VR Industralization

Analysis of barriers and overcoming strategies to support the adoption and complete industralization of VR technology. A collective case study at AF-KLM

Master's Thesis

Francisco A. Jaime Sanchez

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by

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Abstract

This research illuminates the complexities of Virtual Reality (VR) technology adoption within the airline industry, with a specific emphasis on Air France-KLM. Despite VR's transformative potential and its increasing prevalence in various sectors, its adoption in the airline industry presents unique challenges. The central research question guiding this study was: "How can VR technology adoption be effectively supported within the airline industry to achieve complete industrialization?"

A methodological blend of comprehensive literature review and a detailed case study at AF-KLM was employed. The literature review revealed established technology adoption frameworks while also highlighting potential gaps, particularly concerning the airline industry's unique context. The case study at AF-KLM provided empirical depth, identifying various adoption barriers and potential strategies to overcome them.

Key findings underscored the importance of strategic alignment, managerial commitment, user acceptance, and continuous assessment in the VR adoption process. Based on these insights, a tailored technology adoption framework was developed, offering a roadmap for entities in their VR adoption journey. While the framework was specifically crafted for AF-KLM, its principles hold broader applicability.

This research contributes significantly to the academic understanding of technology adoption in specialized industry contexts. Practically, it offers a strategic tool for organizations, ensuring that VR adoption translates to tangible benefits. As the technological landscape continues to evolve, this research serves as both a reflection on VR's current adoption challenges and a guide for future endeavors.

Keywords: Virtual reality, Technology adoption, barriers, strategies, innovation, airline industry, Air France-KLM.

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Executive Summary

In the ever-evolving landscape of technological innovation, Virtual Reality (VR) emerges as a transformative tool with potential applications across various sectors. The airline industry, characterized by its rigorous safety standards, slim profit margins, and sensitivity to external factors like the COVID-19 pandemic, stands to gain significantly from this technology. However, while the merits of VR are evident, its full-scale integration into industry operations remains a challenge, mired by barriers that hinder its complete industrialization.

Air France-KLM (AF-KLM), a relevant player in the airline industry, has made significant strides in exploring VR's capabilities, primarily through its Extended Reality Center of Excellence (XR-CoE). Yet, despite these efforts, the complete integration of VR into the company's core processes and value chain remains elusive.

This Master's research dives into this intricate challenge, aiming to:

- Assess and synthesize key insights from existing scientific literature on technology adoption models.
- Determine the specific barriers and strategies that influence the adoption and integration of VR in the airline industry.
- Address identified gaps in existing technology adoption models to foster a holistic understanding of the factors driving VR technology adoption in the aviation sector.
- Construct a technology adoption framework, grounded in both theoretical and empirical insights, that provides a roadmap for the full-scale industrialization of VR products in the airline context.

Driven by the central question, "How can VR technology adoption be effectively supported within the airline industry to achieve complete industrialization?", this study navigates both the theoretical constructs and practical intricacies of technology adoption, offering insights on the VR technology adoption within a large airline .

This research utilizes a qualitative paradigm, focusing on the adoption of VR technology within the AF-KLM group. A case study design forms the basis, chosen for its depth and context specificity. The multi-faceted methodology encompasses: (1) two literature reviews, one examining technology adoption theories and another detailing industry-wide technology adoption challenges; (2) semi-structured interviews with key AF-KLM stakeholders, shedding light on firsthand experiences and perspectives; (3) an experiment, spanning six weeks, where a geographically distributed AF-KLM team employed VR to assess its efficacy in collaborative tasks; and (4) direct observations of the XR-CoE team's dynamics, offering a real-world vantage point. Regarding the analysis, due to the qualitative nature of the research, it was grounded mainly in thematic and content methodologies, allowing for comprehensive interpretation of data and ensuring a holistic understanding of the VR adoption landscape. Only in the experiment, where questionnaires were handed, quantitative analysis were used to provided objective comparison before and after.

The theoretical insights obtained from the study provided a robust understanding of technology adoption literature and its applicability in an organizational context. The Unified Theory of Acceptance and Use of Technology (UTAUT) emerged as a key model, encapsulating the nature of technology adoption. Despite providing an extensive overview of factors influencing intention and actual use of technologies, UTAUT lacks context identification, which is key in an organizational environment. This led to include theories such as the Technology-Organization-Environment (TOE) framework that categorizes influencing factors into different groups. Consequently, there were established four categories based on these findings: Technology, People, Organization, and Environment. Additionally, there were identified three crucial concepts drawn from the literature that significantly contribute to the framework: the importance of compatibility between new technology and existing systems, the role of time in differentiating intention from actual use, and the necessity of assessing the alignment of new technology projects with the organization's goals.

The empirical findings derived from various data collection methods, highlight the complexity of the adoption process and the different barriers and strategies identified by the stakeholders involved. The barriers were categorized into five distinct categories, adding "Process" to the ones established in the theoretical chapter. To overcome the identified barriers, strategies at higher levels focus on building a compelling business case, securing the necessary budget for development, and managing stakeholders during the initial stages. Conversely, at lower levels, strategies are concerned with user acceptance when new technology is being rolled out. Transparency emerged as a critical component at both levels, particularly in aligning operational procedures and managing expectations. Stakeholder commitment was found to be crucial for subsequent adoption. The study also highlighted the importance of differentiating early-stage projects: those that address existing business problems directly are more likely to succeed, while technology-push projects or those without direct financial impact face more significant challenges.

By integrating theoretical insights with empirical findings, the initial theoretical model is both validated and enriched. This leads to the development of a comprehensive technology adoption framework tailored to guide VR adoption in organizations like AF-KLM. The framework delineates between the organizational adoption and user acceptance phases, systematically categorizing influential factors into five domains: Technology, People, Organization, Environment, and Process. Rooted in established theoretical models of technology adoption and reinforced by empirical evidence from AF-KLM, this framework offers substantial practical value. Specifically for AF-KLM, it serves as a blueprint for the XR-CoE's journey towards VR industrialization. The visual representation combined with a meticulous categorization of factors provides both a strategic and operational roadmap, designed to assist organizations in navigating the multifaceted process of VR adoption. However, the efficacy of this framework is dependent upon its proper application, iterative refinements based on continual feedback, and its adaptability to the evolving dynamics of both the organization and the VR technological landscape.

The derived framework advances scientific understanding by integrating diverse theories and empirical findings on technology adoption, specifically for VR in industries like aviation. Intended as a guide, the framework offers strategies to address VR adoption barriers, emphasizing stakeholder engagement, technological compatibility, and user training. Furthermore, it underscores resource allocation and strategic communication to highlight VR's benefits. Collectively, these strategies form a comprehensive plan to tackle both organizational and technological challenges in VR adoption.

Based on the findings, numerous recommendations emerge to deepen our understanding of technology adoption in unique contexts, such as VR in the airline sector. Future research should validate the proposed framework and introduce novel concepts and elements to make it adaptable to varied contexts. Practically speaking, organizations are advised to implement the framework and gauge its influence on the adoption trajectory. For instance, this research introduces a preliminary design of a digital tool rooted in the adoption framework. This tool aids in practical application, evaluating the feasibility, technological alignment, and strategic fit of potential VR use cases. Continued development and fine-tuning of this tool, based on any modifications to the framework, are highly recommended.

In sum, this Master's research offers a comprehensive exploration into the multifaceted domain of VR technology adoption in the airline industry, with a specific focus on AF-KLM. By intertwining theoretical perspectives with empirical data, it presents a pragmatic framework to navigate the complex journey of VR industrialization. The insights and tools generated from this study hold the potential to enhance the way organizations approach technology adoption, ensuring that innovations like VR are not momentary trends but are seamlessly integrated into the core value chain of business operations. As the technological landscape continues to evolve, this research underscores the importance of rigorous academic inquiry in informing and shaping industry practices for a technologically advanced horizon.

1

Introduction

1.1. Background

Innovation, particularly technological innovation, has become a cornerstone for companies across industries, enabling them to gain a competitive edge in an increasingly dynamic and interconnected world. Embracing innovation as a strategic pillar has become imperative for organizations seeking to adapt to evolving market trends, enhance operational efficiency, and foster improved collaboration among geographically distributed teams (Tippmann, Sharkey Scott, and Gantly, 2021; McKinsey & Company, 2022). However, it has been demonstrated that simply intending to innovate and investing in it does not guarantee the success of the innovation. In fact, the majority of digital transformation programs at organizations fail to meet their objectives (Tabrizi et al., 2019).

The challenge of introducing new technologies and ways of working in organizations is often met with resistance that can frustrate the change process and goals, which could result in delays, and in some cases its cancellation (Darmawan and Azizah, 2020; Ansoff et al., 2018). This phenomenon, often referred in the litarature as 'the incumbent curse', 'family trap', or 'path reliance', characterizes organizations' tendencies to focus on reproduction and incremental improvements, rather than radical innovation. This resistance to change often arises when the proposed innovations do not align with established routines, existing knowledge, or proven technology. (Wee, Annema, and Köhler, 2022)

Studies have analyzed these challenges and recognized that introducing new technologies can disrupt habits and routines, posing significant obstacles to organizational goals (Val and Martinez Fuentes, 2003; El-Taliawi, 2018). These phenomena need to be considered when planning and implementing organizational change programs (Darmawan and Azizah, 2020), as there are a wide variety of reasons, and specific for each case (Hultman, 2003). Understanding and addressing the reasons behind resistance to change is crucial for the success of technological change programs.

1.1.1. Virtual Reality Technology as a corporate resource

Transformation initiatives within companies primarily focus on the incorporation of digital technologies (Subramaniam, 2021), as these allow companies to automate and streamline operations, and as mentioned before, increase productivity and gain competitive advantage. Digital technologies comprise a wide range of technologies and tools such as mobile technologies, robotics, cloud technologies, artificial intelligence, or Internet of Things, among many others. Virtual Reality (VR), the focus of this research, is a digital technology that is gaining popularity in society (Alsop, 2023). Despite the consumer market for VR not taking off as projected, the Extended Reality (XR), which encompasses VR, market in the professional realm has experienced considerable growth (Booth, 2023; European Commision, Unknown).

VR is a digital technology that creates a simulated, interactive environment, allowing users to experience a sense of physical presence in a non-physical world (Lowood, 2023). It has found diverse applications in the corporate sphere, for example in the healthcare industry for treatment and rehabilitation purposes, or in sectors such as manufacturing or maintenance for skill acquisition (Li, 2022). The adoption of VR for training has been acknowledged to be more accessible and cost-effective than traditional methods, outperforming 2D video training in efficacy (Goodwin, 2017; Raducan, 2019; Schöne, Wessels, and Gruber, 2019; PwC, 2020). Furthermore, VR presents an opportunity to connect individuals in different locations, creating a sense of immersion that surpasses conventional 2D meetings and potentially enhancing productivity. Although current technological limitations challenging the full realization of this use case, some companies such as Accenture are already investing in VR for connecting people worldwide (Zahn and Serwer, n.d.).

The industrial applicability of VR is particularly valuable in the aviation industry, where it can enhance the effectiveness and efficiency of operations, and also offer innovative services to customers. VR serves as a powerful training tool, enabling real-life simulations that are more cost-effective and minimize potential errors. Furthermore, the application of VR extends to the development of new in-flight entertainment services or products(Aviation Pros, 2023). Several airlines, such as AF-KLM, Lufthansa, and Qatar Airways, are already exploring VR use cases within their value chain

1.1.2. Virtual Reality at AF-KLM

This study intends to delve into the process of VR adoption within the context of a large airline, using a case study at Air France - KLM (AF-KLM) to gain in-depth insights on the topic. To fully comprehend the circumstances of an airline such as AF-KLM, it is necessary to acknowledge that airlines are embedded within a complex industry ecosystem characterized by slim profit margins, rigorous safety standards, and extensive regulation. Furthermore, the airline industry contends with a significant dependence on external factors, exemplified by the COVID 19 pandemic that originated a period of high uncertainty and economic pressure on airlines, from which they are still recovering (ICAO, 2023). The ongoing impacts of events that create global economic fluctuations together with the competitive landscape, changing customer expectations, and increasing environmental concerns, are forces collectively influencing and shaping airlines' activities (IvyPanda, 2020; BCG, 2020; IATA, 2021).

In this landscape, AF-KLM views technology and innovation as catalysts for change, aiding the company adapt to the challenges the airline industry faces. Guided by the company's purpose, "Being at the forefront of a more responsible European aviation, we unite people for the world of tomorrow," transformation initiatives have emerged within the company to achieve their goals across key pillars: people, customers, finances, and sustainability.

Among these opportunities for transformation, VR emerged as a promising technology, leading to the establishment of the Extended Reality Center of Excellence (XR-CoE). As a branch of the Information Technologies (IT) department, XR-CoE explores potential benefits VR could bring to AF-KLM operations and services. The XR-CoE's aim is not only to investigate the technology's use cases but also to execute Proof of Concepts (PoCs) to test new ideas, develop Minimal Viable Products (MVPs), and, if successful, implement them and provide the necessary support for their use. The portfolio of products developed by the XR-CoE primarily consists of training for different departments at AF-KLM, as well as external collaborators (e.g., Embraer). However, they also work on other projects such as virtual travel, rehabilitation programs, and virtual work collaboration.

1.2. Practical problem statement

AF-KLM has been actively working with VR for over seven years, aexploring, developing, and testing different VR products in collaboration with other company departments. Despite the growth of VR capabilities, the maturity of the technology in the company, and the significant evolution of VR itself over recent years, few projects that have proven their viability have achieved a complete industrialization. Figure 1.1 illustrates the industrialization process for VR projects developed by the XR-CoE. The goal of this process is to bring VR innovations to full industrialization, integrating these innovations into the company's value chain. While the process may vary between projects, it typically follows a similar timeline. Innovations start with the idea creation phase, often initiated by a business unit aiming to increase operational efficiency, and are subsequently followed by the experimentation and production phase. It is during these phases that the XR-CoE has observed significant challenges in technology adoption, as experimentation phases often extend without conclusive decisions on adoption, or products are implemented but not fully used.

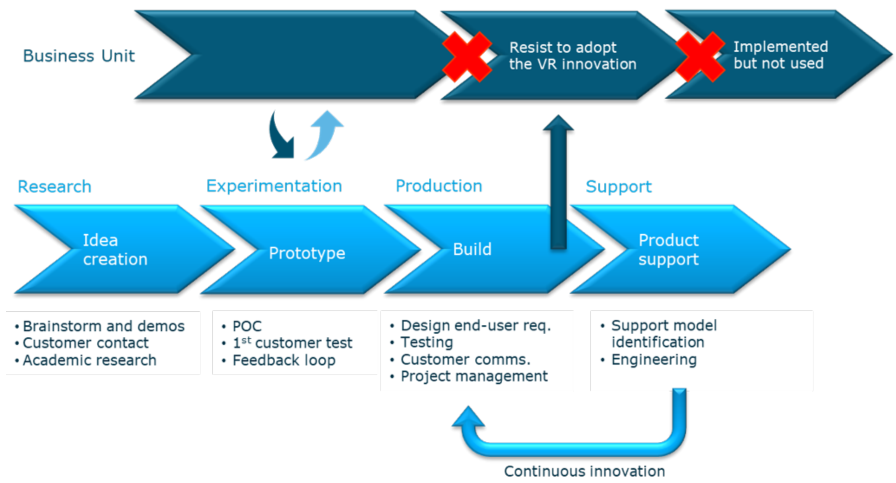

Figure 1.1: VR innovation's industrialization

AF-KLM has conducted numerous studies over the years to investigate the usability and feasibility of VR products across various business units. However, no research has been conducted that takes into account the complete picture of technology adoption and the industrialization process. The issue of incomplete industrialization of VR projects within AF-KLM is significant as prolonged adoption phases and underutilized products represent not only wasted resources but also missed opportunities for innovation and improvement. Additionally, these challenges can lead to frustration within the teams, negatively impacting the organization's perception of the technology. This could result in a slower response to market changes and a diminished competitive edge.

It is therefore crucial for AF-KLM, and companies introducing new technologies such as VR, to explore the factors influencing VR product adoption, identify barriers, and determine strategies that can facilitate this process. By addressing these aspects, companies could achieve full industrialization of VR and unlock its benefits. Importantly, it is necessary to keep in mind that the ultimate goal of integrating VR products within corporations is to enhance current systems and operations, rather than viewing VR adoption as an end in itself.

1.3. Theoretical problem statement

Although the practical aspects of technology adoption have been highlighted, this thesis also aims to provide a significant scientific contribution to the literature on technology adoption. Research on technology adoption within organizations has often relied on established theoretical frameworks such as the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), or the Technology-Organization-Environment (TOE) framework. While these models offer valuable insights into the factors influencing technology adoption, they often lack specific contextualization and may not fully capture the complexities and unique challenges encountered by industries like aviation or specific technologies such as VR.

This represents a key theoretical gap: the current models do not sufficiently account for the specific characteristics and challenges of VR technology adoption in the aviation industry. Furthermore, they do not fully explain why promising technologies, despite proven viability, may struggle to achieve full industrialization.

To address these gaps, a thorough review of the existing scientific knowledge, coupled with in-depth qualitative research exploring the unique experiences, motivations, and challenges within the adopting organization, is proposed. This approach will facilitate the development of more nuanced theories of technology adoption, tailored to the unique context of VR in the aviation industry. Through a synthesis of theory and empirical findings, this research aims not only to enrich the understanding of the VR adoption process in the aviation industry but also to contribute to the body of scientific knowledge on technology adoption within industry-specific contexts.

1.4. Research objectives

This thesis is guided by dual objectives: practical application and scientific contribution. These objectives are derived from the background information and problem statements discussed previously.

On the practical side, the aim is to create a technology adoption framework for the XR-CoE that can guide new technology adoption and enable the complete industrialization of VR products. This will be accomplished by: (1) understanding the current state and factors influencing the adoption and use of new technologies in the company, (2) identifying barriers that hinder VR adoption, (3) determining the criteria to assess new initiatives, and (4) defining strategies that can support VR adoption.

From a theoretical perspective, this thesis aims to fill identified gaps in existing technology adoption models and develop a comprehensive understanding of the factors influencing the adoption of VR technology in the aviation industry. This will be achieved by: (1) reviewing and critically evaluating existing scientific literature and technology adoption models, (2) conducting in-depth empirical research within AF-KLM, and (3) refining the initial theoretical findings based on the empirical results to create a refined theoretical framework.

As mentioned before and further explained at chapter 2, to achieve these objectives the study will conduct an in-depth review of the existing scientific literature combined with empirical research within AF-KLM. The process is designed to ensure that the final adoption framework is grounded in empirical realities while also contributing to theoretical knowledge. The final framework is expected to serve as a tool to support complete industralization for airlines, as well as other organizations and sectors dealing with similar technology adoption challenges, and contribute to the broader theoretical discourse on technology adoption.

