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VIRTUAL REALITY IN JOURNALISM: EKSPRESS MEEDIA'S PILOT IN THE IMMERSIVE STORYTELLING

Bachelor's thesis

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VIRTUAALREAALSUS AJAKIRJANDUSES: ÜMBRITSEV SÜVALUGU AS EKSPRESS MEEDIA PILOOTPROJEKTI NÄITEL

Bakalaureusetöö

Juhendaja: Eduard Petlenkov
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Author’s declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

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Abstract

International news organizations have been creating immersive news stories since 2010. Over the past eight years, the technology for both developing and consuming virtual and augmented reality has become more prevalent. This has encouraged legacy news organizations to invest into producing immersive news stories as part of their daily reporting. The goal of this Bachelor's Thesis is to develop the prototype for computer graphic mobile virtual reality news story and to conduct usability testing in order to analyze the prototype's usability.

To achieve this goal research was done to assess the state of the art of the immersive journalism and the framework for the Immersion-Journalism Intersection was introduced for bringing together development and journalism. The Impact Mapping method was used to identify the impacts necessary for reaching the goal of the development of the prototype. The prototype was created using software Cinema 4D by Maxon and integrated to the Android application for the usability testing purposes. The test was conducted with 6 participants and the results analyzed in accordance with ISO 9241 part 11 standard to determine the usability of the prototype.

The test revealed that the product is usable but needed additional guided information for the end users at least as long as the product is still novel. The result of the usability testing and the overall positive feedback from the test group encourages to advance the pilot project.

The author would like to thank Mart Nigola and Ioane Sharvadze for developing the prototype and journalist Ester Vaitmaa for the investigative news story.

This thesis is written in English and is 51 pages long, including 5 chapters, 13 figures and 7 tables.

Annotatsioon

Virtuaalreaalsus ajakirjanduses: ümbritsev süvalugu AS Ekspress Meedia pilootprojekti näitel.

Rahvusvahelised uudisteagentuurid on alates 2010. aastast loonud ümbritsevaid süvalugusid. Viimase kaheksa aasta jooksul on virtuaalreaalsuse ja liitreaalsuse arendamiseks ning tarbimiseks mõeldud tehnoloogiad muutunud üha levinumaks. See on omakorda julgustanud traditsioonilisi uudisteagentuure investeerima üha enam ümbritseva süvaloo tootmisesse ning kasutamisse. Käesoleva bakalaureusetöö eesmärgiks on töötada välja arvutigraafikaga loodud ümbritseva süvaloo virtuaalreaalsuse prototüüp mobiilse seadme jaoks ning viia läbi prototüübi kasutatavuse testimine kasutatavuse analüüsimise eesmärgil.

Püstitatud eesmärgi saavutamiseks viidi bakalaureusetöö esimeses osas läbi uurimus ümbritseva ajakirjanduse olemuse hindamiseks ning ajakirjanduse ja arenduse ühendamise eesmärgiga, tutvustati *Immersion-Journalism Intersection* raamistikku. Prototüübi väljatöötamiseks kasutati *Impact Mapping* meetodit, mille käigus kaardistati vajalikud mõjutegurid eesmärgi saavutamiseks. Prototüübi arendamiseks kasutati Maxoni tarkvara Cinema 4D ja kasutatavuse testimise eesmärgil integreeriti toode Androidi rakendusse. Test viidi läbi 6 osalejaga ja prototüübi kasutatavuse kindlaksmääramiseks analüüsiti testi tulemusi vastavalt ISO 9241 osa 11 standardile.

Test näitas, et toode on kasutatav, kuid toote uudsuse tõttu vajavad lõppkasutajad enne toote kasutamist detailset juhendamist. Kasutatavuse testi tulemus ja testgrupi üldine positiivne tagasiside innustab pilootprojekti lõpuni arendamist tulevikus.

Autor tänab Mart Nigolat ja Ioane Sharvadzet prototüübi arendamise eest ning ajakirjanik Ester Vaitmaad juurdleva uudisloo idee eest.

Lõputöö on kirjutatud inglise keeles ning sisaldab teksti 51 leheküljel, 5 peatükki, 13 joonist ja 7 tabelit.

List of abbreviations and terms

VR	Virtual Reality. Consumer Technology Association's (CTA) definition for VR: creating a digital environment that replaces the user's real-world environment
AR	Augmented Reality
AI	Artificial Intelligence
ML	Machine Learning
360-video	Consumer Technology Association's (CTA) definition for 360-video: video that allows the user to look in every direction around them
Slack	Searchable Log of All Conversation and Knowledge, Slack is cloud-based team messaging service
3D	Three Dimensional
2D	Two Dimensional
Room-scale	Design Paradigm for Virtual Reality. VR experience which allows users to freely walk around a play area, with their real-life motion reflected in the VR environment
CG	Computer Graphics
AR	Augmented Reality
HWD	Head-Worn Display
FIJI	Framework for the Immersion-Journalism Intersection

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1 Introduction and Problem Statement

In the rapidly evolving world of technology, news media organizations have to be innovative to withstand the ever-expanding social media channels, where the wide range of news is consumed today. Research and development is a big part of modern day news organizations. New technologies, amongst which are artificial intelligence (AI), machine learning (ML), augmented reality (AR) and virtual reality (VR), are becoming the core functions in the news telling web portals. Consumers are technically savvy and expecting more than just reading, they expect to feel and be part of what they read, in addition to finding quickly what is relevant to them. Traditional newspapers, who in a sense missed the digitalization at the beginning of the 21st century and gave way to the online portals, have been adopting immersive storytelling as part of their daily reporting in an impressive pace.

Immersive storytelling and virtual reality as a platform is a novelty and not yet fully studied area of journalism in Estonia. 360-video has been used in several digital newspaper articles, for example, Madis Jürgen's article *Rooste ei lase Kirsil öösel magada* published in Eesti Ekspress's digital channel in 2016 (Jürgen, 2016). But up till now, there has not been any computer graphic (CG) based mobile VR projects created for the head-worn device (HWD) by Estonian news organizations. This thesis' primary goal is to develop the prototype of CG-based mobile VR immersive news story in Ekspress Meedia and to validate the prototype with end users through usability testing. Once usability testing is analyzed, it will be annexed with the development framework and provided as a guideline for the future immersive storytelling projects in Ekspress Meedia.

Ekspress Meedia AS is the subsidiary of Ekspress Group AS, a media company, whose activities include publishing, printing services, and online media content production. Ekspress Group's goal is to be the leading media company in the Baltic States. Ekspress Meedia AS has online news portal Delfi, two weekly newspapers Eesti Ekspress and Maaleht, a daily newspaper Eesti Päevaleht, a weekend issue LP and a magazine Maakodu.

1.1 Outline

In the first chapter of the thesis, the author gives an overview of the state of the art of virtual reality in journalism and overview of the author's contribution and of the methodology of the thesis.

In the second chapter, the author describes the Impact Mapping method used for developing the prototype.

The third chapter is devoted to introducing the content and the outcome of the prototype. The author uses Framework for the Immersion-Journalism Intersection (FIJI) and guidelines, which bring together journalism and development, in producing the pilot in the immersive investigative news story in Ekspress Meedia.

The fourth chapter is dedicated to conducting the usability testing, collating and analyzing the outcome and participants feedback.

The fifth chapter draws up the conclusion and musters the recommendations for the future projects of immersive storytelling in Ekspress Meedia.

1.2 The State of the Art

Immersive, first-hand storytelling has been an object of interest of newsrooms for the past eight years. The first project, where an audio recording was an inspiration of 3D room-scale VR recreation, was Hunger in LA in 2010. The author of the Hunger in LA, Nonny de la Peña asked on her TED Talks: 'What if you could experience a story with your entire body, not just your mind?' (de la Peña, 2015). She described it wasn't until she started working with virtual reality that she, as a journalist, started seeing an intense and an authentic reaction from people, which really blew her mind. It is in a virtual reality where journalists can place their readers to the scene where the actual news took place, thus giving the users opportunity to feel and experience the entire news story.

News organizations like BBC, the *Guardian* and *New York Times* have dedicated departments where VR content is being created and developed, though the technology for developing immersive stories and for consuming VR, is still becoming prevalent. The concept of immersive journalism, which is the production of news in a form in which people gain first-person experiences of the events or situation described in news stories,

was introduced by Nonny de la Peña in her paper written in 2010 (de la Peña et al., 2010, p. 291). The fundamental idea of immersive journalism is to allow the participant to actually enter a virtually recreated scenario representing the news story. The participant can also enter the story in one of several forms: as oneself, a visitor gaining first-hand access to a virtual version of the location where the story is occurring, or through the perspective of a character depicted in the news story (de la Peña et al., 2010, p. 292). De la Peña also distinguishes two types of immersive storytelling: interactive journalism, where reader is first-hand involved as the player, but not subject of the story; and deep immersive journalism, where the participant can feel that his or her actual location has been transformed to the location of the news story, and more importantly that the participant's actual body has transformed, becoming a central part of the news story itself (de la Peña et al., 2010, p. 293).

Zillah Watson interviewed more than 20 VR experts from leading newspapers and broadcasters (mostly traditional news organizations) in the USA and Europe in February/March 2017 to establish the current state of VR in the news industry and the motivations driving it (Watson, 2017, p. 8). Watson interviewed leading digital news innovators in the journalism who had started experimenting with the VR in the last 12 to 36 months, some of whom included the *New York Times*, *Die Welt*, the *Guardian* and Euronews. Almost all interviews were conducted face to face with interviewees who were directly involved in developing, creating, or commissioning VR.

Firstly, Zillah Watson tried to establish what is the attraction with VR. What highlighted from the answers is that the legacy news organizations find it important to be innovators on this field, they believe that VR is the future and that this is the way to attract the younger audience to consume legacy journalism. Furthermore, Paul Cheng (then Director of Interactivities and Digital News Production at Associated Press) makes the contrast between the news approach to VR and how slow the industry was to understand Web: 'This is an opportunity for the news industry to stay current and ahead of the curve. I feel like the news industry is having a role in shaping the outcome of VR and 360, which is vital because that means in the early stages we are thinking not only about how to tell the story but what will the business model look like' (Watson, 2017, p. 10).

