University of Stavanger

Faculty of Science and Technology

MASTER'S THESIS

Study programme/ Specialisation:

Industrial Asset Management — The Spring Semester, 2023

Author: — Open or Restricted access

Marius Heltne

Author's signature

Faculty Supervisor(s):
Idriss El-Thalji

External Supervisor(s):
Hermilo Gonzalez

Alex Esquivel

Kåre Bergene

Thesis title:

Cost-Benefit Analysis of the Transition From Traditional On-Site Training to Interactive VR-training

Credits (ECTS): 30

Key Words:
VR
Cost-analysis

Pages: 50
+ appendix: 2

Stavanger, June 15, 2023

Cost-Benefit Analysis of the Transition From Traditional On-Site Training to Interactive VR-training

By

Marius Heltne

Thesis is submitted to the Faculty of Science and Technology
University of Stavanger
In Fulfillment of the Requirements for the degree of Master of Science
(MSc)
Specialization: Industrial Asset Management

FACULTY OF SCIENCE AND TECHNOLOGY
University of Stavanger
Year 2023

ABSTRACT

Virtual Reality (VR) is increasing in popularity as a training tool. The recent development of head-mounted displays (HMDs) that have become affordable and more companies starting to use VR, have made VR a popular research topic. The research on advantages such as increased knowledge retention, engagement, confidence, focus, and more have made it interesting for companies to invest in the technology. There are also some disadvantages like VR sickness and situations where VR is not as suitable such as memorization of academic material and fine motor training. The main focus of the research and results of use-cases have been on the pros and cons of VR, but there is little information available regarding the financial aspect. Therefore this thesis aims to show whether VR-based interactive training can be a competitive method to the traditional training methods from a financial and training effectiveness point of view.

This will be done through a review of studies, reports and use-cases on VR-training to create a foundation for making the decision to go for VR. The financial aspect will be shown through a simple cost-benefit analysis on two different scenarios that applies to different aspects of the usefulness of VR.

The thesis concludes that VR can be a competitive method to the traditional training methods based on the results of the two scenarios. The cost of VR is drastically reduced when the program can be standardized and sold without customization or with limited customization. The customized programs are still expensive but can be beneficial depending on the time frame of the project and needs of the training.

SAMMENDRAG

Virtuell virkelighet (VR) øker i popularitet som treningsverktøy. Ettersom utviklingen i VR-briller har gjort de rimelige og flere selskaper har begynt å bruke VR, har VR blitt et populært forskningstema. Forskningen på fordeler som bevaring av kunnskap, engasjement, selvtillit, fokus med mer har gjort det interessant for selskapene å investere i VR. Det er noen ulemper med VR også som VR-sykdom og situasjoner hvor VR ikke passer som memorering av tekst og finmotorikk. Hovedfokuset i forskningen har vært på fordeler og ulemper med VR, men det er lite informasjon om det finansielle aspektet. Derfor er målet med denne oppgaven å vise om VR-basert trening kan konkurrere med mer tradisjonelle metoder på pris og resultat.

Dette vil bli gjort gjennom en gjennomgang av litteratur, eksempler fra bruk i industrien for å danne et grunnlag for avgjørelsen om VR er et reelt alternativ. Det finansielle aspektet vil bli vist gjennom en enkel nytte-kostnadsanalyse av to ulike scenarier som dekker ulike bruksområder for VR.

Oppgaven konkluderer med at VR kan være et konkurransedyktig alternativ til mer tradisjonelle metoder basert på de to scenariene som er satt. Scenariene viser at kostnadene til VR går betraktelig ned når de blir standardisert og solgt uten tilpasning eller med begrenset tilpasning. Tilpassede VR-program er fortsatt dyrt, men kan være fordelaktig avhengig av tidsrammen på prosjektet og kravene til treningen.

ACKNOWLEDGMENTS

I would like to express my gratitude towards my faculty supervisor Idriss El-Thalji and my external supervisors at Capgemini Hermilo Gonzalez, Alex Esquivel and Kåre Bergene and for guidance and inputs given during the process of writing the master thesis. I also want to thank Øivind Hansen at Capgemini for input.

Lastly I want to express my gratitude to PaleBlue and Felipe Longé for taking their time to meet with me and provide some input and data for the analysis.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

VR - Virtual Reality

CAVE - Cave Automatic Virtual Environment

HMD - Head-Mounted Display

1 INTRODUCTION

1.1 BACKGROUND AND MOTIVATION

Virtual reality (VR) has the possibility to reshape the future of training and technology development. Several companies use VR actively to simplify and/or create visualization for technology that would otherwise be expensive or difficult to do.

Training is important to ensure that the staff is qualified for the tasks, operating equipment safely and efficient to avoid accidents and unnecessary downtime, working according to the company's vision and know how to conduct themselves in emergencies. VR provides an unique opportunity to prepare for their tasks or emergencies in realistic simulations that increases the confidence and know-how of employees to deal with the situations they are faced with.

The development of VR since the emergence in the 1990s, have been immense and with the hardware now being available at affordable prices compared to at the beginning. Although VR is most prominent in the gaming industry, companies such as Royal Dutch Shell and BP have adopted VR as a training tool. The development of VR will continue and the cost will continue to decrease with increased focus on templates for software development. These are some of the reasons why a cost-benefit analysis of the transition from traditional in-site training to VR-training is useful to determine whether VR is currently a viable option and to what extent.

1.2 STATE OF THE ART AND RESEARCH GAPS

With the recent increase in popularity of VR technology, the amount of research and use-cases have largely increased. Companies such as ExxonMobil, Baker Hughes, Audi, Boeing are already using VR as part of their training courses [12]. Other companies such as Paleblue[24] and Strivr[29] are focusing on developing VR-training solutions that can enhance the training experience and learning outcomes. As training is a broad term that can cover many topics and methods, there are still some unknowns with regards to VR-training.

VR is most useful when training is either expensive or dangerous. Training can be expensive due to traveling, need to shut-down production to conduct training on machinery, etc. The dangerous training can be pilot-training, working at height, fire extinguishing, police training, etc. VR can allow the user to train in a virtual environment similar to the actual environment without having to be physically present and therefore the costs or dangers can be avoided.

There is a lot of research on the pros and cons of VR as a training tool. Increased knowledge retention, engagement and confidence are the major mental advantages provided by VR. Other advantages include speed,consistency and safety of training, employee retention, scalability, sustainability, on demand training, less distracting and more measurable training. There are also some negatives that need to be taken into account when deciding if VR is the right training tool. VR sickness is the major issue that can have a big effect on the learning outcome. Another issue is that VR is not suitable in every situation. If there is a lot of memorization of academic or knowledge-based materials or fine motor skill training.

Even though there is a lot of research on VR-training from a pros and cons perspective, there is limited data on the cost aspect. As training can be different based on the objectives of the company, the sector, the skills and experience, a general cost analysis of VR-training is difficult. There are use-cases such as those provided by Strivr[29] that report on savings in certain aspects but there is a lack of financial analyses that considers the investment as well as the savings. This is the main research gap that the thesis will cover.

1.3 CAPGEMINI

This thesis is written as a collaborative effort between Capgemini Engineering Norway and the University of Stavanger. Capgemini is a consulting firm that was founded in France in 1967. With more than 360 thousand employees and presence in more than 50 countries, Capgemini is a leading strategic partner to companies all around the world [2]. Capgemini Engineering is a brand of Capgemini that focuses on digital transformation and helping clients towards intelligent industry with a focus on sustainability and innovation. Capgemini Engineering is the world leader in engineering and research and development [7].

Capgemini Engineering Norway was launched in January 2022 with more than 20 employees in Stavanger. Their vision is "To combine information technology with (IT) and operational technology (OT) to meet future demands on efficiency and sustainability" [8].

Figure 1.1: Capgemini Engineering logo [8]

1.4 RESEARCH QUESTION AND OBJECTIVES

The research question is to determine if VR-based interactive training is a competitive method to the traditional training methods from a financial and training effectiveness view. This can be divided into two objectives:

- Determine the pros and cons of VR.
- Do a economical comparison of VR and non-VR training.

As training is a broad term, the economical aspect cannot be determined on a general level. Therefore, this comparison will be done through two scenarios that cover different types of training and level of customization needed for the VR-program. The third objective will be:

- Find two scenarios to be used for economical comparison.

1.5 RESEARCH METHODOLOGY AND SCOPE

To determine if there is grounds for using VR as a training tool, a literature review of studies and use-cases will be used. The scenarios will be determined through research and discussions. This will be done to decide on scenarios that are plausible and covers different aspects of VR training. VR and traditional methods will then be compared in the scenarios using a simple cost-comparison on the changed variables such as wage cost and capital expenses.

As training can include several different disciplines in different sectors, the thesis will focus on two scenarios for the cost-comparison. The cost-comparison will be made simple as depending on the company the training may be different and therefore will vary in cost. Some other cost-factors will be discussed but not added in the comparison for the aforementioned reason. The cost-comparison is not meant to be definite proof of whether VR is more cost-efficient than traditional on-site training, but more an indication of whether VR can be defended as an option from a cost-perspective. Due to the limited time and the collaborative effort between companies that would be required to do a practical experiment testing the methods, this was considered the best approach.

1.6 THESIS STRUCTURE

The thesis starts with an introduction of the VR training as well as a short introduction to the development of VR and why it is seen as a possible tool for use in training. Chapter 1 also includes a short introduction on Capgemini Norge AS as the case provider and the problem that the thesis discusses. The objective and scope is defined as well as the limitations of the thesis.

Chapter 2 presents some relevant information to understand the topic of VR and learning. This will be done through a deep dive in what VR is, how it is used, the basis for using VR in training, when to use VR in training and useful software and hardware. The chapter ends with an introduction to cost-benefit analysis.

Chapter 3 presents the two scenarios that will be included in the cost-comparison and the reasoning of why these two scenarios are chosen. The research approach, methods and methodology will also be shown in greater detail. The data sources, collection methods and data analysis methods will be discussed in this chapter.

Chapter 4 presents the data used for the results and some assumptions that were made with regards to the data.

Chapter 5 presents the pros and cons of VR in a training setting done through data collected from sources mentioned in chapter 2. analysis and results of the thesis. The chapter ends with a cost-comparison of the two scenarios based on the data collected in chapter 4.

Chapter 6 will discuss the results, the validity and generalizability of the results, the data and the methods. Then a discussion about other affecting cost-factors that can affect the results, that were not included in the cost-comparison will proceed before the chapter ends with a discussion about what could have been done differently and suggestions for future work. Chapter 7 is

the conclusion which will sum up the results from previous chapters and determine whether VR is a useful training tools based on the findings of the thesis along with some personal reflections.

2 THEORETICAL BACKGROUND

2.1 WHAT IS VIRTUAL REALITY?

"Virtual reality (VR) is the three-dimensional digital representation of a real or imagined space with interactive capabilities" [1]. VR can further be divided into three categories based on the level of immersion [4];

- Non-immersive
- Semi-immersive
- Fully-immersive

Non-immersive VR can be a 3D-model run on a desktop where the user can interact with the model. Semi-immersive VR is represented by the Cave Automatic Virtual Environment (CAVE) system and similar systems. The CAVE-system is a dedicated space where the user is in a room surrounded by screens that project the virtual world. CAVE is not considered fully-immersive as the user can still see themselves[4].