1.5. Research question

Based on the presented information, problem definition, the research objectives and the identified knowledge gaps, it is defined the following main research question:

"How VR technology adoption can be effectively supported within the airline industry to achieve complete industrialization?"

In order to give an answer to the main research question the subsequent sub-research questions have been formulated:

- What are the key concepts, barriers, and overcoming strategies related to technology adoption in companies according to the literature?
- What are the main barriers for complete industrialization of VR innovations identified by employees at AF-KLM?
- What are the potential strategies identified by employees at AF-KLM to overcome the adoption barriers for complete VR innovation's industrialization?
- What implementation strategy could be proposed, informed by both theoretical insights and empirical findings, to support VR industrialization and overcome adoption barriers?

1.6. Significance for MOT

This thesis aligns directly with the core of the Management of Technology (MoT) master's program. By examining KLM's implementation of VR within its value chain, the study illustrates how technology serves as a pivotal corporate resource to enhance outcomes and realize strategic objectives. The research delves into the profound impact such technology has on KLM's organizational context, employing scientific methods and techniques for comprehensive analysis. Furthermore, the thesis provides a unique lens to understand the multifaceted challenges technology managers confront during the adoption of new technologies.

The thesis resonates deeply with the essence of MoT, as evident by its thematic links with numerous courses in the program. Examining the four modules of the master's programme, each finds relevance within the context of this research. Particularly, the modules of "Technology, Innovation & Organization" and "Technology, Innovation & Commercialization" strongly connect with the primary concepts addressed in this thesis.

Courses such as "Leadership and Technology Management (MOT1524)", "Technology, Strategy, and Entrepreneurship (MOT1435)", and "Emerging and Breakthrough Technologies (MOT2421)" encompass discussions on technology strategy, innovation processes, and management practices, and they provide the theoretical underpinning that supports this research. Similarly, the course "Technology Dynamics (MOT1412)" in the "Technology, Innovation & Engineering Economics" module offers insights into the intricate dynamics of innovation decisions and interactions.

Lastly, while the "Research & Reflection" module might not directly provide content knowledge, its emphasis on rigorous scientific methods shapes the design, analysis, and evaluation processes essential to fulfill the research objectives of this thesis

1.7. Thesis outline and reader's guide

The thesis is divided into six chapters that provide both answers to research questions and practical considerations to the complex issue of implementing an adopting virtual reality products at a large organization. A chapter overview is provided in Figure 1.2.

The first chapter consists of the introduction of the research, the problem definition, and objectives. It also provides a brief background of the current state of the technology, and innovation at the company.

Chapter 2 details the methodology of the research. As this is a qualitative study, this chapter provides a comprehensive overview of the data collection methods and data analysis employed, ensuring transparency and rigor in the research process.

Chapter 3 sets a theoretical framework based on the literature reviewed on technology adoption. The most relevant adoption theories and frameworks are studied, providing an overview of the state of barriers and strategies for technology adoption in organizations.

Chapter 4 presents the case study results, presenting the insights of all the methods included in the research. In Chapter 5, the findings are discussed, and theory and empiricals insights are compared. At the end, a technology adoption framework is developed based on that comparison that could serve large airlines such as AF-KLM in supporting VR adoption.

Finally, Chapter 6 presents a conclusion and offers a series of recommendations, summarizing the efforts and findings of this study. It provides reflections on the research question and its associated objectives. The recommendations are derived from the knowledge accumulated during the research and seek to both expand understanding of the topic and enhance the application of VR technologies within corporate settings

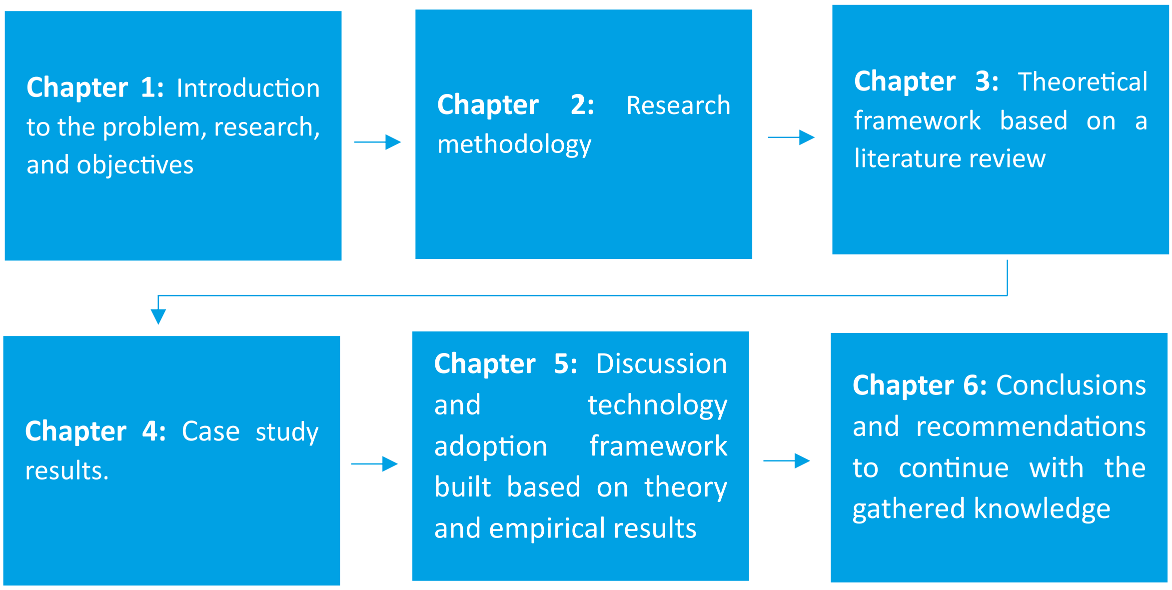

Figure 1.2: Thesis outline and chapter overview

2

Research Methodology

This chapter outlines the methodology employed in this study, which aims to explore the adoption and industrialization processes of VR products within AF-KLM. The research approach is grounded in the qualitative paradigm, allowing for a comprehensive understanding of the subjective experiences, perceptions, and strategies of those involved in the process (Camic, Rhodes, and Yardley, 2003). A case study design has been chosen for its capacity to provide in-depth, context-specific insights into the complex process of VR adoption (Yin, 2009), and give answer to the research questions.

The methodology is multi-faceted, integrating a variety of qualitative methods to ensure a thorough exploration of the research questions. The methods, which include a literature review, an experiment, direct observations, and semi-structured interviews, are designed to provide multiple lenses through which to examine the phenomenon, thereby enhancing the robustness and richness of the findings (Schoepf and Klimow, 2022).

The purpose of this chapter is to detail the design, execution, and analysis stages of each method, including any ethical considerations and potential limitations. The aim is to ensure the transparency and rigor of the research process, thereby enabling others to understand, evaluate, and possibly replicate the study. Table 2.1 shows an overview of the methodology used, and Table 2.2 shows the research flow and used methods at each of the research stages.

Research component	Details
Research approach	Qualitative nature, multi-case study
Data collection	Literature review, Expriment, direct observations, semi-structured interviews
Data sources	Academic literature, experiment (questionnaires, surveys, feedback), field notes, interview transcripts
Sampling	Main VR products at AF-KLM, and selection of participants based on their involvement in the VR adoption process at different company levels
Data Analysis	Content analysis (literature), thematic analysis (interviews, observations, and questionnaires), and descriptive statistics (questionnaires and surveys)
Tools used	Zotero, Excel, Word, Draw.io, PowerPoint, ATLAS.Ti
Limitations	Lack of generalizability, time and resource constraints, and potential researcher bias.
Validity and reliability	Method guided by theory and triangulation of data sources.

Table 2.1: Methodology overview

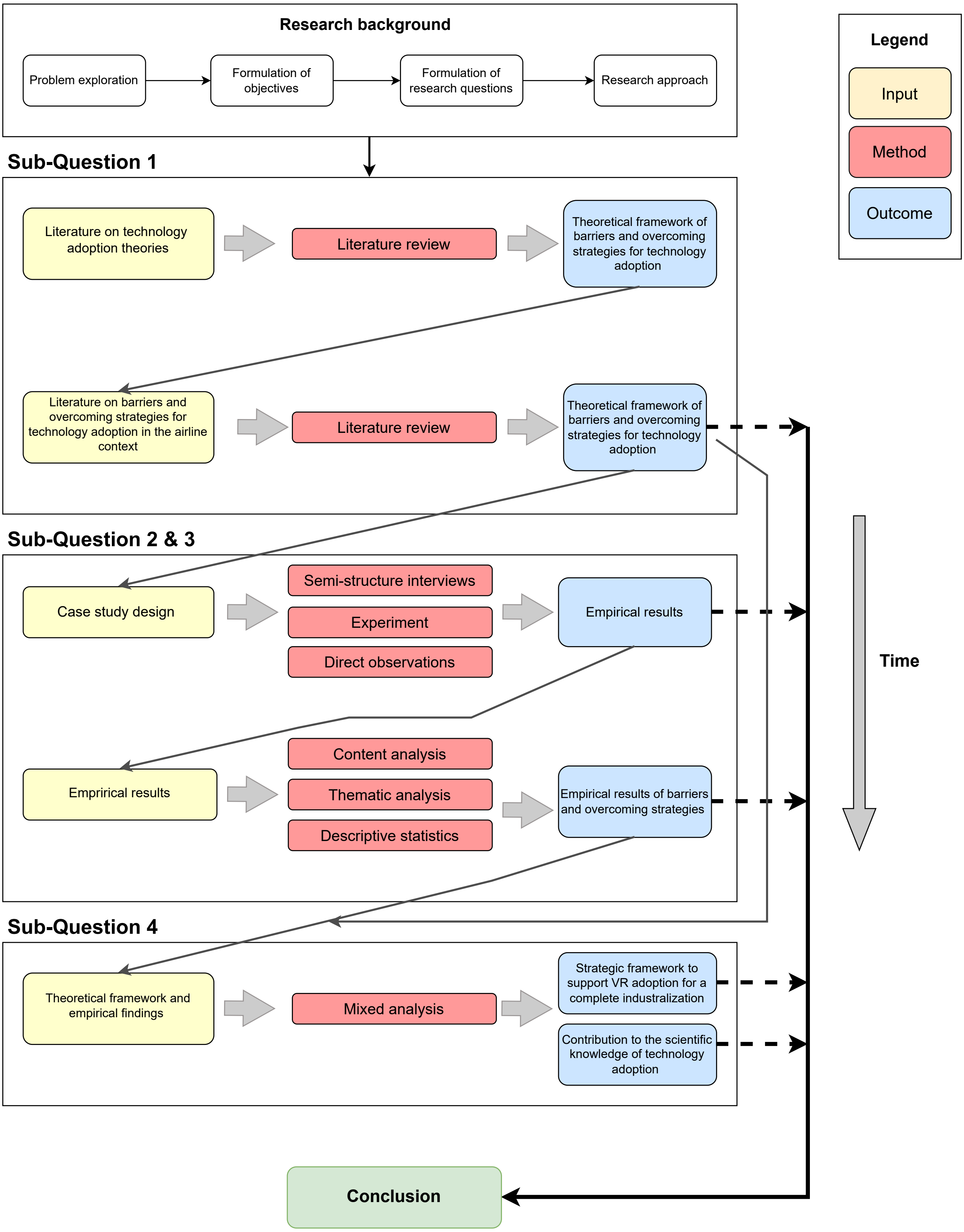

Table 2.2: Research flow chart

2.1. Case selection

A collective case study was chosen because it allows for a more comprehensive exploration of the phenomenon of interest as well as comparative analysis that can provide deeper insights and help build more robust theories or conclusions (Mills, Durepos, and Wiebe, 2010; Schoepf and Klimow, 2022). Therefore, the selection of cases is a critical step to ensure that the insights derived are both relevant and impactful for the research objectives.In the context of this research, the selected cases are purposed to offer a comprehensive understanding of the adoption process of VR products within a large airline. The XR-CoE at AF-KLM is exploring all the possibilities that this technology can bring to the company, but it was decided to choose the cases with a larger trajectory inside the company which are yet facing resistance and are not fully adopted. Therefore the VR for telepresence and VR for training cases were chosen. Other cases yet in early stages of development, such as VR for rehabilitation or virtual travel products, were not directly included.

2.1.1. VR for telepresence

As previously mentioned the XR CoE, as AF-KLM VR's arm, is leveraging VR as a tool aimed to unlock new dimensions for efficiency, collaboration, and customer engagement. As part of this broader vision, the XR-CoE is exploring the use of VR for facilitating collaborative workflows within AF-KLM's geographically distributed teams. VR for telepresence stands for the integration of VR technology with the telepresence concept, allowing users to experience a sense of being physically present in a different location, enabling enhanced remote collaboration through immersive virtual environments (Steuer, 2006; Steuer, 2000).

It was identified by the XR CoE the amount of internal travel required for AF-KLM employees between different locations as a significant concern, as it was perceived to be inefficient and costly. Moreover, it poses some questions about the sustainable efforts of the company. With the premise that personal contact would not be completely replaced, it was thought that VR could provide an alternative to traveling back and forth from different locations, and a more engaging, creative, and productive environment compared to 2D online meetings. When looking at the strategic pillars of AF KLM, VR for telepresence has the potential of reducing costs (finances), reducing emissions (sustainability), and enhancing employee collaboration and engagement (people).

Due to this opportunity, the XR-CoE began experimenting with VR as a tool for remote collaboration. In collaboration with the start-up Glue (Glue, n.d.), the XR-CoE developed an application to replicate existing meeting rooms in KLM buildings within a virtual world. This allows users to select their preferred meeting room and place themselves in a familiar space (Fink, 2020). The collaboration between the XR-CoE and Glue continues to be productive, with both entities persistently working together to develop new functionalities and provide feedback on the products. Nevertheless, the application of VR for telepresence within KLM has not met initial use expectations. The exploration of VR applications was initiated in 2018, and since then, numerous tests and pilot programs have been conducted for various VR telepresence use-cases. Despite the opportunity for experimentation that arose during the COVID-19 pandemic, the diffusion of VR for telepresence throughout the company has been limited. As of now, the product is primarily utilized for specific tests and occasional uses.

2.1.2. Training

Virtual Reality for training, a rapidly advancing field, refers to the use of VR technologies to create immersive training environments that closely simulate real-world scenarios. In these environments, learners can practice tasks, experience situations, and make decisions with real-world implications, all within a safe, controlled setting. This approach to training has been recognized for its potential to enhance learning outcomes, increase learner engagement, and improve the efficiency and cost-effectiveness of training programs (Merchant et al., 2014; Rizzo and Kim, 2005; Abich IV et al., 2021).

Virtual Reality training services, developed and explored by the XR-CoE, leverage the potential of VR to enhance the effectiveness and efficiency of employee training across various scenarios and areas of the company. For instance, several VR training modules have been developed to simulate emergency situations onboard an aircraft for cabin crew training. These modules include the use of fire extinguishers, the operation of emergency doors, and the transmission of emergency signals in the event of a water landing. The immersive environment provided by VR significantly enhances the realism of these training scenarios, contributing to the efficacy of learning outcomes. Another notable application of VR technology lies in pilot training. XR-CoE has developed a VR cockpit training module that enables pilots to practice operational procedures using a VR headset. This immersive experience provides a more authentic simulation compared to traditional teaching aids like posters and presentations, aiding in the development of muscle memory. Consequently, this could potentially reduce the need for expensive physical simulator time, making the training process more efficient.

The XR-CoE's portfolio of VR trainings encompasses emergency modules for cabin crew such as fire safety and slide raft training, operational procedure training like jetway bridge and push-back operations, as well as the aforementioned cockpit training for pilots. Despite the potential for these VR training modules to enhance learning experiences, they have not been fully implemented and adopted by the relevant business departments, with the exception of the cockpit training module. Each of these VR training modules presents distinct adoption challenges. The objective of this study, therefore, is to discern the true factors influencing the adoption and full utilization of these VR training products.

2.2. Theoretical framework

Review and analysis of literature forms a foundational aspect of this research, providing the necessary theoretical background against which the practical findings can be evaluated and understood. In this study, two literature reviews have been conducted to gain a holistic view of the subject. The first review delves into the wider realm of technology adoption theories, understanding the core aspects and the evolution of key models. It aims to consolidate the theoretical underpinnings of technology adoption and identify gaps where the context of VR adoption within an airline industry might bring new insights. The second literature review explores the general challenges of technology adoption across industries, focusing on barriers and strategies identified in the recent literature. By conducting these two literature reviews, this research aims to build a robust theoretical framework that can inform the subsequent empirical investigation and help answer the research questions effectively.

2.2.1. Literature Review I

To select the sources, it was carried a search using the Google Scholar, Web of Science and SCOPUS databases. It was applied the search in titles, abstract and keywords, and the following words were used: 'technology adoption', 'technology acceptance', 'resistance to change', 'Information Technologies' or 'IT', 'innovation adoption', 'employees', 'internal adoption', 'UTAUT', and 'VR'. Combinations of these words were used to expand the search, with examples including 'UTAUT Technology adoption VR', 'UTAUT model for new technologies adoption in employees', 'Employee adoption IT innovation', 'UTAUT internal adoption', and 'UTAUT VR technology'.

Inclusion criteria were based on the paper's relevance, considering papers written by the authors of the original theories,reviews of these theories, or applications of them. Exclusion criteria included lack of new insights on the theory, and lack of rigorous methodology. The references of the obtained articles were also reviewed and included if they contained relevant information, a process known as backward snowballing (Webster and Watson, 2002). After the selection process, 20 papers were identified for complete screening, analysis, and inclusion in the results. This systematic approach was facilitated by the use of Zotero and Microsoft Excel software, which were employed to organize and annotate the papers, ensuring a comprehensive overview of the current literature.

2.2.2. Literature Review II

This literature review adopts a systematic approach to analyze and synthesize information from various scholarly articles that delve into the barriers and overcoming strategies related to technology innovation adoption in companies. The papers were selected from two academic databases: Scopus and Web of Science.Given the extensive literature on the topic of adoption in academia, a specific set of keywords were used to narrow the search. In order to limit the search the following criteria was followed in both databases: TITLE (Technology AND Adoption) AND ABSTRACT (Technology AND adoption AND barriers AND organizations) and set the time range to 2018 to 2023. This search yielded 79 results, of which 53 were unique. To further refine this selection, the process outlined in Figure 2.1 was followed.