Watson also explored the subjects of VR technology, the variety of the journalistic content beyond documentary, during her interviews. Though the majority of news

organizations explore with high-end VR gadgets such as Oculus Rift, HTC Vive, and Sony PlayStation VR, it is rather clear that for news to reach the wider spectrum of the audience the focus should be on mobile VR, a smartphone in a headset. What has developed rapidly in news organizations over the past year is generally the 360-video – a spherical video that allows the viewers to look around. It can be viewed through a VR headset, which is immersive or watched on a smartphone by moving the phone around or on a computer using the mouse to move around. Plus 360-video comes in a number of forms – from short films created on consumer cameras intended for mobile viewing through to expensively produced VR films designed for headset viewing (Watson, 2017, pp. 14–15). In terms of variety of the content Watson, who has led the editorial development of virtual reality experimentation at the BBC, points out that as of early 2017 and due to the improved technology of the small consumer 360-camera, has enabled newsrooms to fast-turnaround of 360-video from shot to published, hence allowing the immersive storytelling with 360 to be used in the fast-moving news outlets.

Francesca Panetta, Executive Editor for VR at the *Guardian*, says: 'If you're in a headset then you're immersed in another world. If you're clicking around on a 360-video, then you're not.' Creating high-quality VR for headset viewing takes longer and involves additional production considerations – restrictions that can impact on storytelling. These include camera positions, limiting camera movement and the way film is edited. This is primary to avoid nausea and a feeling of disembodiment for viewers. And creating high-end computer-generated VR requires even more specialist skills such as Unity developers and 3D designers (Watson, 2017, p. 18).

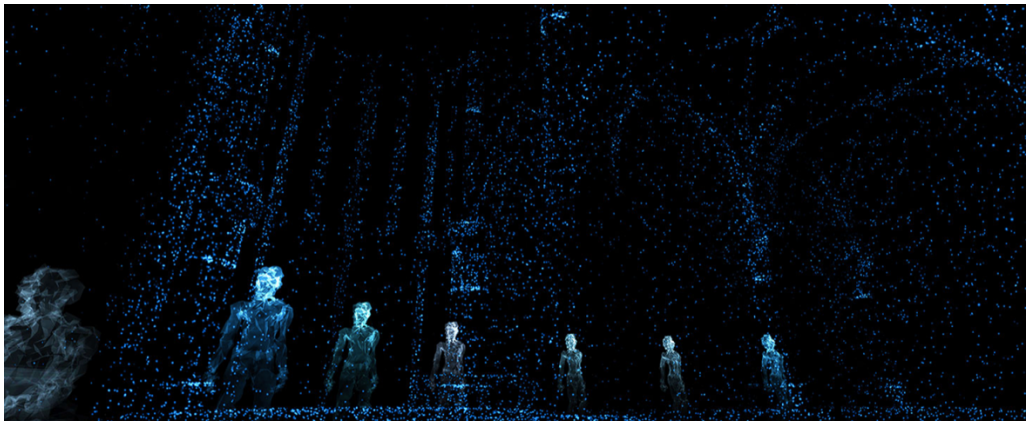

Figure 1: Notes on Blindness: Into the Darkness (Source: ARTE)

ARTE, the publicly funded European Culture Channel, has focused on high-end VR for the headset. In 2016 they launched their VR project *Notes on Blindness: Into the Darkness*. They describe this as an immersive virtual reality project based on John Hull's sensory and psychological experience of blindness released alongside the feature film (ARTE Experience, 2016). Kay Meseberg, ARTE's Head of VR, explains: 'We are a public broadcaster, so we don't need to think that deeply about revenues. The key drivers for us are more being upfront in terms of innovation. So for us, it's a question of exploring how might TV look like in the future' (Watson, 2017, p. 19).

As the technology advances, the possibilities to cater news stories will become even greater. Technology provides the opportunity to be more creative in journalism, both for journalists and readers.

1.3 Author's Contribution

The current thesis is a team collaboration, where the author is the initiator and the product owner. As Business Development Manager, the author is responsible for the research and development of new innovative business opportunities in Ekspress Meedia.

In terms of the project in hand, the author's contribution is to provide an overview of the state of the art of the immersive storytelling to the development team and to the business owners. As a result of researching for the existing guidelines of bringing technology and journalism together, the author has introduced the Framework for the Immersion-Journalism Intersection to the teams involved.

In the development process of the prototype, the author participates as the primary project manager. In this role, the author explains the Impact Mapping method to the developers involved in the development of the prototype. At the kick-off workshop, the impact of each team member is stated and visualized on the diagram by the author as is presented in Figure 2. The project team agrees with delivery deadlines and it is the responsibility of the author to monitor compliance with deadlines. The author also coordinates the workflow of the team members and makes sure that all the questions asked are answered in a timely manner.

Once prototype is ready to be tested, the author's responsibility is to set up the usability test and to formulate the standard task, to find participants for the test and to observe the

test group, in order to analyze the test results in accordance with the definition of usability and to discuss the recommendation for the improvements before launching the product.

1.4 Methodology

This thesis is based on practical approach and the usability testing. In the practical approach, Impact Mapping framework is used for delivering the prototype. Usability testing will be held with 6 users, who will be given the same task. The results of the tests will be reviewed and analyzed, the precept of necessary changes to be implemented before launching the live product will be provided.

2 Method

Ekspress Meedia's product development process is modified Scrum, an agile method where developers concentrate on business requirements and user stories, however, the presumption is that requirements evolve, and adaptiveness is vital during the development process. Business requirements and expected functionalities have to be set in advance by business product owners, whereas the requirements are split into smaller tasks. Developers give estimations for each task biweekly. The sprint, a timeframe during which the development tasks need to be completed, lasts for two weeks and unless there is a critical or blocker issue, the closed-window principle applies to the sprint. That means no new task during the sprint is accepted unless it is a blocker or highly critical to a specific service. In addition to daily stand-ups, project managers have a biweekly planning meeting with business owners, where the priority list for tasks in the backlog will be set for the starting sprint.

As virtual reality is a novelty project and not yet part of the existing business, platforms, and processes, the author finds that working together with developers and designers, brainstorming ideas and creating requirements together, is more effective. For this, the author uses Impact Mapping framework.

As part of current thesis author sets a clear goal, introduced the key performance indicators (KPI) and key risks to the project team.

2.1 Impact Mapping

The author uses Gojko Adzic's Impact Mapping: Making a Big Impact with Software Products and Projects (Adzic, 2014) as a framework, where deliverables may also be considered as requirements for the project in hand. Prior to this thesis Impact Mapping method has not been used as development process in Ekspress Meedia.

Agile thought leaders often say that creating a set of requirements in advance – as in the Waterfall approach – is not effective because circumstances change, because the team

learns as it goes, or because no business is great at figuring out all of its requirements in advance (Schwartz, 2017, pp. 91–92).

2.1.1 About Impact Mapping

Impact map is a visual diagram, an outcome of the project team's workshops. The diagram for the prototype delivered must answer the following questions:

1. Why are we doing this? The answer to this question gives us the goal that is understood by the project team. This understanding is key so that all team members can give their input on how they could achieve it.

2. Who is part of delivering this prototype and who are the users of the prototype? The key persons involved in delivering the prototype and testers who will be participating in the usability testing. By answering this question, the project team is built, and the team knows to whom they are delivering the outcome.

3. How can the persons involved help us achieve the goal? By answering this question, we have impacts that we are trying to create and we prioritize deliverables.

4. What are the deliverables to support the impacts? Answering the first three questions gives us the scope. Team members collaboratively will list down deliverables how the impact can be achieved. This is the least important level of the impact map. Treat deliverables as options, don't take it for granted that everything listed here will actually be delivered. List only high-level deliverables (Adzic, 2014, p. 28).

It is important to keep in mind that impact map is dynamic, and changes are expected while working towards the target impact.

2.1.2 Preparation Step: Defining Goal and Measurements

The goal is to be innovation leader of the media market in Estonia. To achieve this goal computer graphic (CG) based mobile virtual reality (VR) news story will be developed for Delfi Android application. The initial prototype will be validated with end users through usability testing, before launching the final product. Ekspress Meedia as leading news organization in Estonia, believes that immersive storytelling impacts journalism, consumers of the journalism, and journalists.

1. From the readers perspective, it is a new and innovative way to consume journalism.
2. From the editorial side, it provides inner motivation to journalists as they can take the digital news to the next level and provides them opportunities to reflect news in a way that is more immersive and engaging.

Initial measurements are divided into Key Performance Indicators and Key Risks.

1. Key Performance Indicators (KPI):
    - Traffic – 30% of overall traffic to Delfi Android application to visit CG-based mobile VR project;
    - Engaged Minutes – 80% of entire length of the project to be consumed;
    - Partners who would use the solution – i.e. Estonian National Museum, Estonian History Museum;
    - Media Coverage – Covered by other media outlets in Estonia (i.e. Estonian Public Broadcasting), in the Baltics (MTG Group) and other international technology news portals;
    - Brand Image – Ekspress Meedia as a publisher of both legacy and online media to be recognized as the innovator in the field of digital news in Estonia.
2. Key Risks:
    - Unable to achieve full compatibility of the equipment's needed to consume the project outcome;
    - Data usage;
    - Lack of user interest;
    - The project does not achieve expected Media Coverage.

