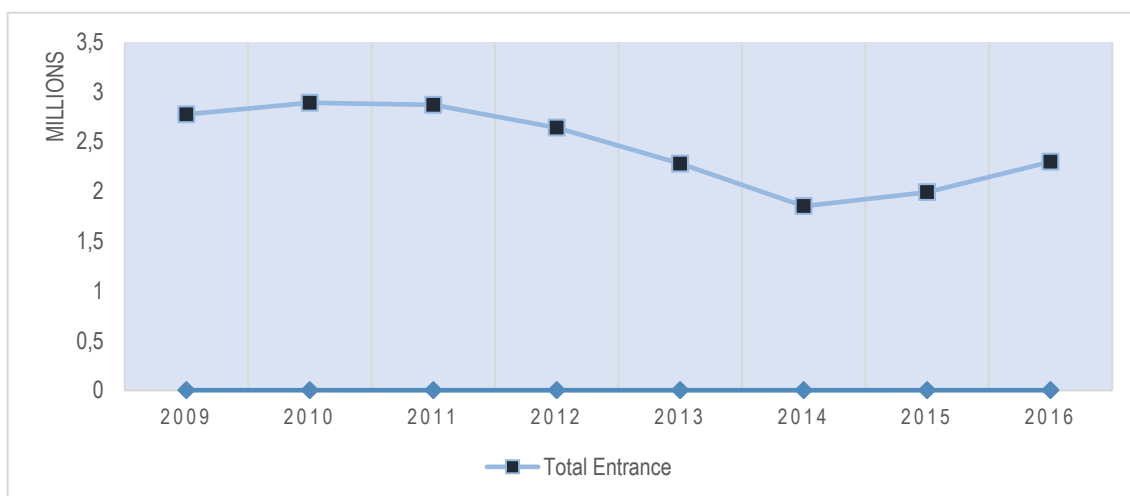


Source: Fivia (2017).

The following Figure 16 is the overall (3D and 2D formats) entrance to the cinemas in Slovenia. Here is also the same decline in 2014 is noticeable, proves the Slovenian market was also under the same influence as the worldwide market.

Overall cinema business in Slovenia is gradually increasing over the year 2014. It is gradually increasing again in the year 2015 and 2016 that shows positive impact over the cinema business. Slovenian cinema managements comment that 2017 is going to be more successful than 2016. Since the present data is not available in the split of 3D and 2D modes, so it is not possible to reveal that how much audience is coming for 3D. However, certainly the tendency towards the cinema is gradually increasing since last couple of years.

Figure 16: Cinema Inflow in Slovenia (2009-2016)



Source: Fivia (2017).

2.2 Versatility of 3D

Commonly the 3D technology is famous only as a mode of watching movies or playing video games. However, there are several useful sectors where 3D technology is useful on a large scale. The present business models of 3D products, versatility and the diversification of the companies concretizes our hypothesis H₂: 3D technology is versatile and having different trends.

2.2.1 Medical

Medical devices use 3D technology, especially for the cure of eye diseases. A common and useful use of 3D technology is for the Amblyopia. This disease begins in the early childhood with one eye weakness. The affected eye will lead to the legal blindness if not controlled at early stages (Heiting, 2016). Crossed eyes and misalignment are the symptoms; deeper examination will identify the weak and normal eye. The treatment involves a strabismus surgery for the alignment followed by a vision therapy. The vision therapy is to close the normal/good eye with a patch to force the brain to focus and bring into work the affected lazy eye.

For the purpose of this vision therapy (orthoptics therapy), a special pair of glasses is useful instead of patches, as shown in Figure 17. Since the mechanism of Active 3D Glasses is to flick, hence the same tech follows for the vision therapy. One lens of the glasses for the normal eye will be shutter OFF, and for the lazy eye, this will be shutter ON. For example Xpand Vision has a separate medical division for their brand Amblyz (Xpand Vision, 2014).

Figure 17: Medical Glasses for Amblyopia Therapy



Source: Xpand Vision (2017a).

2.2.2 Theme Parks

At the theme parks, there are plenty of recreations and games for the visitors. Theme parks build the props and environment, according to the game or attraction for the visitors. As the special effects include, the so-called “D” increases like 4D, 5D and so on (Corrado, 2017). The special effects of sound, noise, and temperature synchronized with the video that is visible with the Active 3D glasses and the visitor feel the real environment. Disney Quests are the multistory facilities of the virtual video gaming experience in Disney theme parks (Rukstad, David J. Collis, & Levine, 2009, p. 12). McCormick (2015) wrote about the trend of 4D video games in the theme parks of California with mass effects. The visitor will encounter the mass effects over his body like a splash of water or liquid while playing the video game, the games are Sci-fi-based scenes. The Live Park (2017) is another 4D theme park in Seoul (Korea) has the virtual effects. There are virtual games like a maze, 4D art stage, 3D theatre, 4D pavilion, and 4D robot for the attraction of the visitors. MacDonald (2015) mentions in an online article about a Dream Fight recreation theme park of the Netherlands. The visitors sit on the moving vehicles with 3D glasses where they could see the virtual objects (evils, enemies) on the ceiling to shoot them with the laser, as they hit the object it disappears. FutureScope (2017) France has *Arthur the Adventure Park*; there are several adventure games with 3D and 4D effects.

2.2.3 Education

According to Siebert and Stephen (2000), the C-3D (Classroom 3D) technology is useful for the display of human body parts through speckle texture projection. Mikhail and Ekaterina (2012) explained the designing of CVEs (Collaborative Virtual Environment) for the academic purpose. The group of students could observe the visualization of the content in 3D displays. Xpand Vision has a separate education division, which designs the Insta3D Classrooms, as shown in Figure 18.

Figure 18: 3D Classroom



Source: Wakefield (2010).

According to Xpand Vision (2017b), 3D education for the display of objects in the classrooms is a support for the students as well as the teachers. According to Xpand Vision (2017b), 3D education for the display of objects in the classrooms is a support for the students as well as the teachers, as shown in Figure 18. The company is already with a collaboration of a couple of schools from the UK, The Abbey School (2017) and The Embbrook School (2017). The classrooms are equipped with DLP Digital 3D projectors to show the difficult diagrams of biology (Texas Instruments, 2017).

An example of 3D teaching is a plant project where the teacher displays a plant cell structure in three-dimensional model, students can see through the 3D glasses for the better and easy understanding. The outcome was impressive as the mean score of 12-13 students in a classroom was 8.33 out of possible 10. Pupils' feedback about the teaching method is interesting as they claim to be more efficient because they can see how the organ as lungs work and they look like. It is also easy for them to memorize the structure of an object through 3D projection. The schools are slowly designing more subjects like chemistry and physics in 3D classrooms (Xpand Vision, 2017b).

2.2.4 Simulation

Flight simulation uses the 3D technology for the haptic feedback (Danaher, 2004). Flight simulator companies use 3D visuals for the training of the pilots. 3D simulation helps to build the architectural designs and the models. The use of 3D projection simulation is an important tool for the engineering. Designing the model and object in 3D simulation enables the viewer to get an insight of the construction of a site, building, or the product through CAD/CAM (Computer-Aided Design and Manufacturing) simulation applications. Many companies like Cyviz 3d (2017) are providing solutions for the engineers with CAD based software and *Passive 3D Systems* to show their engineering product designs to the audience/customers. Another example of simulation and the major use of 3D technology is in the learning driving or playing video games in simulation with the real kind of experience (STEAM, 2017). Fudan University, China used 3D virtual reality for the medical treatment of tumor in 2008. Dextroscope Process builds up the virtual environment of the body part in three-dimensional imaging (Shi et al., 2014).

2.3 Impacts of Innovation on 3D Technology

According to the preliminary information and the correspondents of several companies engaged with the 3D manufacturing and 3D cinemas, the industry is highly concerned about the confidentiality and privacy. Since the technological improvements directly connect to their product development, some companies turned into private incorporations after 2012. The public information is rare and fewer, for example, in the US the largest market shareholder Real-D went into private incorporation, before 2011, this was public incorporated.

The major reason is the concern of confidential information regarding products and technology. As the public corporation, the company was publishing their latest news and technological steps for the public and it was easier for the competitors to access their competitive advantage. The reason of camouflaging the companies supports our research hypothesis H₁: Pro-AV industry is sensitive and highly correlated to the innovation. The less tendency of cooperation among the market participants also shows the sensitivity. Public data do not even include the prices of the products/equipment for the cinemas. Sales figures are not available. During 2009-10, there were some companies such as IHS Markit and AVIXA were somehow cooperating the market participants to show their market coverage. An intermediary role is rising in the industry as some companies are providing tailored services of 3D cinemas. Innovative companies are providing plenty of services to equip the cinemas like installation of 3D equipment, digital projection and 3D glasses (Simon et al., 2015, p. 106).

2.3.1 Innovation in 3D Video Games

Unlike the Gaming World models, companies are designing the Social Networking Worlds as social spaces. The users can explore, build, sell virtual objects, and interact with other users. Without any specific end game, these virtual spaces encourage the user to integrate and extend real world experiences into the VM (Virtual Model) environment (Oyedele & Minor, 2011, p. 31). Latest virtual gaming model example is online stream games like PubG (2017) where the online players can build, sell, and trade their assets to the other players.

“3DTV technology requires the purchase of equipment, including a 3D-ready TV, 3D glasses, and 3D-capable media players. One factor slowing the adoption of 3DTV is a scarcity of content. Video games would be good candidates for 3DTV, but currently, 3D games are not meaningfully different from 2D games for consumers” (Shin, 2012, p. 56). The trend of 3D games is gradually increasing in the public places and at the theme parks, but the cost of building a 3D video game is much higher. Although home entertainment or individual users of 3D games are fewer than 2D games, but 3D online gaming trend is magnificently rising. The earned points has the role of virtual currency that could be gained or withdraw into bank currencies. The surge of online gaming and virtual models can escalate the 3D industry. The virtual 3D gaming models enable the players to make their own avatars to confront the other players; this virtual model is enable 24/7/365 and users access it through high-speed internet (Wyld, 2010, p. 532).

The present technological product and services marketers are focusing on the younger customers (Niemelä-Nyrhinen, 2007). The statement strengthens the 3D and VR product's target market, which is more likely kids or younger generation. The evaluation of the innovation from a consumer is dependent upon the consumer's knowledge in the product category and the supplemental product category (Saaksjarvi, 2003, p. 92). To use such high tech products either online video games or 3D games, the user must have the knowledge to

initiate as well as to troubleshoot the problems. The early adopters of technology could imitate other (Heshan, 2013, p. 1034). Young people have more likelihood to adopt the technology as they see this as the mode of expressing themselves (D. Arthur, Sherman, Appel, & Moore, 2006, p. 34).

2.3.2 Video Content and Diversification of Tech Giants

The tech companies are expected to gain more earnings in the coming years, but it's vulnerable as well since all the companies are one-product based and they are diversifying (Tully, 2017). "Apple, Google, and Facebook are all going to make multi-billion-dollar investments in producing scripted video entertainment seems ludicrous – a folly launched by frustrated nerd-dom" (Levy, 2017). Webb (2017) wrote in his online article about the diversification of Apple towards the programming and production. Apple's music application is already providing the documentaries and reality shows to test the video streaming. "Netflix alone will spend more than \$6 billion this year on programming, including about 1,000 hours of original shows" (Webb, 2017). While 3D movies are already available at Amazon. As the tech companies are entering into the video production market, which is the "content" or the "compliment" for 3D industry, there are chances that 3D industry will have to concentrate upon the home entertainment/retail market besides cinemas.