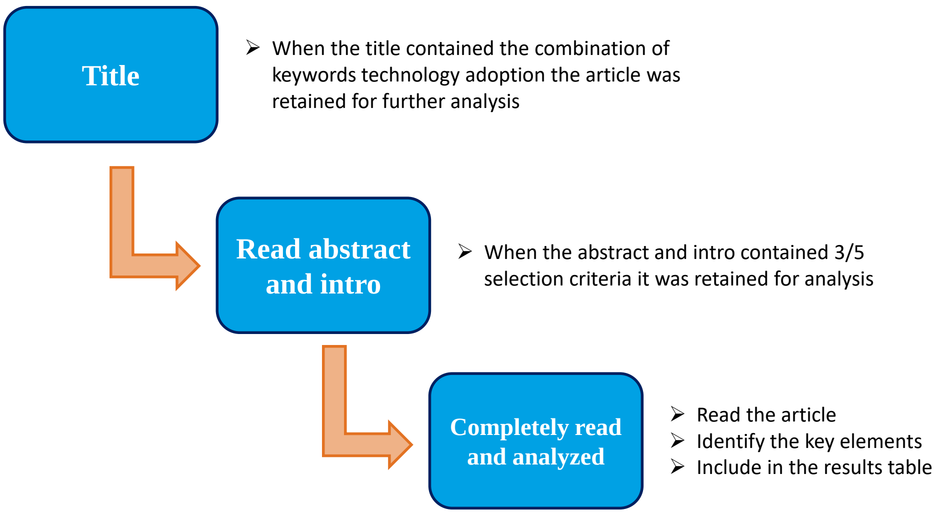

Figure 2.1: Article selection method

After the initial search, each article's abstract and introduction were read to further filter the results according to several inclusion and exclusion criteria. The criteria, referred to as Requirements for the Abstract and Introduction (RAI), were established based on the objectives of the literature review and the research questions. If a paper met 3-5 of these requirements, it was included for complete analysis. This selection process aimed to thoroughly analyze the most relevant articles for the study, complementing the findings of the previous literature review and serving as a basis for subsequent parts of the research. This selection criteria also considered the time constraints that a complete analysis of all 53 articles would impose

- RAI1: Considers individual factors that influence the adoption of technologies.
- RAI2: Considers organizational factors that influence the adoption of technologies.
- RAI3: Contextual factors are combined with a theoretical framework.
- RAI4: Identifies barriers affecting the adoption of technologies in organizations.
- RAI5: Identifies strategies used to support the adoption of technologies at organizations.
- RAI6: The technology in the context analysed can be considered disruptive.

Ultimately, 26 papers were included in the review for a complete analysis. Each paper was read thoroughly, and key information was extracted, including the identified barriers and strategies for overcoming them. Similar to the previous literature review, software tools such as Zotero and Excel were used to organize, structure, and analyze the collected data. After the analysis, the key findings were organized in a results table to facilitate the discussion and support the findings.

2.3. Semi-structured interviews

One of the primary methods of data collection used in this study was semi-structured interviews. This form of qualitative data gathering was chosen due to its flexibility, allowing for an in-depth exploration of the participants' perspectives and experiences with VR adoption in their respective departments. The semi-structured interview format allowed for a set of predetermined open-ended questions, which provided a general direction and focus for the interview. At the same time, it allowed for impromptu, exploratory questions based on the interviewees' responses (Bougie and Sekaran, 2019). An outline of the predetermined interview script is shown in Table 2.3. The interviews started asking for the participant's consent, and an introduction of myself and the research, as well as allowing the participant to ask some questions regarding my study. Then, the main areas of inquiry included the participants' roles and responsibilities, experiences with new technologies and introducing changes in the company. Although the interviews varied depending on each participant position, the approach was very similar in all case except for the technical department's interviews. In this case, questions regarding their experience in the processes and challenges implementing VR into business departments were also asked, but great part of the interview was also devoted to understanding the VR products from a technical perspective and how these technical characteristics may influence users adoption. The interview scripts can be found at Appendix E

The interviewees consisted of key personnel involved in the VR adoption process in

Period	Aspects
Presentation	1. Explanation of the research: scope and objectives 2. Ask for the consent of participation
Warm-up	1. The interviewee (role and responsibilities) 2. The organization (vision and goals) 3. Introduction to new technologies
Exploration of the change process	1. Role of new technologies within the organization 2. Experience of the interviewee introducing changes 3. Resistance to change (past, present, future) 4. Change process (stakeholders involved)
Exploration of adoption decision factors	1. Factors influencing adoption decision 2. AF/KLM Pillars influence in the adoption 3. Adoption support
Conclusion	1. Sum-up of findings 2. Interviewee questions

Table 2.3: Interview script outline

the cases under investigation. This included team leaders, technical staff, business departments managers and end users of the VR technologies. Participants were purposefully selected based on their experience, knowledge, and role in the adoption and use of VR technologies. An important remark is that the interviewees from the planned interviews lead to connect with other relevant stakeholders in the topic with whom informal interviews were conducted. A list with the overview of participants is shown at Table 2.4.

All interviews were conducted in a comfortable setting, in-person when possible or via video conferencing software due to geographical constraints if necessary. The average duration of the interviews was approximately 45 minutes, and all participants were read the consent form to participate in the research (see document at Appendix E, in which they were asked permission to audio-record the interview to ensure accuracy in the transcription and analysis of the data. In case it was not possible to record, as it was the case in some of the informal interviews or due to technical difficulties, the notes taken from the interview were used to construct the transcript. The confidentiality of the participants' responses was upheld throughout the research process, with all data anonymized in the study's reporting. While the results were presented at an aggregate level for each group (technical, business, and top management), individual participants were assigned specific identifiers, as outlined in Table 2.4. Members of the technical team received labels such as T1, T2, and so forth. Those from the business segment were designated B1, B2, etc., and individuals from top management were identified as TM1, TM2, and so on. These identifiers were used when directly quoting interviewees to ensure transparency in the analysis and to provide clarity for reader.

The interview transcriptions were the primary data source for the analysis, which was structured into three parts corresponding to the interview questions: description of the adoption process, identification of barriers, and strategies. The analytical method applied was qualitative, utilizing a narrative approach. In each section, the findings were further categorized by stakeholder levels.

	Position	Topic	Identifier
Planned interviews	Technical department	Training/Telepresence	T1
	Technical department	Training/Telepresence	T2
	Team Manager	Telepresence	B1
	Top Manager	Telepresence	TM1
	Top Manager	Training/Telepresence	TM2
	Executive Manager	Training/Telepresence	TM3
	Top Manager	Training/Telepresence	TM4
	Service Manager	Training	B2
	Trainer Manager	Training	B3
Informal interviews	Team Manager	VR adoption (general)	B4
	Innovation Project Manager	VR adoption (general)	T3
	Innovation Project Manager	Training	T4
	Business director	Innovation initiatives	B5
	Process Improvement Manager	Change programs	B6
	Financial controller	Innovation financing	B7
	External aviation trainer	Training	B8
	Product owner	VR adoption (general)	T5

Table 2.4: Interview's overview

Results describing the adoption process are presented narratively, using direct quotes from interviewees to convey their perceptions. While the results for barriers and strategies are also presented in a narrative format, they integrate both content and thematic analyses, with thematic analysis being the primary technique. This method is widely recognized for its utility in analyzing qualitative data due to its flexibility and capacity to discern, examine, and report data patterns (Braun and Clarke, 2006). An initial familiarization phase involved reading the interview transcripts multiple times, noting first impressions and recurring topics.

Subsequent to this was a formal coding process. For the barriers results, a combination of deductive and inductive analyses was employed, using some predefined themes from existing adoption literature (Bougie and Sekaran, 2019). The list of initial themes and codes is shown at Table 2.5. Coding, which entailed tagging text segments relevant to research questions, was manually executed with the aid of ATLAS.ti a qualitative data analysis tool.

Theme	Codes
Technology	Usability, Compatibility, ease of use, perceived usefulness
People	Skills, training, social influence, resistance
Environment	Industry, technology market
Organization	Culture, structure, management support

Table 2.5: Initial themes overview

After the initial coding, the emerging themes were closely reviewed and refined to ensure their coherence and relevance to the research question. This refinement process finished in the definition and naming of each theme, accompanied by a comprehensive analysis explaining what the theme is about and what aspect of the data it captures. Notably, in addition to the pre-established themes derived from existing theory, a new theme titled "Process" was introduced. This theme encapsulated the interviewees' perspectives and insights on the adoption process itself.

For the analysis of the strategies' results, a simialr approach to the one described above was adopted. However, a distinguishing factor was the absence of predefined coding frameworks, as the existing theory did not identify clear general strategies. Consequently, the thematic analysis for this section was inherently inductive, with themes organically emerging from the data.

The following are some illustrative examples from the interview transcripts that shed light on the analysis and coding processes undertaken:

- Interviewee B1 remarked "I need to explain the benefits, and the business case must be positive [...] when there are other factors than money, it's more difficult to evaluate.". This was categorized under the Process theme and encoded as both Traditional business case and Impact quantification.
- B1 also stated, "People are more willing to adopt change when they are part of the discussion from the beginning." This was coded under the Process theme as stakeholder engagement, and also highlighted when discussing strategies centered on open communication and stakeholder engagement.
- Another participant, TM2, mentioned, "You have a phone or tablet at home, but probably you don't have a VR headset [...] And people might also be afraid of going to the metaverse and being separated from the real world. For example, I prefer augmented reality where I can see my environment." This was included in the barriers' theme Environment, and People, under Personal concerns and VR diffussion in society codes.
- The statement, "If people see the utility of the technology they would use it, otherwise they won't make the effort to change," by B2 was classified under the Technology, People, and Process themes, representing perceived performance, attitudes, and stakeholder engagement. It was also integrated into the strategy theme emphasizing the importance of recognizing and promoting technology benefits.

While the thematic approach is the primary method of analysis, content analysis complements it by quantifying the frequency of each theme and code. This not only offers a comprehensive overview but also enhances interpretation clarity, for example, by highlighting the number of interviewees who identified specific barriers or strategies. Furthermore, in illustrating the adoption process, direct quotations from the interviewees effectively underscore the identified themes and sub-themes.

2.4. Experiment

Given the research's objective to collect data from all stakeholders involved in the VR adoption process, different strategies were needed for different contexts. For instance, in the case of VR for training, interviews were an effective method for gathering data from end users, primarily the trainers. However, this approach proved challenging for VR telepresence, as employees who had not previously integrated VR into their work routines could not provide meaningful insights. Therefore, it was decided to carry out an experiment to investigate the impact of VR on the workflows of AF-KLM teams. In this experiment an AF-KLM team geographically distributed had to make continued use of VR for collaboration and communication as part of their usual working routine.

The team selected for the experiment was a team that had already shown interest in testing VR technology to explore new ways of improving team collaboration, and the broader research on VR adoption opened an opportunity window for it. The team is part of AF-KLM Digital, and it was originally formed by 13 people located in 4 locations in 3 different countries (Amsterdam, Paris, Valbonne, and Bombay).

The timeline of the experiment was designed in such a way that the start and end coincided with the offline Planning Interval (PI) events in which most of the team was together. Figure 2.2 shows the timeline of the experiment. After a first in-person introductory session used to explain the technology and train the team, it was established some time to allow the team to familiarize themselves with the technology. Then, the team made use of VR for the coming six weeks. Before and after this period there were organized some VR sessions to gather feedback from the team. Some pictures of the different sessions can be found in Figure F.1.

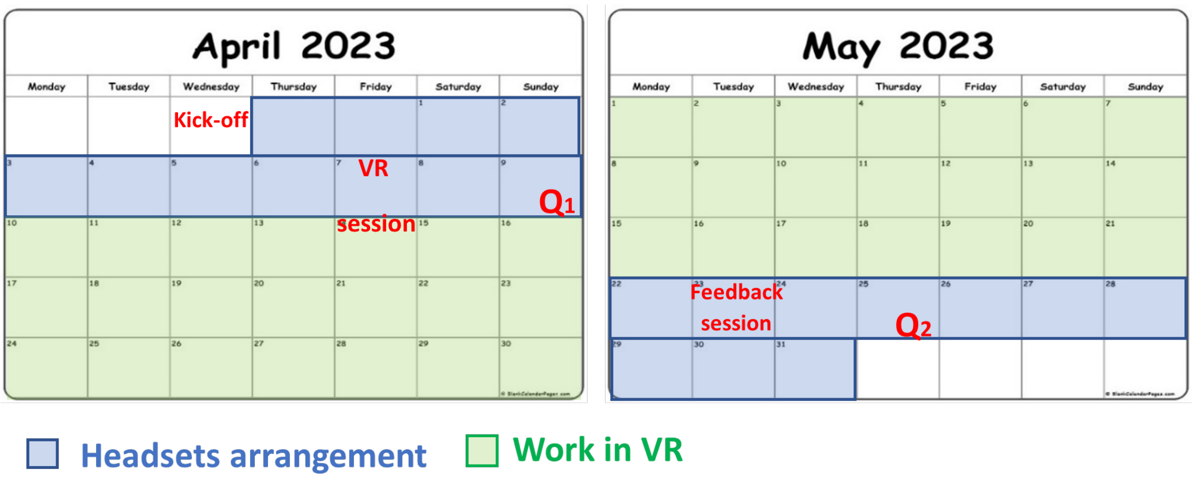

Figure 2.2: Experiment timeline

Earlier VR experiments at the company were largely focused on short-term usability and technical capabilities of VR products. In contrast, this experiment aimed to explore broader aspects of VR adoption over an extended period of time, rooted in the technology adoption theory outlined in chapter 3. The primary objective of integrating VR was to enhance team collaboration and engagement, simulating the experience of co-location. This served as the foundation for assessing the technology's fit for this specific purpose.

A mixed-methods approach was used in the experiment, combining quantitative and qualitative data collection and analysis. This enabled a comprehensive understanding of the situation, capturing both objective performance metrics and subjective participant experiences. Data was collected through three methods: (1) Team Promoter Score (TPS), (2) a custom questionnaire, and (3) qualitative feedback via a Microsoft Chat platform and a concluding feedback session.

The TPS is a survey commonly used by the company designed to measure team's collaboration and engagement in an standardized and qualitative manner. In addition, custom questionnaires were utilized to collect data on participants' experiences with VR, their perceived benefits and challenges, and attitudes towards its potential future use. These questionnaires comprised structured questions, utilizing Likert scales, and open-ended questions to allow for more detailed feedback. The questionnaires were designed with reference to technology adoption theories and drew upon established questionnaires in the existing literature. This ensured that questions were framed around participants' perceptions of VR and their intention to use it, incorporating key concepts such as perceived usefulness, ease of use, and management support, among others. Both the TPS and the custom questionnaires were distributed electronically to the 13 team members participating in the experiment. These questionnaires can be found in Appendix E section E.2.

For both TPS and Likert scale responses, basic descriptive statistics were employed to offer an overview and compare data before and after the experiment. The mean and standard deviations served as primary metrics for extracting insights. Additionally, other metrics such as maximum and minimum values, as well as the variation in answers from pre to post-experiment, were incorporated into the analysis. Specifically, for the Likert scale questions within the questionnaires, the significance of the results was evaluated using t-tests and confidence intervals.

On the other hand, open-ended responses from the questionnaire were subjected to qualitative analysis. Responses were examined and categorized based on recurring themes: based on the questionnaires questions (challenges, positive aspects, and future views using the technology). These themes then underwent frequency analysis; for instance, barriers and overall participants' perceptions were quantified. Similarly, as observed in the semi-structured interviews, quotes from participants were employed to shed light on the findings.

To encourage honesty and preserve privacy, responses were anonymized. Participants were assigned an ID number for data organization, but these were removed after data compilation to ensure non-traceability. The data was organized, stored, and analyzed using Microsoft Excel.

2.5. Direct Observations

The third method of data collection employed in this study was direct observations. Direct observations offer an on-the-ground perspective and a chance to record data in real-time in the natural setting of the XR-CoE team. Observations can provide a deeper understanding of the context and processes, enabling the researcher to capture behaviours, interactions, and environmental factors that might not be readily shared or even recognized by the participants during an interview or in a questionnaire (Patton, 2015).

As part of my graduation internship I had the opportunity to work 2-3 days at the office together with the team of the XR-CoE, so the direct observation data have been taken from the observation of the team dynamics, the informal interaction with the team (e.g. coffee or lunch breaks), or the participation in team's activities such as project meetings or presentations. To provide insights based on the observations, these have been systematically documented. The documentation has been carried out using a table in Microsoft Excel, recording the following information: Type of observation, Event or context (where or how the observation took place), Description of the observation, Insights, and Potential impact. These categories were defined based on literature on the topic (Patton, 2014; Holmes, 2013; Fix et al., 2022; Bougie and Sekaran, 2019). An example of the table used to organized and classify the observation is shown at Table 2.6. For the type of observation category, each observation was classified in six predefined categories based on the technology adoption literature. By organizing the observations by type, it allows for easier and more organized analysis of them afterwards. The six type categories are:

- **Technology:** Observations related to the VR technology itself (hardware, software, updates, issues, etc.).
- **User Engagement:** How individuals in the organization are using or responding to the VR technology (acceptance, resistance, learning curve, etc.).
- **Business impact:** Any impacts or potential impacts on the company's business processes or outcomes (productivity, cost, efficiency, etc.).
- **Work processes:** How different tasks and projects are conducted within the organization, including collaboration between teams, project management, and workflow efficiency.
- **Organizational culture:** observations into the company's culture and norms, such as communication styles, decision-making processes, and values.
- **Training & support:** Observations about how training and support for the VR technology is conducted and received.

	Type	Event/Context	Observation	Insights	Potential impact
1	Business impact	Weekly meetings	Discussions on the effectiveness of ...	There are no quantitative analysis of the impact of...	If there are no metrics ...
2	Organizational culture	Informal chat over the lunch break	Chat about colleague's experience ...	Sometimes the managers are more focused on putting off fires ...	Managers see new initiatives as a ...

Table 2.6: Direct observation organization and classification example

The data collected from direct observations was analyzed qualitatively, similar to the process used in the thematic analysis conducted for the interviews. This analysis provides a rich source of contextual information that will complement the interview and experiment data by revealing real-world interactions. Initially, field notes were thoroughly reviewed and organized in a table format as shown above (The complete table can be found at Appendix G). Observations were then grouped by the type of observation that acted as broader theme, in which codes were established based on the identified factors within each category. The coding process was iterative and flexible. For instance, the 'User Engagement' category, included the following codes: 'stakeholder's perspectives', 'technology awareness', and 'interest and time evolution'. The final list of themes and codes is shown at Table 2.7. Finally, these themes and codes were reviewed for their relevance to the overall research objectives and questions. They were also cross-referenced with findings from the literature reviews and interviews to form a comprehensive understanding of the VR technology adoption process within the organization.