2.1.3 Mapping Step: Delivering Virtual Reality Prototype for Delfi Android App

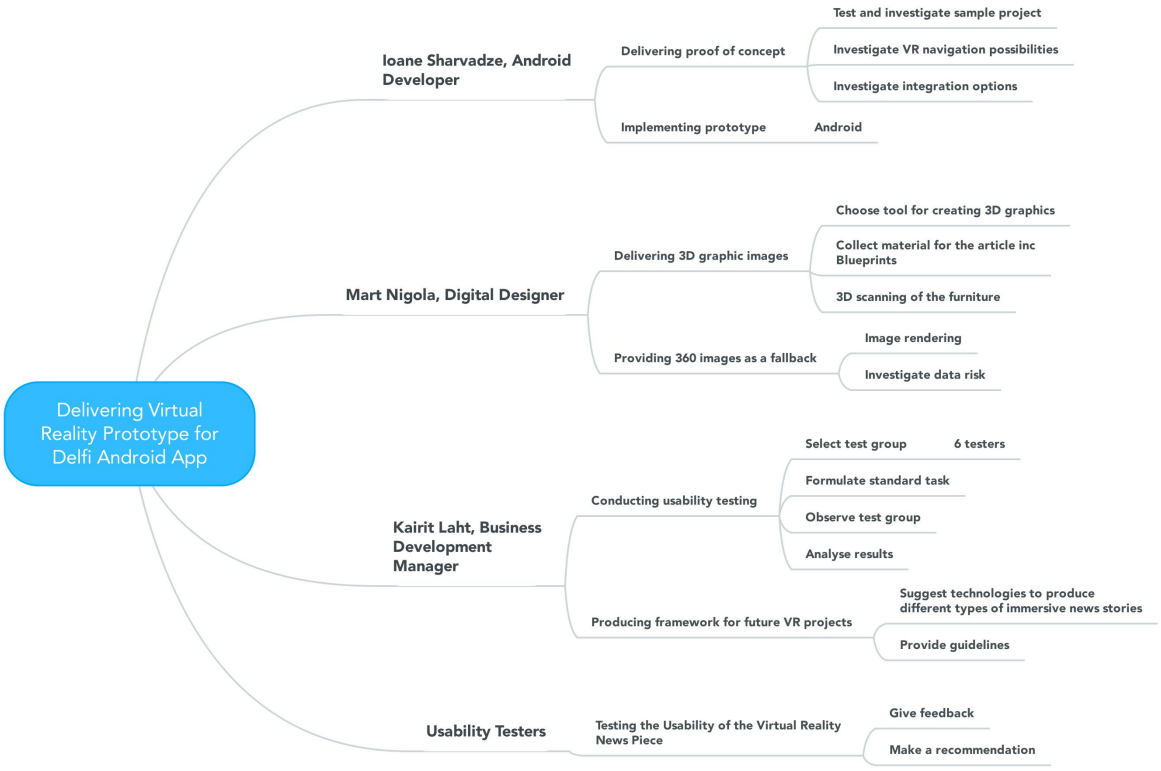

Figure 2: Impact Map of the Project. Created with Mindmeister.com

For the project in hand, the prototype is considered as the first milestone. The aim of the usability testing is to learn from the test results and improve the usability before moving further with the production.

The project team includes business, designer and Android developer as the key members. In terms of collaboration, the team had biweekly face-to-face workshops and regular check-ins in the dedicated chat on Slack.

The outcome of the mapping are tasks for each team member:

- Ioane Sharvadze, Android Developer is contributing to achieving the goal by delivering the proof of concept and implementing the prototype. For delivering the proof of concept he will test and investigate sample project; investigate VR navigation possibilities; investigate integration options. The prototype will be implemented to Android.

- Mart Nigola, Digital Designer is contributing to achieving the goal by delivering 3D graphic images and by providing 360 images as a fallback. For delivering 3D graphic images he will select the tool; collect material including blueprints for the design. For fallback 360, 3D images will be rendered to 2D.

- Kairit Laht, Business Development Manager is contributing to achieving the goal by conducting usability testing and producing the framework for the future VR projects. For conducting usability testing author selects test group; formulates standard task; observes test group; analyzes results. For producing framework author will suggest technologies to produce different types of immersive news stories; provides guidelines.

- Usability Testers are contributing to achieving the goal by testing the usability of the virtual reality news piece, giving feedback and making recommendations.

2.2 Choosing Tools for the VR Pilot

In choosing the right tools for creating 3D room-scaling as well as the right set of VR libraries, it is very important to consider the desired outcome of the project:

1. Creating CG-based mobile VR application with the option to add room-scale VR moving forward;

2. Maximum quality experience with in-expensive mobile VR head-worn device, i.e. Google Cardboard, Destek etc.;

3. Possibility to integrate audio and motion recognition in the future projects;

4. Cross-platform usability.

3 Development of the Ekspress Meedia's Pilot

Virtual reality, just as artificial intelligence and machine learning, has to be subtly introduced to the general public. Although personalization and the right product, at the right time, at the right place, is expected by users these days, the unfamiliar concept of VR, AI, ML and other abbreviations alike, might be taunting. Furthermore, the incorrect usage of virtual reality may cause cybersickness amongst other, especially for consumers who are not experienced user, like computer gamers. For these reasons, the author introduces the Framework for the Immersion-Journalism Intersection (FIJI) and insists that the principles will be taken as guidelines in developing-writing immersive news stories in Ekspress Meedia.

3.1 Framework for the Immersion-Journalism Intersection (FIJI)

Hardee and McMahan have developed Framework for the Immersion-Journalism Intersection (FIJI), where they identify four domains of knowledge that intersect to define the key requirements of immersive journalism: the fundamentals of immersion, common immersive technologies, the fundamentals of journalism, and the major types of journalistic stories. FIJI identifies four types of journalistic stories – breaking news, public service, investigative reporting, and explanatory reporting – and their journalistic requirements (Hardee and McMahan, 2017).

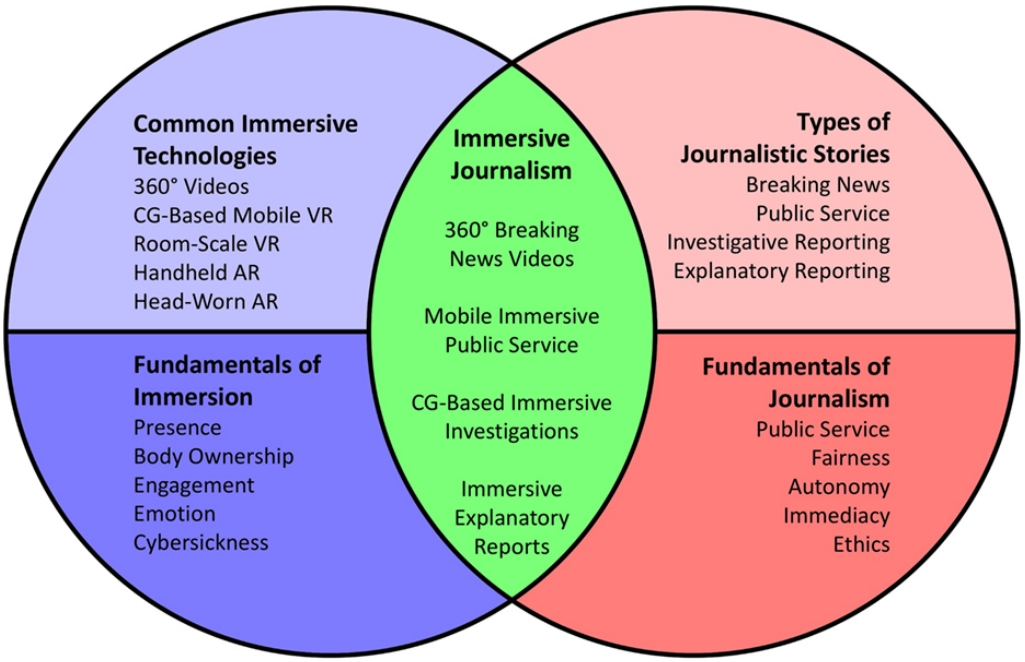

Figure 3: FIJI Guide for Journalists and Developers (Hardee and McMahan, 2017)

3.1.1 Technology

As per FIJI, it is suggested to focus on the technology that is more readily accessible for both journalists and broader audiences when creating an immersive news story. These include:

1. 360-video, as they are most common technology nowadays and do not require any CG rendering or 3D room-scaling. In the consumer point of view, 360-video does not need any high-end gadgets and are consumable from Google Cardboards to HTC Vive or just using smartphone. The downside of 360-video is that they lack interactivity, as they are nothing more than 2D pixels wrapped around the viewer. However, journalists must be careful how they capture 360-video, this can induce cybersickness, especially when viewed through immersive HWD (Hardee and McMahan, 2017).

Figure 4: Samsung Gear 360 (Source: The Official Samsung Site, samsung.com)

2. CG-Based Mobile VR, any technology that uses a smartphone, a mobile HWD peripheral, and a CG-based simulation to provide an immersive experience. CG-based simulations are more interactive than 360-video, the virtual world can be interacted with and changed according to user's actions, which are limited to user's head orientation and menu buttons (Hardee and McMahan, 2017).

Figure 5: Remembering Pearl Harbour. CG-based Mobile VR (Source: http://time.com/4583817/remembering-pearl-harbor-virtual-reality/)

3. Room-scale VR is similar to CG-based mobile VR, but room-scale VR has more tracking capabilities, which allow users to walk around and to interact with virtual objects using handled controllers. Room-scale technology offers the most convincing immersive experience, but at the same time due to the ability to walk around (though

teleporting technique should be used instead of simulated walking to avoid moving beyond physical tracking limits) the room-scale VR is less likely to cause cybersickness (Hardee and McMahan, 2017).

Figure 6: Hunger in LA. Room-Scale VR (Source:(de la Peña, 2015))

4. Handheld AR, as the technology is afforded by software rather than hardware, AR can be used with nearly all smartphones or tablets, which means that handheld AR is available for wider range of audience. For AR story, AR solutions such as ARToolKit, Vuforia, Aurasma, and Layar can be used. However, with AR solution, the sense of presence is questionable and the same level of immersive experience as with room-scale, is not achieved (Hardee and McMahan, 2017).