2.4 The Virtual Reality

Virtual Reality is another kind of 3D technology, as it is also immersion, but at a closer point. The VR headset has the sensors, which allow the user or viewer to look for the content (video) from different angles. As the user moves the head to look around, the sensors, direct the viewpoint in the headset to focus on that side of the content. Since the content has 360-degree viewable capability, that means there are 180-degree (on each left and right side) viewable points. Content companies typically record the movie with a special camera, including multiple lenses.

2.4.1 History of VR

History of VR started between 1950 and 1960 while the first Flight Simulator was introduced in 1970, VR video Games were introduced in 1980 (Yi Xiao, 2000). The images or the virtual environment is not possible to watch through a bare eye, user needs special headset consists upon an enclosure around the eyes. In 1988, Advanced Robotics Research Limited investigated the use of VR to control the robots with human-computer interface in the most hazardous environments. While UK Government funded the project. The same method applied in industrial demonstrations like the maintenance of Rolls-Royce engine. As shown in Figure 19, the hardware accessories of VR consist of a head mounted display provides

180 degrees of horizontal view and 75 degrees of vertical view (Fernandes, 2016). Present version of VR system is a 360 degree view (Gordian, 2015). “NASA has developed a prototype of a simulated patient so that entire operations can be performed on virtual patients” (Patel & Cardinali, 1994, p. 6). The US armed forces prepared a VR project of 500 million \$ for the soldiers’ training to provide a virtual environment of the Persian Gulf (Patel & Cardinali, 1994).

Patel and Cardinali (1994) mention a business model regarding the VR entertainment. A three to four minutes of the VR movie show in a shopping mall with the ticket price \$8 in Ottawa was launched, investor estimated to cover the cost of the project (\$175,000) soon by observing the inflow of people.

Another business model in 1994 was the CAD software for architect engineers. At that time, the software was limited up to only 2D images (Patel & Cardinali, 1994). Yi Xiao (2000) investigated the Virtual Tour of Texas A&M University library. Visit of the library was available through physical tour or the web based tour. The web tour was possible through the internet website with the help of Apple QuickTime VR Authorizing Studio software. The access and the view of the area was possible in 360-degree realistic view. The tour was physical and virtual regarding navigation, reading, listening, and remote access. VR is a mode of communication with the artificial environment. There are barriers for the initiation of such business as “this fantasy is possible not because fewer mistakes are being made, but because the mistakes are being made in simulated environments” (L. P. Lee, 1997, p. 1057).

Figure 19: VR Headset with Samsung Smartphone



Source: Fernandes (2016).

2.4.2 Feasibility of VR

In technical terms, VR is a Three Dimensional Computer Generated Environment that can be interacted with a person and being the part of this environment, the actions can manipulate the objects around (Virtual Reality Society, 2017). Certainly, interaction with 3D graphics is an important element of VR (Stone, 1995). Significance of VR depends upon the richness of the data that makes the visual demonstration of the environment like a supermarket or a

product or the models of a prototype. The 3D virtual reality models for the training of the employees could help to strength the human capital of an organization (Lau, 2015).

2.4.3 Contents of VR

Present era is the fourth industrial revolution, we are unable to imagine the future with the power of development (Sinclair, 2017). The VR gaming market will touch the worth of \$5.1 billion by the end of 2016. Google developed a Cardboard VR headset device for the daily news updates from The New York Times; the device will support Android and Apple mobile phones. Facebook integrated with the travel experience of Venice to show the 360-degree view on Facebook Messenger.

The popularity of VR and the entry of smartphone manufacturer companies into the business signs a beginning of a new era of entertainment. Since 3D or VR Products are *Compliment Driven* as they are dependent upon the “content or movie”, so it is not so far that, the same companies will also diversify into the production of contents. Here, I can see a slight tendency supporting my research hypothesis H₅: VR Cinemas have a likelihood to replace 3D cinemas.

Talking about the stock prices of Nasdaq, Tully (2017) discovered that five tech titan companies are single product companies. Presently, they call these companies as FAANG (Facebook, Amazon, Apple, Netflix, and Google) or investors called them *FAANG Inc.* Explicitly, these companies made a big spike of market share growth. “Since the start of 2016, they have driven the Nasdaq to record after record. As a group, accounted for well over 30% of the strong rise in the S&P 500” (Tully, 2017). The Virtual Reality Cinema (2017) in Amsterdam is already providing a seven-minute VR movie at the price of nine Euros. The content is too short as compared to a two-hour movie, but still the price is higher than the 3D cinema ticket. If the content production from FAANG can disrupt the orthodox trend of cable TV, a beginning of a new era of video entertainment does not seem far. The most important use of VR is for the online shoppers, the products are able to view at extended images and videos.

A survey from Market Intelligence revealed that 35% online buyers showed their openness if the products are shown realistic way on the remote access (Stroppa, 2016). YouTube videos are VR compatible if they are uploaded with 360 degree option (Brendan, 2015). “VR presents a number of opportunities for more impressive marketing and sales, educational, entertainment, and travel (simulation) experiences” (Brendan, 2015). Consumers Electronics Show in Las Vegas presented the Virtual Reality camera which is capable to capture the image at 360-degree (Kesselman, 2016, p. 16).

3 METHODOLOGY

The broad purpose of the research is to describe the industry analysis, including with the consumers' utilization and acceptance of innovation in 3D cinemas. The previous narrative chapters explain the 3D industry players, industry highlights, history, and the competition between the companies. Another purpose of the research is to identify the modes and usage of 3D products in various linked industries like education, medical, recreation, and training. The descriptive part emphasizes the knowledge of a niche market derived from AV industry. Qualitative research method is used to collect the primary data about the individuals' emotions and feelings (Rahi, 2017, p. 2). The reason behind the rise of 3D industry in 2008-10 is the release of consecutive award winning films from Hollywood. The production of such contents/movies is also depends upon the taste of the audience what I revealed through the history of the industry and the literature about the previous decade. This research will identify the consumers' problems while using the product. Our research will elaborate that under which conditions the 3D consumer can make a comeback to the 3D theatres. The technological adoption among the cinema audience is obviously seems rare. Giving a try to the new things is an initiative, but theoretically, the adoption of technological products is actually influencing from others. The users influence the followers, but to find the first drop of rain depends upon the strong marketing campaign from the film distributors.

The following sections under this chapter describes the consumers' approach towards acceptance of 3D movies, specifically in the Slovenian cinemas. There is concrete evidence that the consumers of 3D films are not price-conscious as there is a minor price difference of a 2D and 3D movie ticket of the cinema. There are unsaid reasons behind the decline of 3D audience in the cinemas; the later section of this chapter interprets the descriptive statistics of consumers' preferences and the attitudes.

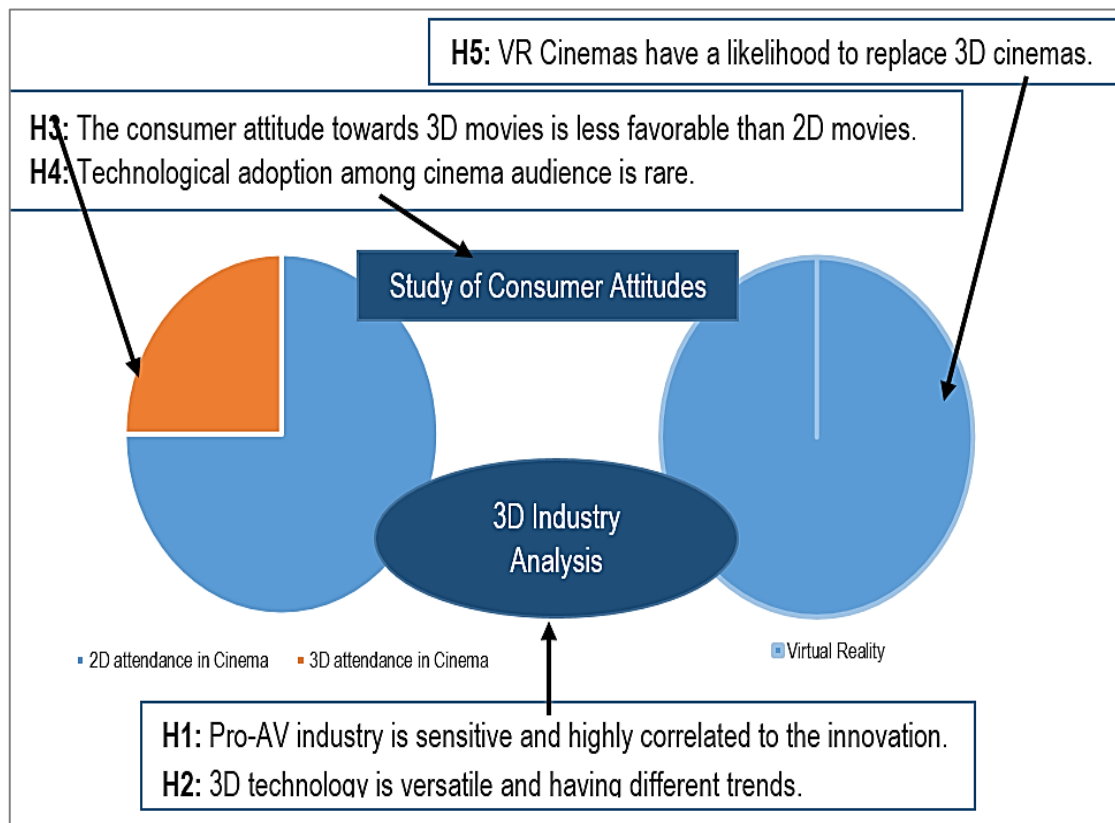
To analyze the consumer attitudes towards 3D and the VR, I use descriptive statistics and the mean ranks. For this purpose, I approach the population with an online survey. I collect the factors that influence the consumers to appear in the 3D cinemas. I study these factors by evaluating the likelihood of certain variables and ask people to rank their preferences. The interpretation of the variables explains the positive influence with the larger mean and lower mean for the negative aspects for a specific variable. The direction of the interpretation is on the positive side, I make the reverse coding for the negative questions in the SPSS. In order to get the meaningful results, I try to include all the possible variables regarding the positive and negative response of the population to evaluate the drawbacks of 3D. To identify the reasons of 3D business decline, I approach the responsible authorities of some 3D companies. I prepared specific set of questions for the developers of 3D equipment and send it via emails. The questionnaire includes the questions regarding the 3D product development and the future of the 3D industry. I will include the personnel of 3D companies from Sales, Engineering and Research departments in my questionnaire. I will also include the partial question regarding the impact of VR over 3D products.

3.1 Research Model

The design of the following conceptual model interprets the linkage of hypothesis and the research questions. The model also describes the chapters' flow of the thesis. The proportionate of 3D audience is obviously less than the 2D where the research question develops the tendency to study the consumer attitudes to get a meaningful answer. The concept of VR links to the 3D as it is the same category of technology with additional features. The industry analysis describes the awareness of multipurpose usage of 3D technology. The analysis of 3D company also includes the competition status among the market players. In order to test the first hypothesis regarding the sensitivity and the relationship with the innovation, I use the industry analysis tool. Narrative chapters test the versatility of 3D technology with the support of secondary data, articles, and company websites.