2.6. Ethical considerations

Ethical considerations are paramount in any research involving human participants. Thus, prior to the start of this study an application outlining the research design, participant

Type of observation (Theme)	Codes
Technology	Perception of technology Previous experience Technical complexity
User Engagement	Interest and time evolution Stakeholder's perspective Technology awareness
Business Impact	Impact quantification New impact areas Overlaping responsabilities
Work Processes	Previous experiences Personal relationships and Champions Complex department dynamics
Organizational culture	Stakeholder engagement Departments' cultures Short vs long term focus
Training & Support	Imprtance of training Standard protocol

Table 2.7: Direct observation analysis: themes and codes

selection, data collection, and data handling methods was submitted to the Ethical Committee at TU Delft. The committee reviewed the proposal of the research and it was approved. The letter of approval is attached at Appendix D. As a part of the ethical assurance, informed consent was obtained from all participants before engaging in any data collection activities. Participants were informed about the purpose of the research, their role, the voluntary nature of their participation, and the measures taken to ensure their confidentiality and anonymity. This last aspect was the main ethical concern in this research, and every effort has been made to uphold this commitment by securely storing the collected data and disposing it in the best manner that maintain confidentiality of the participants.

2.7. Limitations

Inherent to research design are certain limitations that need to be considered. Case studies offer an in-depth understanding of a case and information of a context, but it could be the case of limited transferability to other cases or organizations (Baxter and Jack, 2010). To overcome this limited transferability of the results it has been chosen a collective case study, but it also poses some challenges over practical limitations regarding the volume of data and possible time constraints that could impact the achievable depth of analysis Crowe et al., 2011. Attention has been given to avoid the urge of acquiring as much data as possible to gain a complete overview, and sufficient time has been set aside to analyze and interpret the data.

Aside the general limitations of the case study approach, each of the data collection methods employed also carry out some limitations that must be considered. For semi-structured interviews the main limitation is the potential for bias, both from the interviewer and the interviewee. The interviewer might inadvertently lead the participant towards certain responses or interpret responses based on their own preconceptions. On the other hand, the interviewee might not feel comfortable expressing their true thoughts and feelings, especially if they feel they may be judged or if their responses might impact their employment. (Bougie and Sekaran, 2019)

For the experiment, very similar limitations to the case study apply. As the findings may not be applicable to other teams within the organization or to other organizations as it is conducted in a specific context, and external factors such as the participants' previous experience with VR, their level of technical proficiency, and their willingness to adapt to new technologies could all have influenced the results (Bougie and Sekaran, 2019). Also, some practical limitations for the experiment carried in this study must be considered:

- **Limited headset availability:** One of the primary limitations was the lack of headsets for all team members, particularly those located in India. As a result, these team members had to join the VR sessions using the PC app, which offered a less immersive experience compared to the VR version. This discrepancy in technology access may have influenced their level of engagement and interaction within the virtual environment.
- **Interruptions due to holidays and training:** The experiment spanned a six-week period, during which there were holiday breaks, including Easter, and the team located at Valbone had a dedicated week of training. These interruptions in the regular working routine and team dynamics may have impacted the consistency of collaboration experiences and outcomes. It is important to note that these external factors may have introduced variability in the results.
- **Technological nature of the research:** While the research aimed to assess the impact of VR adoption on work and collaboration, it is essential to recognize that it is still fundamentally rooted in technology and development. The focus was on evaluating the integration of VR within the working routines of geographically distributed teams, and therefore, certain aspects related to organizational dynamics, individual work styles, and other non-technological factors may not have been fully captured.

Finally, direct observations pose concerns about the observer bias and the interpretations that can be made based on the researcher experience and objectives (Bougie and Sekaran, 2019).

Despite the limitations, this study provides valuable insights into the adoption of VR in the workplace. Future research could build on these findings by conducting similar studies in different settings or with different populations to further investigate the generalizability of the findings.

2.8. Validity and Reliability

The first step towards ensuring validity and reliability in research is acknowledging and being aware of potential limitations, as discussed in the previous section. Recognizing these limitations not only enhances the credibility of the research by providing a transparent view of potential weaknesses and boundaries but also facilitates replication by offering detailed insight into the methodology, data collection, and analysis techniques. This transparency aids other researchers in verifying the findings, enhancing the overall reliability of the study. (Hassan, n.d.)

Moreover, a robust literature background supports the validity of the research. By grounding the study in established theory and previous research, it ensures that the research question, design, and interpretation of the results are well-founded and credible (Snyder, 2019). It also helps provide a balanced view of the research by offering a context through which both strengths and weaknesses can be assessed, allowing readers to make informed decisions about the generalizability and applicability of the findings.

To enhance validity, referred to as the degree to which results accurately represent what they are supposed to (Bougie and Sekaran, 2019), triangulation of data sources was used. This means that multiple methods (semi-structured interviews, experiments, and direct observations) were utilized to gather data on the same phenomena. This approach provided a more comprehensive understanding of the research problem and helped to cross-verify the data from different sources, thereby reducing the chances of misinterpretation.

As for reliability, it refers to the consistency or repeatability of the study's results (Bougie and Sekaran, 2019). Therefore, to enhance reliability the research process was documented in detail, allowing others to follow the same procedures and arrive at similar results. The interview questions were standardized to some extent, and the data collection process for the observations and the experiment was systematic and consistent.

However, it's important to note that due to the qualitative nature of the study and the specific context in which it was conducted, the results may not be entirely replicable. That said, the goal of this research was not necessarily to produce universally applicable findings, but rather to generate in-depth insights into the adoption of VR technology in a specific workplace setting.

3

Theoretical Framework

This third chapter of the research delves into the relevant theory of technology adoption to construct a theoretical foundation that will underpin the subsequent steps of the study. It seeks to answer the first research sub-question: ***What are the key concepts, barriers, and overcoming strategies related to technology adoption in companies according to the literature?"***.

To address this question, the chapter is divided into two main sections, each constituting a literature review. The first literature review focuses on general theories of technology adoption, with the aim of identifying and understanding the key concepts that shape technology adoption, their defining characteristics, and their interrelationships. This initial review is complemented by a second, more applied literature review that investigates the current state of literature on technology adoption within organizations. This second review provides a comprehensive examination of the barriers that can impede technology adoption in companies, the strategies employed to overcome these barriers, and how existing theories can inform and facilitate adoption.

By carrying these literature reviews and answering the research question, it will be established the theoretical framework that can be utilized to make sense of the empirical data collected. This theoretical lens will be very important in analyzing the findings and deriving meaningful conclusions from the study.

3.1. Part I: Technology Adoption Theories

Technology adoption has been a wide-ranging area of research in the field of Information Systems (IS). Researchers have proposed and tested several technology adoption theories and models to explain and predict user acceptance and use of IT. Some of these include the technology acceptance model (TAM), the Diffusion of Innovations (DOI), or models based on the theory of planned behaviour (TPB). Venkatesh et al., 2003 synthesized the existing theories and models into the Unified Theory of Acceptance and Use of Technology (UTAUT), identifying key factors and moderators related to predicting behavioural intention to use a technology and actual technology use primarily in organizational contexts (Venkatesh, Thong, and Xu, 2016). While UTAUT has proven its theoretical validity to predict and assist during the IT adoption processes at an individual level, it has been identified a gap in the real use of the theory in organizational environments due to the lack of contextualization (Venkatesh, Thong, and Xu, 2016; Hong et al., 2014; Gallivan, 2001). Although technology adoption occurs finally at the individual level it is influenced by the context in which those individuals are embedded, and hence, the organizational context should be given more relevance. On the other side, organizations ongoing through technological changes payed attention to the importance of management support to technology adoption, but in many cases and studies on the topic it is seen a lack of conceptual definitions and insufficient theorization (Sargent, Hyland, and Sawang, 2012).

3.1.1. Results

The selected papers has been analyzed and the main aspects of each of the papers has been recorded at Table A.1, that can be found at Appendix A. In the table it is shown the theoretical foundation used in the studies, the main results, the main factors found in each of the theories, and additional notes considered relevant for the purpose of this study.

In the reviewed papers several adoption theories have been analyzed, formed, or adapted to specific situations. The theories appearing most frequently in the papers are UTAUT and TAM theories, appearing in 40% and 35% of them. Also, the selection includes theories such as TOE framework (20%), Technology Systems perspective (10%), or different models implemented in adoption studies. In almost half of the selected articles there is not an used an unique theory, but instead a combination of theories is employed to capture a wider spectrum of the situation.

Regarding the methods employed by the articles included in the review, seven of them are purely literature reviews that serve as theory revisions providing and overview of existing literature in the topic identifying the main factors and theory gaps in existing research. Also, in the adoption literature is common to support the theoretical study with data collection methods in order to test the theory hypothesis or gain practical practical insights to be included into the theories. As a data collection method, six articles used case studies and employed a ore qualitative approach for enriching the theory. While seven articles employed questionnaires to end users with the main objective of testing hypothesis of the relevance and interconnection of theory constructs.

3.1.2. Discussion

After reviewing the results, in this section it is aimed to delve deeper into the findings and draw out the broader implications. The section starts with a general review of the most known technology adoption theories. Then, the focus has been given to the Unified Theory of Acceptance and Use of Technology (UTAUT), and how other theories can be combined to capture contextual factors and a broader perspective of the adoption phenomena. Finally, it is explored how the literature combines different theories, ending with a conclusion of the findings and the identified gaps in the literature.

Technology adoption theories

One of the most common causes of changes at organizations in the last years is the introduction of new technologies, in order to streamline processes and improve their performance (Tabrizi et al., 2019). But changing processes is not easy at big organizations and although its benefits, new technologies are not always adopted. As mentioned in the introduction of this section, technology adoption has been a wide-ranging topic in the literature and several theories have appeared to understand the characteristics of the adoption process of new technologies at both consumer and organizational levels. Technology adoption theories provide a framework for understanding and predicting technology adoption behaviours and outcomes, helping organizations to make more informed decision in technology investments and implementations.

In the literature, four major models of technology adoptions can be found. These models are the Technology Acceptance Model (TAM) (Davis, 1989), the theory of Diffusion of innovations (DOI) by Rogers, 2003, Theory of Planned Behaviour (TPB) (Ajzen, 1991), and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). The theories have been widely validated, tested and modified to improve their predicting power (Venkatesh et al., 2011; Lai, 2017; Momani and Jamous, 2017; Al-Gahtani, 2006; Oliveira and Martins, 2011), applied in diverse settings (e.g. education, organizations or governments), and also to different technologies. All theories are designed to measure the degree of acceptance and perception of towards the new technology, although each of them use different constructs (Momani and Jamous, 2017). The main difference between theories can be found in DOI theory, as it not only describes the main constructs affecting users' perceptions towards technology, but also explains the different types of users that shape the diffusion of the technology among a population (Rogers, 2003).

Based on the reviewed literature, it has been chosen the UTAUT model as the base for building the theoretical framework on barriers and potential strategies for this research. This decision has been made as UTAUT is built by the combination of previous theories such as TPB or TAM, and has proved a higher prediction power (Venkatesh et al., 2003). Also, TPB, TAM and its extensions, TAM 2 and TAM 3 (Venkatesh and Davis, 2000; Venkatesh and Bala, 2008), consider that constructs affect use intention, and this is the only variable influencing use behaviour. In contrast, UTAUT considers that most factors shape use intention which is the main construct for actual use, but not the only one. As facilitating conditions could also affect to actual use (Venkatesh et al., 2003). And this situation can be resembled in the case under study, as it has been seen that sometimes even when business units at KLM are willing to use VR innovations they don't use them anyway.

UTAUT

As mentioned previously, UTAUT is a comprehensive model that aims to explain the factors that influence technology adoption (Venkatesh et al., 2003). The model is based on eight key predictors, that are further divided in four main categories: performance expectancy, effort expectancy, social influence, and facilitating conditions. Performance expectancy refers to an individual's belief that using a technology will help them achieve their goals. Effort expectancy refers to the belief that using a technology will require little effort. Social influence refers to the influence that others have on an individual's decision to adopt a technology. Facilitating conditions refer to the resources and support that are available to an individual to facilitate the adoption of a technology.

The theory has been widely used in the field of Information Technology (IT) adoption, and has been modified in several occasions in order to add some constructs to improve the explanation of adoption phenomena (Venkatesh et al., 2011; Venkatesh, Thong, and Xu, 2016). Also, several authors have modified or used the theory in combination with others to adapt it to specific contexts (Hewavitharana et al., 2021). The model has been criticized for not being able to capture the contextual factors in which the technologies are implemented, as it focuses at the individual level and it ignores the context in which the individuals are embedded. Park, Lee, and Yi, 2011 suggested that the UTAUT theory needs to be expanded to better capture the group-level effects of facilitating conditions on individual acceptance, as they demonstrated that organizational level facilitating conditions have a greater impact on the actual use of the technology than individual ones. Similarly, other studies analyzed the importance of management and proper leadership to support adoption (Sargent, Hyland, and Sawang, 2012; Neufeld, Dong, and Higgins, 2007). Kupfer et al., 2016 highlight the strong prediction power of the model for intention to use, but remark that it is reduced when it comes to continuous usage. What could be better understood by incorporating contextual factors.

UTAUT has been also used for a wide variety of technologies, including recent technologies that are disrupting the way work is done such as Artificial Intelligence (AI) and Virtual Reality (VR). In 2022, Venkatesh, 2022 proposed a research agenda grounded in UTAUT for the adoption and use of AI tools. This study highlighted the importance of understanding the factors that influence the acceptance and usage of AI tools, as it is an emerging technology that has the potential to bring significant changes to organizations. Similar outcomes were achieved in the studies where the adoption of VR was analyzed, stressing the importance of understanding the factors that influence the acceptance and usage for this specific technology, as well as knowing how to moderate perceived risks due to the uncertainty of a completely new technology Toyoda et al., 2021; Kupfer et al., 2016.

Summarizing the findings, UTAUT offers a theoretical lens to analyze technological adoption processes at the individual level, but it does not provide a complete overview of the context in which the technology is implemented. Although several studies included contextual factors and researched the expansion of the model, it has been identified a knowledge gap on the influence of organizational and individual factors on each other and their interactions. Therefore, future research should study the relation between them in a more extensive number of contexts and technologies.

Other relevant concepts

In understanding the broad domain of technology adoption, several key concepts have emerged beyond the UTAUT framework. Insights from different academic sources expand the dimensions of technology adoption, ranging from the time considerations involved in adoption decisions to the vital roles of organizational structure and environment, to the relevance of task-technology fit. For instance, Ciganek, Haseman, and Ramamurthy, 2014 delve into the time dynamics of adoption decisions, while Gallivan, 2001 and Van Lancker et al., 2016 explore how organizational aspects influence adoption. Bryan and Zuva, 2021 emphasize the comprehensive context of technology adoption through the Technology-Organization-Environment (TOE) framework. Virdyananto et al., 2016 anchor on the importance of task-technology fit, revealing how the perceived usefulness of a technology is heavily influenced by how well it aligns with the tasks users need to perform. These concepts underscore the multi-dimensional nature of technology adoption and provide a holistic approach to the analysis and application of the UTAUT model.

Venkatesh, Thong, and Xu, 2016 identified that time consideration were one of the main aspects that UTAUT models should consider,and several articles state the temporal aspects that influence the adoption highlighting the need to consider not just the immediate reactions to a technology but also the longer-term evolution of its acceptance (Kamal, 2006). Some authors demonstrate that time plays a crucial role and assert that the duration of the decision-making process is shaped by various factors such as the characteristics of the decision, organizational attributes, the process of decision-making, and the broader environmental context (Ciganek, Haseman, and Ramamurthy, 2014). Also, Brown et al., 2002 found that in mandatory technology adoption contexts the amount of time before the mandate's implementation influences individuals' acceptance of the technology, as it gives them a chance to familiarize themselves with the technology, understand its benefits, and mitigate any perceived challenges. Similarly, (Hwang, Al-Arabiat, and Shin, 2016) suggest that as users gain experience with the technology, their perceptions about its usefulness and ease of use may evolve, further affecting their acceptance. Finally, regarding the temporal dimension of technology adoption Ortt and Kamp, 2022 argues that introduction strategies should consider the timeline pf large-scale diffusion.

The literature also highlights the applicability of the Task-Technology fit in the adoption of new technologies, as it emphasizes the importance of technology's relevancy and applicability to user tasks, underscoring the fact that even the most advanced technology can fail if it does not meet the user's task requirements effectively (Virdyananto et al., 2016). Xu and Lu, 2022 and Park, Lee, and Yi, 2011 argue that the perceived fit between the technology and the task significantly influences the individual acceptance of innovation systems even when embedded in a collective group. Yusof et al., 2008 posit that the fit between task and technology is crucial in healthcare settings, where the effectiveness and efficiency of task completion can directly impact patient outcomes. Although it might seem that all new technology initiatives are developed with the aim of achieving an specific task of outcome, from this review it can be stressed the relevance of assessing the alignment between the technology used and the fit into its purpose.

Organizational (contextual) factors

Contextualization is a key facet of meaningful research and theory application, as underscored by Hong et al., 2014. The authors emphasize that theories, including those related to technology adoption, often carry specific assumptions about the environment in which they operate. However, these assumptions may not universally apply to all contexts. Thus, it is important to clearly articulate and understand the context in which a theory is applied. In the case of technology adoption, this could include specifics of the industry, the organizational culture, and the nature of the technology itself, among others. By tailoring the theory to fit the specific context, researchers can better understand the dynamics at play and potentially reveal new insights. Without this contextualization, there is a risk of oversimplification or misinterpretation, potentially leading to inaccurate conclusions.

Besides the technology adoption theories presented above that are mainly focused on the individual level, there are other adoption frameworks that aim to explain adoption at a higher level. The Technology-Organization-Environment (TOE) framework (Tornatzky, Fleischer, and Chakrabarti, 1990) emphasizes that technology adoption is a complex and dynamic process that is influenced by multiple factors. By taking into account the interplay between technology, organization, and environment, the TOE framework provides a comprehensive perspective on technology adoption and can help organizations to understand the factors that are most likely to influence the success of their technology adoption efforts (Ciganek, Haseman, and Ramamurthy, 2014; Ediriweera and Wiewiora, 2021b). However, TOE framework also presents some limitations as it is criticized by simplifying the adoption process, considering technology as an static factor, or lacking on the focus of the user's perspective (Bryan and Zuva, 2021). In order to gain a more comprehensive understanding of the adoption process it has been also supplemented in several studies with UTAUT (Hameed and Arachchilage, 2020; Park, 2020).

The Human-Organization-Technology (HOT) framework offers a holistic approach to understanding technology adoption, much like the TOE framework. This framework posits that successful technology adoption and assimilation are contingent on the effective alignment or 'fit' among human, organizational, and technological aspects (Yusof et al., 2008; Xu and Lu, 2022). In other words, technology must be suited to the users' capabilities and needs (Human), be congruent with organizational structures and processes (Organization), and be technologically sound and compatible with existing systems (Technology). By combining a framework like HOT with more focused models like UTAUT it will aids in contextualization. For example, integrating constructs like performance expectancy or social influence with the HOT framework could provide insights into why individuals in an organization may accept or reject a technology, thereby adding a personal behavioral perspective to the systemic view of HOT.