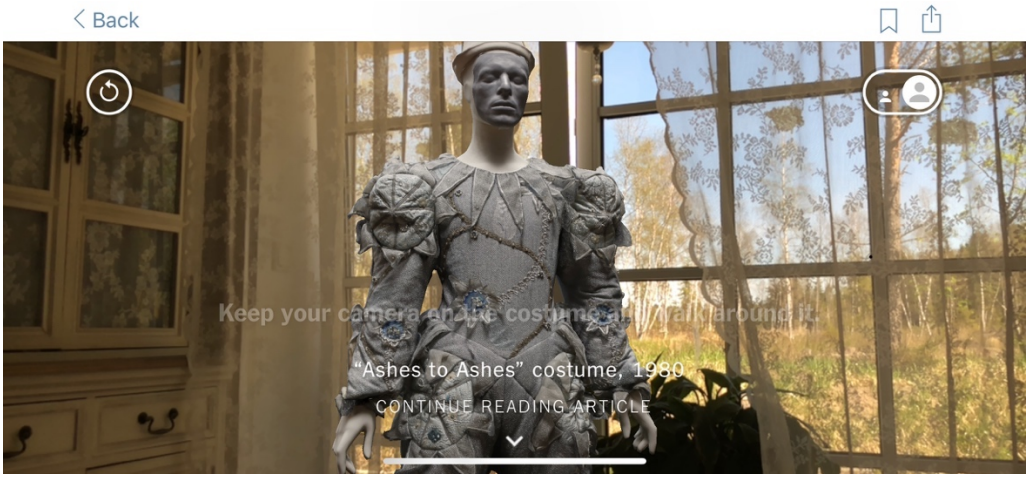

Figure 7: Augmented Reality: David Bowie in Three Dimensions. Handheld AR (Source: NYTimes mobile application)

5. Head-Worn AR, which is not yet fully explored in journalism, as the technology itself is new. Hardee and McMahan suggest that head-word AR will be soon adopted for immersive journalism. In head-worn AR the user wears a see-through HWD, and videos or virtual 3D objects are superimposed within the user's view. AR headset provides a stereoscopic display and head tracking, which handheld AR does not. This means that head-worn AR is likely to afford greater levels of presence, but also that it is more likely to induce cybersickness due to accommodation problems, latency, and poor headset ergonomics (Hardee and McMahan, 2017).

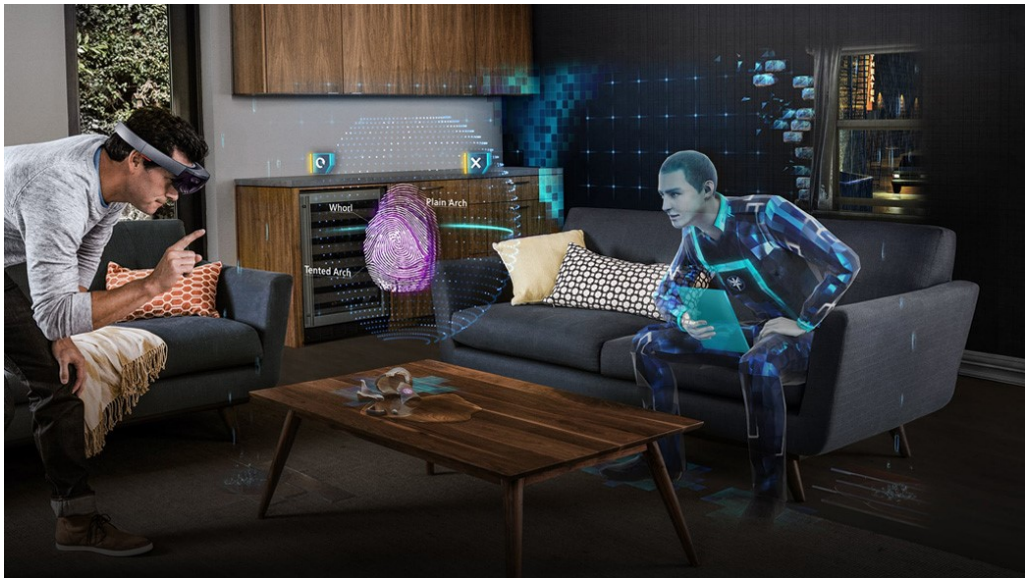

Figure 8: Microsoft HoloLens. Head-Worn AR (Source: microsoft.com)

3.1.2 Summary of Immersive Journalism, Technology, Key Journalism requirements

In terms of immersive journalism, Hardee and McMahan have presented four fundamental domains of knowledge of FIJI and identified which of the immersive technologies are best suited for each type of journalistic story, taking to the account their key journalistic requirements. Table 1 provides a summary of the four types of immersive journalism, including their type of journalistic story, key journalism requirements, the immersive technologies recommended to implement them with (Hardee and McMahan, 2017).

Immersive journalism	Type of journalistic story	Key journalism requirements	Recommended immersive technologies	Expected effects of immersion
360 Breaking News videos	Breaking news	Immediacy, ethics	360-video	Presence
Mobile immersive public service	Public service	Public service, ethics	360-video, CG-based mobile VR, handheld AR	Presence, emotion
CG-based immersive investigations	Investigative reporting	Autonomy, ethics	CG-based mobile VR, room-scale VR	Presence, body ownership, engagement, emotion
Immersive explanatory reports	Explanatory reporting	Fairness, ethics	360-video, CG-based mobile VR, room-scale VR, handheld AR, head-worn AR	Presence, body ownership, engagement, emotion

Table 1: Summary of Each Type of Immersive Journalism (Hardee and McMahan, 2017)

3.1.3 Design Guidelines for Immersive Journalism

Hardee and McMahan have identified design guidelines for immersive journalism, which are part of FIJI framework. These guidelines include:

1. Do not move the camera when capturing a 360-video – moving camera when capturing 360-video will create visual-vestibular sensory conflict for viewers, especially if consumed through HWD. Such sensory conflicts are believed to be the cause of most cybersickness and should be avoided. It is suggested to use a separate 360-video if the journalist wishes to capture multiple locations, and fade-out-fade-in technique could be used to transition between videos (Hardee and McMahan, 2017).
2. Avoid virtual camera motion in CG-based mobile and room-scale VR – virtual camera motion may also cause cybersickness, thus should be avoided for news stories that are meant for general public. It is suggested to use the teleporting technique, that allows users to point to a new location and then fade-out-fade-in animation to transition the user to the new location (Hardee and McMahan, 2017).
3. Use 360-video when immediacy is your primary journalistic requirement – as CG-based mobile VR simulations are costly to produce and time-consuming to create, and

360-camera are prevalent, it is advised to use 360-camera to quickly capture and produce immersive journalism piece (Hardee and McMahan, 2017).

4. Do not use room-scale VR or head-worn AR when public service is your primary journalistic requirement – as neither HWD VR nor head-worn AR is widely adopted devices and public service news piece should target a wide audience for dissemination, these technologies should not be used for immersive public service journalism (Hardee and McMahan, 2017).
5. Use CG-based mobile VR or room-scale VR technologies when working on an investigative reporting piece involving restricted real-world locations or events. For an investigating reporting piece, where the locations involved in the story may be limited or not available, 360-video, handheld AR, head-worn AR are less viable options, as probably neither the journalist nor the readers can access these locations. For these immersive news stories, CG-based simulations provide virtual access to locations (Hardee and McMahan, 2017).

For the current theses and for future projects the above listed design guidelines should be taken into account when producing immersive news story in Ekspress Meedia.

3.2 The Immersive Explanatory Reporting for the Pilot

Since 2014 Eesti Ekspress has used journalistic storytelling format, called *longread,* for longer investigative and explanatory reporting pieces. A similar format is used by all major newspapers in their digital channels, i.e. *The New York Times*, BBC, the *Guardian*. *Longread* formats are generally quality journalistic news story, ad-free, non-branded and engaging user experience. Ekspress Meedia has used this format for newspapers Eesti Ekspress, Maaleht, Eesti Päevaleht and online news portal Delfi. The *longread* pieces, amongst which *Me Armastame Mandariine* (Vaitmaa et al., 2017), Rail Baltic (Saarmann et al., 2017), have won Estonian Newspaper Association's press awards.

For Ekspress Meedia's pilot project in immersive storytelling, virtual reality and *longread* will be incorporated by inserting CG-based mobile VR as article images. The content of the explanatory reporting is a sequence to already published article series *Tallinna Maja* (Vaitmaa, 2016a) and *Stalinistlik Maja* (Vaitmaa, 2016b). The sequence will be about *Lender* houses, which were built at the beginning of 20th century in Tallinn and are considered to be the cradle of Estonian city culture. The fact that most of these houses

have been reconstructed nowadays, makes this story a perfect candidate for the virtual reality project and according to the FIJI design guideline, CG-based simulation is recommended.

3.3 Computer Graphics for the Pilot

The intention is to recreate both exterior and interior of one of the original *Lender* houses as it was at the beginning of the 20th century. Ekspress Meedia's investigative journalist Ester Vaitmaa was able to retrieve original blueprints for seven *Lender*-type houses in Tallinn. From these, Rohu 18 in Tallinn was chosen to be recreated.

Digital Designer, Mart Nigola, used Cinema 4D by Maxon to recreate Rohu 18 house from original blueprints. For the prototype trial version of the Cinema 4D software was used.

Three separate views of the exterior and one view of the interior was created. Teleportation technique was not added in this phase but is considered to be implemented before launching the live product.

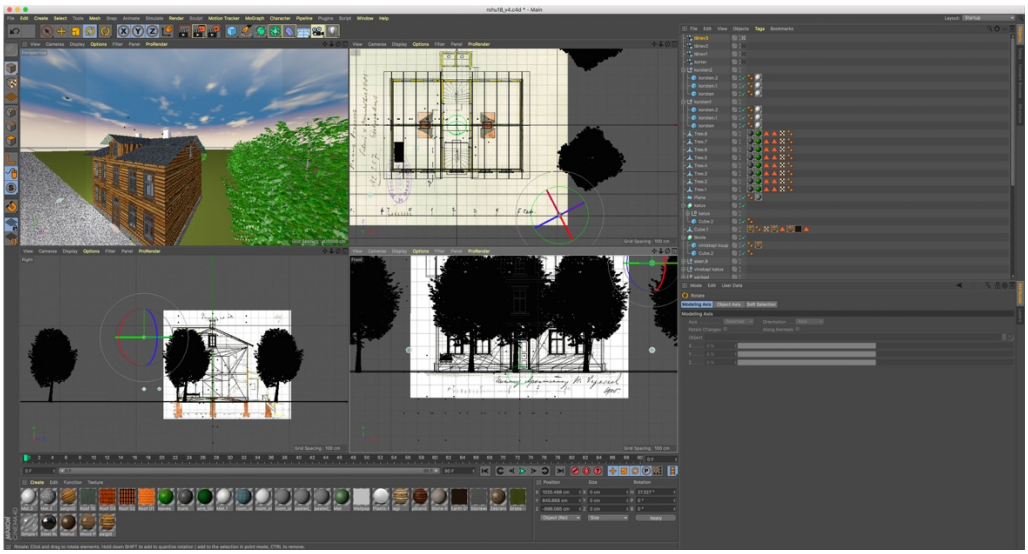

Figure 9: Printscreen of Cinema4D Tool

3.4 Integration to Delfi Android Application

Android developer, Ioane Sharvadze was responsible for integrating CG images to Android application. For the prototype, the test article was hard-coded and vertically

aligned images used to create VR simulation. Since the navigation for teleportation technique was not implemented for the prototype, single panorama image was shown using provided VR views, which did not require any additional tool.