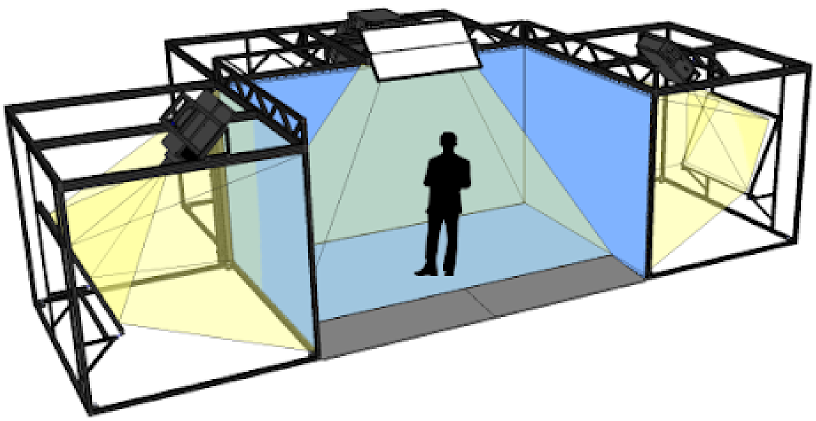

Figure 2.1: Cave Automatic Virtual Environment (CAVE) [19]

Fully-immersive is what most people would consider or call VR. Here the user is completely immersed in a virtual world through the use of head-mounted displays (HMDs) or similar technology [4].

Figure 2.2: Example of HMD (Meta Quest 2 128GB) [20]

There are 5 key elements of the virtual reality experience presented by Sherman & Craig [27];

- Participants
- Creators
- Virtual world
- Immersion
- Interactivity

The participants are considered the most important element to the VR experience as their background and experiences all create an unique individual experience of the virtual world. The experience is a collaboration between the participants and the creators of the application. The creators can affect the participant's VR experience through the application, but each participant can have different VR experiences. The virtual world is defined as "an imaginary space often manifested through a medium". In terms of VR the virtual world can be either be an imaginary place or a model of a real location.

Immersion is the ability to create a sense of presence. VR has the unique opportunity to recreate all the aspects of a situation which can make the user feel as they have actually experienced the situation. VR can create a mental and physical immersion that other technology cannot compete with. Interactivity can be introduced through collaboration with other users, interaction with items and/or ability to move within the virtual world [27].

2.2 EVOLUTION OF VR

Virtual reality was first introduced in the 1960s but were held back from the mainstream by insufficient quality and high equipment cost. In the modern day, the technology has managed to overcome the aforementioned obstacles. Affordable and high quality equipment and software have created a platform for VR to grow, especially within the gaming and entertainment industry. The market value of VR is expected to skyrocket in the coming years, from 7,3 billion USD in 2018 to 120,5 billion USD in 2026[33].

With the rapid rise of VR, the use of VR in other areas are being researched. VR provides an unique opportunity to simulate real scenarios in a virtual environment for educational purposes. As the hardware are available now, the software and public perception is the main components that is holding VR back at the moment. Unity and Unreal Engine are the main competitors on the software side. Although the software have already come a long way, it is fair to assume that the templates that can be used for individual customization will become available and increase the use of VR drastically in the future [33].

2.3 THE SCIENCE OF LEARNING AND VR

According to the science of learning, a student will learn better by actively engaging in the material[10]. Virtual reality enables engagement in a way that previously was infeasible either financially, practically or ethically.

The perceptual fidelity that VR provides, which is the ability to provide an environment that feels, looks and sounds real, is a key factor in enabling engagement. The more realistic the experience is, the more will it increase the translation from practice to action. The perceptual fidelity is affected by a number of factors such as resolution, field of view, refresh rate, color depth, contrast, lighting, sound quality and spatial audio. [9]

Once the VR-program is set-up it also allow for repetition training in order to reach the set goals and maintenance of the learning objectives by being able to refresh regularly. Repetition is important in increasing knowledge and confidence in actions when dealing with an emergency or difficult situation, but also as a tool to create behavioral change. Science show that intermittent testing increases the retention compared to repetitive presenting of information. The knowledge is connected to the context and VR can enable the user to obtain the knowledge in the context where it is needed and thereby make it easier to access when a situation may arise. Immediate feedback is also an important part of experiential learning. VR can provide accurate feedback in the moment to increase the confidence of the user in their actions as the progress depends on the right actions. [9]

There is also a possibility to add variation to the situation allowing the user to be prepared for different variations and outcomes of their actions. Variation can also help the user to focus on the concept and not surface features that are necessary for the simulation but has nothing to do with the concept. This could also affect the difficulties, for example dealing with different customers with different requests and/or in different state of minds. *Desirable difficulties* is a concept where the conditions for learning are manipulated to increase the frequency of errors which is shown to increase the long-term retention and transfer of knowledge between different scenarios. There are several ways to this but the easiest ones are *interleaving training concepts* and *spacing repetitions out*. *Interleaving training concepts* focuses on mixed examples rather than *block training* which is focusing on one concept until proficient. *Block training* is more efficient in learning the concept straight away but *interleaving training* is more efficient after a week. As long as the intervals between the repetitions are not too long, the long-term retention increases. A spacing of days or a week is effective, but waiting for a month or longer will remove the benefits because the learner will have forgotten most of the material. [9]

Andragogy is "the art and science of helping adults learn" [17] according to Malcolm Knowles who popularized the term in the United States in 1970. He was known for a practically oriented andragogy compared to what was prevalent in Europe at that time. He made five assumptions to adjust the learning theory to the increased maturity in adults. They were as following [17]:

- "Their self-concept moves from one of being a dependent personality towards being a self-directed human being."
- "They accumulate a growing reservoir of experience that becomes an increasingly rich resource for learning."
- "Their readiness to learn becomes oriented increasingly towards the developmental tasks of their social roles."
- "Their time perspective changes from one of postponed application of knowledge to immediacy of application,

and, accordingly, their orientation towards learning shifts from one of subject-centeredness to one of performance-centeredness."

- "As a person matures, the motivation to learn is internal."

Although Knowles' assumptions were dismissed as being to simple to cover the complexity of humans, there are some points that are interesting when considering VR[17] These will be discussed further in Chapter 5.

2.4 VR IN THE INDUSTRY

Figure 2.3 shows how certain companies within the energy, automotive and aviation sector use VR [12]. The main use is training but maintenance, planning and support/production are also areas where VR is useful.

Industry	Company	Purpose			
		Training	Maintenance	Planning	Support/production
Energy	ExxonMobil	X			
	Equinor			X	X
	ConocoPhillips				X
	Chevron		X		
	BP Plc	X			
	Baker Hughes	X			
	Halliburton				X
	Siemens	X			
	Royal Dutch Shell	X			
Automotive	BMW	X			
	Peugeot	X			
	Audi	X			
	Volkswaagen	X			
Aviation	Boeing	X			
	Airbus		X		
	Rolls Royce				X
	KLM	X			

Figure 2.3: VR in the industry [12]

Figure 2.3 is not a complete overview but more a representation of how VR is used in the industry.

2.5 WHEN TO USE VR IN TRAINING

Although VR can be a useful tool in training, not every situation or training is suitable for VR. The two main reasons for using VR is when training is either expensive or dangerous[32]. As VR provides a possibility to practice in a realistic situation without the risk, VR can elevate the training experience. This could be if the skill or procedure is dangerous in itself or the situation may escalate if the wrong measures are taken. For example in an emergency scenario in a nuclear power plant, the wrong actions can have catastrophic consequences and the only way to ethically practice where the employees can see the impact of their actions is through simulation.

If the training is dependent on the physical environment, the training often requires to stop production in order to be adequate. Having to stop production, buy separate equipment or having experienced employees supervise the new employees for training is not effective use of resources. VR allows the employee to get familiar with the physical environment and the procedures or steps of action without affecting the production and simultaneously receiving the same experience. VR can also help the decision making of an employee by increasing the amount of scenarios the employee can practice on. If the training is experiential such as dealing with customers or other soft skills needed in a workplace, VR can be a useful tool.

VR should be avoided when the training requires a lot of memorization of academic or knowledge-based materials. A lot of text can be uncomfortable to read and reduces the immersive feeling. Although text can be necessary for the learning outcome, the amount should be used sparingly in VR. Another situation where VR does not provide adequate training outcome is when practicing fine motor skills. At the moment the controllers are not able to replicate the intricate movement of fingers and hands, and should therefore be avoided unless the user already knows the fine motor skills, but need to practice the surrounding procedures [32].

2.6 AVAILABLE SOFTWARE

When talking about game development software there are two major competitors, Unity and Unreal Engine[11]

2.6.1 *Unity*

Unity is the clear front-runner in terms of use with a 48% in market share. This is due to its large asset store, big community, user-friendly interface and ease of use compared to Unreal Engine. Unity uses C# as a programming language which is considered easy to use and with a large community of users most of the issues a coder may run into are already solved by others and available online. The game engine is also free to use which attracts a lot of new and hobby developers[11].

Figure 2.4: Unity logo [11]

2.6.2 *Unreal Engine*

Unreal Engine is the preferred software used by AAA-studios which are the companies that creates the highest budget games. The reason is the increased graphic quality and scalability [11].

Figure 2.5: Unreal Engine logo [11]

2.6.3 *Comparison*

The table below shows a short comparison between Unity and Unreal Engine. For graphics and scalability the high and low indicates which one has the largest potential[11].

Feature	Unity	Unreal Engine
Programming Language	C#	C++
Graphics	Low	High
Price	Free or 75$/month for Pro version	5% royalty when revenue exceeds 1 million $
Scalability	Low	High
Target Platforms	Desktops, mobile devices, consoles and web browsers	PC and console
Target Audience	Indie developers & new coders	AAA-studios & artists

Table 2.1: Comparison of Unity and Unreal Engine

Both software are suited for use in development of VR-games and programs and the choice of which to use may vary from user to user. The main differences that will affect the choice are which programming language the programmer prefers, the graphical requirements and the scale of the project.

2.7 AVAILABLE HARDWARE

The table below shows some available HMDs. Some HMDs such as the Valve Index VR Kit and the Meta Quest Pro were excluded due to their price. Others such as the Sony PlayStation VR and PlayStation VR2 were excluded as they are only tailored towards the PlayStation systems.

Headset	Storage	Connection	Resolution	Hardware Platform	Refresh Rate	Motion Detection	Battery Life	Price
Meta Quest 2	128GB	Standalone	1832 x 1920	Standalone	120 Hz	6DOF	2-3 hours	5490 NOK
Meta Quest 2	256GB	Standalone	1832 x 1920	Standalone	120 Hz	6DOF	2-3 hours	5895 NOK
Pico 4 All-in-One	128GB	Standalone	2160 x 2160	Standalone	90 Hz	6DOF	2-3 hours	4695 NOK
Pico 4 All-in-One	256GB	Standalone	2160 x 2160	Standalone	90 Hz	6DOF	2-3 hours	5395 NOK
HTC Vive	None	Tethered	1080 x 1200	PC	90 Hz	6DOF	N/A	4997 NOK
HTC Vive Pro	None	Tethered	1440 x 1600	PC	90 Hz	6DOF	N/A	8359 NOK
HTC Vive Pro 2	None	Tethered	2448 x 2448	PC	120 Hz	6DOF	N/A	8490 NOK
HP Reverb G2 VR	None	Tethered	2160 x 2160	PC	90 Hz	6DOF	N/A	8279 NOK

Table 2.2: Technical information for different HMDs [13]

The connection shows whether the HMDs require a cabled connection or if they can function independently. Tethered headsets have a greater processing speed, power and graphics capability but does not provide the mobility that a standalone headset does. The resolution is given per eye. The motion detection 6DOF means 6 degrees of freedom which allows the user to move forward, backwards, right, left, up and down. Some headsets such as the Pico G2 4K provide 3DOF which makes the user able to look around but not move in the virtual space. This can be used with 360-video but are not suitable with CGI as the user cannot interact with the environment. The prices may vary with time and seller/location but are used as an indicator of price range when comparing the different HMDs.