Organizations can be considered as complex systems, in which different actors and relations take place during the adoption process of new technologies. Is therefore interesting to explore the Organization Innovation System (OIS) framework to explain technology adoption at companies, as organizations can gain a better understanding of the complex and interconnected factors that influence technology adoption, and develop a more systematic and integrated approach to managing technology adoption initiatives. Van Lancker et al., 2016 developed the OIS as a micro-level innovation system, and developed the main components, supporting functions, and potential system imperfections. This framework could provide with an analysis tool to companies in order to gain insights and establish best practices for successful adoptions. In a similar approach, Ortt and Kamp, 2022 adapted the Technology Innovation System (TIS) and identified the system's building blocks and actors that may shape adoption process. By knowing the building blocks and the influencing factors, organizations could establish better strategies for introducing technological innovations.

Theory combination

The combination of theories is often employed to gain a richer, more comprehensive understanding of complex phenomena such as technology adoption. This approach enables researchers to consider multiple aspects and perspectives, creating a more holistic view that can offer greater insights into the behaviour being studied. In the context of technology adoption, the combination of theories is particularly valuable. For instance, while the Unified Theory of Acceptance and Use of Technology (UTAUT) provides a strong basis for understanding technology adoption, it can be enriched by considering aspects from other theories like Task-Technology Fit (TTF), the Technology-Organization-Environment (TOE) framework, and considerations of the system in which the individuals are embedded.

However, it's important to exercise caution regarding model complexity, ensuring that the resultant model is both interpretable and practical. One potential pitfall lies in the risk of creating an overly complex model, which might prove difficult to empirically test. Additionally, there's the possibility of "conceptual stretching" - forcing constructs from differing theories together, potentially leading to confusion and a lack of clarity. The objective of this research is to construct a comprehensive theoretical framework that can effectively analyze the case of VR adoption at AF-KLM. Therefore, it was decided to supplement the UTAUT model with other concepts, aiming for a more holistic approach. However, it's crucial to note that this study does not aim to provide an empirical test of a wholly new model. In an effort to circumvent the potential drawbacks of theory combination, the methodology employed in this literature review has been carefully analyzed. This allows us to discern the principal steps necessary for a successful theory combination, ensuring a clear, focused, and relevant theoretical framework.

The first step towards theory combination is identifying relevant theories, as showcased in the study by Bryan and Zuva, 2021, where they meticulously reviewed the progression of both the Technology Acceptance Model (TAM) and the Technology-Organization-Environment (TOE) frameworks. Upon identifying the theories, understanding the constructs and relationships is crucial. This can be seen in Gallivan, 2001 work, where a thorough comprehension of various constructs related to technology adoption and assimilation and their interrelationships was exhibited. Following this, the conceptualization of the combined model and justification of the combination needs to be articulated (Virdyananto et al., 2016; Yusof et al., 2008). After justifying the combination, the constructs need to be operationalized, by specifying how each construct will be measured (Kamal, 2006). In the majority of literature the new developed models are tested prove their validity in an quantitative manner. However, as it has been mentioned before, the aim of this combination in this research is to provide a comprehensive lens to analyse the situation at the company and not to test a new completely model. That is why in this research the relationships and significance of the construct won't be directly tested, but rather they would be assesed in a more qualitative way. These steps collectively would also lead to a more comprehensive and valid model.

3.1.3. Conclusion

Technology adoption is a complex phenomenon, influenced by a multitude of factors across individual, organizational, and environmental dimensions. It is therefore crucial to adopt a comprehensive theoretical framework that considers the interplay of these factors to gain a nuanced understanding of technology adoption processes and to devise effective strategies for overcoming resistance to change in organizations. This review has presented a range of theories that have been developed to explain and predict technology adoption, each offering unique perspectives and insights.

Unified Theory of Acceptance and Use of Technology (UTAUT) is selected as the core model for this research due to its encompassing nature, providing a holistic overview of factors influencing both the intention to use and actual use of new technology. However, despite its comprehensiveness, UTAUT has its limitations, particularly when the contextual factors of a specific scenario are overlooked. Indeed, while technology adoption occurs at the individual level, it is crucial to recognize that individuals are embedded within organizational structures and cultures that can significantly impact the adoption process.

Given the need to incorporate the contextual perspective, we have proposed potential supplements to UTAUT from the wider theory landscape, such as Task-Technology Fit (TTF) and the Technology-Organization-Environment (TOE) framework. The TTF model, with its focus on aligning specific tasks with suitable technology, can bring a practical dimension to the understanding of technology adoption. Additionally, concepts like time, which plays a crucial role in the adoption process, have also been discussed to enrich the theoretical framework. Contextualization and theory combination, thus, play an important role in capturing the complex dynamics of technology adoption. By tailoring theories to fit specific contexts and integrating perspectives from multiple theories, we can create a more robust and comprehensive understanding of technology adoption. However, we must proceed with caution to avoid an overly complex model, ensuring its interpretability and practical applicability.

Existing literature leaves significant gaps, particularly concerning the application of technology adoption theories in the airline industry. This presents an opportunity for this research to contribute valuable insights by examining the adoption process of new technologies, such as Virtual Reality, in the context of the airline industry, specifically AF-KLM.

In conclusion, this research aims to build a comprehensive, contextually relevant theoretical framework, combining elements of UTAUT with relevant constructs and perspectives from other theories, to effectively analyze the adoption of VR technology at AF-KLM. As it is strived to contribute to the existing body of knowledge on technology adoption, it remains cognizant the challenges of theory combination and the need for empirical validation.

3.2. Part II: Adoption barriers at organizations

In the previous literature review, the focus was placed on technology adoption from a theoretical standpoint. This second literature review aims to provide a more practical perspective on the barriers to technology adoption within organizations, as well as the strategies used to overcome these challenges. By examining the various obstacles businesses face and the approaches they employ to solve these issues, this review seeks to present a comprehensive understanding of the dynamics of technology adoption in organizations.

This review serves a dual purpose: first, to synthesize the existing literature and identify common barriers and strategies to technology adoption; and second, to to comprehend the processes employed by organizations to support the adoption and its implications for this research. Through a comprehensive analysis of 26 papers, this review intends to offer a broad and well-informed understanding of the multifaceted nature of technology adoption, providing valuable insights that not only complement the previous findings but also offer a more practical perspective on the theoretical framework.

3.2.1. Results

The review of the 26 selected papers revealed interesting patterns and insights into the field of technology adoption. The papers were quite diverse, representing a variety of technologies, sectors, and theoretical frameworks. A complete overview of the results is given in Table B.2 at Appendix B. In the table is seen the description of the paper including authors, year, technology and context of study. Also, it is included a summary of barriers and strategies, and key findings and implications.

In terms of technology focus, the bulk of the studies (32%) dealt with blockchain technology, reflecting the growing interest in this technology's potential impact on various industries (Akhtar et al., 2021; Kouhizadeh, Saberi, and Sarkis, 2021; Mohammad and Vargas, 2022; Yadav et al., 2020; Yadav, Shweta, and Kumar, 2023). Artificial intelligence and Cloud-based technologies also received considerable attention (16% each), demonstrating the importance of these technologies in the current digital landscape (Al Hadwer et al., 2021; Weinert et al., 2022). The papers covered various sectors, with the highest representation in the healthcare sector (28%). This demonstrates the increasing relevance of technology adoption in healthcare, especially in improving service delivery and patient outcomes (De Leeuw, Woltjer, and Kool, 2020; Iyanna et al., 2022; Wendland, Lunardi, and Dolci, 2019).

The Technology-Organization-Environment (TOE) framework emerged as the most frequently applied theoretical framework, utilized in 36% of the papers, signifying its robustness and relevance in technology adoption studies at companies (Al Hadwer et al., 2021; Shahadat et al., 2023). Regarding the identification of barriers hindering technology adoption, lack of technological literacy and skills (Abdelhakim, Abdeldayem, and Aldulaimi, 2022; De Leeuw, Woltjer, and Kool, 2020; Ullah et al., 2021), resistance to change (Saghafian, Laumann, and Skogstad, 2021; Mohammad and Vargas, 2022), financial constraints (Ghobakhloo et al., 2022; Shahadat et al., 2023), and regulatory issues (Yadav et al., 2020; Yadav, Shweta, and Kumar, 2023) were highlighted.

Despite these barriers, the literature shows that the potential benefits of technology adoption, such as improved efficiency, cost savings, enhanced security, and improved customer service, can be substantial (Akhtar et al., 2021; Ghobakhloo et al., 2022). These findings hold implications for practitioners, emphasizing the importance of adequate training, support to employees, and clear regulatory guidelines for technology adoption, as well as financial incentives could help overcome constraints. For researchers, these results suggest a need for more detailed, context-specific studies and underscore the importance of theoretical frameworks in understanding technology adoption.

3.2.2. Discussion

This discussion synthesizes the main themes that emerged from the review of literature on technology adoption barriers related to the objectives of this research. The discussion begins with an examination of the prevalent barriers and strategies identified across diverse sectors, acknowledging both common and unique characteristics of technology adoption challenges. Subsequently, the implications for Virtual Reality adoption are examined. The discussion then evolves towards an intersectional analysis of theory and practice, incorporating the role of contextualization in technology adoption. The discussion finishes with the limitations found and a conclusion, offering a comprehensive understanding of the technology adoption phenomena that would inform the theoretical framework employed in this research.

Barriers and overcoming strategies

The barriers to technology adoption represent a significant aspect to be considered in any endeavor to implement new technology, like VR products within a large organization. This literature review has identified several recurrent barriers across different contexts, which are categorized into individual, organizational, and environmental levels. This categorization has been made following the usual approach at companies of differentiating between levels following similarly to the TOE structure.

Individual-level barriers often involve a lack of skills or resistance to change, which is identified in studies like those of (De Leeuw, Woltjer, and Kool, 2020; Melia et al., 2021). Overcoming such barriers involves providing comprehensive training and fostering a culture of openness to innovation. The role of change management in this process cannot be understated, as it is crucial in addressing individual resistance and facilitating a smooth transition to new technology adoption (Roberts et al., 2021; Iyanna et al., 2022).

Organizational-level barriers include aspects such as lack of top management support, inadequate infrastructure, and insufficient financial resources (Abdelhakim, Abdeldayem, and Aldulaimi, 2022; Ediriweera and Wiewiora, 2021a). Strategies to overcome these barriers involve securing commitment from top management, making necessary infrastructure upgrades, and ensuring financial resources are allocated appropriately for technology adoption (Ghobakhloo et al., 2022; Mohammad and Vargas, 2022).

Environmental-level barriers, such as regulatory issues, market uncertainty, and technology complexity, have also been identified (Akhtar et al., 2021; Kouhizadeh, Saberi, and Sarkis, 2021). To navigate these barriers, organizations need to actively engage with regulatory bodies, invest in market research to understand and mitigate uncertainties, and seek expert assistance to deal with the complexities of the technology (Han and Rani, 2022; Yadav, Shweta, and Kumar, 2023).

In summary, the literature provides insights into a wide array of barriers that might hinder technology adoption. However, it also suggests various strategies that organizations can employ to address and overcome these challenges. As VR technology is introduced within the case organization, these barriers and strategies will be carefully evaluated to ensure successful technology adoption.

Implications for VR adoption

While this literature review did not cover studies specifically focusing on the adoption of VR technology, the themes and patterns identified in technology adoption can still provide valuable insights applicable to its context. Although VR technology presents unique characteristics that might translate into specific barriers, the underlying principles of technology adoption remain consistent across different technologies (Razmak, Bélanger, and Farhan, 2018; Saghafian, Laumann, and Skogstad, 2021; Senna et al., 2022). Thus, the strategies suggested for overcoming barriers in other technological contexts can be adapted for the implementation of VR technology.

At the individual level, the unique nature of VR might intensify resistance due to unfamiliarity or perceived complexity (De Leeuw, Woltjer, and Kool, 2020). Users may also perceive VR as a disruptive technology that significantly changes their work routines (Best, Sibson, and Morgan, 2021). Therefore, comprehensive training and the establishment of a supportive culture towards VR technology are crucial.

At the organizational level, implementing VR may necessitate substantial investment in specialized equipment and IT infrastructure. Additionally, the novelty of VR could present challenges in securing managerial support and justifying the investment required (Abdelhakim, Abdeldayem, and Aldulaimi, 2022). Clear communication about the benefits and potential of VR for the organization, as well as careful resource planning, can help address these barriers.

At the environmental level, VR operates within a fast-evolving market and a still-developing regulatory landscape (Akhtar et al., 2021). The complexity of VR technology can also pose challenges. Therefore, keeping abreast of market developments, actively engaging with relevant regulatory bodies, and obtaining expert advice for dealing with technical complexities are essential for the successful implementation of VR technology.

In conclusion, while the adoption of VR technology has its unique aspects, the general insights provided by the broader technology adoption literature can inform the process of VR implementation. A careful consideration of these factors and the development of an adaptive strategy can help ensure the successful integration of VR into the organization's operations.

Intersections of Theory and Practice

One of the key insights drawn from this literature review is the interplay between theory and practice in the field of technology adoption. The theories identified in the papers–such as the Technology Acceptance Model (TAM), Diffusion of Innovations (DOI), and the Technology-Organization-Environment (TOE) framework–provide a structured way to understand, predict, and address the complex issues surrounding technology adoption (Al Hadwer et al., 2021; Saghafian, Laumann, and Skogstad, 2021; Shahadat et al., 2023).

In the context of practical applications, these theoretical models offer organizations a roadmap to navigate the intricacies of technology adoption, pointing out potential barriers and suggesting ways to overcome them. For instance, the TAM framework, with its focus on perceived usefulness and perceived ease of use, can guide organizations in designing and implementing user-friendly technologies that meet the needs of their employees

(Zamani, 2022).

Similarly, the TOE framework emphasizes the importance of the broader organizational and environmental context, suggesting that successful technology adoption requires not just technological readiness, but also organizational and environmental preparedness (Ghobakhloo et al., 2022).

On the other hand, the practice of technology adoption feeds back into these theories, enhancing and refining them. The case studies and empirical research findings from the reviewed articles reveal the nuances of technology adoption in different industries and contexts, providing valuable data that can be used to further refine these theoretical models (e.gAkhtar et al., 2021; Ediriweera and Wiewiora, 2021a; Iyanna et al., 2022).

In conclusion, there exists a dynamic intersection between theory and practice in the field of technology adoption. The continuous connection between the two enhance both the theoretical understanding of technology adoption and its practical implementation, and highlights the need for intersection for successfully navigating the new technology adoption initiatives.

Limitations of the literature

While this literature review provides a comprehensive overview of technology adoption within the context of diverse sectors, several limitations should be noted. Firstly, despite the broad search criteria used, the scope of the literature selected may not fully cover all aspects of technology adoption. Given the rapid evolution of technology and the diverse range of industries, there might be relevant research that has been inadvertently omitted or has not yet been published.

Secondly, the studies included in this review encompass a broad range of technologies, sectors, and geographical locations. While this provides a rich, diverse data set, it also means that specific insights about a particular technology, industry, or cultural context may be obscured in the aggregate analysis. And the contrary also holds, as no specific studies in the airline industry have been found.

Thirdly, the papers reviewed relied on a variety of research methodologies, including qualitative, quantitative, and mixed-methods approaches. While each of these methodologies has its own strengths, they also have different limitations that could influence the conclusions drawn. For instance, quantitative studies may overlook nuanced individual experiences, whereas qualitative studies might not be generalizable to larger populations.

Fourthly, as none of the studies specifically focused on the adoption of VR technologies, the implications drawn for this technology in this review are extrapolated from findings on other technologies. Therefore, they might not fully capture the unique challenges and opportunities presented by VR.

Lastly, the review is also subject to the typical limitations of secondary research, including potential bias in the original research, misinterpretation of the original authors' intent, and limitations of the original study designs. Despite these limitations, this review provides valuable insights into the complex dynamics of technology adoption across different sectors and offers a strong foundation for the research.

3.2.3. Conclusion

This review of the existing literature on technology adoption within various sectors has revealed several key insights that inform our understanding of technology adoption processes. Despite the diverse range of technologies and sectors considered, common barriers to adoption have emerged, such as resistance to change, lack of adequate skills or training, and concerns over cost and security (Ediriweera and Wiewiora, 2021a; Ghobakhloo et al., 2022; Saghafian, Laumann, and Skogstad, 2021).

Strategies to overcome these barriers include targeted training programs, leadership support, positive organizational culture, and clear communication of the benefits of technology adoption (Akhtar et al., 2021; Abdelhakim, Abdeldayem, and Aldulaimi, 2022; Abich IV et al., 2021; Shahadat et al., 2023). These insights are crucial for organizations in different sectors that are looking to improve their technology adoption processes and ultimately increase their competitiveness and efficiency.

Although none of the studies reviewed specifically focused on VR technology or the airline industry, the general findings are likely to be applicable. The barriers identified, and the strategies proposed, can help airlines overcome resistance to VR adoption. These research can further elucidate VR-specific challenges and opportunities in the airline context and contribute to the theory.

There is a clear intersection between theory and practice in the realm of technology adoption. Theoretical frameworks, such as the TAM or TOE framework, provide a robust foundation for understanding adoption processes (Choi et al., 2020; Kouhizadeh, Saberi, and Sarkis, 2021). In particular, TOE framework has been the most common framework applied in the reviewed literature, showing its strong applicability in the industry as it provides an structured manner of visualizing and analyzing the projects at different levels. Simultaneously, the practical experiences of organizations offer rich insights that can further inform and refine these theories.

In conclusion, this literature review has illuminated some of the key factors influencing technology adoption across various sectors. It has identified common barriers and strategies for overcoming them, highlighted the intersection between theory and practice, and emphasized the value of context for deepening our understanding of technology adoption. This research will build on these findings to delve deeper into the specific technology of VR, in the context of an airline, to help organizations navigate the complexities of technology adoption in the digital age.

3.3. Theoretical Framework

After conducting an extensive review of the literature on technology adoption, it is possible to provide an answer to the first research sub-question presented in the research: *"What are the key concepts, barriers, and overcoming strategies related to technology adoption in companies according to the literature?"*.

The initial literature review revealed salient concepts within technology adoption theories, demonstrating their evolution and adaptation over time. Notably, the Unified Theory of Acceptance and Use of Technology (UTAUT) offers a robust foundation for understanding technology adoption. The differentiation between the intention to use and actual use was relevant, as facilitating conditions and habit, alongside intention (shaped by various aspects), contribute to actual use. Within the factors influencing intention, elements like perceived effort and performance, social influence, hedonic motivation, attitude, or habit are found (refer to Figure C.1 for an extended UTAUT framework). Despite UTAUT includes the most relevant factors at an individual level, it does not encompass certain concepts crucial for analyzing technology adoption within a company, particularly the importance of context.