I test the third hypothesis regarding the less favorability of 3D movies through the study of consumer attitudes via survey. I test the following fourth hypothesis regarding the acceptance of the technological products like 3D and VR among users through the primary data/survey analysis. I test the last hypothesis regarding the feasibility of VR cinemas with the help of a questionnaire from the experts/personnel in the 3D industry. The conceptual research model is shown in Figure 20.

Figure 20: Conceptual Design of the Research model



3.2 Research Methods for Data Collection

The preliminary stage for the secondary data collection was to search for the authentic sources. I tried to contact several 3D companies via emails to build a foundation for the research purpose. It took quite a while to get a lead of the secondary data; a Skype interview with a 3D professional from the US was fruitful. I got useful information about the US 3D market as well as some contacts to source the secondary data.

Surveys are the frequent mode for the collection of primary data on consumer attitudes. Electronic surveys are making the data collection much easier and faster. It is much convenient for the respondent to answer the question on the web-based questionnaires (Saunders, Lewis, & Thornhill, 2012). Self-selection sampling technique allows the individuals to take part in the research upon their desire (Saunders et al., 2012, p. 289). On November 2, 2017, I launched the survey on <https://www.1ka.si>. I shared the survey on various modes of social media; the willing participants conveniently filled out the survey. The survey was active for 53 days. I closed it on December 25, 2017 and made the analysis. The sampling frame is the target population in any primary data collection (Rahi, 2017). My sampling frame randomly covers some other countries as well, but the majority is from Slovenia.

The online survey includes six sets of questions, as shown in the Table 4. The purpose of the first set of questions is to identify the entertainment preferences of a respondent. The concept is to know the recreational activities and the rankings in the priority list.

Table 4: An Overview of Measurable Variables

	Concept	Question Label	Scale
1	Consumers' Preferences	Please rate the following activities according to your preference: Movies, TV Shows, Playing Sports, Hiking/Running, Parties, Travelling, Concerts	Don't like at all – Like it a lot
		Where do you like to watch movies?	List of options
		In a typical year, how often do you go to the cinema to watch a movie?	List of frequency
2	Identification of 3D users and 3D cinema audience	Have you ever used 3D glasses?	Yes/No
		Where did you use 3D glasses?	List of places
3	Problem identification	What was your experience with using 3D glasses in a cinema? 3D glasses made me headache I was worried about hygiene The brightness of the movie was reduced (it was too dark to watch movie) 3D glasses were comfortable to wear I couldn't properly adjust 3D glasses due to my prescription glasses I only watched because of my kids I enjoyed 3D as it seemed more realistic	Strongly Disagree – Strongly Agree

Table continues

Table 4: An Overview of Measurable Variables (cont.)

4	Identification of factors affecting cinema consumers to chose a 3D movie over 2D	<p>If a movie at the cinema is offered in both 2D and 3D options, how important are the following factors in your decision whether to buy the 2D or 3D ticket?</p> <p>(2D Movie is a regular movie, 3D Movie is with a pair of 3D glasses)</p> <p>If the price of ticket for 2D and 3D movie is the same</p> <p>If I have never seen the movie before</p> <p>If someone explicitly recommends to watch a particular movie in 3D</p> <p>If the movie has special effects</p>	Strongly Disagree – Strongly Agree
5	Identification of a VR trend among people	<p>Have you ever experienced a Virtual Reality headset?</p> <p>Where did you use a Virtual Reality Headset?</p>	<p>Yes/No</p> <p>List of available places</p>
6	Analysis of new technology acceptance	<p>What was your experience with using a VR headset?</p> <p>I got motion sickness</p> <p>The Headset was comfortable</p> <p>I felt disconnected from the real world</p> <p>It was amazing, I liked it</p>	Strongly Disagree – Strongly Agree

A second conceptual set of questions is to identify the size of 3D users or the cinema audience. The design of the third level of questions expresses the tendency to explore the elements that affect the respondent's decision to select a 3D movie. I designed the fourth level of questions to know the factors that can bring back or influence a respondent to select 3D movie in the theatres. To identify the size of VR users and the popularity I designed the last section of the questions.

There are two useful sources of secondary data for this thesis. IHS Markit (2010) provided the global figures of 3D companies' market shares and industry dynamics (updated until 2011) in an MS Excel spreadsheet. The availability of latest market share reports are not possible, however some useful magazine articles helped in this case. Another major contributor to the secondary data is the Motion Pictures Association. For the Slovenian market and cinema history facts, Fivia (2017) provided the MS Excel dataset from 2009-2016. This data gave the historical figures of Slovenian cinema influx. The dataset is the sum of tickets sold with the split of movie names and the year. The split between 3D and 2D films is available only from 2010-2013. Before and after figures are available as the total box office business of Slovenia.

Regarding the innovation and the future of 3D industry, I prepared a questionnaire and sent to the professionals, engineers, and the sales offices of various 3D companies. The questionnaire contains of the following questions:

- What is going to be the future of 3D cinemas?
- The rise of 3D cinema trend gradually declined from 2011, what are the possible reasons?
- Can Virtual Reality disrupt the market of 3D cinemas?

In this regard, I selected the respondents by using snowball-sampling technique. When it's difficult to identify the members of desired population, the snowball sampling technique is used where the participants are volunteers (Saunders et al., 2012, p. 289).

3.3 Ethical Consideration for the Study

Ethical measures are important for the entire research work and require the ethical integrity of the researcher with the subject. Research ethics are the standards of behavior that researcher follows towards the subject of the research (Saunders et al., 2012, p. 230). Regarding the secondary data collection, I took the proper written approval from the sources via emails. Regarding the primary data collection, there is no manipulation or misuse of the facts. Moreover, I follow the technical guidelines from the Faculty of Economics, University of Ljubljana to cite these references.

I mention the proper references for the secondary data wherever it is necessary like in the direct quotes, idea presentation, or the numbers and figures. I took only the public information about the companies from their websites, magazines, and online articles. I designed the questionnaire and the survey for the primary data collection under the instructions from the mentor. The intro of the survey describes the assurance of anonymity and usage of the data only for the academic research work. The purpose of data collection was the completion of this thesis and not for any commercial activity. I ensure that there was no distribution or manipulation of the primary data.

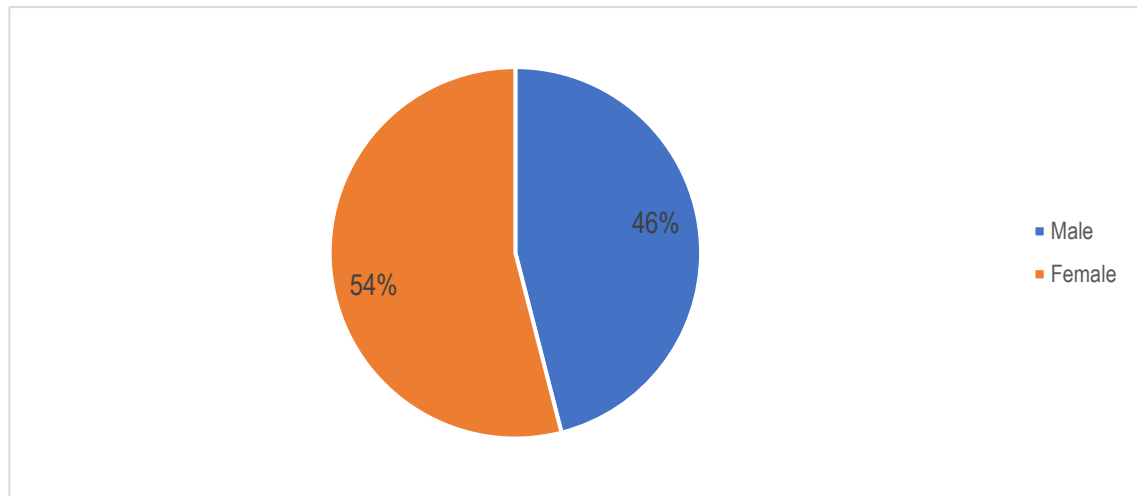
4 PRIMARY DATA ANALYSIS

In this chapter, I present the findings and the analysis of the primary data extracts. As mentioned in previous chapters, for the primary data collection I used an online survey to analyze the consumer attitudes and a questionnaire for the personnel of 3D industry to analyze the development of the product.

4.1 Sociodemographic Characteristics

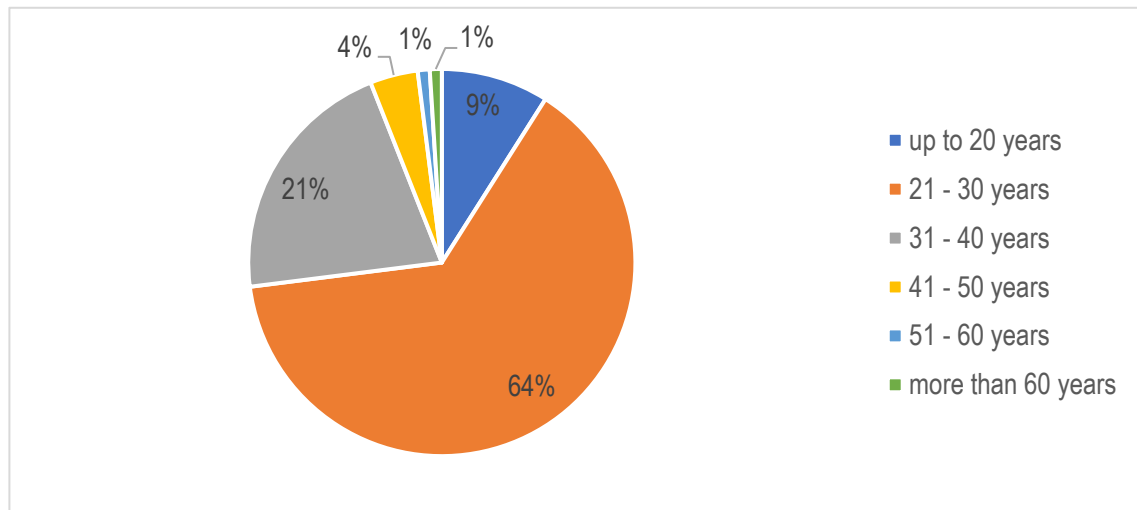
Target population is the public that I approached through the non-probability sampling via social media; total 451 respondents came across the survey. Whereas 105 are valid and 102 respondents completed the survey, which is the sample size for this research. The majority of respondents is female, more precisely 54% of them. Remaining respondents are male accounted for 46% as shown in the next page Figure 21.