2.8 TYPES OF VR TRAINING DATA

In general, VR can provide the user with five types of data:

- Usage
- Performance
- Attention and engagement
- Sentiment
- Predictive analytics

Usage shows the frequency, duration and completion of the program which enables the organization to keep track of the employees training. Performance tracks the completion of tasks and correct answers which can help the organization assess the proficiency of the training and where the strengths and weaknesses of the employees are within the training program. Attention and engagement tracks where and how the trainees pay attention which ensures that the employees are focused on the right information or actively engaged in the material for the training program to progress. Sentiment is qualitative feedback from the participants that can help evolve and determine the perceived quality of the program. Predicitive analytics uses the combination of immersive data and real-world data to create a machine learning-based predictive model that can be used to improve the program. [30]

2.9 CGI VS 360° VIDEO

There are two options when creating the 3D-scenes for the virtual experience, Computer Generated Imagery (CGI) and

360° Video. The choice depends largely on the budget and the desired amount of immersion[32]

2.9.1 *CGI*

In CGI everything is computer generated which allows the user to move around and interact with items which enhances the immersive qualities of VR. This is helpful for training muscle memory, getting familiar with an environment and examining/interact with objects due to the 6 degree of freedom that are enabled [32].

2.9.2 *360° Video*

360° video is a cost effective alternative to CGI. It allows the user to see a photorealistic version of the location but cannot interact with the environment in the same way as with CGI. The 3 degrees of freedom reduces the immersive qualities of VR but enables the program to be available through mobile devices, web browsers, etc [32].

2.10 COST-BENEFIT ANALYSIS

A cost-benefit analysis is used to compare the estimated costs and benefits for a project to determine if it is a sensible option from a business perspective[28]. This ensures a data-driven approach where the costs and benefits are taken into account before the decision is made. The cost-benefit analysis can be divided into 4 steps:

- Establishing a framework
- Identifying the costs and benefits
- Assign a value to each cost and benefit
- Find the total value of costs and benefits and compare

The framework can vary in different organizations but the main issue is to determine the goals and objectives that are trying to be solved. This helps identifying and understanding the costs and benefits. It is also important to decide a common metric to compare the costs and benefits.

The next step is to identify the costs and benefits. The costs can be divided into direct costs, indirect costs, intangible costs and opportunity costs. Direct costs are all the expenses that are related to production, development of a product/service or implementation of a project. These can be labor, manufacturing, materials costs, etc. Indirect costs are fixed expenses such as utilities and rent that are not directly connected to the project but still necessary for the project to proceed. Intangible costs are costs that are hard to quantify. An example of intangible costs can be reduction in production while implementing a new process. Opportunity costs refers to lost benefits from choosing one project over another.

The benefits can be divided into direct, indirect, intangible and competitive. Direct benefits can be increased revenue from sale of a new product. Indirect benefits can be improved interest in brand from happy customers. Intangible benefits can be increased production due to improved employee morale. Competitive benefits can be created by being innovative and being first in an industry.

After identifying the costs and benefits, they need to be quantified in terms of value. Direct costs and benefits are easiest to assign a value while the other ones can be hard to quantify due to uncertainty. When all the costs and benefits have been valued, they can be compared and a decision can be made. It is also important to check with the framework established in step 1 to ensure that the analysis complies with the goals and objectives. Even though the cost-benefit analysis can be positive, their can be other projects that better aligns with the goals and objectives which is why this should be considered as well.

The advantage with using a cost-benefit analysis is that it ensures a data-driven approach without biases. It makes the decision making easier by reducing the complexity of the decision to a comparison of costs against benefits. The analysis also makes the decision maker uncover indirect and intangible costs that will affect the economic aspect of the project, that could have gone unnoticed. However, it can be difficult to accurately predict all the factors and value of them. This becomes more prevalent the longer the time-frame of the project is and a cost-benefit analysis is therefore often more suitable for short and mid-length projects. As the time goes by, the market can change, inflation will affect the finances and new competitors can arise which all can affect the profitability of the project[28].

2.11 COMPANIES THAT PROVIDED DATA

The following subchapters will give some information about the companies that provided the data for the cost-comparisons.

2.11.1 *FireSafe*

Firesafe AS is a total supplier of fire safety solutions. With over 1000 employees in the Nordics and a turnover of about 1 billion NOK, Firesafe is a market leader within the subject. Since the start-up in 1981, the company have developed solutions for fire alarm systems, extinguishing system, fire detection and alarm systems as well as courses on fire safety[22].

2.11.2 *PaleBlue*

PaleBlue is a Norwegian company that specializes in creating state-of-art VR applications, simulators and interactive solutions. Their digital simulators are approved by IMCA, the leading international trade association for the marine contracting industry, which allows specialist training of offshore workers onshore. They provide both customized and non-customized solutions depending on the customer's needs [24].

2.11.3 *Industri Energi*

Industri Energi is the Norwegian trade union for industry and energy sector. With over 56 000 members, they are responsible for the collective agreement on wages in the energy sector among others. The agreement is negotiated every 2 years and is used as a guideline for the wages of offshore workers[23]

2.12 USE-CASES AND STUDIES ON PROS AND CONS OF VR

The following subchapters will give some context to the studies and use-cases that are referred to in Chapter 5.

2.12.1 *Knowledge Retention*

According to the Cambridge English Dictionary retention is "the ability to keep or continue having something.[25]" In terms of learning, the ability to keep the information is essential.

A study done by Babu et al. in 2018[6], compared the retention of knowledge after using a 2D based interaction model and VR with the same learning content. The 2D based interaction is tablet based and features a labeled diagram of a motorbike along with close-up images of individual components. The VR interaction allows the user to move around the motorcycle and interact with the parts. The final test was done on a real motorcycle. There were twenty-six participants that were divided into a control group (2D interaction) and an experimental group (VR) of 13 people each. The participants followed the same activity plan of an orientation to the activity, the interaction with the learning content and its revision, an immediate recall test and an delayed recall test after a day. For the test, the time was recorded and the responses were divided into three categories: correctly recalled, wrongly recalled and confused recalls. Correctly recalled responses were correct in both name and position, wrongly recalled was wrong in either name and position or both and confused recalls involved incomplete or equivalent names.

2.12.2 *Soft Skill Training by PwC*

In 2020, PwC did a soft skills training efficacy study [16], comparing VR, e-learn and classroom teaching as training methods. The soft skill that was taught was discussing and acting on issues of diversity and inclusion. The users were measured on time, confidence in dealing with the issues, emotional connection to the learning material and focus.

2.12.3 *VR Sickness*

A systematic literature review presented by Saredakis et al.[26] shows how the the users of 55 different studies reported the symptoms of VR sickness. This was done through a Simulator Sickness Questionnaire (SSQ) score reported by the participants. The symptoms were divided into nausea, oculomotor and disorientation and compared with regards to level of visual stimulation, time used, condition, locomotion, age and content type. Oculomotor symptoms are related to eyestrain, blurred vision and difficulties focusing and concentrating.

The level of visual stimulation was divided into high and low depending on the speed of the visual changes. The time used in the simulation was divided into less than 10 minutes, 11 to 20 minutes and more than 20 minutes. The condition reported on induced and not induced depending on whether the program was intended to increase/decrease VR sickness or if VR sickness was a secondary result of the study. Locomotion is how the user moves around in the simulation. This was divided into controller, stationary and walking. The age of the participants were divided into below 35 and 35 and older. At last the type content was divided into 360° video, game, minimalist and scenic. 360° video is explained earlier in Chapter 2, gaming included interaction with the environment and perform tasks, minimalist had simple interactions and basic shapes and minimal textures, whilst scenic had high detail on the environment but no interaction.

2.12.4 *Empathy Training at Verizon by Strivr*

Verizon[18] used VR to teach the employees how to deal with and deescalate high stakes situations. This included among others how to deal with armed robberies with a focus on the safety of employees and customers.

2.12.5 *Nurse Training at Adventh Health by Strivr*

Advent Health[3] used VR to train new and experienced nurses in safe procedural sedation in three different units: emergency department, the cardiac cath lab and the interventional radiology suite. The pilot covered 367 learners on 4 different locations for 1 month with 5 VR headsets per location. The pilot ended in May 2022.

2.12.6 *Onboarding Training at Sprouts Farmers Market by Strivr*

Sprouts Farmers Market[31] used a VR-training solution provided by Strivr to do onboarding for new employees. The program was aimed at frontline employees who got to practice the needed skills, procedures and processes in a realistic situation.

2.12.7 *Pickup Tower Training at Walmart by Strivr*

Walmart[31] used a VR-training solution provided by Strivr to allow their employees to practice on the new equipment before it was installed without the need of a trainer in physical presence.

This allowed each employee to practice at their own speed and when available which increased the efficiency at the stores.

2.12.8 *VR in Assembly Training*

In a study done by Wolfartsberger et al[34], they reported on the effect of VR in assembly training. The study was done by comparing a control group of 21 people that were trained by a tutor on an assembly deck. A group of 21 people went through a non-assisted VR-simulation with visual and audio instructions. The last group of 22 people did an assisted VR-simulation with visual cues for parts and placements, automated snapping and visual instructions but no audio instructions. After going through the training, the participants were asked to remember a list of ten words to reduce the impact of short-time memeory on the test. The participants where asked to build a replica of the LEGO model built in the training course which consisted of 13 pieces. The number of position errors, order errors, number of hints requested and the sum of all of these were recorded.

3

RESEARCH METHODOLOGY

3.1 RESEARCH APPROACH

The research question is to determine if VR-based interactive training is a competitive training method compared to the traditional methods from a financial and training effectiveness view. The first challenge is to determine whether VR as a training tool is effective enough to warrant a potential investment. The second challenge is to determine how the finances of VR training compares to the finances of traditional training methods. As training is a broad term that can involve different methods, objectives, sectors, etc., it is not possible to determine the costs on a general level. Therefore, the financial aspect is determined through two scenarios that cover the two main areas where VR can be an useful tool as mentioned in Chapter 2. One scenario involves a non-customized VR-training solution and the other involves a customized VR-training solution in order to determine if VR can be a feasible option. The scenarios will be described in the following subchapters.