Accounting for the context is a complex task for technology adoption theories, which aim to generalize across diverse technologies and industries. Organizing the influencing factors at different levels is an effective strategy to adapt these theories for varying environments, as noted in both literature reviews. Frameworks such as the Technology-Organization-Environment (TOE) or the Human-Organization-Technology (HOT) categorize different factors into three distinct groups. These categories integrate several factors from other theories such as UTAUT (refer to Figure C.2 and Figure C.3 for the visual models). Furthermore, studies adopting a systems approach to analyze technology adoption processes in complex environments like organizations have been identified. Consequently, for this study, it is considered pertinent to categorize different factors for adoption, enabling the identification of main aspects within each area. The initial categories of Technology, Environment (external), Organization, and Human (People) will be considered for subsequent steps of the report, and refined based on empirical results.

Beyond these core concepts, three additional concepts have emerged as relevant to the research. First, from Task-Technology-Fit (TTF) framework, it was taken the importance of assessing the new technology projects to be able to support technologies that align with desired goals. Second, compatibility, wherein new technologies must be compatible with existing systems, norms, or activities. However, complete compatibility could imply a lack of changes and, therefore, the potential benefits of the new technology may not be realized. Lastly, the concept of time, implicit in UTAUT's differentiation of intention from use mediated by habit, should be explicitly acknowledged. Adoption is a process with different phases in which distinct aspects must be considered.

Next to answering to the main concepts, is answering to the identified barriers and strategies followed by organizations. The context in which technologies or industries are embedded is essential, and thus the barriers and strategies highlighted in the literature vary between cases, with solutions highly dependent on the specifics of each situation. The theories and frameworks constructed upon the study and analysis of a multitude of cases already include areas where barriers may arise and where overcoming strategies should focus. However, in the second literature review, certain barriers were identified as more common than others, including lack of skills or resistance to change, management support, inadequate infrastructure, insufficient financial resources, and technological complexity. Therefore, the strategic approach to address these barriers should be case-specific and rooted in an in-depth understanding of the unique barriers prevalent within each context.

The literature may not provide specific strategies to overcome barriers impeding adoption, but it underscores the importance of translating theoretical concepts into practical cases. Theoretical frameworks equip practitioners with powerful tools to develop more informed projects and adapt to situations based on the main aspects provided by theory, adapted to their case. Therefore, it is relevant for this research to identify the main aspects to be considered that will guide the subsequent steps of the research. To summarize, UTAUT concepts will be expanded with concepts such as time, compatibility with current systems, and the need to asses technology impact to prove alignment between the technology and the objective of adopting the technology. This approach will provide a robust means to assess initiatives and decide on their support. Moreover, to contextualize the case clearly, several levels will be used to classify findings and provide insights.

The objective of this chapter was not to construct an entirely new theoretical framework, but rather to use the identified primary concepts as a foundation for the next steps. Figure Figure 3.1 offers a summary of concepts. For instance, the most relevant factors identified in the framework will guide the formulation of interview and questionnaire questions and influence the design of the experiment. Simultaneously, direct observations have been documented and organized based on insights from the theoretical framework derived from the two literature reviews. In conclusion, empirical results will be integrated with these theoretical findings to offer a comprehensive overview of the situation. This approach will ensure a thorough understanding of the strategies and actions necessary for achieving full industrialization of VR products within an airline such as AF-KLM.

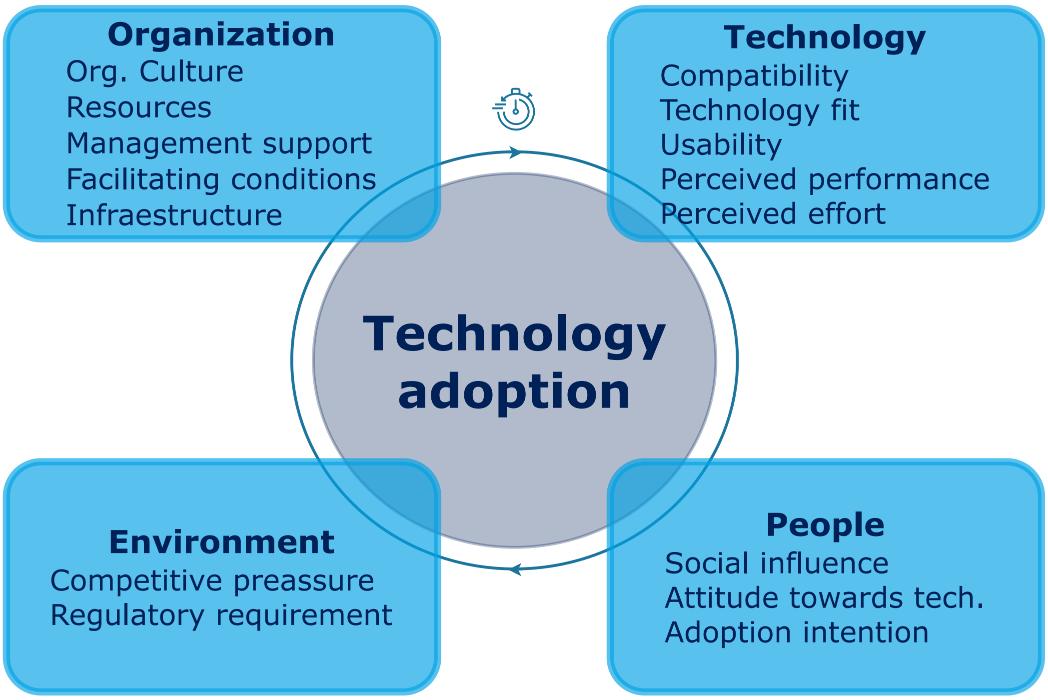

Figure 3.1: Theoretical framework for the research

4
Case study results

This chapter delves into the core of this research, presenting a detailed case study on the adoption process of VR products within AF-KLM. As highlighted in the methodology chapter (see chapter 2), this research draws upon two distinct applications of VR technology. The first case examines the use of VR for telepresence, while the second investigates its application for training purposes.

Data collection encompassed a multifaceted approach, combining semi-structured interviews, direct observations, and, in the case of telepresence, an additional real-use experiment. The following sections offer an in-depth presentation of findings from each method. These results aim to shed light on employees' perceptions of VR and provide empirical insights that address the sub-questions, which will be further discussed and answered in the subsequent discussion chapter. The case study results will not only pave the way to addressing the primary research question but will also enhance our understanding of the journey towards the full industrialization of VR technology.

4.1. Semi-structured interviews

This section of the research report presents the findings from the semi-structured interviews conducted with key stakeholders involved in the adoption process of virtual reality technologies. As a primary part of this qualitative case study, these interviews provided an in-depth look into the perspectives, experiences, and strategies of the individuals directly navigating this process. This direct source of data offered rich and nuanced insights, closer to the lived reality of the participants.

The objective of the interviews was threefold. First, it aimed to gain a more understanding of the adoption process as it unfolded in real-world contexts. Second, identify and understand the various barriers that these stakeholders faced when adopting VR or other new technologies. Finally, uncover the strategies these individuals employed to overcome the identified barriers. Consequently, this section is organized around these three main themes: the adoption process, the barriers to adoption, and the strategies for overcoming barriers. It is provided an overview of the analysis and the salient points that emerged from the interview transcripts.

4.1.1. Description of VR adoption process

To gain a comprehensive understanding of the adoption process of virtual reality technologies, the study included participants from different levels within the organization: top management, the technical team, and the business departments. Each group, with its unique perspective and roles in the process, brought distinctive insights and perspectives that significantly enrich our understanding of the process in its entirety.

As explained in the introduction chapter, the usual industralization process follows several stages: Ideation, validation, development of an MVP, and its final scaled implementation, followed by a final stage of support for the continuous use. And one thing has been noted from the interviews at the different levels, and it is the need of interaction and collaboration between all the stakeholders involved in the process.

At the **top management level**, they have an overarching view of the organization's direction and the strategic implications of technology adoption, providing perspectives on the process from a strategic standpoint. It was seen that their view can be summarized in four points: establishing the strategic directions, providing support, acting as a bridge between different departments, and decision-making.

Within the establishment of strategic directions, top management defines the strategic goals that anchor the objectives of different business sectors and departments. A crucial element in this phase is the understanding and acknowledgement of the company's pillars: technology, sustainability, people, and finances.

Technology is seen as a new pillar that's just as important as the others. One executive exemplified this point by referencing Google Flights, a digital tool that has a profound effect on how KLM interacts with users, emphasizing the need for the company to be ***"aware of technologies when they become mainstream, and be able to efficiently and effectively adapt."*** [TM4]

Sustainability represents the organization's commitment to being environmentally responsible. It is considered a strategic pillar that helps align business processes with global sustainability goals, and top management sees technology as a key enabler for this sustainability strategy. Simmilarly, the people pillar emphasizes the importance of the workforce's well-being. An executive underscored this point, saying, ***"If your people are not happy, you will also lose money."*** [TM3] This sentiment reinforces the notion that investing in people not only promotes a positive work environment but also contributes to the company's financial stability.

Lastly, finances serve as a driving force for the company's strategic goals. They're not just about profitability, but also about allocating resources effectively for innovation and assessing the financial feasibility of new projects.

"I am currently working on making sure that there is an innovation budget that goes to areas in which we are not yet there" [TM4]

Top managers also play a crucial supportive role in the technology adoption process, as one executive expressed, "***My view is managing the process to ensure things go smoothly. The organizers themselves are responsible for the business projects and for the activities in their own area."***[TM4] This perspective underscores the distribution of autonomy and responsibilities within the organization, while highlighting the support role of top management. Furthermore, they act as a bridge between departments, helping to navigate through the complexities that emerge from new projects or initiatives. They leverage their positions to align different businesses with new projects, fostering smooth communication of strategies and goals across all departments. This dual role of top management exemplifies a blend of providing necessary support while promoting interconnectedness within the organization.

Top management is indeed an integral part of the decision-making process when it comes to technology adoption. During the initial stages of exploration and testing for new projects, teams are given significant autonomy. This approach, which refrains from micromanagement and encourages experimentation. However, when these projects progress and require substantial investment, they demand top management's examination. Before such initiatives can be scaled up, they must be validated with a comprehensive business case that establishes their potential for return on investment, alignment with the strategic pillars, and their contribution to the broader organizational objectives.This can be summarized by a manager's quote: ***"In the experiment you are carrying for example, it doesn't need my approaval. But as a new investment is needed I will have to asses it".*** [TM2]

So, the decision-making process can be seen as a balance between fostering innovation through autonomy in the early stages and maintaining financial prudence by requiring top management approval for larger investments. The traditional nature of this process is reflected in an executive's words: ***"In our company, business cases are still very traditional business cases."***[TM1]

The technical department, in this case, the XR-CoE, has two primary functions, to work on business departments' projects, where there's established communication and interest from the business departments, and to explore new possibilities for VR application within the organization. When it comes to projects with the business departments, the technical department is responsible for understanding the objectives and requirements of the business. They assess whether the envisioned VR solution is indeed the best fit for the intended use case, determining whether to proceed with an initial proof of concept (POC) or a minimum viable product (MVP), based on cost and outcome considerations.

The development team is responsible for building the VR system and its user interface. During this process, they follow an agile approach, iterating on the product based on continuous feedback from the business department and internal testing. As one developer puts it, ***"We design in a way where it's the least amount of steps to achieve that goal, but in an intuitive way."***[T2] Also, it was noted by the developers the iterative nature of their work: ***"We test first internally, and if the tester and product owner thinks it is good, then we push it to the client to get feedback for the next iteration."***[T1]

Depending on the project's nature, the design objectives may differ. For training simulations, it is crucial to replicate real-life conditions as closely as possible. However, for projects such as VR for telepresence, it is vital to consider and possibly eliminate certain workflow dynamics, underscoring the need for expertise in user interaction behaviours.

Outside the scope of ongoing projects, the technical department is also responsible for showcasing their work and the potential of VR to other business departments. This function helps create awareness about the VR capabilities within the organization, guiding other departments on how to leverage VR solutions for their unique needs. By doing so, they enable the organization to fully capitalize on VR's potential, sparking innovative ideas and applications.

Within **the business departments** of the organization, the implementation of VR technology is primarily driven by the exploration of new initiatives. These initiatives aim to solve existing challenges or align the department's performance with strategic goals set by the company's higher levels. The process usually begins with middle managers who spot potential solutions to problems, then present these ideas to their superiors.

As one manager noted [B5], ***"If the new project is innovative, it is people-centric, or tackles sustainability matters, it is usually approved for its initial exploration."*** Once approved, a POC is conducted to validate the potential benefits of the proposed solution. At this point, financial controllers play a critical role as the financial assumptions they make underpin the subsequent business case. To continue with the project after the exploratory phase it doesn't require re-approval by management if the initiative was included in initial budget. However, if it is not, and as a manager clarified [B1]: ***"I need to go back to management and present the business case to them."***

These protocols and procedures, however, are not consistent across all departments. Some departments have established more structured protocols, promoting a culture of innovation among all employees. An interviewee [B5] mentioned that a long experience within a department can make it easier to assess the potential of initiatives, as this person-dependent process relies heavily on the individual's understanding of the situation and the technology.

Translating the effects of initiatives into financial terms is a significant part of building a business case. the team manager interviewed [B1] further explained, ***"Investments are measured in money, and the impact is expected in euros as well, and that is challenging."*** In operational departments, budget allocation is necessary for the proposed initiatives. Notably, the three main anticipated impacts of initiatives in financial terms are increasing revenue, decreasing costs, and avoiding costs. With regards to indirect financial aspects it was highlighted the employee engagement that could lead to lower workers turnover and more productivity.

Throughout the entire process, effective communication between stakeholders at all levels is pivotal. Not only is this crucial when seeking approval from higher management levels, but also when disseminating information about new projects to lower-level employees within the department. This becomes even more critical when technologies, like VR for telepresence or tablets, need to be diffused among a large number of employees. ***"Management and bottom employees need to assure that everybody is up to date with new projects and can take part in the new initiatives,"*** interviewee B4 pointed out.

In summary, the adoption process is a complex, multi-stakeholder task that requires careful management, clear communication, and the ability to effectively translate the benefits of initiatives into financial terms. It highlights the importance of personal experience, the need for innovation, and the different roles that individuals at various levels of the organization play in fostering successful innovation. Also, each of the players focus on different steps or stages of the adoption process, in which they have greater involvement and influence. Consequently, this diversity in focus will be reflected in the identified barriers and strategic approaches.strategies.

This section, although not delving into the intricacies and the possibles barriers that may arise during the process(which will be explored in the following section), presents the view of the different stakeholders. In greater lines it can be seen that although a common line guiding each of the stakeholders, each of them showed to have different timings, incentives, and views of the same steps of the process. This poses an important remark on the importance of clear and good communication between the different departments, converting a technical project, into a stakeholders management problem.

4.1.2. Identification of main barriers

Following the description of the VR adoption process, this section delves into the barriers identified by the interviewees. The analysis is grounded in a thematic approach, guided by topics that have emerged from relevant theoretical frameworks and explained in the chapter 3. As part of this analysis, an additional theme titled 'Process' was identified and included, in order to accurately represent the challenges observed in stakeholder interactions and workflow integration. A thematic map detailing the relation and overlap of the different themes is included in Figure 4.1, offering a visual representation of the complexities in the VR adoption process. After the thematic analysis, the barriers identified by the interviewees have also been categorized based on their organizational level.

Several barriers were identified pertaining to the **technological aspects** of the adoption process. First and foremost, the concept of fitting new technology into existing systems was frequently mentioned. Respondents pointed out the difficulty of integrating innovative technology, such as VR, into established legacy systems: ***"We are an old airline, with legacy systems that are not easy to change"*** [TM3]. The compatibility issues are also present across various departments, with some operating on more modern systems than others.

The efficacy of the technology is also questioned, with users needing to understand and appreciate the distinct benefits over existing methods: ***"VR can improve team engagement, but could be this done with a simpler app?"*** [TM2]. Furthermore, the ease of use and intuitive nature of the technology is a crucial factor. The steep learning curve and the unfamiliarity with VR technology for some users were identified as major barriers: ***"Technology is not as intuitive for everybody, so there are different learning curves that must be considered."*** [T2].

The perceived performance of the technology is also a critical factor, as is the case with VR technology. There's an inherent need for the potential users to perceive a clear, superior benefit compared to existing solutions. This extends to the need for the technology to be user-friendly, easy to understand and interact with. One trainer [B3] said: ***"When using VR you are more focused on how to interact with it rather than focusing on the steps you need to learn in the training"***. These concerns indicate the importance of the technology's ease of use and performance expectancy in shaping its adoption, as it creates a paradox where technology, intended to facilitate tasks, can end up becoming a distraction.

The pace at which VR technology is evolving also raises concerns. Participant T3 said: ***"Fast technological development can make that a project could be improved already at the end of the implementation. So it needs to be prepared to be adapted in case of necessary,"*** pointing to the need for adaptable solutions that can keep pace with technological advancements. Also, as the technology advance, it becomes increasingly challenging to keep the workforce equipped with the necessary skills and knowledge.

Organizational barriers show the inherent resistance to change present in many established entities. Incorporating a culture of continuous innovation into more traditional departments, which are not commonly known for disruptive innovation, poses a significant challenge. The diverging operational procedures across various departments also add to the complexity, as the adoption of VR technology would demand some level of standardization. As interviewee B2 pointed out: ***"More traditional departments where they are not used to disruptive innovation face more difficulties. There is no the culture of POCs or MVPs for example"***. Differences between departments can also arise not by discipline but also by location. ***"Cultural differences between different locations also relate to their views on innovation"*** was highlighted by TM3 as a potential organizational barrier.

It was mentioned the interviewee TM4 the Conway's Law, which highlights the fact that the structure of an organization and its communication patterns are reflected in the systems being developed. Also, it was mentioned by several participants at the business and technical department that overlapping responsibilities can lead to divergent views on the technology, thereby affecting the adoption process.

At the **individual level**, people's attitudes towards the technology plays a crucial role. Personal experiences and perceived threats significantly influenced the willingness to adopt VR. As participant TM1 shared: ***"Wearable technologies are difficult for me. I get dizzy with them, and I find them too intrusive."*** This quote represents the barriers encountered at the personal level, ranging from physical discomfort to privacy concerns. Concerns about privacy or job security can also lead to resistance. For instance, the same interviewee (TM1) shared that when tablets were introduced, people were worried about increased control over their work. Similarly, projects involving the exploration of Generative AI or autonomous ground operation vehicles are raising concerns among some employees as noted by B1.