Figure 21: Gender in Percentage (N=98)



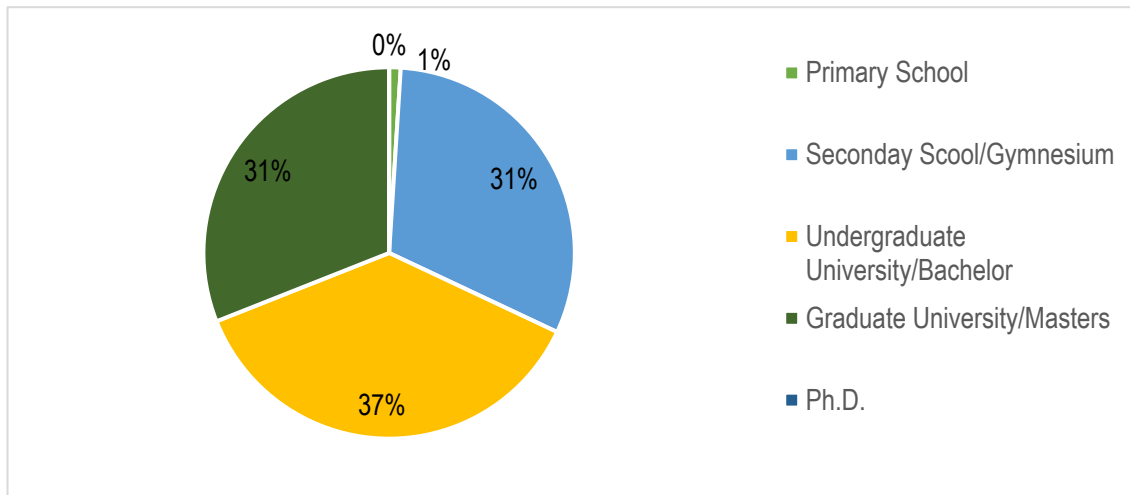
The range of ages covered all possible populations. The majority of the respondents belongs to from 21 to 30 years old group with the total of 64%. The second largest group of respondents is the over thirties with 21% proportion. Third largest group of respondents is the young people up to twenties age, while over forty year old group is 4%. Over fifty and sixty years old brackets are respectively 1% each as shown in the below Figure 22.

Figure 22: Age Groups of the Sample (N=100)



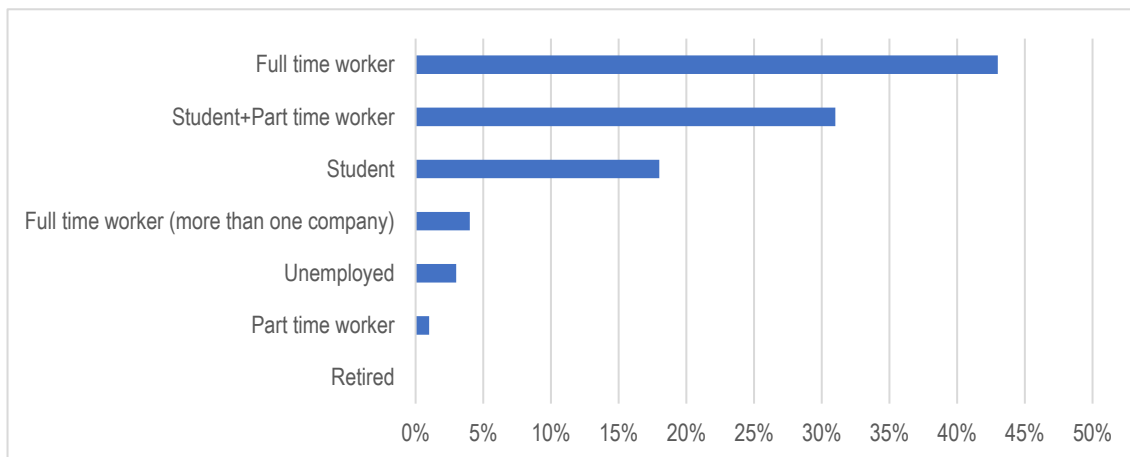
The education segment of the survey shows the largest group of respondents which is undergraduate with 37% share of the whole sample size as shown in the Figure 23. Second largest educated group of this sample is the master graduate with the proportion of 31%, while the same size of the group is the secondary school education holder. Primary education holder group is 1%, while there is no doctoral level educated respondent in the sample population.

Figure 23: Education Levels of the Respondents (N=101)



In the occupation segment of the survey, most of the respondents are full time workers with the proportion of 43%. As shown in the below Figure 24, the second largest group consists of the students who are part time workers as well; their proportion in this survey is 31%. There are 18% students who completed the survey. Respondents who are working full time for more than one company and took part in this research survey are 4%. Unemployed respondents and part time worker respondents are 3% and 1% respectively, while none of the respondents is retired.

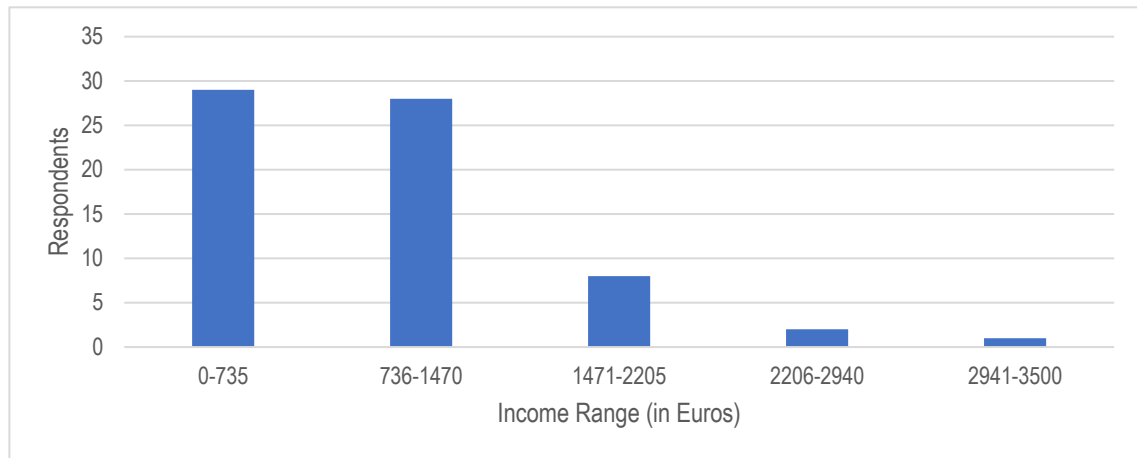
Figure 24: Respondents' Occupation Groups (N=100)



The income among the respondents falls between a zero minimum and €3500 with an average of €974 and the standard deviation of €683. Income level is a sensitive question, which is the reason I found only 68 valid answers in the survey. The summary shows two largest clusters of the respondents earning up to €735 and €736-1,470, as shown in the following Figure 25. Based upon the general knowledge about the income levels in Slovenia, It can be interpreted that there are two larger groups of respondents. A first cluster covers the students, students with part time workers, and the regular employees having minimum

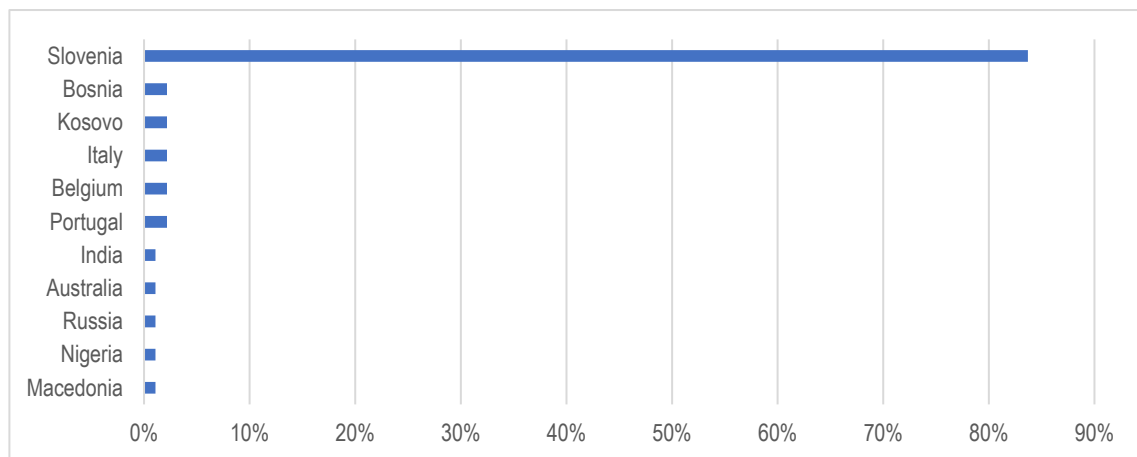
wage. The other major cluster covers the respondents who are regular employees at a better wage.

Figure 25: Income Groups of the Respondents (N=68)



The respondents of the survey are from 11 different nations with the majority of 84% Slovenians, however only 92 respondents mentioned their nationality. Respondents from Portugal, Belgium, Italy, Kosovo, and Bosnia & Herzegovina are 2%. The remaining nationals are from Macedonia, Nigeria, Russia, Australia, and India that is 1% each, results are shown in Figure 26.

Figure 26: Sample Characteristics by Citizenship (N=92)



4.2 Analysis about 3D Cinemas

The ranking of the favorite entertainment activities of respondents is shown in the descriptive statistics. Among the listed recreation activities, watching movies falls on the second priority with the mean of 4.49 (likeliness of level 1-5, where 1 is “don’t like at all” and 5 is “like a lot”). The passion for travelling among our respondents is the highest priority with the mean of 4.59, details are shown in the following Table 5, the minimum value of this variable is 2 that reveals that none of the respondent dislikes to travel.

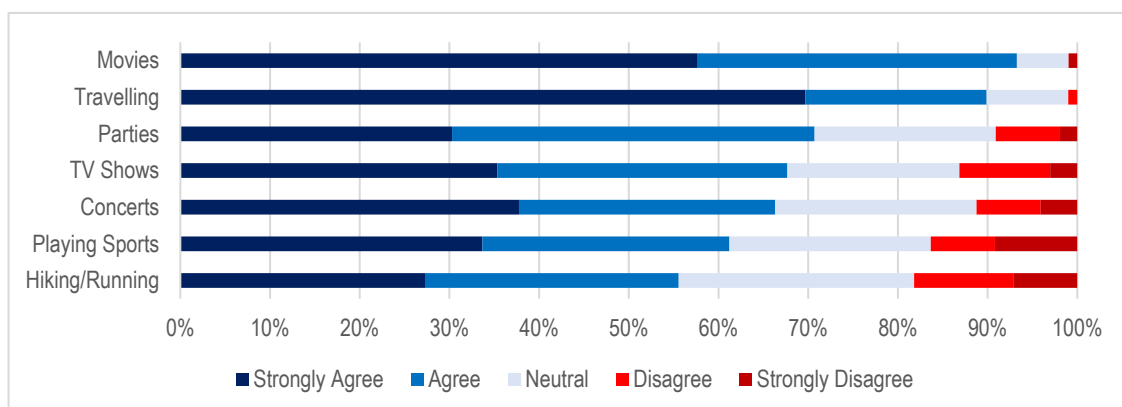
For the best interpretation, I can state that the larger mean in the descriptive stats shows the favorable tendency towards the variable. Parties are the third priorities for the respondents with the mean of 3.90 followed by the concerts with the mean of 3.89. It is obvious as the majority of respondents is younger. Watching television is the next highest mean 3.87. Following sports activities with the mean of 3.69. The least favorite activity is hiking and running with the mean of 3.58 points. Other frequent activities found in the survey include “reading books” and “cooking”. Rankings are shown with the help of stacked bar chart in the Figure 27.