3.1.1 *Scenario 1*

Scenario 1 is a fire safety scenario where an employee has to extinguish a fire. The VR scenario is standardized and bought, not customized as this will bring the cost down whilst still providing the necessary output. The VR-program gives the user the experience of putting out a fire using VR and a customized fire extinguisher. The VR training program can be used by 30 people and will take about 10 minutes to complete. The regular extinguishing exercise can involve 20 people and takes one hour to complete. The real life training involves a trailer with fire that the users can extinguish. Both training exercises can be done at the workplace.

3.1.2 *Scenario 2*

Scenario 2 is an offshore familiarization scenario where the employee can be made familiar with a platform before traveling offshore. The scenario will compare the cost of traveling offshore and doing the tour of the platform with a VR-simulation. This is a mandatory training for all new visitors at a platform.

3.2 RESEARCH METHODS

The pros and cons of where will be established through a litterature review of studies involving VR-training. This will consist of public reports posted online and different use-cases from companies providing VR-training solutions.

The cost-comparison for scenario one will be simple as the only different factors are the time used and the amount of people that can be trained at once. For scenario two, the cost-comparison will be more detailed as there are more varying factors and the initial investment for VR is larger. The result will be done as a payback period but with the number of sessions that will have to be completed to reach break-even rather than time.

3.3 RESEARCH METHODOLOGY

Steps	Data Sources	Methods	Expected Outcomes
Step 1 : Define and support pros and cons of VR as a training tool.	Public resources	Litterature review, use-cases, reports	A thorough overview of pros and cons
Step 2 : Choose scenarios for financial comparison	Public resources, supervisors	Research, discussions	2 different scenarios
Step 3 : Determine if VR can compete on a financial level with more traditional methods in 2 different training scenarios.	Companies providing VR-solutions and more traditional solutions, public wage data and experienced workers from the industry.	Public data collection, contact with relevant companies and workers.	A simple cost-comparison of the different training methods in two scenarios.
Step 4 : Compare the pros and cons of VR as a training tool.	Collected data in step 1	Discussion	Determine if VR is an effective training tool in terms of training outcome based on publicly available research done on the matter.
Step 5 : Compare the pros and cons to the financial aspect determined in step 2.	Collected data in step 1, 2 and 3	Discussion	Determine if the potential financial investment can be justified based on the pros and cons.

Figure 3.1: Research methodology

Step 1 is to define and support pros and cons of VR as a training tool. This will be done through a thorough research of use-cases, literature reviews and reports on VR-training found through *Google Scholar* and company sites. Due to the limited time and resources available, this was determined to be the best method as it would not be possible to create a VR-program to test all the possible pros and cons. This will create an overview of the pros and cons that should be considered before choosing training methods.

Step 2 is to choose the scenarios used for the cost-comparison. The main reason for having two scenarios are that:

- training is a broad-term that can vary a lot in cost and content.
- there are two main areas that VR is considered to be the optimal choice which is when training is either expensive or dangerous.
- the cost will highly depend on the level of customization of the VR-program.

The scenarios chosen are designed to fit all these criteria. Fire safety as the dangerous and non-customized training and offshore familiarization as the expensive and customized training. Although fire safety training is relatively safe there is always the possibility of something going wrong during an extinguishing exercise. Although not the best example on a dangerous training, this is training that every company can do.

Step 3 is to collect and analyze the cost data. The data for scenario one will be collected from FireSafe that provides both traditional and VR-based training and the wage data will be collected from Statistics Norway. For scenario two the data will be collected from PaleBlue for the VR-program, the wage data will be collected from Industri Energi. Some information such as the time needed for the training will be provided through discussion with people with experience offshore and also to ensure that all factors are considered.

Step 4 is to compare the pros and cons determined in step 1 and discuss them to provide a basis for decision making when choosing training methods. The idea is to be able to determine if VR can be used in certain situations before starting to look at the financial aspect.

Step 5 is to compare the pros and cons with the financial aspect to determine if VR can be used in training. The financial aspect will be focused on the scenarios mentioned and is therefore not applicable in every instance as in some cases the finances of VR may not provide the same results as in these scenarios.

3.4 LIMITATIONS

For the financial aspect of the cost-benefit analysis, only the investment and wage/time consumed will be considered as it is assumed that all the other variables are the same in both training solutions. The pros and cons will not be taken into account for this as their value will vary greatly based on training situations and companies.

3.5 DATA SOURCES AND COLLECTION METHODS

The data will be collected from online resources (reports, use-cases, studies) and companies that provide these training solutions. There is also some information needed to analyze the data such as time needed for familiarization and some other comments on the process that have been given by employees that have experience with the processes.

3.6 DATA ANALYSIS METHODS

The data will be analyzed through a cost-comparison of the different aspects of the scenarios. For scenario 1, the results will show which method that is the most cost-effective based on the cost of the programs, the time used and the cost of the wages. For scenario 2, the results will show how many sessions that needs to be done for the initial investment of the VR-training program to be payed back through reduced wage expenses.

3.7 ACTIONS TO ENSURE OR INCREASE THE RESEARCH QUALITY

All the data for pros and cons are based on user experience or data and taken from different sources that validates each other in terms of similar outcomes/trends. For the cost-comparison part, all the data are collected directly from companies that provide these training-solutions. The wage data for scenario two are collected from the same source and the same job-role to ensure a fair comparison.

4 DATA COLLECTION

4.1 SCENARIO 1

Scenario 1 is the fire safety scenario. The data for the cost of the different training programs are collected from FireSafe[22]. The employee cost is based on the median income in Norway provided by SSB (Statistics Norway)[15]. This is set to be 47680 NOK per month. As there is on average 230 working days a year[14] and an average of 7,5 working hours a day[5]. This gives an average of 143,75 working hours a month which ends up in mean salary per hour of 331,69 NOK.

4.2 SCENARIO 2

Scenario 2 is the offshore familiarization scenario. The data for the VR-program is collected from PaleBlue[24]. They reported that it could be done in a minimum of 4 complete working weeks at an hourly rate of approximately 1500 NOK. The data for the traditional on-site training is collected from Industri Energi[21] and their collective agreement on wages for offshore workers. The wages were chosen The numbers used are from 2020-2022 as there is a differentiation between wage for working onshore and offshore that is not separated in the current. Category B was selected as the salary is not the highest or lowest, and the salary stayed approximately the same in the new collective agreement. The time used for familiarization is set as 60 and 90 minutes as the estimated time needed to complete the process was in that time span. The time needed will of course depend on the size and design of the platform, but the effect is assumed to be the same for both training methods.

5 ANALYSIS AND RESULTS

5.1 ADVANTAGES OF VR

There are several advantages of VR that cannot be adequately estimated in the form of monetary value. These will be discussed below.

5.1.1 *Knowledge Retention*

Figure 5.1 and Figure 5.2The results of the study show that the control and experiment group achieves almost the same results at the immediate test, but there are bigger differences even after one day. The experimental group performs better than the control group with a mean of 13,69 correctly recalled compared to 10,33 for the control group. It is also worth noting that the wrongly recalled for the experimental group decreased on day two whilst significantly increasing for the control group.

	Immediate		**Delayed**	
	Mean	***SD***	***Mean***	***SD***
Control	14.46	5.35	10.33	5.43
Experiment	14.15	5.24	13.69	6.43

Figure 5.1: Retention Stats [6]

5.1.2 *Engagement and Confidence*

The time used on interaction with the learning content was higher for the experimental group which likely affected the results. The increased time can be attributed to the immersive qualities of the VR-scenario where the user had to walk around and interact with the motorcycle compared to seeing pictures with labels. The results show that the increased engagement in the learning content provides notable effects. Another example is Verizon who uses VR to train employees on what to do in the

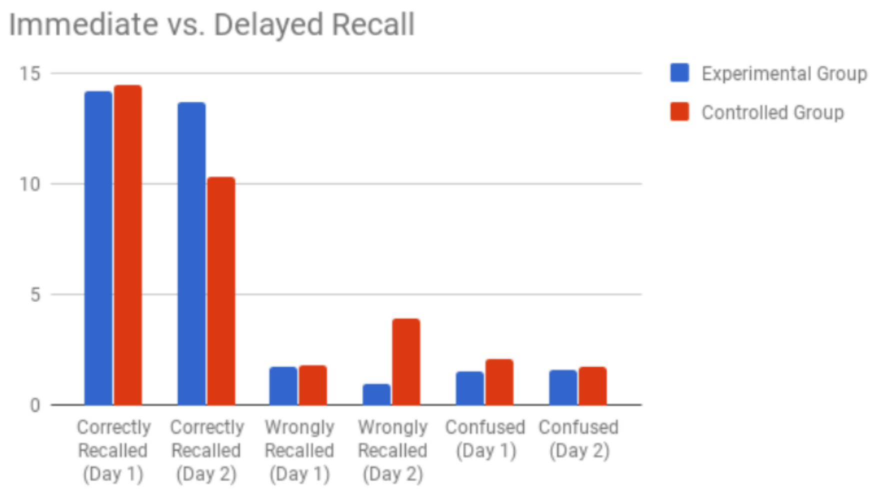

Figure 5.2: Retention Graph [6]

event of a robbery in a store. The employees reported that 97% felt prepared for the situation after completing the VR training.

The results from feedback by the learners from AdventHealth show[3]:

- "88% believe it was an effective way to apply and practice the training."
- "79% would like to continue to use VR as a tool for training."
- "85% enjoyed it more than non-VR training."
- "88% more confident to assess the patient condition."
- "87% more confident to administer medication incrementally."
- "87% more confident to monitor patient response continuously."
- "84% more prepared to handle real life moderate sedation situation."

The feedback show that the majority enjoyed using VR for training purposes. If someone enjoys something they are more likely to be engaged and therefore more focused on the tasks at hand. The confidence is consequence of experience. Having done the actions in a similar environment with accurate feedback and without the pressure of consequences will make the real situation more familiar to the employee. A PwC study on soft skills training[16] also reported on the impact on confidence in discussing and acting on issues of diversity and inclusion comparing those who used classroom teaching, e-learning and VR. The results are presented in Figure 5.3:

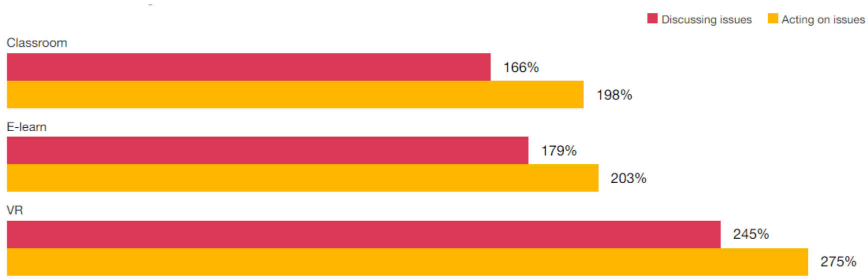

Figure 5.3: Confidence [16]

Figure 5.3 shows that the VR users were significantly more confident in applying the learning material compared to the classroom and e-learn users. An average improvement in confidence of 245% for VR-users compared to 179% for e-learn users and 166% for classroom users show that VR can effectively increase the confidence of the employees. VR enables the user to practice in lifelike situations and thereby increases the experience of the user in dealing with the situation. Combining the lifelike situation with guidance and a safe environment ensures that the user knows how to act in the situations.

Figure 5.4 shows the average emotional connection the learners experienced using the different learning methods.