Therefore, barriers related to people are closely tied to the personal experiences and emotions of the stakeholders, making them challenging to address uniformly. As stated by participant TM1, ***"Resistance to changing old ways of working is a significant barrier. For example, travelling to different destinations has become a social event deeply ingrained in the DNA of AF-KLM."***

The **environmental factors** encompass the broader context in which the organization operates. This includes the industry's regulatory requirements, which might hamper the scope of technological experimentation. For instance, the airline industry's stringent security protocols can pose a significant barrier to the adoption of disruptive technologies like VR. interviewee B2 stated: ***"At more operational department there is more influence of external environmental factors such as regulations."***

The societal standing of VR technology significantly impacts its perception within AF-KLM. Given that the technology is not yet widely diffused in the mass market, many employees within the company are unfamiliar with it and lack a clear understanding of its operation. This fact was highlighted by numerous interviewees who suggested that if VR were more integrated into our personal lives, it would be easier to overcome user barriers. They underscored the linkage between personal familiarity and professional acceptance, indicating that the societal diffusion of VR could positively influence its adoption within the organizational context.

Lastly, the **process** of VR adoption has its unique set of challenges. Creating a compelling business case for VR requires a nuanced understanding of the potential benefits and the ability to communicate these benefits to diverse stakeholders. As one participant mentioned [TM3], comparing the benefits of VR adoption to existing methods is like *"comparing apples with oranges,"* emphasizing the difficulties in quantifying VR's advantages in conventional terms. The challenge lies in making a convincing argument for the adoption of VR technology when the direct financial returns may not be immediate. Also, the process of assessing the impact of the VR product in comparison with current systems and adjusting strategies accordingly can be hindered by a *"Lack of resources to validate the impact of the VR product in comparison with current systems."*[T1]

It was also pointed by TM3 the cost estimation of the adoption process as a barrier, *" from the IT side you need things to be scalable and readily available. And the tendency is to underestimate the costs involved with that"*.

Additionally, successful adoption needs on the effective engagement of stakeholders. Participant B5 pointed out that issues such as *"Not involvement of the business in early stages"* and *"You don't always engage with the correct stakeholders, as then they don't have the connection or the power for the budget."* can cause setbacks in the process. It was also found from the interviews that the lack of commitment of stakeholders is an important barrier for adoption, delaying the process or even compromising its completion.

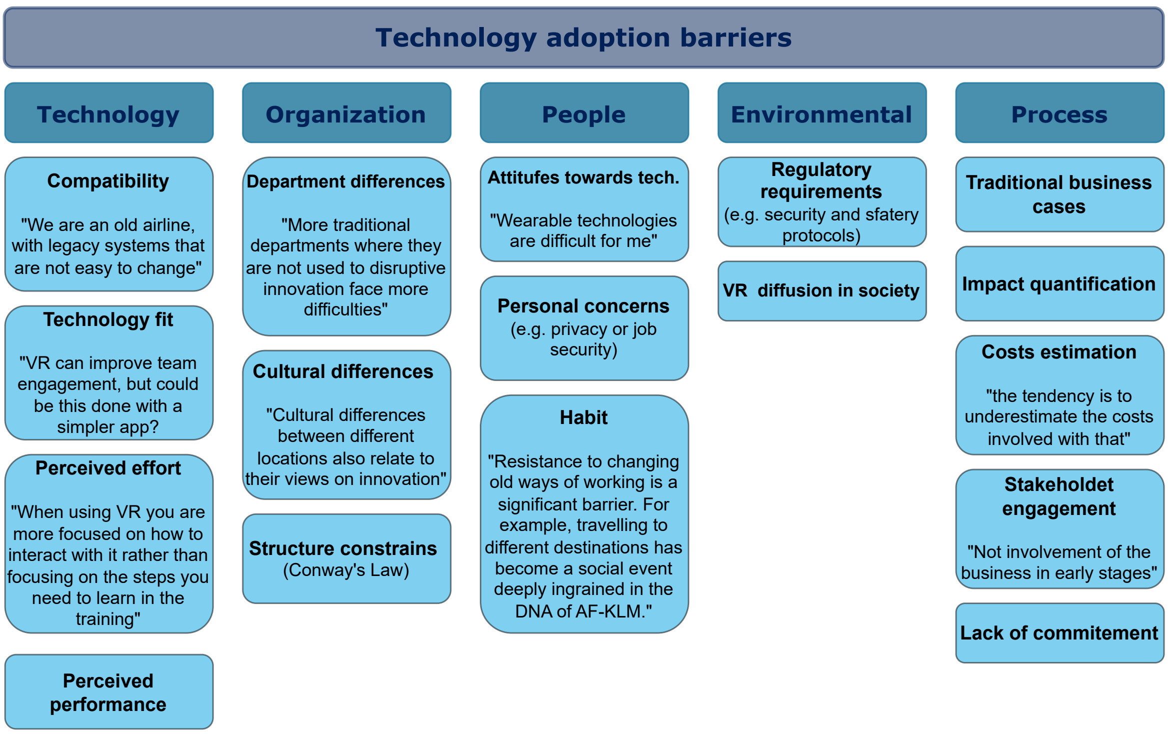

Figure 4.1: Adoption barriers overview map

The thematic analysis identified various barriers perceived by all interviewees. From the quotes used, it's evident that there isn't a distinct separation between organizational levels and the identified barriers. A potential reason for this discerned during the research, is that many interviewees have been with the company for an extended period allowing them to rotate through various departments and roles. Consequently, when discussing barriers in technological change projects, they often drew from past experiences in addition to their current position. To gain a broader understanding of these barriers, each code was quantified. Table G.1 at Appendix G section G.1 lists each code and indicates which interviewees explicitly mentioned that barrier. It's important to approach this table with caution as some participants may have referred to barriers implicitly in their responses, which leaves room for the researcher's interpretation. To address potential biases and ensure accuracy, only explicit mentions are considered. This approach offers an insight into the relative importance of barriers across different company levels.

Examining the frequency of responses reveals a wide distribution of answers across all codes and organizational levels. To provide a clearer interpretation, Table 4.1 presents the average percentage calculated for each theme. Upon reviewing these themes, it's evident that the 'environment' theme was mentioned the least by interviewees. In contrast, 'technology' and 'process' were the most frequently cited. Delving into the specific organizational levels, technical interviewees predominantly mentioned technological barriers, business interviewees focused on people and processes, while top management emphasized the 'process' theme most frequently. It's essential to approach these findings with caution, as previously noted. Nonetheless, they offer insight into the significance of barriers at different levels. These insights, combined with other interview results and methodologies, allow for a more comprehensive understanding.

	Overall	**Technical**	**Business**	**Top Management**
Technology	51.5%	60.0%	37.5%	68.8%
organization	37.3%	53.3%	37.5%	16.7%
People	47.1%	53.3%	45.8%	41.7%
Environment	20.6%	30.0%	12.5%	25.0%
Process	45.9%	36.0%	45.0%	75.0%

Table 4.1: Themes quantification overview

4.1.3. Strategies to overcome barriers

In their quest to navigate and overcome barriers to VR technology adoption, interviewees shared various strategies that, despite addressing different levels of the value chain, all converged on a central theme: an acute awareness of potential barriers encountered in the past can critically inform and facilitate the integration of new technologies.

"You can't get rid of all barriers, but you can be aware of them and work to minimize them."[TM1]

In the analysis of strategies from various participants, there seemed to be a differentiation of focus between higher-level strategies, including constructing the business case, securing development budgets, and managing stakeholders, and user acceptance strategies at lower levels when a technology is finally ready for implementation. Transparency is key in both situations, especially in aligning ways of working and managing expectations, and a recognition of the need for stakeholder commitment to achieve its later adoption. This commitment was linked to the agreement on success metrics before initiating POC, which was crucial at both higher levels to secure budget commitment, and lower levels to ensure the usage of the technology, for example, VR for telepresence.

The origin and potential impact of a project played a significant role in the early stages. Projects that address existing business issues, like high absenteeism or a shortage of trainers, were deemed more likely to succeed. Such projects, typically initiated by business units, already target strategic aspects and often present a positive financial case. However, projects driven by technology push, or those with no immediate financial impact, faced greater challenges in securing stakeholder engagement. For such cases, securing technology champions who believe in the potential and are willing to carry out the necessary experiments was recommended.

At the top management level, the importance of recent changes in terms of innovation strategy was highlighted, such as allocating an innovation budget to departments to distinguish innovation from existing business case processes. This strategy was attributed to the inherent challenge of quantifying the impact and value in the exploratory phases of innovation. The interviewee TM4 likened the VR department's position to that of startups, which need to convince investors (in this case, the business departments) of the viability of their technology. If there is no clear problem to be solved or no obvious return on investment, only those who believe in the technology are willing to back it. Continuing the startup analogy, it was suggested that companies introducing a new product need to leverage retailers to promote their product, ensuring that potential customers are aware of its existence. Interestingly, the interviewee also noted that startups typically don't target the mainstream market immediately but start in a niche and expand from there.

Raising VR awareness within the organization was a recurring theme among the proposed strategies. Participant TM4 stated, ***"From a business perspective we need to change the way we are working, and from the VR perspective more in the marketing part"***. To this end, they suggested initiatives such as featuring VR in internal reports and news, as well as encouraging participation in inter-departmental activities to ensure that a broader number of employees are aware of VR's existence and potential within AF-KLM.

Moving to the end user acceptance strategies participants noted the diverse attitudes towards change within teams, observing that ***"You always have in the team people that like new things and people that don't like change. It is normal to have different profiles."*** [TM1] This sentiment was echoed by another who asserted, ***"Human people is not science, so you need to try different things."*** [B1] A call to understand and agree on problems before moving to solutions was also evident, as well as the need for occasional firmness to ensure the adoption of better methods. Participants highlighted the power of having either direct benefits or strong upper management support to make a new initiative successful.

Incorporating change management into the adoption process emerged as a prevailing theme among the interviewees when introducing changes at lower levels of the company. They noted that change management should encompass celebrating achievements, fostering a sense of teamwork, and phasing out older technologies gradually but definitively. Interviewee TM3 stressed that implementing these measures required ***"hard work and strict management"***. It was also important to outline clear and concise expectations of new initiatives, like VR training. Engaging all employees from the outset, setting measurable success criteria, and nurturing a sense of ownership and responsibility among team members was highlighted as crucial steps towards successful technology adoption. The need for transparency and trust underscored the dialogue, hinting at the necessity of an open and collaborative work environment. As participant B1 put it: ***"You need to agree on the metrics to be measured and set success criteria beforehand to get commitment from everybody***," thus underlining the importance of setting agreed-upon benchmarks right at the beginning.

The suggestion of initially voluntary adoption was made, with an understanding that, over time, old systems would be phased out making the new ones mandatory. However, as participant TM2 noted ***"I would go more for the voluntary approach at the beginning."*** The use of real demos and a gradual introduction of people to the technology were also suggested to avoid overwhelming those unfamiliar with the technology.

In summary, a central point from the interviews is the necessity to acknowledge the complexity of introducing innovative technology into a corporate environment. Developing a clear business case, obtaining stakeholder buy-in, establishing agreed-upon success metrics, and enhancing awareness across the organization are some of the key strategies to foster adoption. Additionally, understanding and accommodating different attitudes towards change and managing these transitions effectively through celebratory milestones, teamwork, and a steady phase-out of old systems can help navigate this complex landscape. Finally, openness, collaboration, and transparency, paired with the right balance of voluntary and mandatory adoption, can make the journey smoother and ensure the successful incorporation of new technology.

4.2. Experiment

The experimental design, mirroring the multifaceted case study approach of this research, included various data collection methods to capture a more comprehensive and accurate depiction of the VR adoption phenomenon. Specifically, this experiment aimed to delve deeper into the telepresence case, using Team Promoter Score (TPS) surveys, questionnaires, and participant feedback as collection methods. The results of each of these methods are shown next.

4.2.1. Team Promoter Score (TPS) Surveys

The Team Promoter Score (TPS) surveys are used periodically by AF-KLM as a metric to assess team's satisfaction and quantify their engagement, both among team members and with the work. The survey includes the TPS score, which represents the difference between promoters and non-promoters within the team, as well as other metrics of engagement. Table 4.2 shows an overview of the main scores before and after the experiment, where it can be appreciated a significant increase post-experiment. The overall TPS score increased from -33% to 11%, a change of 46%, and both team and work engagement also increased. The percentage changes for each of these measures are visually shown in Figure 4.2.

	TPS	Promoters	Team Engagement	Work Engagement
Before	-33%	11.0%	3.0	3.6
After	11%	37.5%	3.9	4.2
Variation	+46.8%	+241%	+30%	+16.7%

Table 4.2: TPS survey results overview

To measure team and work engagement, the TPS survey uses various items that make up each of the concepts to then calculate the average of them. Table 4.3 shows the items measured and the results of those metrics before and after the experiment, and Table G.3 at Appendix G shows the descriptive statistics calculated. Although both engagement levels saw increases, the most significant improvements were observed in the team engagement metrics. Team dynamics measures such the sense of working well together, and trust notably increased by +40% and +30% respectively.

Concept	Item	Before	After	Variation
Work Engagement	I enjoy going to work	3.6	4.1	+13.89%
	I like my job	3.7	4.1	+10.81%
	I know what is expected from me to do my job well	3.6	4	+11.11%
	I feel fit for my job	3.8	4.4	+15.79%
Team Engagement	In this team we work together well	2.7	3.8	+40.74%
	Working with other teams goes well	2.9	3.9	+34.48%
	This team is there for me when I need them	3.6	4.1	+13.89%
	In this team we trust each other	2.9	3.8	+31.03%

Table 4.3: TPS engagement items' scores

This difference between work and team engagement was also appreciated at the standard deviations (Table G.3), suggesting that while team dynamics and collaboration improved consistently, individual experiences or perceptions related to personal job roles or tasks might have varied more.

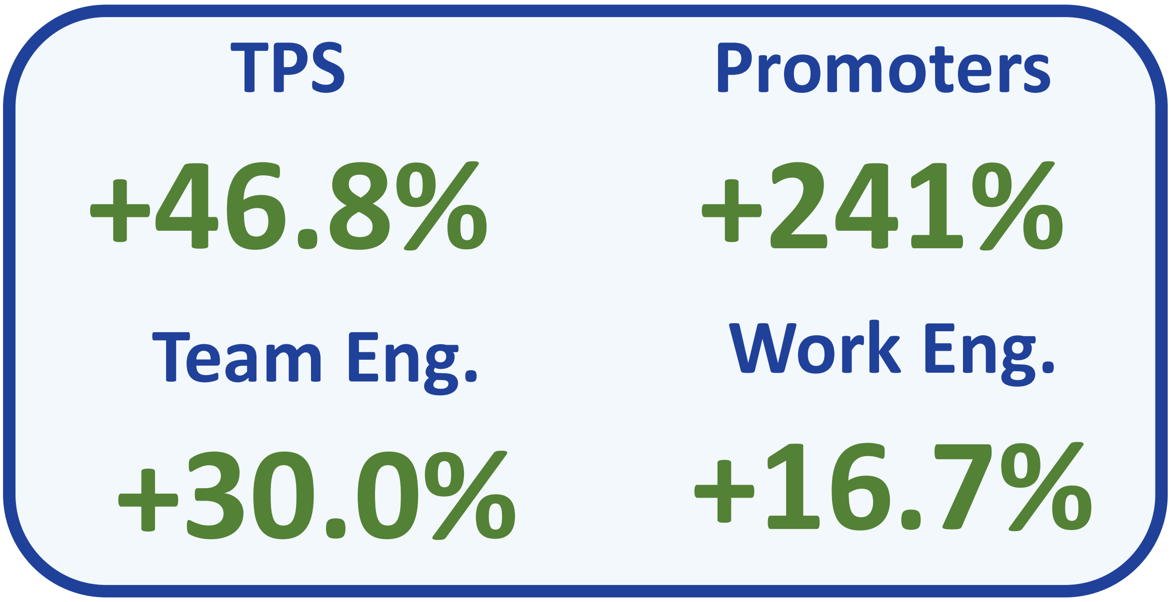

Figure 4.2: TPS results comparison

The strength of this survey lies in its ability to quantify subjective and qualitative aspects of work such as satisfaction and engagement. Additionally, it incorporates open-ended questions allowing team members to provide insights that extend beyond the quantitative scores. In these questions, participants evaluate team dynamics and processes by commenting on what they believe is going well, identify areas for improvement, and suggest ways to implement these improvements. The responses tend to be quite general, often related to the team's technical work. However, in both surveys, it's seen that the team values good, transparent, and honest communication.

In the initial TPS survey, all participants explicitly mentioned the importance of transparency and trust for achieving high performance and engagement. This sentiment was echoed in responses such as:

"For the future team we have to improve communication, relationships, and trust."

"More open communication towards each other (transparency)"

The challenges of geographic distribution and the necessity of effective communication to navigate these were also highlighted.

"With two strong teams with diverse set of skills and talent coming together, we should collaborate effectively."

Comparing the open responses in the second TPS survey showed a shift towards more work-related topics. The importance of communication, team building, and good communication remained, but the most frequent comments related to the need for technical workshops and greater individual ownership of work. This shift suggests that initial concerns about team communication and collaboration were addressed, allowing team members to focus more on honing their technical skills and understanding their individual responsibilities.

In conclusion, the TPS surveys provided a quantitative overview of the team dynamics, demonstrating significant improvement in teamwork and collaboration. These results can be taken as indicators of successful alignment between the technology and its intended purpose of enhancing team cohesion and work engagement. However, these findings need to be interpreted in conjunction with the entirety of the results to gain a comprehensive understanding and obtain valid conclusions.

4.2.2. Questionnaires

Similar to the TPS survey, questionnaires were administered both before and after the experiment to evaluate the impact of VR on the team's workflows. These questionnaires included both qualitative and quantitative questions, and as mentioned in the methodology chapter, they were based on insights obtained from the technology adoption theories analyzed in chapter 3.

Regarding the Likert scale items, participants were asked to rate a set of statements on a scale from 1 to 5. To facilitate a comparative analysis of perceptions before and after the VR intervention, the same questions were included in both the pre-experiment and post-experiment questionnaires. An overview of the Likert scale responses, encompassing aspects such as ease of use, compatibility, effect on team communication and productivity, requisite for training and support, role of management, and intention, is presented in Table G.4 at Appendix G subsection G.2.2. In the appendix, the descriptive statistics values obtained are also presented, along with the analysis performed to assess the significance of the answers.