Table 5: Preference of Entertainment Activities

Descriptive Statistics

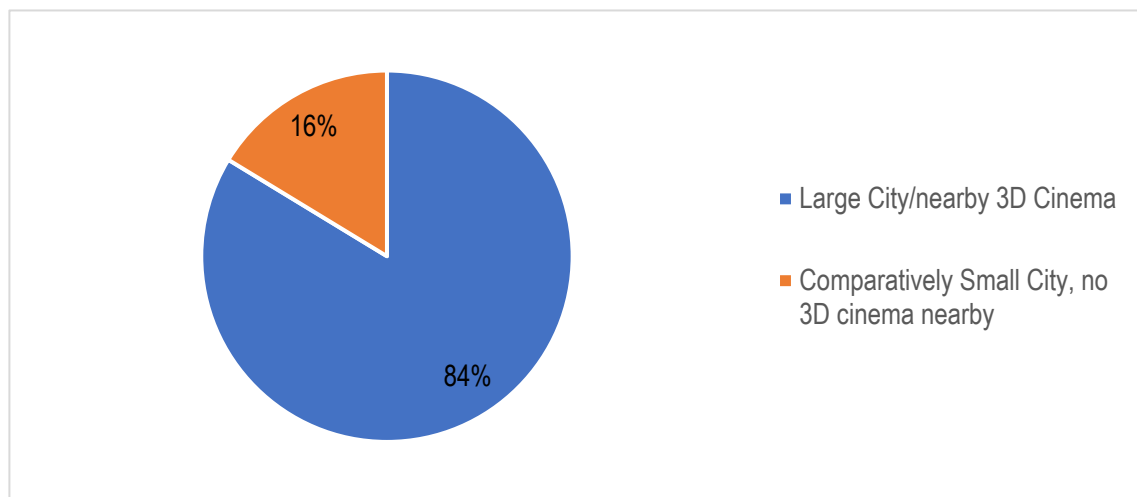
	N	Minimum	Maximum	Mean	Std. Deviation
Watching Movies	104	1	5	4.49	0.697
Watching Television	99	1	5	3.87	1.103
Playing Sports	98	1	5	3.69	1.263
Hiking and Running	99	1	5	3.58	1.205
Going for Parties	99	1	5	3.90	0.985
Preference of Travelling	99	2	5	4.59	0.700
Preference of attending Concerts	98	1	5	3.89	1.120
Valid N	97				

Figure 27: Ranking of the Preferences



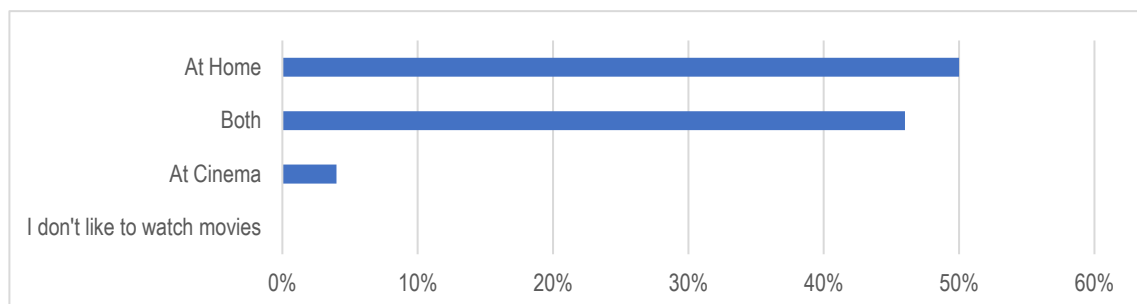
Despite the distance does not matter but theoretically I analyzed that how many people have the quick access to the 3D cinemas. Since the sample population is from 11 different countries, but I also added a variable *place of residence* in the survey. One by one, I explored all the places of residents from the survey output on google. I explored the city on the google map and tried to find the 3D cinema nearby. The place/town that have a 3D cinema nearby is dedicated as the Large City; the place/city that does not have a 3D cinema in 50km radius is dedicated as the Small Town. I distributed the sample into two portions, one portion is the sum of the respondents who are the resident of large cities with quick access to any 3D cinema nearby, and the other portion consists of the respondents who are living in small towns. I figured out that the majority of the respondent with 84% proportion is the resident of large cities with an access of 3D cinema nearby. The remaining 14% of the sample is from small regions or cities without any 3D cinema nearby, results are given in the Figure 28.

Figure 28: Accessibility of a 3D Cinema (N=92)



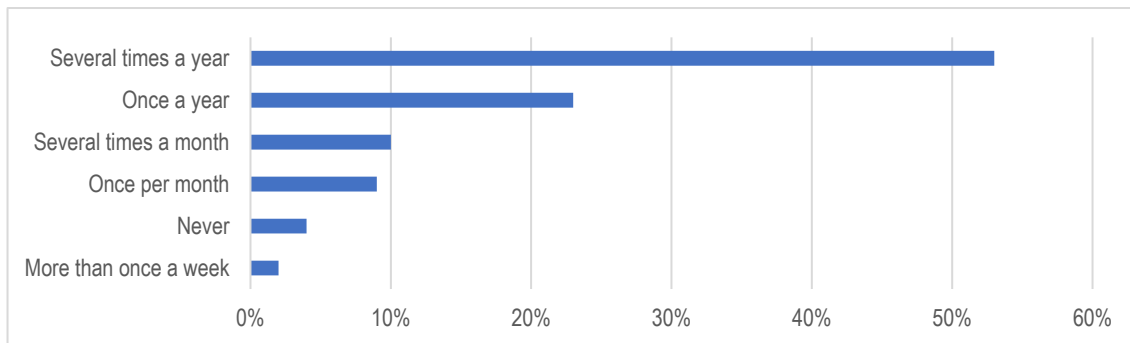
As the below Figure 29 shows, half of our sample size prefers to watch the movies at home while 46% of the respondents like to visit the cinema to watch the movie. Only 4% respondents prefer to watch the movies specifically at the cinemas. Moreover, all the respondents are positive and like to watch the movies.

Figure 29: Preferred places to watch the Movies (N=88)



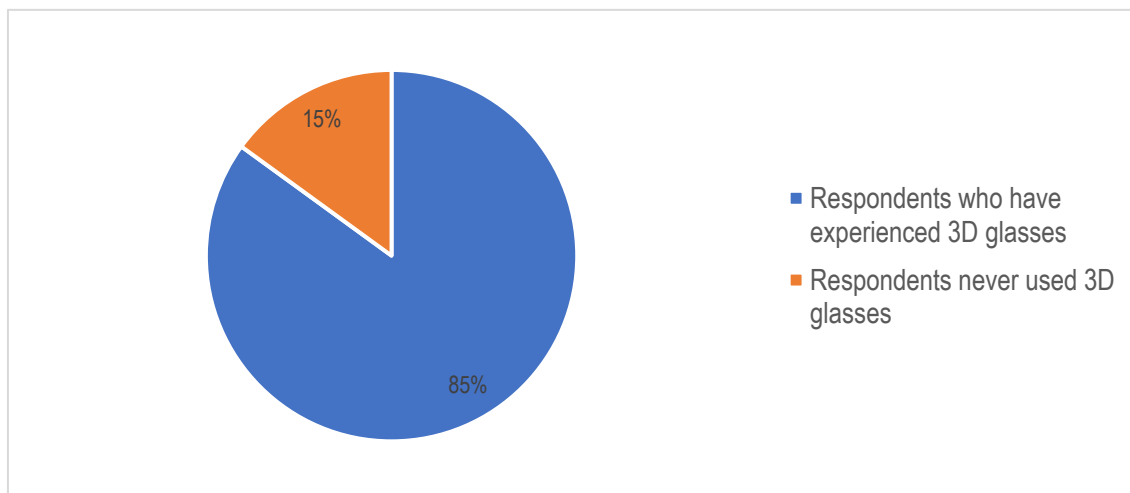
More than half of the sample size uses to visit the cinema several times per year. Once per year cinema visitors are the second largest group of sample with 23%. Several times per month cinema visitors are only 10%, as shown in below Figure 30. Once per month cinema visitors are only 9% that is the fourth large group of my sample. The respondents never been to the cinema are 4%, while respondents who use to visit the cinema on weekly bases are 2% which is the smallest group.

Figure 30: Frequency of Cinema (N=102)



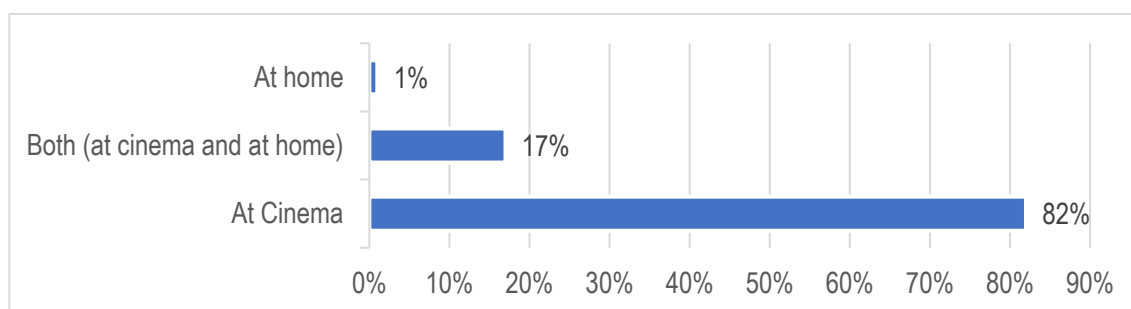
Most of the respondents (85%) have experienced 3D; the sample size for this question is 103 respondents. The below Figure 31 shows that 15% of the respondents never experienced 3D. I phrased the question about the usage of 3D glasses because the following question leads us to the actual 3D cinema sample size.

Figure 31: Sample of 3D Users (N=103)



The majority of the sample population has used 3D glasses at the cinema, as shown on the next page Figure 32. Respondents who used 3D glasses at home and in the 3D cinema are 17%, total positive sample regarding 3D cinema sums up to 88 respondents while only one respondent used 3D glasses at home. This result shows that the most popular mode of 3D usage among the respondents is only cinemas.

Figure 32: Places where Respondents used 3D Glasses (N=88)



The Table 6 on the next page shows the output results from SPSS regarding the evaluation of 3D movie experience of the customers at the cinema. All variables show the positive effect as some of them are reverse coded to make the analysis in the same direction. Lower mean interprets the Likert scale “strongly disagree” and the larger mean expresses the Likert scale measure towards “strongly agree”.

Most of the respondents show their good experience with 3D movies, but the mean is not substantially higher. The majority of the sample size agreed that the 3D is an amazing experience with the mean of 3.54 that is quite distinguishable among the other variables. The second highest mean is 3.44 that represents the respondents who agreed that 3D glasses do not create a problem of headache. While according to Caba (2016), 3D could make the viewer headache if the theatre is not well equipped.

The agreement ratio of respondents about no such problems might indicate that the Slovenian theatres are technically well equipped. Respondents agreed that the 3D glasses were adjustable with their prescription glasses as the mean 3.42 is third largest among the other variables. Still using two pair of glasses to watch a movie could be a burden for the users. I cannot fully rely upon the significance level of this variable. Respondents have shown the concern about the hygiene, as the mean is 3.11 that is not much higher. This represents that the customers hesitate to use 3D glasses that are not clean well or had an unpleasant experience of hygiene.

Lowest mean of 2.95 shows the comfortlessness of the 3D glasses. This could be a managerial implication for the manufacturer of 3D glasses to work with the comfort of the products. Since the glasses are a bit heavy as compared to the sunglasses or the prescription glasses due to the electronics components inside the frame, it is hard for the manufacturer to control the comfort level. Weightless and flexible eyewear can give the customer a little comfort. Parents coming with their kids to the cinemas always have to follow their kids’ demand. This variable has the lowest mean of 1.95 describing the negative impact that the customer was forced due to the kid to watch 3D. I cannot fully rely upon the significance level of this variable, as majority of our sample is younger. The respondent who does not have a kid left this variable blank or marked as *disagree*.