Figure 5.4: Emotional connection [16]

As seen in Figure 5.4 above there is a large increase in emotional connection of the VR-learners compared to the traditional methods. As mentioned in Chapter 2, a student will learn better by actively engaging in the material. The increased emotional connection is proof of increased engagement which increases the knowledge retention and confidence.

5.1.3 *Speed and Consistency*

Strivr[30] reported in two use-case studies that Sprouts Farmers Market[31] managed to reduce onboarding time from 4 hours to 45 minutes and Walmart [31] reduced the pickup tower training time from 8 hours to 15 minutes using VR. The PwC study on soft skills training efficacy[16] reported that VR-users completed the training in 29 minutes on average, E-learn took 45 minutes and classroom teaching took 2 hours. When these results accounts for the extra time needed for first-time learners to learn how to use the VR headset, the classroom learners still used 3 times as long. The results are shown in Figure 5.5.

Figure 5.5: Time used for the training program [16]

VR allow the users to proceed at their own pace without having to adjust the course for the different learning speeds of individuals. This can decrease the time needed to do the training program and also remove some frustration regarding the pace of the course. Having to wait or repeat information during a long course repeatedly for everyone to be up to speed can be frustrating and doing the course at ones own speed can remove this.

By removing the human factors, the training becomes more consistent. All humans have bad days sometimes or be distracted due to personal matters. This can affect the instructors ability to convey the training to employees. Consistency is highly sought after as better training provides better results.

5.1.4 *Safer Training*

VR provides a safe environment for the user to learn the wanted skills whether they involve dealing with heavy machinery, armed robberies[18], fire safety[22], 9 life saving rules, etc. VR can also show the consequences of the user's actions without putting them at risk. This can be beneficial in situations where safety precautions can become routine. Fully understanding the consequences can increase the focus of the user and result in better results without the user ever needing to be in any danger.

5.1.5 *Employee Retention*

A study presented by Strivr[29] shows that:

- "70% of the employees would be likely to leave their current job for a company better known for investing in employee learning and development."
- "86% of millennials would be deterred from leaving their current position if more training and development were offered by their employer."
- "Organizations with poor onboarding processes are twice as likely to experience employee turnover."
- "The retention rates rise from 30% to 50% for organizations with strong learning and development cultures."

Although these findings are connected to training in general, VR can play a big part in increasing employee retention. Laura Lee, the former chief human resources officer at MGM Resorts International, reported that the company had seen an increase in employee retention after implementing VR in their training program for front desk workers[29]. The employees also reported an increase in comfort in their work as they had been exposed to angry customers in the training modules and knew how to handle them. Employee retention provides financial benefits as there is a reduction in need for onboarding and adaptation for new employees whilst also increasing the quality of the workforce with experience.

5.1.6 *Scalability*

VR-training is very scalable as hardware is the limiting factor. As shown in subchapter 5.2-5.4, VR can be more cost-effective at scale due to faster training, less instructors, etc. The cost of the extra hardware can quickly be regained. Unlike with traditional training, there is no difference if the training-program is to be scaled within one location or across many as the VR-program does not have to be location specific such as the PwC soft training skill program mentioned in subchapter 5.5.2.

5.1.7 *Sustainability*

The major sustainability factor regarding VR is reduction in traveling as the user can access the programs from anywhere as long as they have access to a VR-headset. Whether the traveling is for the user themselves or an instructor, the emissions can be reduced to a minimum. There is also no risk of emissions when practicing dealing with toxic waste, production procedures, etc.

5.1.8 *Available On Demand*

As mentioned in Chapter 2, as adults mature they are more inclined to learn when there is an immediate need for the knowledge or skills. With no need for instructors, VR can provide the employee with the training on demand, allowing th different parts of the organization or employees to learn at different times. The training can also be redone when needed as long as the VR-program and hardware is available allowing the user to refresh the necessary material.

5.1.9 *More Measurable and Less Distracting*

As mentioned in chapter 2.8, VR provides an increased amount of data to be collected. Usage, performance and sentiment can be equally measured in VR and real-life but the real difference can be seen in attention, engagement and predictive analytics. By using a VR-headset, the user is screened from any visual distractions from the real world which allows the user to focus on the tasks at hand. By using headphones, the user can also remove potential audio distractions for further focus. Combining these with the fact that VR-programs can track where the user is putting their attention at all times, it is easier to make training programs free of distractions. Tracking the users eye-movements enables the developers to perfect the training programs by removing unnecessary distracting elements or changing the content where users get distracted. Having concrete data to act on in addition to the standard feedback surveys help improve the training in the long run. Figure 5.6 shows the focus of the learners in the PwC soft skills study in subchapter 5.5.2.

	Classroom	E-Learn	VR
How many times were you multitasking or distracted during this experience?	0.78	1.93	0.48
How many minutes do you estimate it took to get back on task?	1.00	2.63	0.48

Figure 5.6: Focus [16]

Figure 5.6 shows that not only do the VR learners get less distracted than the classroom and e-learners, but they also use less time to get back on task. This does not only affect the time it takes to complete the tasks but can often affect the quality of the learning. The increased focus ensures that the learners receive the information that they are supposed to learn while being mentally present. The focus is tightly connected to knowledge retention as "a student will learn better by actively engaging in the material."

5.2 DISADVANTAGES OF VR

As with pros, there are several disadvantages that cannot be adequately estimated in the form of monetary value. These will be discussed below.

5.2.1 *VR sickness*

VR sickness or cybersickness is a form of motion sickness caused by the brain experiencing movement from the visual inputs but the rest of the body is not moving. This difference in input can cause nausea, dizziness, blurred vision and loss of balance.

Figure 5.7 shows the results of a systematic review and meta-analysis on VR sickness in HMDs [26].

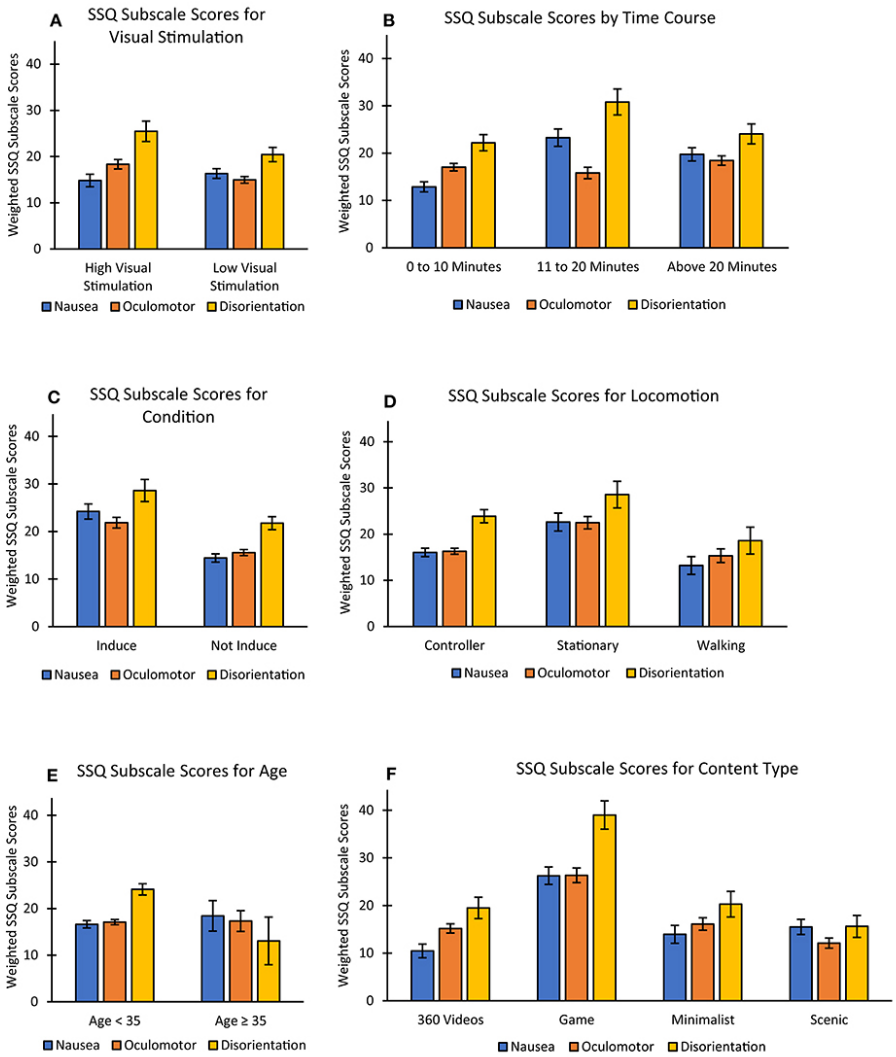

Figure 5.7: VR-sickness [26]

The major takeaway from the review is that the type of content has the largest effect on VR sickness. Gaming content induces significantly higher SSQ-score than the rest of the content types. 360° video, minimalist and scenic content induces less VR sickness as they are less realistic or complex. The reduced realism reduces the confusion of the brain that causes the symptoms. Furthermore, the type of movement or locomotion confirms this as when moving while using the VR-program, the symptoms are reduced as well.

It is also interesting that there is no big difference in when it comes to age, the difference in score for nausea and oculomotor are not significant but the disorientation is higher in people below the age of 35. However, there are some inconsistency in the outcome of studies involving age and

5.2.2 *Not suitable in every situation*

As mentioned in Chapter 2, VR is not suitable in every situation. Figure 5.8 shows a study on VR in assembly tasks[34]. The figure shows that increased visual guidance (VR assisted) reduces the mental workload to the point where the user learns less. There is also not a significant difference between the control group and VR non-assisted, but slightly more reliant on hints for the VR non-assisted. An explanation to this is that VR cannot replicate the feeling of touch which can be important in assembly tasks. The figure also show that the planning of training-program is important as small adjustments can affect the learning outcome drastically.

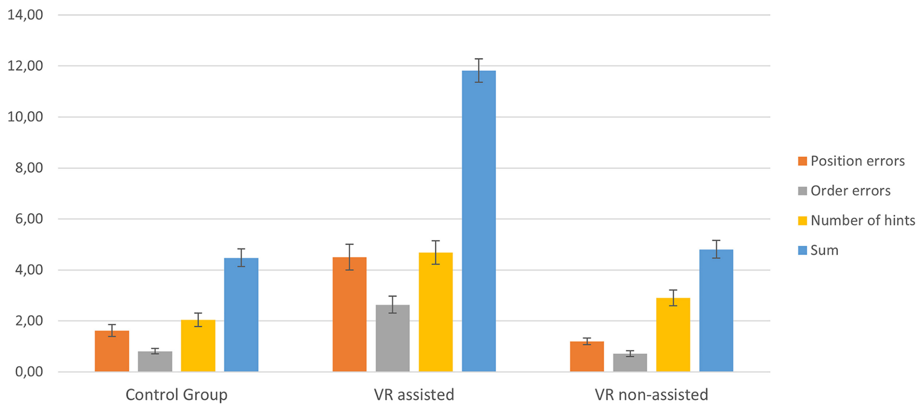

Figure 5.8: VR in assembly training [34]

Another situation where VR should be avoided is when there are a lot of reading or memorization of academic or knowledge-based materials. As the VR sickness increases with time as shown in Figure 5.7, it is unnecessary to use VR for something that can just as well be done in real-life.