On the images, standard VR icon and full-screen icon was used and displayed on the bottom right corner of Figure 10.

Figure 10: Example of Icons Used

The article images were interactive, even without selecting VR icon or full-screen icon, meaning the 3D image was rendered to 2D 360-image, which could be viewed by moving the smartphone. In terms of the current theses and for usability testing, the author considers 360-mode only if the user has selected the full-screen, turning smartphone to the horizontal position is optional. Full-screen 360-mode is displayed in Figure 11.

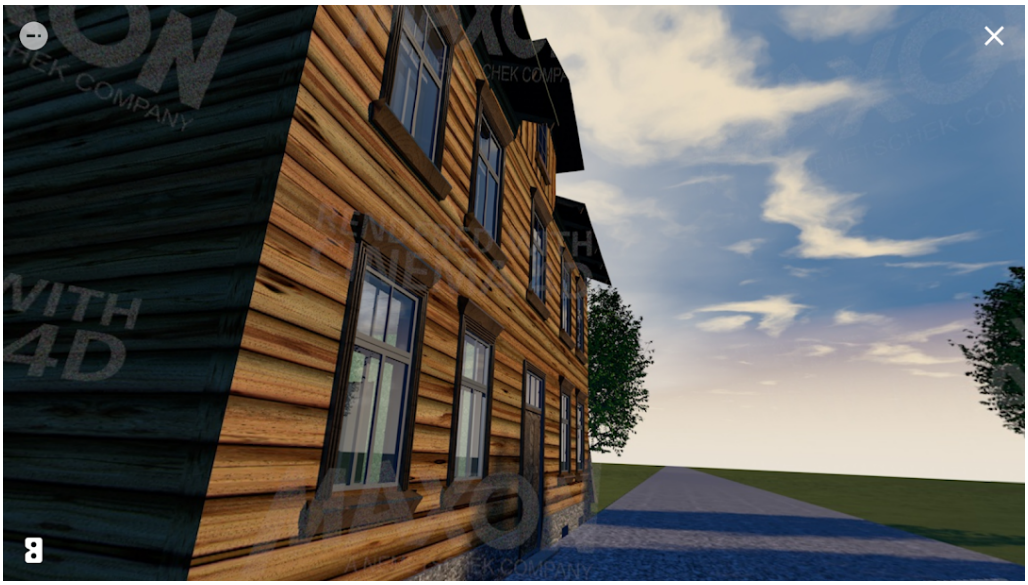

Figure 11: Full-Screen 360 Mode

If the user selects VR icon the panorama view is enabled, displayed in Figure 12.

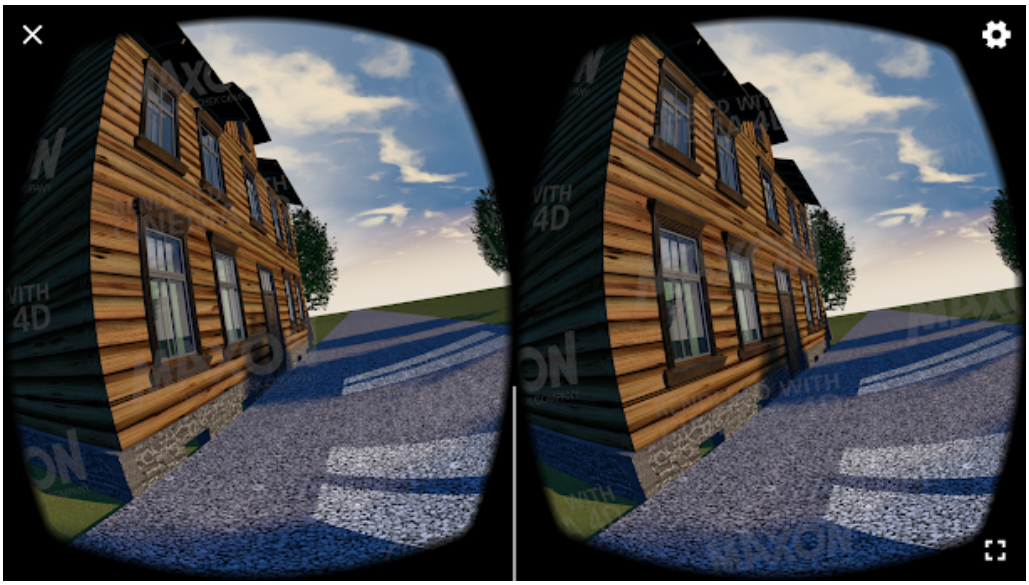

Figure 12: Panorama VR Mode

4 Usability Testing

Validating prototype with users prior to launching the finished product, is an important part of the new product development process. This provides a clear overview whether the product is consumable, delivers the expectations and initially set KPIs.

Usability testing employs techniques to collect empirical data while observing representative end users using the product to perform realistic tasks. Testing is roughly divided into two main approaches. The first approach involves formal tests conducted as true experiments, in order to confirm or refute a specific hypothesis. The second approach, a less formal but still rigorous one, employs an iterative cycle of tests intended to expose usability deficiencies and gradually shape or mould the product in question (Rubin et al., 2008, pt. I).

In the current theses, the author uses the second approach of the usability testing followed by the questionnaire regarding the overall experience with the prototype.

4.1 A Definition of Usability

The International Organization of Standardization (ISO) has issued ISO 9241-11:2018, which provides the framework for the concept of usability. In ISO 9241-11:2018 usability is defined as the extent to which a system, product or service can be used by specific users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use ("ISO 9241-11:2018 Ergonomics of human-system interaction — Part 11: Usability: Definitions and concepts," 2018).

As per the ISO 9241 part 11 for the product to be usable it should be useful, effective, efficient, satisfying, learnable and accessible. Jeffrey Rubin et al. have defined these attributes in the Handbook of Usability Testing as follows (Rubin et al., 2008, pt. I):

1. Usefulness concerns the degree to which a product enables the user to achieve his or her goals and is an assessment of the user's willingness to use the product at all.

2. Effectiveness refers to the extent to which the product behaves the way that users expect it to and the ease with which the users can use it to do what they intend. Measured quantitatively with error rate.

3. Efficiency is the quickness with which the user's goal can be accomplished accurately and completely and is usually a measure of time. Measured also quantitatively like effectiveness.

4. Learnability is a part of effectiveness and has to do with the user's ability to operate the system to some defined level of competence after some predetermined amount and period of training.

5. Satisfaction refers to the user's perceptions, feelings, and opinions of the product, usually captured through both written and oral questioning.

6. Accessibility and usability are siblings and in the broadest sense, accessibility is about having access to the products needed to accomplish the goal.

4.2 The Test Set Up

The main goal of testing the CG-based VR prototype is to understand if the product can be used equally well by different users.

To validate the main goal the following research questions are asked:

1. How easily do the participants understand, which images are CG-based mobile VR?

2. How easily do the participants switch between image, VR, 360 modes?

3. How well do the participants understand the icons on images?

4. Which ones are problematic? Why?

5. What questions do the participants ask while consuming the CG-based mobile VR?

6. How does the participant feel when wearing VR HWD to consume the CG-based mobile VR? Any indication of the cybersickness?

The test will be conducted with 6 participants. As a pre-condition of the task, participants will be given smartphone, where Delfi Android Test application will be opened in the article view and Destek VR headset. The task given to the participants is to consume the article as they would normally and see if they realize that the virtual reality is inserted in the article. In total four CG-based mobile VR simulations is inserted in the article. The

author will observe how the participants complete the standardized task and the following observation tasks:

1. **Task**: enter VR mode.

   Successful completion: when the VR icon is visible on the image in the article, as shown in Figure10, the user understands to use VR headset to enter the CG-based mobile VR.

   Measured quantitatively: time spent until successful completion.

2. **Task**: enter 360-mode.

   Successful completion: when the full-screen icon is visible on the image in the article, as shown in Figure 10, the user selects the full-screen mode for rendered 360 images. Holding smartphone in horizontal position is optional.

   Measured quantitatively: time spent until successful completion.

3. **Task**: view all 4 3D CG-based mobile simulations.

   Successful completion: user scrolls through the entire article body and experiences all four 3D CG-based mobile simulations.

   Measured quantitatively: time spent until successful completion.

The participants are end-users, who have used Delfi mobile applications at least three times in the past 6 months:

Participant number	Male/Female	Age
1	Male	40
2	Female	38
3	Male	11
4	Female	37
5	Male	11
6	Male	50

Table 2: Participants of the Usability Testing

The level of experience with virtual reality will be determined before each individual test. To confirm the experience, each participant is asked how familiar they are with virtual reality by choosing one of the following options:

- I have never used virtual reality;
- I have used virtual reality once or twice;
- I have used virtual reality several times;
- I use virtual reality on regular basis.

After completing the test, the participants will be asked to evaluate their overall experience by answering the following questions, where number 1 is the lowest and number 5 is the highest:

- On the scale from 1 to 5, how would you rate the VR experience?
- On the scale from 1 to 5, how interesting was the application?
- On the scale from 1 to 5, how easy it was to use the application?
- On the scale from 1 to 5, how likely would you use the VR for consuming the news in the future?
- I have consumed the CG-based mobile VR news story before. Yes or No.