Two limitations or flaws are found in this set of questions. First one, I should have been marked a leading question *if the respondent have prescription glasses*. Second one; *I should have marked one leading question if the respondent have kids*. Survey respondents mentioned several factors in the *other* option of the survey. I summarize and accumulate those comments here.

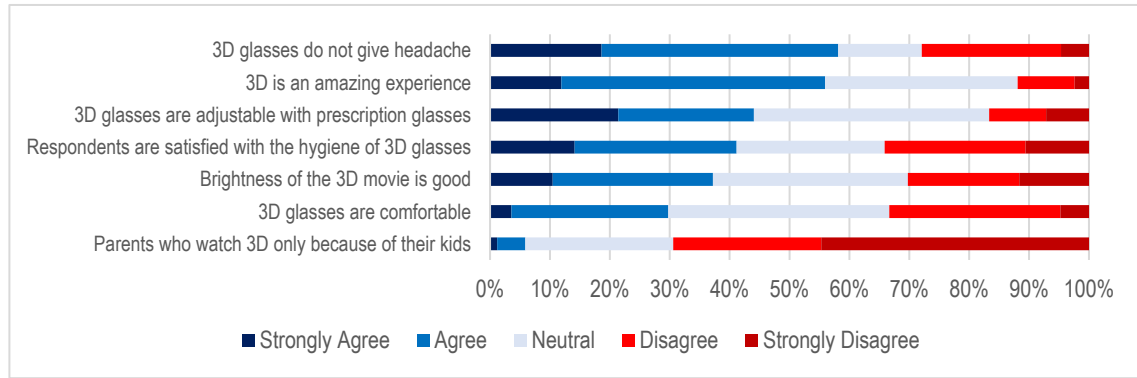
A major negative comment is about the technical problem of 3D cinema. As the front rows of the theatre are closer to the screen, 3D glasses do not cover the whole screen from that point. This comment can give managerial implications to the cinema owners not to sell the 3D tickets for the front rows. Another respondent commented that he experienced different and better experience of 3D in Australia. A respondent wrote that the 3D is much better experience than 2D but you have to sacrifice a little brightness. Following Figure 33 on the next page shows the ranking of the statements in the stacked bar graph.

Table 6: 3D Cinema Experience

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
3D Glasses are comfortable	84	1	5	2.95	0.943
Parents who watch 3D only because of their kids	85	1	5	1.93	0.997
3D is an amazing experience	84	1	5	3.54	0.911
3D glasses do not give Headache	86	1	5	3.44	1.174
The brightness of the 3D movie is good	86	1	5	3.06	1.162
The 3D glasses are adjustable with prescription glasses	84	1	5	3.42	1.143
Respondents who are satisfied with the Hygiene of 3D glasses	85	1	5	3.11	1.225
Valid N	80				

Figure 33: Ranking of 3D Cinema Experience



The survey addresses next set of question which is under which circumstances the respondent could show up for a 3D movie instead of 2D movie. The following Table 7 shows the interpretation of respondents' willingness to watch 3D movies while the Figure 34 summarizes the preferences in the stacked bar graph on the next page. Means for the all possibilities are relatively low but they are distinguishable. The most identifiable factor is that the respondent will come to 3D movie if someone will recommend. 3D entertainment choice upon the suggestion has the larger mean of 3.94; it can interpret that cinema customer will follow the partner, or friend.

The possible significant reason to choose a 3D movie instead of 2D is the special effects. Any added value in the 3D cinema like 4D effects can fulfill the demand of customers. A well-equipped cinema with the digital effects always capture the larger portion of 3D viewers. Such effects include the feature of moving the seats, fog or wind, and the special sound effects.

The price of a cinema ticket depends upon the length of the movie. However, 3D movie is normally one Euro expensive than 2D movie. Price has less influence over the 3D cinema, as the mean of the price conscious customers is 2.94 that is quite low. Fresh released movies also do not influence the respondent to visit 3D cinema, as the mean is lowest 2.62 among the all variables.

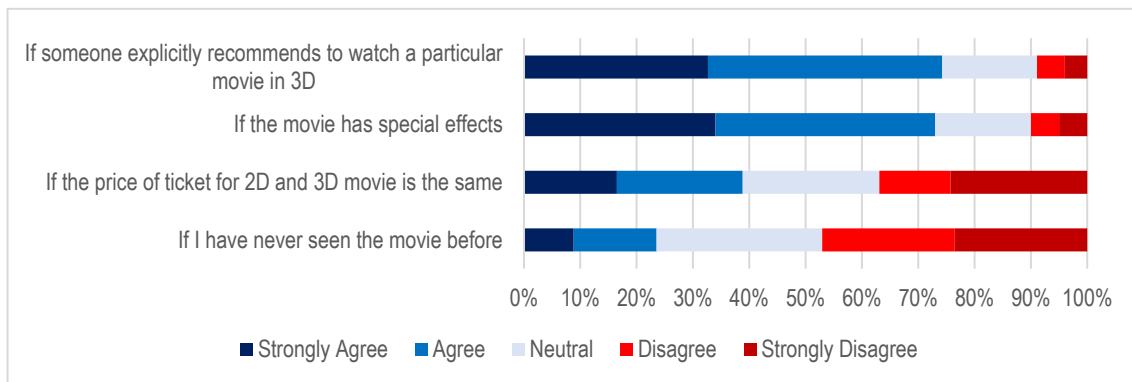
The comments found in the *other choices* from the survey show that the respondents demand for the same special effects as *Avatar*. Moreover, one respondent wrote a technical suggestion that the movies converted into 3D and filmed in 3D are different. A good 3D movie is filmed with stereo cameras, while nowadays, most of the 3D movies are coming which are converted into 3D. The fact also found from Simon et al. (2015) that the success of *Avatar* was due to the special effects and it was filmed in 3D mode.

Table 7: Preferences towards 3D Theatre

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
If 3D ticket is cheaper	103	1	5	2.94	1.413
If I never watched a movie before	102	1	5	2.62	1.243
If someone will refer to a specific 3D movie	101	1	5	3.94	1.028
If there are special effects in the cinema	100	1	5	3.92	1.079
Valid N	100				

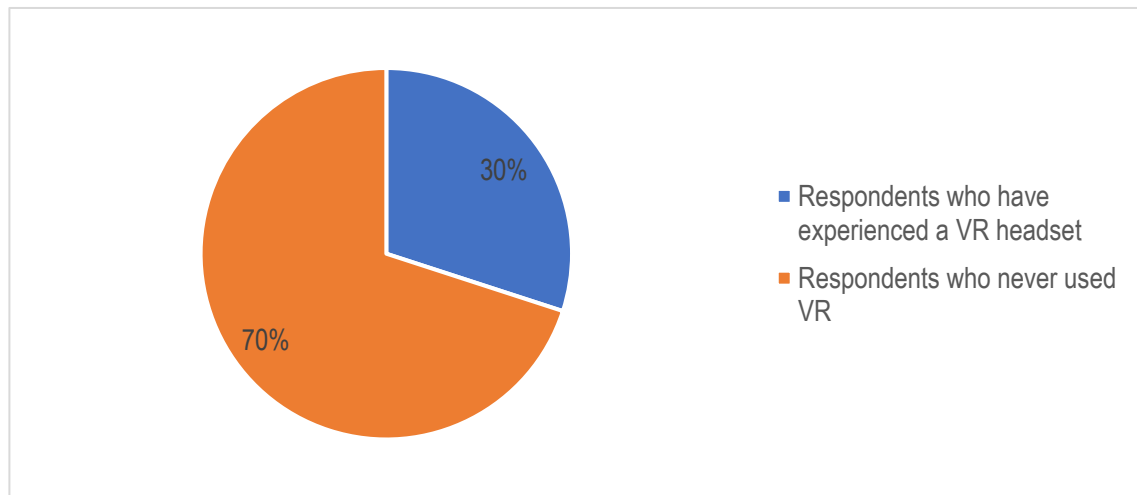
Figure 34: Ranking of Preferences towards 3D Theatre



4.3 Analysis of the Virtual Reality

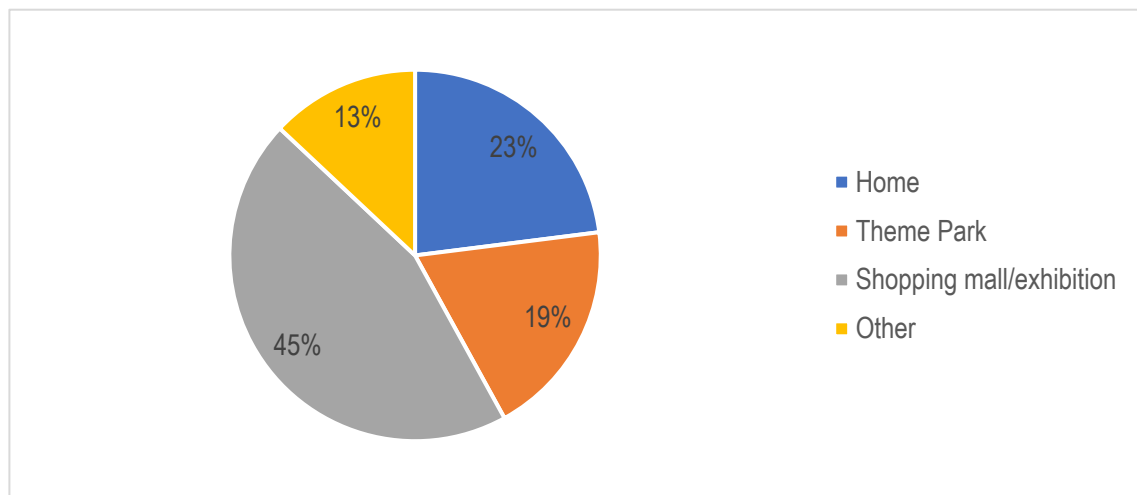
Out of 102 valid survey respondents, only 30% have experienced a VR headset, as shown in Figure 35. The majority of our respondent is the younger generation, but still, the ratio of using or experiencing the new products is less than the expectations. The response rate shows the less popularity of VR in Slovenia.

Figure 35: Respondents' VR Experience (N=31)



The popularity of VR is still not obvious as the below Figure 36 shows the less proportion of individual VR users. Only 23% of the respondents used VR at home that is actually only seven respondents. The majority of respondents experienced VR at the promotional places that is 45%. The remaining sample size summarizes upon the respondents who experienced VR at their friend's place or at the workplace, which is a 13 % proportion of the total 31 respondents. Whereas 19% of the respondents used VR at the theme parks. This figure reveals that VR still not an effective consumer product in Slovenia.

Figure 36: Places where Respondents experienced the VR (N=31)



The descriptors in the below Table 8 shows the maximum likeliness of the VR headsets with the mean of 4.06. Users enjoy the VR experience. It is important to restate that the majority of respondents used the VR in the shopping malls or at some promotional activities. A short time usage of VR does not reveal the actual merits and demerits so I cannot significantly rely upon this descriptive. I designed stacked bar graph for the better interpretation of the descriptors ranks in the Figure 37.

The respondents' experience about the motion sickness is negatively with the mean of 3.72. While according to Mason (2017), 25-40 percent of VR users come across the motion sickness, people feel dizzy with the blurred vision after using VR headsets. The reason might be in our research that the majority of users experienced VR headsets just for a while or a test drive from the promotional campaigns. The target of motion sickness is obviously the VR gamers who play the video games for quite a long time.