5.3 DETERMINING SCENARIOS

When determining the scenarios there were two main objectives to complete. As mentioned in Chapter 2, there are two main reasons to use VR and that is when training is either expensive or dangerous. The other objective was to find one customized and one non-customized VR-training solution. As the time was limited, the thesis had to rely on already completed projects for references. After conversations with the supervisors and Paleblue, I settled on the offshore familiarization scenario for the customized training as this was something Paleblue had experience with and something that is being tested. There is not any public data regarding the cost of such a project, but Paleblue were willing to give an estimated of how much such a program would cost and the time-frame connected to the making of it.

The fire safety scenario was chosen as that is something every company should do and the potential cost saving of preventing a fire in itself could warrant the investment. The data was collected from FireSafe as they provide a VR-solution and a more traditional fire extinguishing exercise The non-customized aspect of the training program also drastically reduces the cost to show that there is a discussion to be had when determining if it is necessary to customize the training. The level of customization depends on the task, the location and the learning objectives which all have to be evaluated before settling on a training method and program.

Other scenarios were discussed as well such as the Basic Offshore Safety Induction and Emergency Training (BOSIET) but were dismissed as it is standard regulated and the program would have to be approved before use and there is uncertainty to if it would have been. There is also elements of the training surviving at sea and escaping a submerged vessel that cannot be accurately replicated in a VR-simulations as the water will have an effect on the trainee. Another scenario that was considered was 9 life saving rules. These are:

- Bypassing safety controls
- Confined space
- Driving
- Energy isolation
- Hot work
- Line of fire
- Safe mechanical lifting

- Work authorization
- Working at height

As none of these are location dependent, they would fall under the non-customized and dangerous training. These were not chosen as the cost-data were not obtainable.

5.4 GENERAL COST OF VR

As the VR hardware have reduced in price in the recent years as mentioned in the theoretical background chapter, the biggest affecting cost-factors are the level of customization and details. Some training is possible to standardize where the action is more important the surroundings. This can be fire safety training, soft-skill training, 9 life saving rules, etc. The more customization that is needed, the higher the price will be. The same counts for level of details due to the increased time needed for development of the training program.

5.5 COST-COMPARISON OF SCENARIO 1

Table 5.1 presents the median wage in Norway in 2022.

Mean salary Norway/month (NOK)	Working hours/month (NOK)	Mean salary/hour (NOK)
47680	143,75	331,69

Table 5.1: Median wage in Norway

Table 5.2 shows the cost-comparison for scenario 1 of a single training course. As mentioned in Chapter 4, the main difference is in time used and amount of people that can do the course. As the courses cost the same, the only difference is the wage cost which ends up in a saving of 4975,31 NOK or 32,03% for the VR-solution.

Company	Type	Cost (NOK)	Time (min)	People	Total wage cost(NOK)	Total cost (NOK)
Firesafe	VR extinguishing exercise	8900	10	30	1658,43	10558,43
	Regular extinguishing exercise	8900	60	20	6633,74	15533,74

Table 5.2: Cost-comparison of a single training course

Table 5.3 shows a comparison when the programs are adjusted to the same amount of employees. To do this, 2 VR sessions and 3 regular extinguishing exercises will have to be completed.

The total saving on using the VR-program is 25484,35 NOK or 54,69% compared to the regular exercise.

Company	Type	Cost (NOK)	Time (min)	People	Total wage cost(NOK)	Total cost (NOK)
Firesafe	VR extinguishing exercise	17800	10	60	3316,87	21116,87
	Regular extinguishing exercise	26700	60	60	19901,22	46601,22

Table 5.3: Cost-comparison of 60 people

5.6 COST-COMPARISON OF SCENARIO 2

Table 5.4 presents the VR-training program cost with 2 Meta Quest 2 128 GB VR-headsets as presented in Chapter 2 and the wage expenses collected in Chapter 4.

Company		Hourly rate (NOK)	Total time (weeks)	Total time (hours)	Number of headsets	Price of Hardware (NOK)	Total price (NOK)
Paleblue	VR-program	1500	4	150	2	5490	235980

Company	Location	Time (min)	Hourly wage (NOK)	Employees	Total price (NOK)
Industri Energi	Onshore	60	361,59	1	361,59
	Offshore	60	402,53	2	805,06

Table 5.4: Cost of VR-Program and Wage Expenses

Table 5.5 shows the development of the expenses onshore compared to offshore. The *CAPEX Onshore* refers to Table 5.4 and the total price of the VR program and equipment. As there is no need for guides, the only wage expenditure is for the employee who is completing the training. There is no *CAPEX Offshore* so the only costs are the wage costs, but there is a need for a guide so that increases the wage total. It is also evident that the biggest increase in wage cost is when there is one employee per guide.

Employees	CAPEX Onshore	Wage expenditure onshore	Total Cost Onshore
1	235980	361,59	236341,59
2	235980	723,18	236703,18
3	235980	1084,77	237064,77
4	235980	1446,36	237426,36
5	235980	1807,95	237787,95
6	235980	2169,54	238149,54

Employees per guide	CAPEX Offshore	Wage expenditure offshore	Total Cost Offshore
1	0	805,06	805,06
2	0	1207,59	1207,59
3	0	1610,12	1610,12
4	0	2012,65	2012,65
5	0	2415,18	2415,18
6	0	2817,71	2817,71

Table 5.5: Onshore and Offshore Costs

Figure 5.9 shows the number sessions needed to break-even for scenario 2. The purple line labeled *Onshore* shows the cost for the VR-familiarization training with an initial cost of 235980 NOK and and an additional 361,59 NOK in wage expenses for every use. The other lines shows the cost of doing the training offshore with a guide. Starting from the left the lines show the number of sessions needed to break-even with 6 employees per guide to 1 employee per guide. The number to the left of the comma is the number of sessions and the number to the right is the total cost up until the point of break-even.

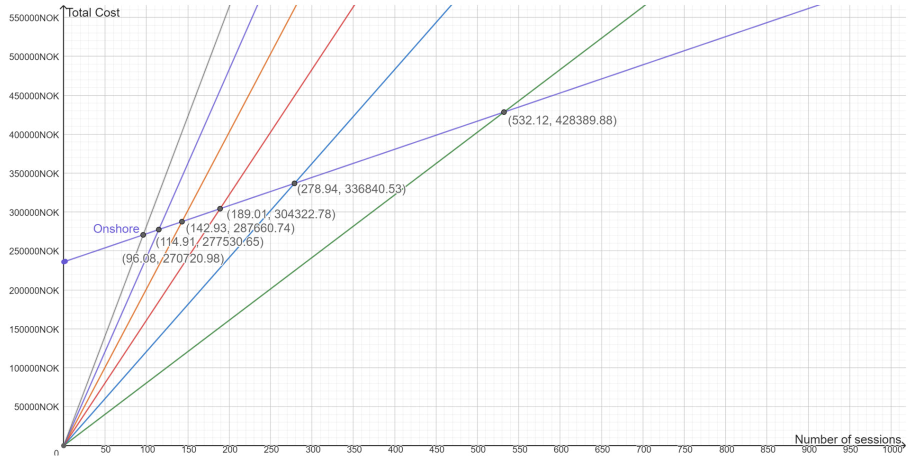

Figure 5.9: Number of Sessions Before Break-Even

Table 5.6 shows the amount of employees that need to go through the training before the break-even point. The table shows that even though the number of sessions are reduced when the number of employees per guide increases the total number of employees that needs to be trained increases. This can be explained as that the more employees that get trained compared to the number of guides will reduce the difference in savings per session compared to the VR-training. As the relative difference in expenses are less, the more sessions needs to be conducted to break-even. This makes sense as it is cheaper to train more people at the same time offshore whilst there is no difference on the matter when using the VR-training program.

Number of Employees Per Guide	Sessions Before Break-Even	Total Employees Trained
1	533	533
2	279	558
3	190	570
4	143	572
5	115	575
6	97	582

Table 5.6: Employees trained before break-even

Table 5.7 shows how the wage expenses increases when the time needed is increased to 90 min. As the familiarization was reported to take between 60 and 90 minutes, it is helpful to compare the impact of the increased length in sessions.

Company	Location	Time (min)	Hourly wage (NOK)	Employees	Total price (NOK)
Industri Energi	Onshore	90	361,59	1	542,385
	Offshore	90	402,53	2	1207,59

Table 5.7: Employees trained before break-even

Comparing Table 5.5 to Table 5.9, it is clear that there is a 50% increase in the cost as the time increases with 50%. This makes sense as it is a linear function that depends on the time.

Employees	CAPEX Onshore	Wage expenditure onshore	Total Cost Onshore
1	235980	542,39	236522,39
2	235980	1084,77	237064,77
3	235980	1627,16	237607,16
4	235980	2169,54	238149,54
5	235980	2711,93	238691,93
6	235980	3254,31	239234,31

Employees per guide	CAPEX Offshore	Wage expenditure offshore	Total Cost Offshore
1	0	1207,59	1207,59
2	0	1811,39	1811,39
3	0	2415,18	2415,18
4	0	3018,98	3018,98
5	0	3622,77	3622,77
6	0	4226,57	4226,57

Table 5.8: Employees trained before break-even

Figure 5.10 shows the numbers of sessions needed to break-even when the training takes 90 minutes.The results are reduced by 1/3 compared to Figure 5.9.

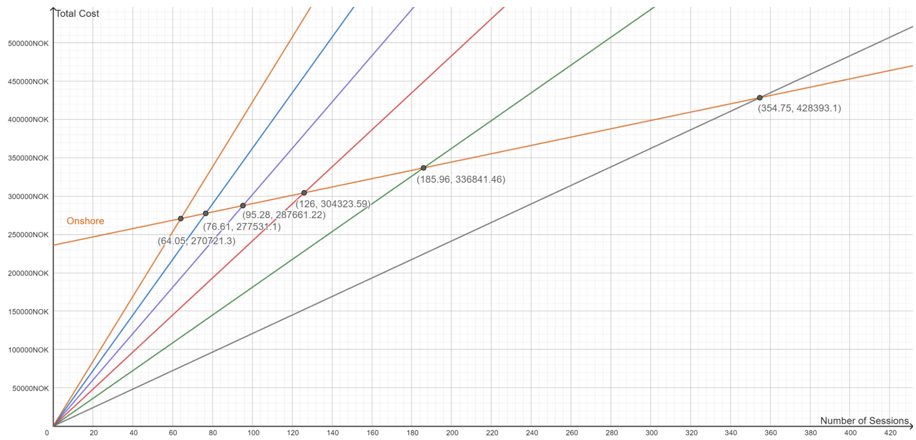

Figure 5.10: Employees trained before break-even

Table 5.9 shows that the total number of employees trained before break-even is reduced by 1/3 compared with Table 5.6 which is accurate according to the results presented in Table 5.5 and Table 5.8.

Number of Employees Per Guide	Sessions Before Break-Even	Total Employees Trained
1	355	355
2	186	372
3	127	381
4	96	384
5	77	385
6	65	390

Table 5.9: Employees trained before break-even

Figure 5.11 shows how the increase time for development will affect the amount of sessions before break-even.