The individual usability tests will be recorded and evaluated afterward for the results.

The devices used for usability testing are Nexus 6P smartphone and Destek VR HWD.

4.3 Test Results

To summarize the performance, the author analyzes the completion of the tasks and the task accuracy and timings. In terms of task accuracy, task success is measured regardless of whether the participant required assistance for completing the task or not.

4.3.1 Evaluation of Performance Data

All participants were asked their level of experience before starting the test. 50% of the participants had used virtual reality once or twice, the rest had had no contact with virtual reality prior to the test. Everyone began testing in the Delfi Android application article view, where the CG-based 3D simulations were integrated, a total of 4 simulations. The author explained to the participants the reasons for testing usability of the new product, which requires virtual reality head-worn device. Also, that it is not measured how well the participants perform the task, but rather how self-explanatory the developed product was.

Table 3 presents the average time spent in minutes and the standard deviation time in minutes to complete the observation tasks set in paragraph 4.2.

Task	% of participants performing correctly	Average time spent in minutes	Standard deviation in minutes
1: Enter VR mode	100%	2.05	0.34
2: Enter 360 mode	66.67%	0.29	0.14
3: View all 4 3D CG-based mobile simulations	83.33%	4.16	1.24

Table 3: Usability Test Summary and Average Time (N=6)

To calculate the average time spent to complete each task, the following formula was used:

$$\text{Average} = \frac{\text{Sum of All Participants Time Spent}}{\text{Number of Participants}}$$

The standard deviation of time spent completing the tasks shows the variability, of how the time differs from each other. For this the following formula was used:

$$\text{Standard Deviation} = \frac{\sqrt{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}}{n-1}$$

Where Σx^2 is the sum of squares of each of the times;

Σx is the sum of times spent;

n is the number of participants.

In case of the first task, where users had to enter VR mode, the average time spent to complete the task was 2 minutes and 5 seconds, the standard deviation 0.35, which shows that the participants completed the task very similar to one another. The same result is for task number two, where the standard deviation is 0.14. As for the third task, the average time spent for completion was 4 minutes and 16 seconds. The standard deviation for completing the third task is 1.24, which suggests that the participants performed the task quite differently from each other. From the data, it is visible, that the younger participants consumed the CG-based mobile VR for the longer period of time and used the VR HWD with all four simulations. The instant comments were also that it is “cool”. This explains the longer standard deviation time.

Furthermore, it is important to highlight that all users had trouble understanding the standard VR, full-screen and information icons used on the image. Which indicates that both tooltips and more explanatory texts have to be inserted into the article.

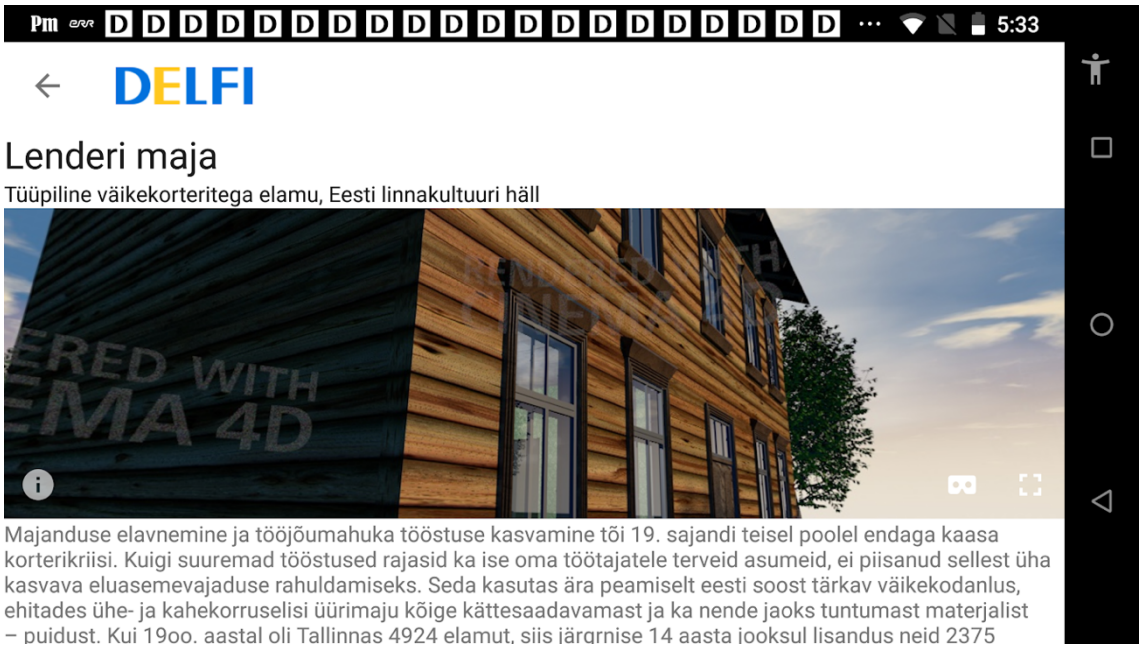

Figure 13: Printscreen of the Delfi Android Application Article Used for Testing

4.3.2 Evaluation of Experience Data

Once tasks were completed, participants were asked to evaluate their overall experience. None of the participants had used virtual reality to consume news stories before.

Table 4 displays how the participants rated the VR experience.

Answer	Strongly disliked	Disliked	Neutral	Liked	Strongly liked
count	0	0	1	2	3
percentage	0.00%	0.00%	16.67%	33.33%	50.00%

Table 4: VR Experience Survey Results

The feedback for the VR experience was that it is gripping, but participants would have liked to be able to navigate. They also brought out that the text should be indicative and possibly displayed on the CG-based mobile VR graphics.

Table 5 displays how the participants rated how interesting the current application was.

Answer	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
count	0	0	1	4	1
percentage	0.00%	0.00%	16.67%	66.67%	16.67%

Table 5: Interestingness of the Application

In terms of interestingness of the current prototype, the participants pointed out that though they liked the quality of the graphics, they would like to see more interaction. One participant also pointed out that it would be better to consume the local news piece while in that place or city with the possibility to walk around.

Table 6 displays how the participants rated how easy it was to use the current application.

Answer	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
count	0	0	1	3	2
percentage	0.00%	0.00%	16.67%	50.00%	33.33%

Table 6: Ease to Use the Application

The participants pointed out that as users who have not consumed VR news story before, they experienced the confusion of what was expected. However, after being guided how to use the VR HWD they had no trouble in using it with all simulations. 360 images were

more habitual, and one participant pointed out that it is something they'd like to use more in the future.

Table 7 displays how the participants rated whether they would consume the immersive news story in the future.

Answer	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
count	1	0	1	2	2
percentage	16.67%	0.00%	16.67%	33.33%	33.33%

Table 7: Likeliness to Use in the Future

Most of the participants said that they would like to consume immersive news stories in the future either VR or AR. Only one participant expressed hesitation and said that they'd seriously consider the type of news they would consume using VR HWD.

4.3.3 Discussions

At the beginning of the current fourth Chapter, the author quoted that according to ISO 9241 part 11 for the product to be usable it should be useful, effective, efficient, satisfying, learnable and accessible. One part of the goal of the thesis was to conduct usability testing on the prototype developed for the pilot virtual reality project in Ekspress Meedia. In this section, the usability of the product in accordance with the defined attributes of ISO 9241 part 11 is discussed.

1. Usefulness – The immediate response from the participants was positive and it was pointed out that the clarity of the images, which is the result of computer graphics, was what made the simulation enjoyable. As can be seen from Table 7, 67% of the participants would use the product in the future, which means users have the willingness to use the product. These results imply that the product is useful.

2. Effectiveness – Table 6 displays the results of the answer to the question how easy the application was. 50% of the participants agreed and 33,3% of the participants strongly agreed that it was easy to use the application, only one participant did neither agree nor disagree. However, it is important to point out that all participants had to be guided to use VR mobile HWD. As a result, if the product will have more guided information on how to use VR, at least until the technology becomes prevalent, it can

be assured that the users can use it to do what they intend, and that the product behaves the way users expect it, hence the product is effective.

3. Efficiency – The completion of the tasks as well as the measured time is accumulated in Table 3. All participants successfully entered VR mode, the average time was measured 2.05 minutes with standard deviation of 0.34 minutes. As all participants were guided how to use the HWD, the time to completion was considered at the point when the assistance was needed. The standard deviation less than 0.5 suggests that there was no deflection to report. In conclusion, it is safe to claim that the user task was completed accurately and completely, hence the product is efficient.

4. Learnability – once all participants were explained how the CG-based mobile VR and the HWD works, 83.3 % of the participants viewed all 4 CG-based simulations, as can be seen in Table 3. Hence, the product is learnable.

5. Satisfaction – Table 4 displays how the participants rated the VR experience. 33% of the participants liked and 50% of the participants strongly liked the prototype. The initial feedback and opinions of the product were positive, though the lack of navigation was pointed out several times, one user instinctively tried to walk in the virtual reality. Therefore, it may be safely deduced that the product is satisfying.

In summary and considering the listed above it can be determined that the product is usable according to ISO 9241 part 11.

5 Conclusion and Future Projects

The aim of this thesis was to develop the prototype for CG-based mobile VR in Ekspress Meedia and to conduct the usability testing to validate the prototype with end users. In this final chapter, the author summarizes the project and provides suggestions for the future immersive storytelling projects in Ekspress Meedia.

5.1 Summary of the Project

The CG-based mobile virtual reality prototype was successfully developed, and usability testing conducted. To achieve this goal the state of the art was researched and the leading virtual reality and augmented reality projects in journalism consumed.

The main method, the Impact Mapping framework for developing the prototype was chosen and introduced. The initial feedback from the developers was that the idea to work closely with business product owners is welcomed, especially on an innovative project like the virtual reality. From the business development side, Impact Mapping method and brainstorming which supports the method, is equally welcomed as compiling the requirements collaboratively is less time-consuming.