Moving on towards the next descriptive, the comfort of VR has a positive impact with the mean of 3.59, users found VR comfortable. Again, it depends how long the user kept watching VR content. 3D glasses are simple as compared to the VR headsets, yet the users found discomfort. VR headsets have two elements that can cause discomfort for the user. Firstly, the lens and the front frame is heavier than 3D glasses. Secondly, the strap that goes around the backside of the user's head to hold the VR headset is tight.

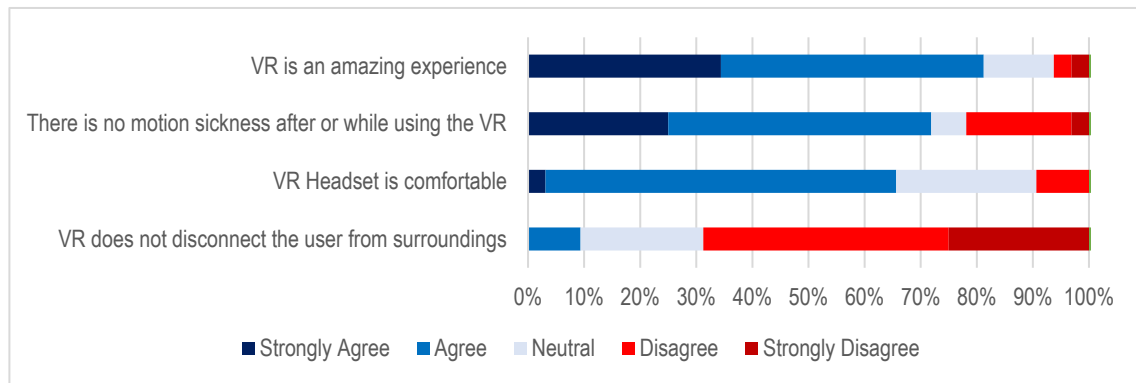
The following descriptive of feeling the surrounding has the negative effect, as the mean is 2.16 that is lesser than other factors. VR headset covers the eyes fully and user cannot see around. The user feels isolated from the actual environment and occasionally feels discomfort. It is hard to give a solid statement about the VR since our sample size is small and most of the users experienced VR for a shorter time.

Table 8: Output of VR Experience

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
VR Headset is Comfortable	32	2	5	3.59	0.712
VR is an amazing experience	32	1	5	4.06	0.948
There is no Motion Sickness while using or after using VR	32	1	5	3.72	1.143
VR does not disconnect the user from the surroundings	32	1	4	2.16	0.920
Valid N	32				

Figure 37: Mean Ranks of VR Experience



4.4 Experts' Opinion about the Future of 3D and VR

From the output of the open-end questionnaire that was sent to the experts of 3D industry, I was able to get four completed questionnaires. The experts related to the 3D industry provided their mixed opinions like yes, maybe, and possibly. I collected these questionnaires on a condition to use and present the information anonymously. I summarized their words in the below text with the location and profession. An electrical engineer from Europe showed the expressions that the VR cinemas would replace the present version of 3D cinemas. Explaining the reason that the technology will become common and cheaper. The retail 3D products are coming into the market and it is becoming popular, 3DTVs are becoming common. The latest version of TVs like 4K resolution can replace the 3D taste of the home entertainment that could be a possible competitor of retail 3D. Commercial 3D might migrate to the theme parts and amusement places. 3D cinema business is more likely to decrease in coming years as it's peak is over. Theme parks are becoming more efficient to use 3D and VR games to attract the visitors. Since theme parks are the huge investment, it is feasible opportunity to form a conglomerate business by merging the video game developers and the 3D manufacturers.

While an electronics engineer from Europe described that VR might replace 3D but both will stay in the market. The present problem in VR is the resolution and the view, which is not easy to maintain in the VR content. The frame size of VR content must be 360-degree that is quite difficult to film. As some of the VR contents are available in the market, those are just stretched into 360-degree but not actually filmed in Go-Pro cameras or VR cameras. Most of VR contents have lower resolution that does not influence the viewer. The costs for the cinema for the screen and the projection will be almost nothing but the VR goggles will be as expensive as they will become high-end product.

A salesperson from the US explained that 3D industry would stay the same with the vicissitudes as it was before. Since the cinema trend will never end, people always want to get something new. The recent years 2015-16 made a positive change over the industry. The 3D cinemas have a long history and the previous decade brought quite a good trend on the

limelight. More precisely, the latest development of the 3D companies is to focus upon the two major flaws of 3D. The first one is to make the lenses of 3D glasses more clear and transparent when the shutter is open. Majority of the audience does not like 3D because of the reduction of brightness. The second major flaw that 3D companies are trying to overcome is to design lightweight and comfortable 3D glasses. Normally the audience spends about two hours in the cinema hall, which is quite a lot. Meanwhile, holding the 3D glasses on the nose is quite disturbing. The case is even sensitive if the user has eyesight/prescription glasses. So far, VR is an individual product, but not a substantial product. Companies are still developing the devices, but each coming year they are replaced with a new design and features. The product is still out of the range from the users, HTC Vive, Oculus and other devices are over \$300. If the user wants to purchase the content like VR supported video game for Sony PlayStation, the entertainment becomes a luxury. To bring down the product to the average households income range, VR needs to be cheaper and with the effective content.

Another engineer from the US explained that 3D would stay in the market as the new movies of *Avatar Series* are coming in 2020. The 3D viewers could make a comeback to the cinemas, but upon three conditions, if:

- 3D glasses become more comfortable
- The brightness of the movie will become as good as 2D format.
- The production of good 3D contents will become more frequent.

The upcoming technology is the AR (Augmented Reality) that could merge into VR. Microsoft (2017) recently released a prototype of AR, which is called HoloLens. Through this VR type headset, the user is able to manipulate the objects around his environment. For example, the video content and size can be moved from the notion of hands and it is possible to create new objects in the surroundings. The objects are only visible through this HoloLens type AR. It might not replace the cinema trend, but it could be the future of VR. The VR technology has already emerged into different sectors like small entertainment contents, engineering and simulation. The best part of AR is that it is transparent; the user can watch the content as well as look through the surrounding.

CONCLUSION

The main purpose of this research was to identify the reasons of decline in the 3D business, specifically in Slovenia. An additional part of the research was to explore the future of VR and its feasible impacts on the 3D business. The literature proves that 3D depends upon the exception of the content/movie, the features, and the visual effects. There are various trends and usage of 3D technology while the products are niche. The cinema audience prefers 2D movies because of certain flaws of 3D. The business of 3D cinemas is solely dependent upon the good 3D content.

The past seven year history of Slovenian 3D cinemas is the replica of worldwide trends. It concludes that the Slovenian 3D market is not distinct from the rest of the world. It has revealed that cinema is the second entertainment priority in Slovenia. Younger population is more inclined towards 3D cinemas. The analysis does not prove H₂ about the less technological adoption of 3D products, as the majority of the sample size has experienced 3D cinemas. However, the reason of the decreased tendency towards 3D is due to the technical flaws of the products and the scarcity of good 3D movies.

The US market of 3D is highly concentrated and monopolistic whilst European and other regions are competitive, new entrants will require enormously differentiated products to erode the market share. Present years seem the recovery phase of 3D industry, but the diversification of leading technological companies towards content production might bring 3D cinemas back to the peak. The US 3D market is sustainable and faced less recession in contrast to the other markets. The reason of being sustainable 3D culture in the US market is the strongest domestic movie production. There are two conclusions of this research highly recommend the 3D industry to make the technical enhancements in their products. First is to control the reduction of brightness in the 3D movie. The second one to improve the efficiency of the product by making 3D glasses comfortable.

Obviously, VR is not an alternate of 3D cinema, but in the near future, the concept of VR will become clearer. During the recent years, some of the leading companies like Facebook, Google, Apple, Amazon, and Netflix are working on the contents of the movies as well as the Virtual Reality. Many companies are releasing various models of VR but so far, the prototyping phase is on the way. The content of VR is complex whether it is the game or the movie; the efficiency of the supplements like motion controller sticks and sensors depends on the content. The video games producers have the most tendency to collaborate with the VR manufacturers.

According to the technical officials and the engineers from the 3D industry, VR is less tentative mode to replace the 3D cinemas since it is a vague concept. As the VR cinemas are merely providing the VR content from 5 to 7 minutes length. VR supposed to be the retail product in the future, as the worldwide VR video gamers are increasing rapidly. While according to the database from Statista (2017), early majority of VR users in 2017 is 58 million, that is more than double from 2016. Video game fans are also briskly increasing; there are 23 million VR game enthusiasts in 2017. The forecasted users of VR in all categories (gamers, early adopters, and innovators) are 271 million by 2018. The price of VR headset in Slovenia varies from €250 to €350 (Ceneje, 2017). The price of the most expensive brand of VR *Facebook Oculus Rift* is €449 (Amazon, 2017b). Based upon the market information, it is convenient to say that VR is an expensive mode of entertainment. Hence, the number of VR users in Slovenia is lower, out of 103 respondents, only 31 have used VR headset. I conclude that there are almost no chances that VR could replace 3D cinemas.

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APPENDICES

Appendix 1: Povzetek (Summary in Slovene language)

Po proučevanju dosegljivih informacij iz obdobja sedmih let med 2009 in 2011 sem izoblikoval mnenje, da se je slovenska kinematografska industrija znašla v obdobju stagnacije z nihajočo aktivnostjo. Ta magistrska naloga podaja razlago za takšno obnašanje trga, pri čemer se opira na dostopne informacije in njihove analize ter zgodovinsko analizo.

Pri zasledovanju cilja magistrske naloge je veliko vlogo igralo zbiranje in analiziranje dostopnih podatkov, ovrednotenje zbranih dejstev ter uporaba statističnih metod. Na podlagi dostopnih informacij sem izoblikoval glavna vprašanja, na katere poizkuša magistrska naloga najti odgovore ter na ta vprašanja vezal hipoteze. Pri iskanju vprašanj na zastavljena vprašanja sem se poleg že omenjenih pristopov opiral tudi na zgodovino in širše ozadje 3D tehnologije. Pri odgovoru na nekatera vprašanja, posebej tistih, ki zahtevajo mnenja uporabnikov o pomanjkljivostih in predlogih o 3D izdelkih s katerimi pridejo v stik sem se oprl tudi na vprašalnike in analizo prejetih odgovorov.

Raziskava se osredotoča na tri glavna vprašanja in pet, z njimi povezanih hipotez:

Vprašanje 1: Kakšni so trendi pri razvoju 3D tehnologije?

H1: Pro-AV trg oz. industrija je močno povezana z inovacijami.

H2: 3D tehnologija je široka, z mnogimi področji uporabe in trendi.

Vprašanje 2: Kakšen je odnos potrošnikov do 3D kinematografije?

H3: Potrošniki v Sloveniji so bolj naklonjeni 2D kot 3D kinematografiji.

H4: Sprejetje 3D tehnologije med obiskovalci kinematografov je slabo.

Vprašanje 3: Ali obstajajo poslovne priložnosti na področju VR (virtualne resničnosti) in kakšni so lahko učinki za 3D industrijo?

H5: VR je potencialen kandidat za zamenjavo 3D kinematografov.