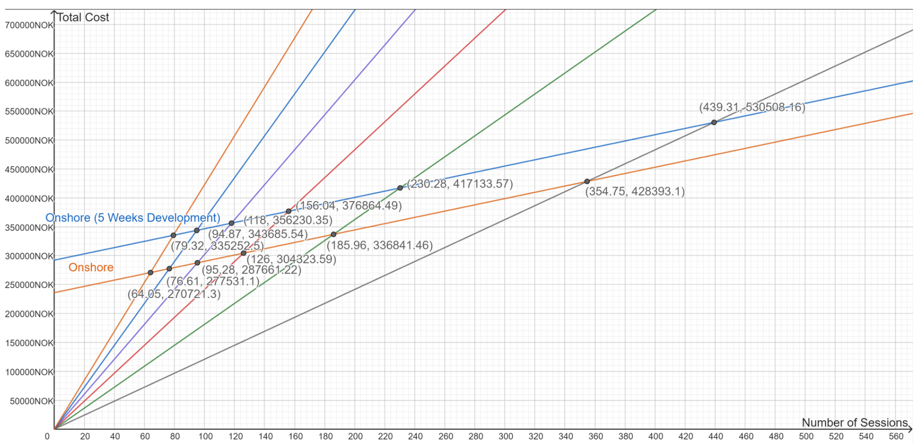

Figure 5.11: Employees trained before break-even

Table 5.10 shows the results from Figure 5.11 in a table. It is clear that the total employees trained are lower compared to Table 5.6 which shows that the length of the session affects the results more than the time used for development.

Number of Employees Per Guide	Sessions Before Break-Even	Total Employees Trained
1	440	440
2	231	462
3	157	471
4	119	476
5	95	475
6	80	480

Table 5.10: Employees trained before break-even

6 DISCUSSION

This chapter will provide some discussion surrounding the results and analysis provided in Chapter 5.

6.1 RESULTS

The results presented in Chapter 5 shows that VR can be a useful training tool in terms of learning outcome in the right situations. However, not all situations are necessary to use VR in. For fine motor skills and memorization of knowledge-based materials it should be avoided. With the development of VR over the last years, the stand on fine skills may change if the controllers can replicate the feeling of touch that they are missing today. As for knowledge-based materials, VR will probably never be a preferred method unless the problem of VR sickness is gone.

Scenario one shows that a non-customized VR training program can compete on a financial level with more traditional methods. The main reason for the time difference is that with the traditional extinguishing exercise all the participants are doing the whole course together which can increase the learning outcome by learning of each other. VR is more intensive in that you get the necessary information, do the training and finish. What is lost on learning from each other may be regained in the increased focus that shorter training enables. The repeatability can also contribute in making up for that as repetition will fill some of the holes in the knowledge.

Scenario two shows that depending on the rate of people that need to do the familiarization, VR can be beneficial in the long run. Assuming that large changes on a platform is rare to do, the model used in the VR will not have to be updated often. Therefore, the investment at the start may be justified. There is also an element in that VR is not restricted by the physical capabilities of humans and can allow the user to move at greater speeds and thereby save some time on the familiarization. But the user may also need some time to get familiar with the VR equipment that can reduce the effect of this benefit. Once the model of the platform is made, it can also be modified to be used for other purposes such as maintenance planning. The more purposes the model can be modified/used for, the more justifiable the initial investment is.

6.2 RESULTS VALIDITY AND GENERALIZABILITY

For scenario one, the results are valid as there is no large initial investment that will be affected by the time value of money. As the main cost difference in the scenario is the wage, the scenario can be generalized to scenarios where the there is no large initial investment and one method is faster than the other. But it is also important to consider the pros and cons of each approach because there is no use in investing in a training program that does not fulfill the needs and requirements of the company.

For scenario two, the results are valid a guideline/example but in reality the time value of money will have an effect on the payback period. As money now is worth more than money in the future, the amount of sessions will increase when the data are adjusted to account for time. But as I could not get an estimate of how many people are getting trained within a certain amount of time, an groundless assumption would have removed any validity from the answer.

6.3 DATA VALIDITY AND GENERALIZABILITY

As all the data are collected from credible sources within the industry, the data is valid. But as with any quickly developing technology, there may be developments that will drastically decrease the cost. In that case, the data can become outdated and a new assessment should be made.

As the data are specifically connected to the scenarios, they are not necessarily representative for all cases. It has therefore limited generalizability but the pros and cons are not connected to the scenarios and can therefore be seen on a more general level.

6.4 OTHER AFFECTING FACTORS

There are other factors that affect the cost of scenarios that are not mentioned in the cost-comparison of the scenarios as these values can vary a lot and be hard to number. The fact that there is no need to stop equipment or machinery as not everyone need to do the training at once, can increase the company's income compared to having to shut down everything while training. There is also an increase in income due to the reduced need for instructors or facilitators which can create value somewhere else in the organization while training is being completed.

A cost-affecting factor that are not connected to the scenarios are the reduction in expenses due to the increased knowledge retention. This can increase the intervals of when training is needed. Also having the possibility to train when needed for a task increases the intervals as the employee gets experience right after completing the training with decreased chances of forgetting parts and having to redo the training.

There is also some paperwork needed to be done after completing the familiarization process. This is time that can be saved by having everything completed before the employee travels offshore. By doing all the formalities before traveling offshore, some inconveniences can be reduced and ensure efficiency while offshore.

6.5 WHAT COULD HAVE BEEN DONE DIFFERENTLY?

After reviewing the work done, there are certain aspects that could have been handled differently. The major ones are the scenarios. Although the scenarios show what they were intended to show, other scenarios could have perhaps given a more in-depth economical comparison. As the scenarios were straight VR-versions of the training, the only cost-aspect changing were the wages due to being offshore or difference in time used for the training. It could have been possible to gather more data here but as it would have been the same for both parts of the comparison it was deemed unnecessary. Other scenarios could have provided more variables to the comparison. Scenarios where the time value of money could have been considered would increase the validity of the cost-comparison. As the amount of sessions for scenario two depends on many unknowns such as the size of the platform, amount of new employees, incidents that require specialist that have not been to the platform before, etc., the time frame for the amount of sessions were hard to determine.

Another issue was the methodology. An experimental method, could have been used where a simple version of the training could have been simulated using VR and done traditionally to compare the results and feedback. This would have to be planned from the start with quick development and available participants. As that was not the case, this method was not deemed feasible within the time available.

6.6 FUTURE WORK

As training is a broad term that can cover many different methods and sectors, there is always the possibility of looking at more scenarios and situations where VR-training can be useful. With more people getting exposed to VR at an early age and/or being more used to the technology it can be interesting to see how that will affect the problem of VR-sickness. By removing the cons, VR will be an even more sought after technology and as the it gets normalized the number of cases and data to analyze will create an even better foundation for a cost-benefit analysis. As seen with the hardware, the cost of developing the programs will probably decrease as templates and experience will allow the process to be more optimized and more beneficial in the future.

7 CONCLUSION

The research question was to determine if VR-based interactive training is a competitive training method compared to the traditional methods from a financial and training effectiveness view. Chapter 5 shows that there are several pros that makes VR a competitive training methods. Factors like knowledge retention, engagement, confidence, speed of training, consistency, safety, employee retention, scalability, sustainability, availability, more measurable and less distracting are all things that should be considered when choosing the training method.

Although there are benefits, VR is not the best choice by default and there are other factors that need consideration as well. VR sickness is the major issue after implementation, but there are measures that can be taken to reduce the symptoms. It is also important to remember that there are situations where VR is not suitable such as when the training requires a lot of memorization of academic or knowledge-based materials or when training fine motor skills.

From a financial perspective, the results of the cost-comparison of the two scenarios show that VR can be competitive on cost as well. However, this may not always be the case for every type of training and should be considered when deciding on which training method to use.

The main objectives that were achieved to answer the research question was:

- Determine the pros and cons of VR.
- Find two scenarios to be used for economical comparison.
- Do an economical comparison of VR and non-vr training.

In conclusion, this thesis shows that VR-based interactive training can be a competitive training method compared to the traditional methods from a financial and training effectiveness point of view.

Based on the research I have done in connection with this thesis, the most important issue to consider is the needs and requirements of the training. The planning is the most important factor for a successful training program whether that is VR or not. As VR is shown with the pros and cons presented in Chapter 5 to be effective, I would choose VR if the finances allowed it, and it aligns with the needs and requirements. The increased knowledge retention, confidence and engagement are factors that I as a user would appreciate. It is also nice to know that you can learn when you need to learn something and not have forgotten the training content when it is needed.

A

APPENDIX

Mail received from Firesafe with prices.

SV: Masteroppgave om VR-trening FIR:0254000467

MH Marius Heltne
Til Firesafe Academy

Fra: Firesafe Academy <kurs@firesafe.no>
Sendt: fredag 14. april 2023 10.03
Til: Marius Heltne <m.heltne@stud.uis.no>
Emne: RE: Masteroppgave om VR-trening FIR:0254000467

Hei,

Det koster 8900,- for begge deler. Ordinær slokkeøvelse opptil 20stk og med VR så kan vi kjøre opptil 30stk.

Lykke til!

Med vennlig hilsen
Firesafe AS

Simen Hafstad
Fagansvarlig kurs og opplæring / Academy

Mail simen.hafstad@firesafe.no / Mobil +47 454 12 946
Sentralbord +47 22 72 20 20 / Robsrudskogen 15
PB 6411 Etterstad / NO-0605 Oslo

Sjekk ut ***Safety Walk*** – brannvernopplæring du *faktisk* husker!

From: Kundesenter NO <kundesenter@firesafe.no>
Sent: fredag 14. april 2023 09:32
To: Firesafe Academy <kurs@firesafe.no>
Subject: FW: Masteroppgave om VR-trening FIR:0254000467

Hei,

Se henvendelse i eposten under

Strålende fredag videre til dere! :)

Med vennlig hilsen
Firesafe AS

Collective agreement from Industri Energi

OSA- OSBA

Avtale mellom Industri Energi og OLF

LØNNSMATRISE FRA 1.6.2021

Med fast avtalt offshorebonus (fyll inn, i de grønne feltene, den avtalte offshorebonusen som gjelder i ditt selskap)

I tillegg kommer: Nattillegg kr. 93,50 pr. time, og Bev. helligdagsgodtgjørelse kr. 2120,- pr. dag