For developing the actual prototype and in choosing the technology for the journalistic news piece of the prototype, the Framework for the Immersion-Journalism Intersection (FIJI) was introduced. FIJI brings together technology and journalism in developing immersive news stories. It also provides a clear summary of the four types of immersive journalism, including their type of journalistic story, key journalism requirements, the immersive technologies recommended to implement them. Ekspress Meedia's immersive story for the pilot was chosen to be the recreation of *Lender* type houses as they were at the beginning of 20th century. According to FIJI, CG-based simulations were created using Cinema 4D software and integrated to Delfi Android application for testing.

The usability tests were conducted with six participants. Both the performance and the experience were evaluated and analyzed. The results of the usability testing were analyzed

and usability determined in accordance with the set attributes of the ISO 9241 part 11 standard. The testing revealed that the product is usable as per ISO 9241 part 11, however, the technology itself requires further training of the general public, which can be done by more explanatory stand-alone articles and by inserting tooltips into the application.

In conclusion, the results of developing and testing the prototype were positive. And the pilot immersive story project in Ekspress Meedia agreeably approved by the end users.

5.2 Future Projects

The result of the goal defined in current thesis encourages the producing of immersive journalism projects in Ekspress Meedia moving forward. The FIJI framework should be considered for the future projects, to avoid inducing cybersickness; to use the right technology with the right content; and to keep in mind the fundamental pillars of journalism, when choosing the content for the immersive news reporting. Journalistic ethics should remain the most important keyword in the immersive storytelling.

Moving forward with the current project, the usability test feedback will be taken into the account to improve the pilot prototype. In terms of the 3D simulations, the aspiration is to solve the navigation issue before the launch of the immersive investigative news story. The actual article itself will be edited and the aim is to provide 3D room-scaling experience of the recreated *Lender* houses as they were at the beginning of the 20th century to the end users.

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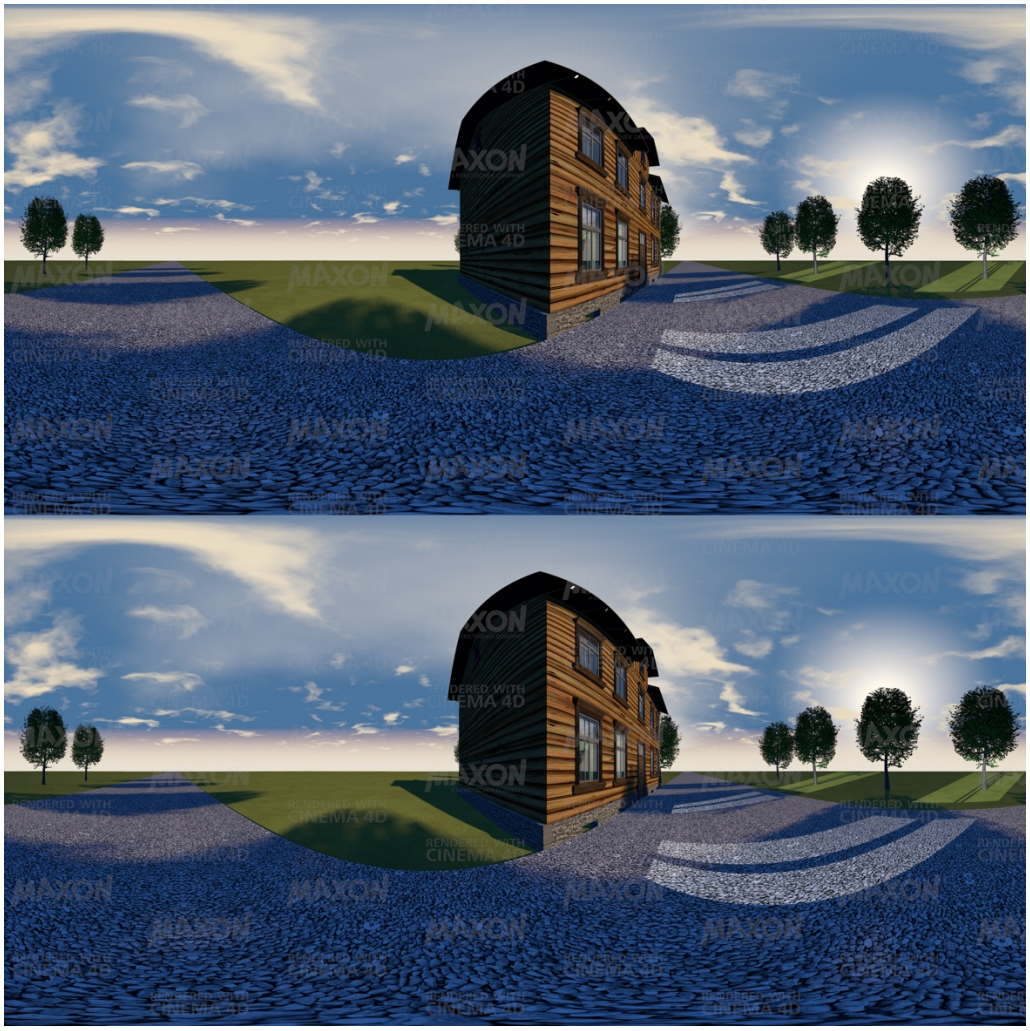
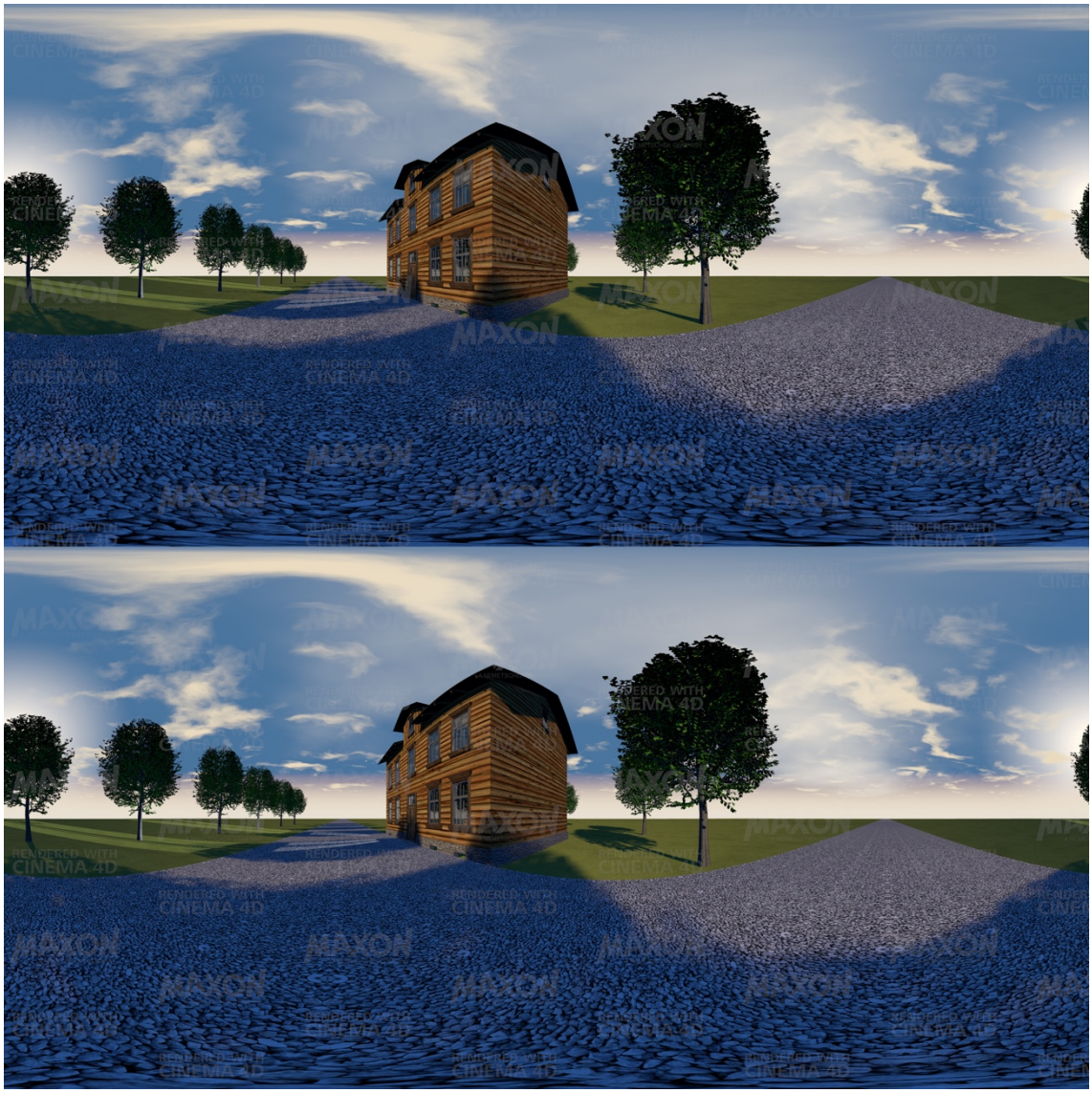
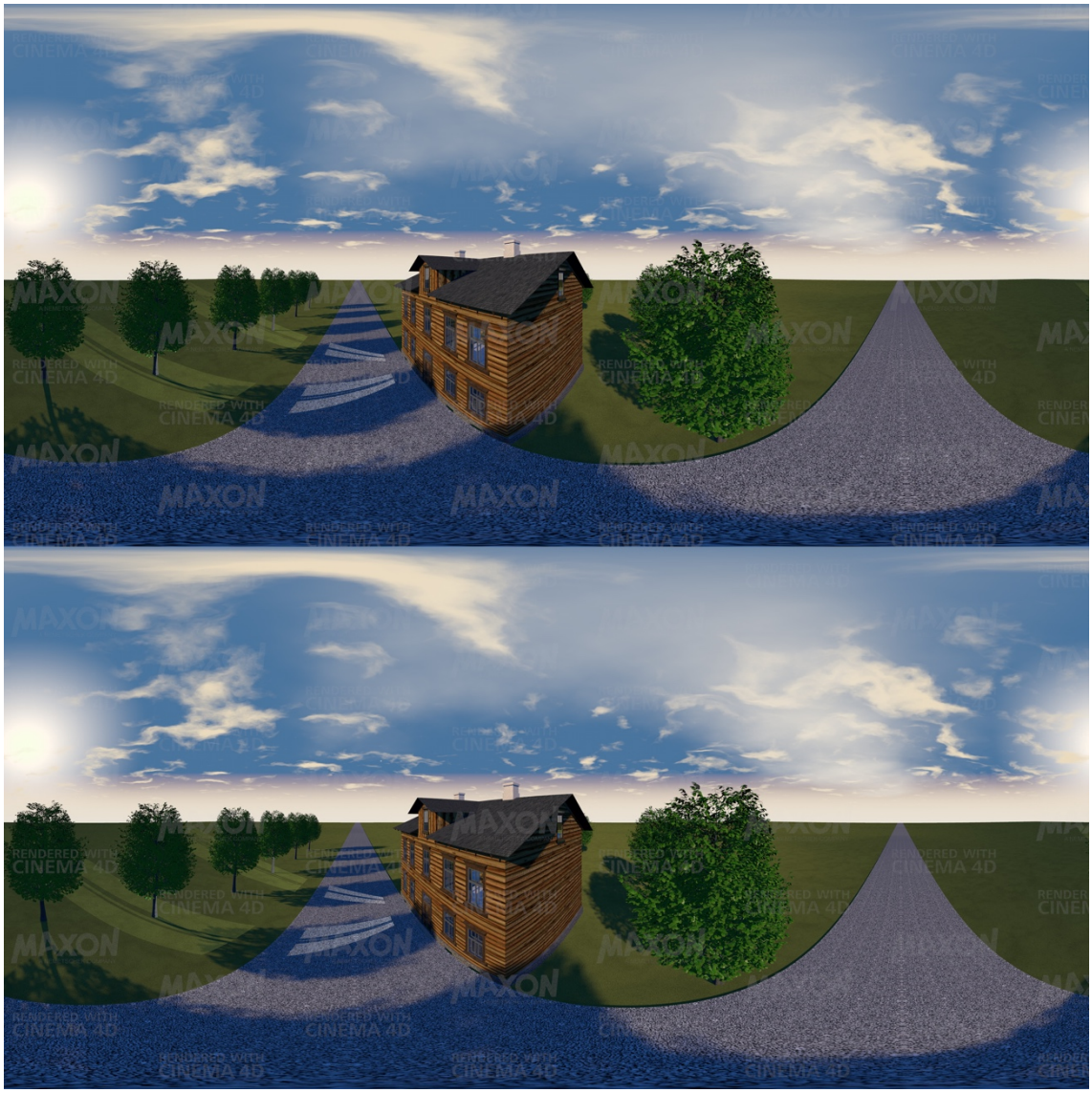
Appendix 1 – Exterior View No 1 of Rohu 18, Tallinn (Cinema 4D)