Prvo vprašanje se osredotoča na trende v 3D industriji in med 3D izdelki. Dve hipotezi, H1 in H2, naslavljata prvo vprašanje. Hipoteza H1 se osredotoča na vlogo inovacij v 3D industriji in je izoblikovana iz dosegljivih spletnih virov. Hipoteza H2 pa se osredotoča na področja uporabe 3D tehnologije. V nalogi izpostavim 4 zanimiva področja (poleg kinematografije).

Drugo vprašanje te naloge poizkuša odgovoriti na vprašanje zakaj se je obisk 3D kinematografov zmanjšal. Tudi to vprašanje naslavljata dve hipotezi, H3 in H4. Hipoteza H3 naslavlja odnos potrošnika do 3D kinematografije. S pomočjo spletnega vprašalnika je bila izvedena spletna raziskava, ki je bila glavna opora pri raziskovanju povezanim s hipotezo

H3. Hipoteza H4 nadaljuje iskanje odgovora na vprašanje št. 3, pri čemer se osredotočam na mnenja razvijalcev 3D izdelkov pridobljena z pomočjo vprašalnika.

Da bi predvidel prihodnost 3D, sem izdelal tretjo raziskovalno vprašanje o oceni Virtualne Resničnosti (VR) in njenih bodočih učinkov na 3D, saj današnje tehnološke izboljšave pogosto zamenjujejo predhodne potrošniške proizvode. Današnja statistika prikazuje rastoče številke prodaje VR širom sveta. VR dandanes počasi prevzema prvo mesto pri zabavi za dom. Medtem ko je VR napredna stopnja 3D, moja H5 naslavlja izvedljivostno oceno VR kinematografov, da bi odgovoril na tretje raziskovalno vprašanje. Zgradba dela vsebuje štiri pomembna poglavja, poleg prvega uvodnega poglavja. Prvo poglavje opisuje ozadje 3D industrije in razumevanje 3D proizvodov. To poglavje sestavljajo tipi 3D proizvodov, konkurenčne analize trga ter Porterjeva analiza petih sil.

Drugo poglavje naslavlja jedro pripovedne študije. Vključuje različne rabe 3D tehnologije, uvod v Virtualno Resničnost in njeno zgodovino. Obstajajo tako svetovne kot Slovenske dinamike 3D industrije, ki razlagajo upad v 3D industriji. Tretje poglavje oriše metodologijo tega dela, sestavljajo ga tehnike zbiranja podatkov, raziskovalne metode, raziskovalni model ter etična vprašanja pri opravljanju raziskovanja. Četrto poglavje predstavlja analizo primarnih podatkov zbranih v anketi in vprašalnikih. Analitično poglavje prav tako opisuje potrošnikovo posvojitve 3D tehnologije in njegove kritične poglede o 3D izkušnji v kinematografih. To poglavje se omeji na izzide raziskave, analitične številke ter na številke primarnih podatkov pridobljenih v anketi o potrošnikih 3D v Sloveniji. Dodaten razdelek v tem poglavju je ocena Virtualne Resničnosti s potrošnikovega gledišča. Zaključek dela, viri in dodatki so v zadnjem razdelku.

Glavni namen te raziskave je bil prepoznati razloge zatona v 3D poslu, natančneje v Sloveniji. Dodatni del raziskave je bil raziskati prihodnost VR in njene verjetne učinke na 3D posel. Literatura dokazuje, da je 3D odvisen od izjemnosti vsebine/filma, lastnosti in vizualnih učinkov. Obstajajo različni trendi in rabe 3D tehnologije, med tem ko so proizvodi niša. Občinstvo kinematografov ima raje 2D filme zaradi določenih napak v 3D. Posel 3D kinematografov je popolnoma odvisen od dobre 3D vsebine.

Zgodovina slovenskih 3D kinematografov v zadnjih sedmih letih je kopija svetovnih trendov. Iz tega prihaja zaključek, da se trg slovenskega 3D ne razlikuje od preostanka sveta. Razkrilo se je, da je kinematograf druga zabavljaska prioriteta v Sloveniji. Mlajše prebivalstvo je bolj naklonjeno 3D kinematografom. Analiza ne potrjuje H2 o manjši tehnološki posvojitvi 3D proizvodov, saj je večina vzorca izkusila 3D kinematografe. Vendar razlog za zmanjšano težnjo naproti 3D obstaja zaradi tehničnih napak proizvodov in pomanjkanja dobrih 3D filmov.

Sedanja leta se zdijo kot faza okrevanja 3D industrije, toda diverzifikacija vodilnih tehnoloških podjetji k proizvodnji vsebine, bo morda pripeljala 3D kinematografe nazaj na vrh. Ameriški trg 3D je obstojen in se je soočal z manj recesije v primerjavi z drugimi trgi.

Razlog njegove obstojnosti je 3D kultura v ameriškem trgu in najmočnejša domača filmska proizvodnja. Obstajata dva zaključka te raziskave, ki visoko priporočata 3D industriji, da naredi tehnične izboljšave v svojih proizvodih. Prvič, potrebno je nadzorovati zmanjšanje svetlobe v 3D filmu. Drugič, potrebno je izboljšati učinkovitost proizvoda s tem, da se naredijo 3D očala bolj udobna.

Jasno, VR ni alternativa 3D kinu. Namembnost in uporabnost VR se bo v prihodnje še izoblikovala. V preteklih letih je nekaj vodilnih podjetij na področju tehnologije, kot so Facebook, Google, Apple, Amazon in Netflix, že začelo z ustvarjanjem vsebin v navidezni resničnosti. Vsebine za VR je težko ustvarjati, pa naj gre za računalniške igre ali filme; prav tako pa je od vsebin odvisna tudi učinkovitost dodatkov, kot so senzorji premikanja ter igralne palice. Najbolj se k ustvarjanju vsebin za VR nagibajo ustvarjalci video iger. V začetku leta 2017 je bilo 58 milijonov uporabnikov VR tehnologije, kar je kar dvakrat več kot v enakem obdobju leta 2016. Prav tako skokovito narašča število uporabnikov VR tehnologij pri navdušencih nad video igrami, v letu 2017 jih je bilo 23 milijonov. Do leta 2018 je napovedano 271 milijonov uporabnikov v vseh kategorijah (video igre, zgodnji uporabniki, inovatorji). Cena seta za navidezno resničnost se v Sloveniji giblje med 250 in 350 euri. Cena najdražjega, Facebook-ovega Oculus Rift-a, pa je €449. Glede na podatke na trgu lahko rečemo, da je VR draga opcija zabave in porabe prostega časa, zato je tudi število uporabnikov VR v Sloveniji manjše. Od 103 vprašanih, jih je samo 31 že poskusilo z uporabo seta za navidezno resničnost. Zaključujem da torej skorajda ni možnosti, da bi navidezna resničnost nadomestila 3D kina.

Appendix 2: Online Survey

Hi,

I am doing research on the topic of “Innovation of 3D technology in Slovenia: Industry development and consumer attitudes” for my thesis, and for this purpose I need your valuable inputs. The questions in the survey are related to your opinions about watching Movies. This survey will take less than five minutes to fill out, and your responses are entirely anonymous. For any assistance, you may contact me at junaid.alqamar@gmail.com.

Q1 - Please rate the following activities according to your preference.

	Don't like at all	Somewhat don't like it	Neutral	Somewhat like it	Like it a lot
Movies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
TV Shows	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Playing Sports	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hiking/Running	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Parties	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Travelling	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Concerts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q2 - Where do you prefer to watch movies?

- ☐ At Home
- ☐ At Cinema
- ☐ Both
- ☐ I don't like to watch movies

IF (4) Q2 = [1, 2, 3]

Q3 - In a typical year, how often do you go to the cinema to watch a movie?

- ☐ Never
- ☐ Once a year
- ☐ Several times a year
- ☐ Once per month
- ☐ Several times a month
- ☐ More than once a week

Q4 - Have you ever used 3D glasses?

- ☐ YES
- ☐ NO

IF (2) Q4 = [1]

Q5 - Where did you use 3D glasses?

- ☐ At home
- ☐ At Cinema
- ☐ Both (at cinema and at home)

IF (5) Q5 = [2, 3]

Q6 - What was your experience with using 3D glasses in a cinema?

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
3D glasses made me headache	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was worried about hygiene	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Brightness of the movie was reduced (it was too dark to watch movie)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3Dglasses were comfortable to wear	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I couldn't properly adjust 3D glasses due to my prescription glasses	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I only watched because of my kids	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I enjoyed 3D as it seemed more realistic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q7 - If a movie at the cinema is offered in both 2D and 3D options, how important are the following factors in your decision whether to buy the 2D or 3D ticket? (2D Movie is a regular movie, 3D Movie is with a pair of 3D glasses)

	Strongly prefer 2D	Slightly prefer 2D	Both are the same	Slightly prefer 3D	Strongly prefer 3D
If the price of ticket for 2D and 3D movie is the same	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If I have never seen the movie before	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If someone explicitly recommends to watch a particular movie in 3D	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If the movie has special effects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q8 - Have you ever experienced a Virtual Reality headset?

- ☐ YES
☐ NO

IF (3) Q8 = [1] (YES)

Q9 - Where did you use a Virtual Reality Headset?

- ☐ Home
☐ Theme Park
☐ Shopping mall/exhibition

☐ Other:

IF (7) Q8 = [1]

Q10 - What was your experience with using VR headset?

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
I got motion sickness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The Headset was comfortable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt disconnected from the real world	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It was amazing, I liked it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

XSEX - Gender:

- ☐ Male
☐ Female

XAGE - In which age group do you belong?

- ☐ up to 20 years
☐ 21 - 30 years
☐ 31 - 40 years
☐ 41 - 50 years
☐ 51 - 60 years
☐ more than 60 years

XSTS - What is your current occupation?

- ☐ Student
☐ Student+Part time worker
☐ Part time worker
☐ Full time worker
☐ Full time worker (more than one company)
☐ Retired
☐ Unemployed

XEDU - What is your highest level of completed education?

- ☐ Primary School
☐ Secondary School/Gymnasium
☐ Undergraduate University (Bachelor)
☐ Graduate University (Masters)
☐ Ph.D.

Q11 - Monthly gross Income (EUR)

Q12 - Your Nationality

Q13 - City/Region of Residence

Appendix 3: Status of Online Survey

Figure 1: Screenshot of an online survey

Basic info (?)		Survey status (?)		Response rate (?)		
Survey name:	Innovation of 3D technology in Slovenia:	Completed (6) :	Hide 0: <input checked="" type="checkbox"/>	Base: <input type="text" value="Entered intro"/>		
Survey type:	Survey	102		Status	Frequency	State
Questions: 17	Variables: 44	Partially completed (5) :	3	Entered intro	451	100%
Pages: 3		Total valid		Entered first page	128	28%
Units: 451	Valid: 105	105		Started responding	110	24%
Language: English		Completely empty (6I) :	1	Partially completed	105	23%
Author: junaid , 2.11.17, 17:16		Partially empty (5I) :	4	Completed	102	23%
Modified by: junaid , 25.12.17, 13:19		Entered first page (4) :	18	Unit usability (50%/80%)		
Status: Survey is closed.		Entered intro (3) :	323	Usable units	80	76%
Activity: 13.12.2017-13.03.2018		Total invalid		Partially usable units	22	21%
Duration: 3min 31s, Estimated: 3min 38s		346		Unusable units	3	3%
First entry: 2.11.17, Last entry: 19.12.17, 19:09		Total surveyed		Breakoffs		
		451				

Source: Center for Social Informatics (2017).