OSA	Stillinger	Satser	Ansiennitet 1	2	3	4	5	6	7	8	9	10	11	12
A	MUB Ingeniør	Årslønn Tariff				**745 614**	**755 808**	**760 808**	**765 808**	**770 808**	**775808**	**780808**	**785808**	**790808**
	Retningsmåler	Sokkelkompensasjon				1	1	1	1	1	1	1	1	1
	Borestedsgeolog	Månedslønn Ujustert				62 122	62 972	63389	63805	64222	64639	65055	65472	65889
	Feltgeolog	Månedslønn Justert				56 094	56 861	57237	57613	57989	58366	58742	59118	59494
	Brønnspesialist	Offshore pr. time				425,58	431,40	434,25	437,11	439,96	442,81	445,67	448,52	451,37
	Senior Surveyor 2	Offshore overtid/time				702,20	711,81	716,51	721,22	725,93	730,64	735,35	740,06	744,77
	Borevæske Ingeniør 1	Onshore pr. time				382,29	387,52	390,08	392,65	395,21	397,78	400,34	402,90	405,47
		Onshore 50% overt.				573,44	581,28	585,12	588,97	592,82	596,66	600,51	604,36	608,20
		Onshore 100% overt.				764,58	775,04	780,17	785,29	790,42	795,55	800,68	805,81	810,94
B	Senior Brønntekniker	Årslønn Tariff			**705 237**	**721 633**	**727 991**	**732 991**	**737 991**	**742991**	**747991**	**752991**	**757991**	**762991**
	Boreveskeingeniør	Sokkelkompensasjon			1	1	1	1	1	1	1	1	1	1
	Senior Dataingeniør	Månedslønn Ujustert			58 758	60 124	60 654	61070	61487	61904	62320	62737	63154	63570
	Senior Geolog	Månedslønn Justert			53 055	54 289	54 768	55144	55520	55896	56272	56649	57025	57401
	Elektro og instrumenttekniker	Offshore pr. time			402,53	411,89	415,52	418,37	421,23	423,84	426,94	429,79	432,64	435,50
	Spesial hydrauliker	Offshore overtid/time			664,18	679,62	685,61	690,32	695,03	699,73	704,44	709,15	713,86	718,57
	Spesial kranfører	Onshore pr. time			361,59	369,99	373,25	375,82	378,38	380,95	383,51	386,07	388,64	391,20
	Senior FU-operatør	Onshore 50% overt.			542,38	554,99	559,88	563,73	567,57	571,42	575,27	579,11	582,96	586,80
	Senior Dykketekniker	Onshore 100% overt.			723,17	739,99	746,51	751,64	756,76	761,89	767,02	772,15	777,28	782,41
	Dekksformann													
	Surveyor 1													
C	Brønntekniker	Årslønn Tariff			**689 476**	**705 420**	**709 224**	**714 224**	**719 224**	**724224**	**729224**	**734224**	**739224**	**744224**
	Dataingeniør	Sokkelkompensasjon			1	1	1	1	1	1	1	1	1	1
	Geolog	Månedslønn Ujustert			57 444	58 773	59 090	59 507	59 923	60340	60757	61173	61589,8333	62007
	Fagarbeider/Sveiser/Kranføre	Månedslønn Justert			51869	53 069	53 355	53 732	54 108	54484	54860	55237	55613	55989
	Hydrauliker	Offshore pr. time			393,54	402,64	404,81	407,66	410,52	413,37	416,22	419,08	421,93	424,79
	FU-operatør	Offshore overtid/time			649,34	664,35	667,93	672,64	677,35	682,06	686,77	691,48	696,19	700,90
	Dykketekniker	Onshore pr. time			353,50	361,68	363,63	366,19	368,76	371,32	373,89	376,45	379,01	381,58
	Junior MUB ing	Onshore 50% overt.			530,25	542,52	545,44	549,29	553,14	556,98	560,83	564,68	568,52	572,37
	Surveyor 2/ Junior Surveyor	Onshore 100% overt.			707,01	723,36	727,26	732,39	737,52	742,64	747,77	752,90	758,03	763,16
E	Hjelpearbeider, Rigger	Årslønn Tariff				**628 310**	**636 797**	**641 797**	**646 797**	**651797**	**656797**	**661797**		
	Opplæringsstilling 1)	Sokkelkompensasjon				1	1	1	1	1	1	1		
		Månedslønn Ujustert				52 347	53 054	53 471	53 888	54304	54721	55138		
		Månedslønn Justert				47 267	47 906	48 282	48 658	49034	49410	49787		
		Offshore pr. time				358,62	363,47	366,32	369,18	372,03	374,88	377,74		
		Offshore overtid/time				591,73	599,72	604,43	609,14	613,85	618,56	623,27		
		Onshore pr. time				322,14	326,49	329,05	331,62	334,18	336,74	339,31		
		Onshore 50% overt.				483,20	489,73	493,58	497,42	501,27	505,12	508,96		
		Onshore 100% overt.				644,27	652,98	658,10	663,23	668,36	673,49	678,62		

BIBLIOGRAPHY

[1] "A meta-analysis of virtual reality training programs." In: *Computers in Human Behavior* 121 (2021). ISSN: 0747-5632. DOI: https://doi.org/10.1016/j.chb.2021.106808.

[2] *ABOUT US*. URL: https://www.capgemini.com/about-us/# (visited on 03/22/2023).

[3] *AdventHealth: Using VR training data to improve patient care*. URL: https://www.strivr.com/customers/adventhealth-using-vr-training-data-to-improve-patient-care/ (visited on 03/22/2023).

[4] Rajaa Al-musawi and Farzaneh Farid. "Computer-Based Technologies in Dentistry: Types and Applications." In: *Journal of Dentistry (Tehran, Iran)* 13 (June 2016), pp. 215–222.

[5] *Antall timer per uke som en full stilling tilsvarer*. URL: https://www.skatteetaten.no/bedrift-og-organisasjon/arbeidsgiver/a-meldingen/veiledning/arbeidsforholdet/opplysninger-om-arbeidsforholdet/antall-timer-per-uke-som-en-full-stilling-tilsvarer/ (visited on 03/22/2023).

[6] Sooraj K. Babu, Sooraj Krishna, Unnikrishnan R, and Rao R. Bhavani. "Virtual reality learning environments for vocational education : A comparison study with conventional instructional media on knowledge retention." In: *Business and Information Systems Engineering* 62.3 (2020), pp. 455–461. DOI: DOI10.1109/ICALT.2018.00094.

[7] *CAPGEMINI ENGINEERING*. URL: https://www.capgemini.com/no-no/about-us/who-we-are/our-brands/capgemini-engineering/ (visited on 03/22/2023).

[8] *CAPGEMINI*. URL: https://www.capgemini.com/no-no/ (visited on 03/22/2023).

[9] Michael Casale. *The science of learning and VR's transformative impact*. Strivr Labs, Inc, 2019.

[10] Louis Deslauriers, Logan S. McCarty, Kelly Miller, Kristina Callaghan, and Greg Kestin. "Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom." In: *Proceedings of the National Academy of Sciences* 116.39 (2019). DOI: 10.1073/pnas.1821936116. eprint: https://www.pnas.org/doi/pdf/10.1073/pnas.1821936116. URL: https://www.pnas.org/doi/abs/10.1073/pnas.1821936116.

[11] Asaf Eldad. *Unity vs Unreal, What Kind of Game Dev Are You?* 2023. URL: https://www.incredibuild.com/blog/unity-vs-unreal-what-kind-of-game-dev-are-you (visited on 03/25/2023).

[12] GlobalData. *How leading oil and gas companies are adopting virtual reality*. 2020. URL: https://www.offshore-technology.com/comment/oil-gas-virtual-reality/ (visited on 03/22/2023).

[13] Will Greenwald. *The Best VR Headsets for 2023*. 2023. URL: https://uk.pcmag.com/virtual-reality/75926/the-best-vr-headsets#swiper-wrapper (visited on 03/26/2023).

[14] *Hva er et aarsverk*. URL: https://fiken.no/forklarer/arsverk (visited on 03/22/2023).

[15] *Hva er vanlig lønn i Norge*. URL: https://www.ssb.no/arbeid-og-lonn/lonn-og-arbeidskraftkostnader/artikler/hva-er-vanlig-lonn-i-norge (visited on 04/30/2023).

[16] Scott Likens and Andrea Mower. *What does virtual reality and the metaverse mean for training?* URL: https://online.hbs.edu/blog/post/cost-benefit-analysis (visited on 04/25/2023).

[17] Svein Loeng. "Various ways of understanding the concept of andragogy." In: *Cogent Education* 5.1 (2018). Ed. by Edith Omwami. DOI: https://doi.org/10.1080/2331186X.2018.1496643.

[18] *MEASURING THE VALUE OF IMMERSIVE LEARNING*. URL: https://www.strivr.com/immersive-learning-impact/ (visited on 03/22/2023).

[19] Reghill J Manuelraj. *HMD vs CAVE in the world of VR*. 2020. URL: https://medium.com/xrpractices/hmd-vs-cave-in-the-world-of-vr-a0c9cbfb435a (visited on 03/22/2023).

[20] *Meta Quest 2 VR-briller (128 GB)*. URL: https://www.elkjop.no/product/gaming/vr-gaming/meta-quest-2-vr-briller-128-gb/327417?gclid=Cj0KCQjw7aqkBhDPARIsAKGa0oKcO9txJ9M-Jc1XVKM0R3G06kNu7EtuC94-IOvvZEwxAwr84ti99IMaAk-iEALw_wcB (visited on 03/22/2023).

[21] *Offshoreservice NR 2020-2022*. URL: https://industrienergi.no/lonns-og-arbeidsvilkar/tariffavtaler/offshoreservice-nr-2020-2022-2/ (visited on 04/22/2023).

[22] *Om Firesafe*. URL: https://www.firesafe.no/om-oss/om-firesafe/ (visited on 05/26/2023).

[23] *Om forbundet*. URL: https://industrienergi.no/hvem-vi-er/om-forbundet/ (visited on 05/26/2023).

[24] *PaleBlue*. URL: https://pale.blue/ (visited on 03/22/2023).

[25] *Retention*. URL: https://dictionary.cambridge.org/dictionary/english/retention (visited on 05/30/2023).

[26] Dimitrios Saredakis, Ancret Szpak, Brandon Birckhead, Hannah A. D. Keage, Albert Rizzo, and Tobias Loetscher. "Factors Associated With Virtual Reality Sickness in Head-Mounted Displays: A Systematic Review and Meta-Analysis." In: *Frontiers in Human Neuroscience* 14 (2020). DOI: 10.3389/fnhum.2020.00096. URL: https://www.frontiersin.org/articles/10.3389/fnhum.2020.00096.

[27] William R. Sharman and Alan B. Craig. *Understanding Virtual Reality*. Cambridge, MA, USA: Elsevier, 2019.

[28] Tim Stobierski. *HOW TO DO A COST-BENEFIT ANALYSIS & WHY IT'S IMPORTANT*. 2019. URL: https://online.hbs.edu/blog/post/cost-benefit-analysis (visited on 04/25/2023).

[29] *Strivr*. URL: https://www.strivr.com/ (visited on 03/22/2023).

[30] *The Ultimate Guide to Immersive Learning*. 2020. URL: https://www.strivr.com/wp-content/uploads/2020/04/The-Ultimate-Guide-to-Immersive-Learning.pdf (visited on 04/20/2023).

[31] *VR Operational Efficiency & Productivity*. URL: https://www.strivr.com/solutions/objective/operational-efficiency/ (visited on 03/22/2023).

[32] *Virtual Reality Training Information & Decision Making Guide for 2022*. Motive.io, 2021.

[33] Isabell Wohlgenannt, Alexander Simons, and Stefan Stieglitz. "Virtual Reality." In: *Business and Information Systems Engineering* 62.3 (2020), pp. 455–461.

[34] Josef Wolfartsberger, Robert Zimmermann, Gabriele Obermeier, and Daniel Niedermayr. "Analyzing the potential of virtual reality-supported training for industrial assembly tasks." In: *Computers in Industry* 147 (2023), p. 103838. ISSN: 0166-3615. DOI: https://doi.org/10.1016/j.compind.2022.103838. URL: https://www.sciencedirect.com/science/article/pii/S0166361522002342.