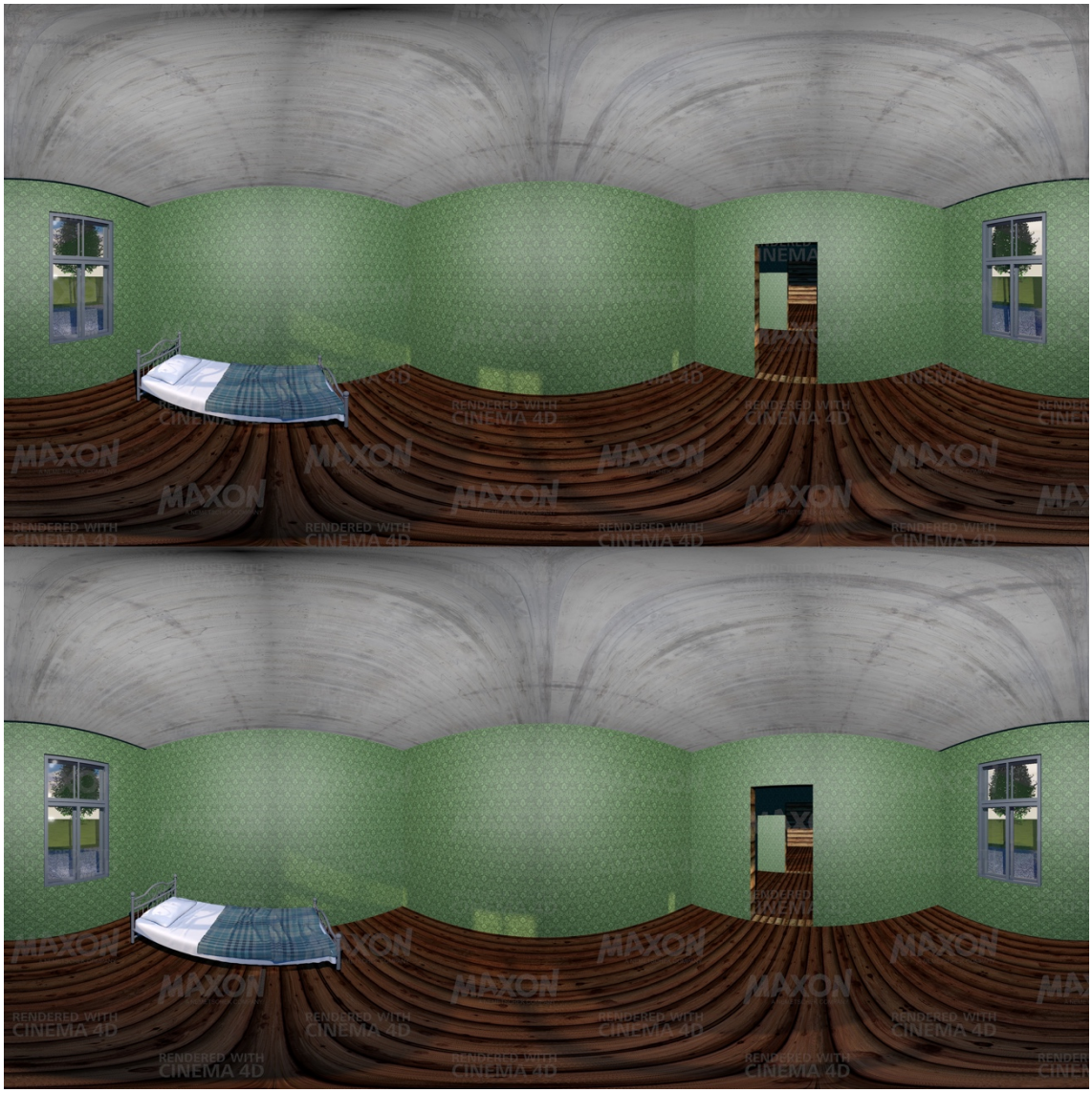
Appendix 2 – Exterior View No 2 of Rohu 18, Tallinn (Cinema 4D)



Appendix 3 – Exterior View No 3 of Rohu 18, Tallinn (Cinema 4D)



Appendix 4 – Interior View of Rohu 18, Tallinn (Cinema 4D)



Appendix 5 – Hard-Coded Article View in Delfi Android Application

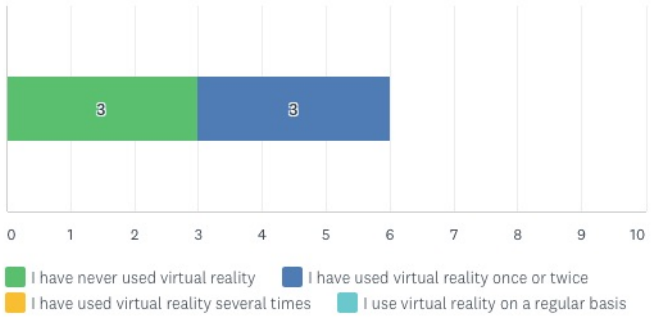
Appendix 6 – Usability Test, Performance Data

Participant number	Male/Female	Age	Level of experience	Task 1	Time spent to complete task 1 (in minutes)	Comments on task 1	Task 2	Time spent to complete task 2 (in minutes)	Comments on task 2	Task 3	Time spent to complete task 3 (in minutes)	Comments on task 3
1	Male	40	I have used virtual reality once or twice	Success	1.17	Icon was clear, but if user got to panorama view the usage of VR HWD was unclear	Success	0.30	User reached 360 full-screen mode quickly and turned smartphone to horizontal position, but tried to zoom in by using fingers to zoom	Success	3.70	User viewed 2 of the 3D simulations with VR HWD, the rest 2 in 360
2	Female	38	I have never used virtual reality	Success	1.53	Icon was unclear. User tried to walk in the VR	Success	0.28	User did not turn smartphone to horizontal position	Success	3.43	User viewed 1 of the 3D simulations with VR HWD, the rest 3 in 360
3	Male	11	I have used virtual reality once or twice	Success	2.67	Icon was unclear	Not success	-	User did not view 360	Success	8.17	User viewed all 4 3D simulations with VR HWD
4	Female	37	I have never used virtual reality	Success	3.00	Icon was unclear and usage of VR HWD needed help	Not success	.	User did not view 360	Not success	-	User only viewed the first 3D, the rest was watched as images.
5	Male	11	I have used virtual reality once or twice	Success	1.43	Icon was unclear and usage of VR HWD needed help	Success	0.52	User did not turn smartphone to horizontal position	Success	6.10	User viewed all 4 3D simulations with VR HWD
6	Male	50	I have never used virtual reality	Success	2.50	Icon was unclear and usage of VR HWD needed help	Success	0.65	User did not turn smartphone to horizontal position	Success	3.58	User viewed 1 of the 3D simulations with VR HWD, the rest 3 in 360. User is wearing subscription glasses and VR HWD is not user friendly with glasses

Appendix 7 – Level of Experience, Survey Result

How familiar are you with virtual reality?

Answered: 6 Skipped: 0



ANSWER CHOICES	RESPONSES	
I have never used virtual reality	50.00%	3
I have used virtual reality once or twice	50.00%	3
I have used virtual reality several times	0.00%	0
I use virtual reality on a regular basis	0.00%	0
Total Respondents: 6		