Given the results of the significant analysis and the sample size of this experiment was small compared to those used in similar questionnaires found in the literature, no statistically significant results can be drawn from it. However, since this experiment is framed within a qualitative case study, the obtained values provide a valuable overview of the participants' perceptions and intentions for adoption. Upon reviewing and analyzing the responses, and looking to the variations and statistics presented at the appendix (Appendix G the primary results can be classified as follows:

- **High Team Expectations:** All metrics scored above 3 in the first questionnaire, indicating a willingness to participate in the experiment and belief in the technology.
- **Steady Perceptions:** The metrics in the second questionnaire showed slight changes, with an average absolute change of 4.5%.
- **Embrace of Virtual Reality:** The highest scores highlighted the team's satisfaction with the decision to use VR, their anticipation of future collaborative opportunities, and their finding of the technology as beneficial for meetings and easy to interact with.
- **Positive Shifts:** The perceived facilitation of communication increased, as did the overall benefits of including VR in the meetings. Also, the perceptions of the interaction with the technology improved after the experiment, indicating that continuous use can build habit.
- **Negative Shifts:** On the other hand, the greatest decrease was seen in the per-

ceived help to improve the quality of work. Perceptions of the technology's purpose and its ease of use during meetings also showed a decrease.

- **Perception Variations:** These changes in perceptions show that while participants were enthusiastic about the technology and saw its benefits, they also identified certain negative aspects. Some of the changes seemed contradictory, with an increase in overall benefits observed, yet a decrease was noted in alignment with purpose. This divergence could suggest potential adoption challenges. Additionally, while despite participants found their interaction with the technology to be clearer, the ease of use during meetings didn't improve, indicating possible issues with specific tasks or meeting software.
- **Management Support:** An interesting result that seems contradictory involves the two questions related to management support. These questions present the most significant changes, each in opposite directions. While participants perceived that management's interest in adopting VR increased, they also perceived that management does not see it as necessary. This presents a valuable insight, suggesting that although there is interest in the technology, the management doesn't perceive it as fitting the purpose or needs of the teams. What can relate to the previous contradiction between purpose and benefits.

In the second questionnaire, additional Likert scale questions were introduced to evaluate the comprehensive impact of VR use, drawing from the participants' experiences. As shown in Table 4.4, all items scored above 4 with the exception of the perceived positive impact on team productivity. Among the other questions, it is significant to highlight how VR stimulated team motivation during meetings and the substantial role social influence is likely to play in promoting the adoption of VR.

Questions	Score
Do you think a wider use of VR within the company would encourage you more to use VR?	4.25
Do you think VR supported better team interaction?	4.13
Do you think VR makes you feel more connected to the team and objectives?	4.00
Do you think VR can positively impact overall team productivity?	3.56
Do you think VR helped in creating a more creative environment during meetings?	4.29
Do you think VR enhanced your motivation during meetings?	4.38

Table 4.4: Second questionnaire likert scale answers

The participants were also asked to rate their overall experience during the experiment, considering both the positive and negative aspects of the technology. The overall experience was rated an average score of 3.7 out of 5.

Complementing the quantitative metrics, the questionnaires also included open-ended questions to gather more profound insights into the participants' experiences. These qualitative inputs provided a comprehensive understanding of the participants' perspectives, addressing aspects that numerical ratings couldn't capture, and adding depth and context to the quantitative results.

Average team experience

(from 1 to 5)

3.7

Figure 4.3: Partcipants's experience metric

In the initial questionnaire, participants were asked about the main challenge faced when working in geographically distributed teams. Unanimously, participants highlighted difficulties in team building and maintaining effective interaction to bridge the distance and cultural differences. Participant quotes such as, ***"It takes more time to actually become a team instead of a group of individuals"***, and, "***When the team is all together in one place, it facilitates the exchange and especially the understanding of the expectations of each other"*** underscore the complexities of remote collaboration.

When asked about their awareness of VR usage within AF-KLM, more than half (55.5%) of the participants reported being unaware of its use at the comapny. This percentage was mirrored in those who had no prior experience with VR technology in general, and from those who did have some VR exposure mostly used it for gaming purposes.

The first questionnaire showed high interest among participants in exploring new technologies such as VR to improve their workflows. However, alongside this enthusiasm, they expressed uncertainty regarding VR's potential and expressed concerns about the adaptation process. Some apprehensions revolved around the time required to get used to the technology and the new needs it would entail, like remembering to charge the headsets. They wondered if the adaptation period might temporarily hamper their efficiency or if the technology could deliver the necessary technical performance concerning comfort, battery life, connectivity, tooling, etc.

Expressing a variety of views, the participants' comments both indicated excitement and curiosity about VR and conveyed caution regarding its practicality and efficacy in their current workflow

"I think it could be beneficial as it offers some unique possibilities that don't exist in the real world."

"Curious about the tool and what it could improve in our current job."

"Completely agree to include it, as long as the adoption and usage of it does not add extra time."

"Not that useful, instead Microsoft Teams Or in-person meetings are more valuable, fast and quality to me."

The second questionnaire was designed to evaluate the actual impact of VR after the experiment and assess the alignment between the objectives set at the beginning and the perceptions after its use. Examining the overall perception of the participants, 75% responded positively or very positively towards integrating VR, while the remaining 25%, despite seeing some benefits, expressed skepticism about fully incorporating VR into their routine.

The second questionnaire was designed to evaluate the actual impact of VR after the experiment and assess how initial objectives aligned with final perceptions. When looking at the overall reception of VR among participants, as illustrated in Figure 4.4, 75% responded positively or very positively towards the integration of VR into their routine, while the remaining 25%, despite seeing some benefits, expressed scepticism about fully incorporating it.

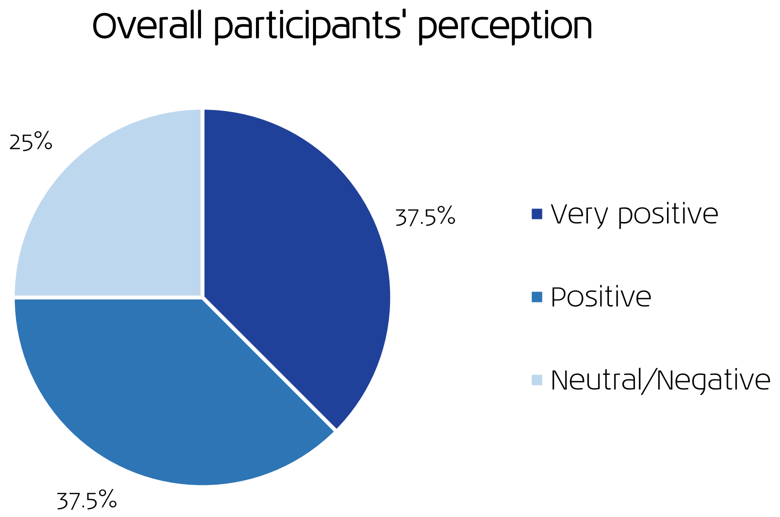

Figure 4.4: Overall participant's perception of using VR

The feedback from participants provided intriguing insight into the experiential aspect of VR. The technology fostered a tangible sense of togetherness and significantly improved team dynamics despite geographical distances. As one participant described it, ***"[VR was] awesome! It really felt we were all in the same room, no matter the distance"***. Another emphasized the feeling of closeness: ***"It was good to have the feeling to be closer to each other than we are in reality"***. Participants also noted the positive effect on team bonding, with one participant stating, ***"The informal and playful environments, really seeing developers from France and India doing high-fives together, it helped us blend two teams into one"***.

However, not all participants found the technology beneficial in terms of their specific project-related tasks. As one participant mentioned: ***"It was not really helping out with our project"***.

The participants used VR for various types of meetings and interactions, with the most prevalent usage occurring during daily stand-up meetings. Participants appreciated VR's capacity to enhance team building, ease communication, and facilitate collaboration, and commented that VR seemed to be particularly suited for short, creative meetings such as brainstorming sessions or presentations.Despite this overall positive perception, several issues surfaced, primarily regarding tooling integration, usability aspects, and access to VR sets for new team members. The chart in Figure 4.5 further illustrates these common challenges encountered during the VR usage.

Participant feedback highlighted both practical and technical challenges in integrating VR into their routine. A common theme was the need for an enhanced user experience, a point summarized by two participants' remarks, ***"The application needs to be improved***

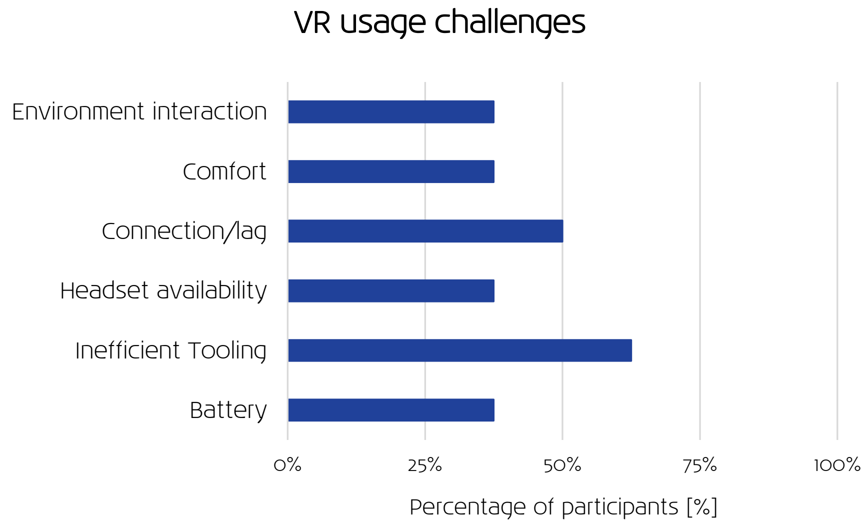

Figure 4.5: Main VR usage challenges

in terms of using it specifically for our own goals.", and, ***"Tools currently used by the team should be made available in the VR environment."***.

Practical issues related to the VR usage were also raised, touching upon the topics of comfort and physical space. One participant noted, ***"I'd prefer a more comfy VR set. Also in the office, we would need separate rooms to avoid kicking into tables, knocking over coffee mugs and look like monkeys from the outside."***. Also, it was mentioned the difficulty of accessing necessary resources, such as laptops and internal networks while using VR, ***"I need to have easy access to my laptop and the AFKL internal network while being in the VR mode".***

Regarding technical limitations, these ranged from local connectivity problems and system lag, ***"Local (dis)connectivity, with a huge lag"***, Moreover, some participants suggested the need for higher resolution in VR and better in-office Wi-Fi to support smooth operation. Others pointed out that the nature of their work was technical, and they couldn't fully replicate their working environment within VR.

Looking forward, the team expressed optimism about the potential for VR within their daily operations, especially for team building and presentation purposes. Although it was acknowledged that a successful integration would heavily depend on the development and availability of necessary tools within the VR environment.

"Team building will be awesome, presentation can be good, but other meetings will depend on the availability of tools within VR" - Participant. Another participant stated, ***"Definitely a thing which will be part of our future. The fact that you can be anywhere with anyone whenever you want is great. It will help save time and money".***

"Future wise I see each & every AFKL "office" employee has its own VR set for meetings, to improve meeting quality, team bonding and remove walls we've built via MS Teams and default webcam"

The majority believe that the future of meetings at AF-KLM could be transformed by VR technology. However, there's recognition that it would require a balance to ensure that its adoption enhances productivity rather than impeding it.

4.2.3. Participant's feedback

In addition to more standardized methods for gathering insights from the experiment (TPS and Questionnaires), direct feedback from participants was also sought. To achieve that, an MS Teams channel was created, and a final feedback session was held to gain more immediate insights into the participants' experiences.

The Teams channel featured a chat and a whiteboard for participants to provide additional feedback. However, the whiteboard saw limited use and little to none valuable data was obtained from there. In contrast, the chat was frequently used for communication among the team regarding the VR topic and also for direct contact with me, the researcher, as the direct contact with the technical VR department. Consequently, the main use of the chat became a support channel. At the beginning most conversations revolved around the usability of the hardware and software and as the experiment evolved, the questions and remarks in the chat shifted towards software issues and inquiries about potential functionalities that were not immediately available.

As another means to gather direct feedback, a final feedback session was organized. In order to maintain a familiar approach for the team, it was decided to use the Sailboat Retrospective framework for the session (TeamRetro, 2022). This tool is used by teams in envisioning their objectives and the path to reach them, using the metaphor of a sailboat journeying towards an island. The following components were considered: the sun (what went well?), the anchor (what was holding the team back?), the wind (what is propelling the team forward?), and the island (what does the future look like?). Figure 4.6 provides a visual representation of the outcomes, while a summary of the main points is provided below.

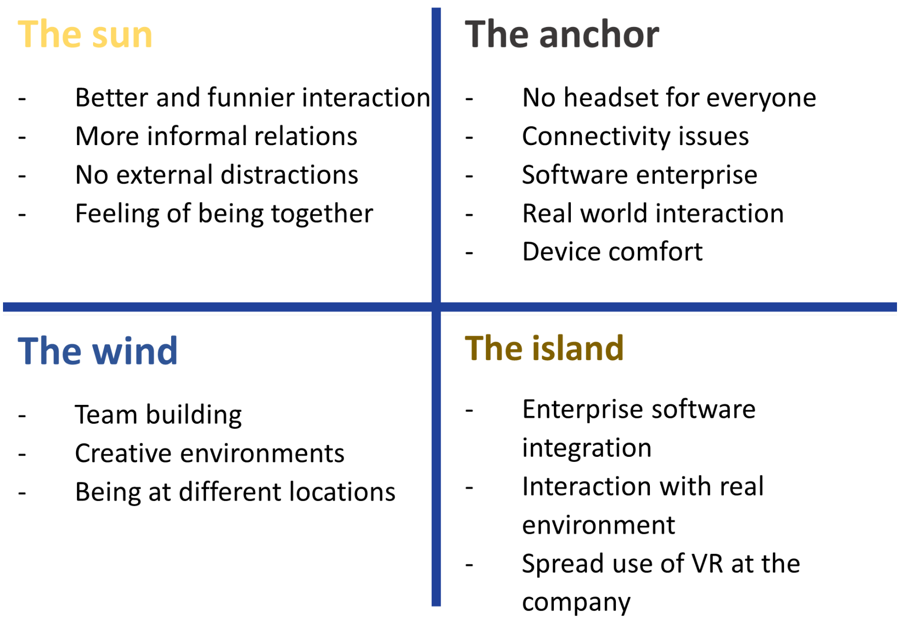

Figure 4.6: Sailboat retrospective results overview

- **Sun:** Participants felt the VR environment offered a better and more enjoyable mode of interaction compared to usual virtual environment. This suggests that the immersive nature of VR can lead to increased engagement, which could ultimately contribute to improved productivity. The absence of external distractions was particularly noted, providing an environment to focus on the meeting's work. Additionally, participants reported a sense of togetherness, pointing to the potential of VR to recreate some of the interpersonal dynamics lost in remote working setups.

- **Wind:** The VR setup was seen as a tool for team building and fostering creative environments. This demonstrates the potential of VR in not just replicating traditional work environments, but in creating unique spaces that can foster creativity and collaboration. Participants particularly valued the possibility of working "together" from different locations, indicating the potential of VR to bridge geographical gaps and facilitate distributed collaboration.

- **Anchor:** Several challenges were identified, the first being the unavailability of headsets for everyone. This underlines significant accessibility and cost barriers associated with VR technology, which could limit its scalability within the company, particularly across different locations and with external partners. The lack of integration with enterprise software was another major concern, emphasizing the necessity for VR platforms to be compatible with existing productivity tools to ensure seamless work processes. Thirdly, connectivity issues were noted, suggesting the need for robust and reliable network infrastructure for effective VR use. Participants also expressed a desire for real-world interaction, indicating that while VR can simulate many aspects of in-person interaction, it cannot fully replace the physical world. Lastly, discomfort with the headset was a common complaint, highlighting the need for improvements in VR hardware design to ensure user comfort and hence, prolonged use.

- **Island:** In the future, participants envision the integration of VR with enterprise software, allowing the technology to combine the immersive experiences of VR with the use of conventional productivity tools. They also expressed a desire for interaction with the real environment, such as using a laptop, implying that hybrid augmented reality solutions might be preferable. Finally, the team envisions a widespread use of VR within the company, showing the participants' positive attitudes towards VR and their recognition of its potential benefits if the aforementioned challenges are addressed.

In sum, the insights from the MS Teams channel and the sailboat retrospective highlighted both the potential and challenges of VR in fostering engaging, creative, and distributed work environments. This feedback, while revealing the practicality of VR, also underscored several key areas for improvement.These findings will contribute to the basis for the forthcoming recommendations and future research directions of VR for telepresence, but also for general VR technology.

4.3. Direct observations

For this research direct observations from the participation on the company environment were taken into account aiming to have wider view and comprehend the diverse factors influencing the adoption and impact of VR within the organization. These observations were documented and classified in a table, that can be seen in the appendix under Table G.6. The insights derived from the direct observations have been systematically analyzed and organized into six predefined categories: Technology, User Engagement, Business Impact, Work Processes, Organizational Culture, and Training & Support. These themes represent key aspects of VR adoption and use within the organization, providing a complete understanding this multifaceted subject.

Technology emerged as a critical factor, with three distinct sub-themes: the general perception of VR technology, its diffusion in the mass market, and technical complexities associated with its use. The observations suggested that VR technology, while captivating and innovative, is still largely perceived as a high-tech niche gaming product. Moreover, some employees' prior experiences with outdated and uncomfortable VR headsets have shaped their views on VR inside the company. The complex nature of VR systems has also led to unforeseen technical issues, underscoring the need for robust technical knowledge and support.

The level of user engagement was deeply tied to perceptions of VR technology. The data shows diverse levels of interest and engagement among users, influenced heavily by personal relations and champions within the organization. The demonstrations conducted by the VR team were a source of initial interest, but there is often a delay in moving beyond this stage. Differences in engagement levels were noted among stakeholders with similar roles, highlighting the complex factors influencing technology adoption.

The impact of VR on business operations isn't always immediately evident due to the vast spectrum of potential effects, many of which are intangible. Demonstrating VR's effectiveness to businesses without quantitative metrics is a challenge, while the overlapping of VR implementation with other departments' systems and responsibilities added complexity. For example, VR's potential in attracting new talent and reducing talent acquisition costs emerged as a significant potential benefit.

Work processes also play an important role in the adoption and implementation of VR products. Challenges were noted in terms of clear points of contact, departmental acceptance, and setting up logistics for VR experiments. The presence of differing speeds in accepting changes across departments was also observed.

Organizational culture was identified as a factor influencing both user engagement and work processes. Differences in the cultures of departments, such as IT and Ground Services, were observed. The data suggests that some managers may view new initiatives as distractions rather than enhancements. Also, the past experiences of the organization with VR had a lasting impact on employees' perception of the technology.

Finally, the theme of training & support highlighted the need for established processes, training, and resources to support the use of new technologies like VR. Technical issues that arose during demonstrations underscored the importance of technical support. The data also suggests the need for training that accommodates the different cultures, perceptions, and personal traits within teams.

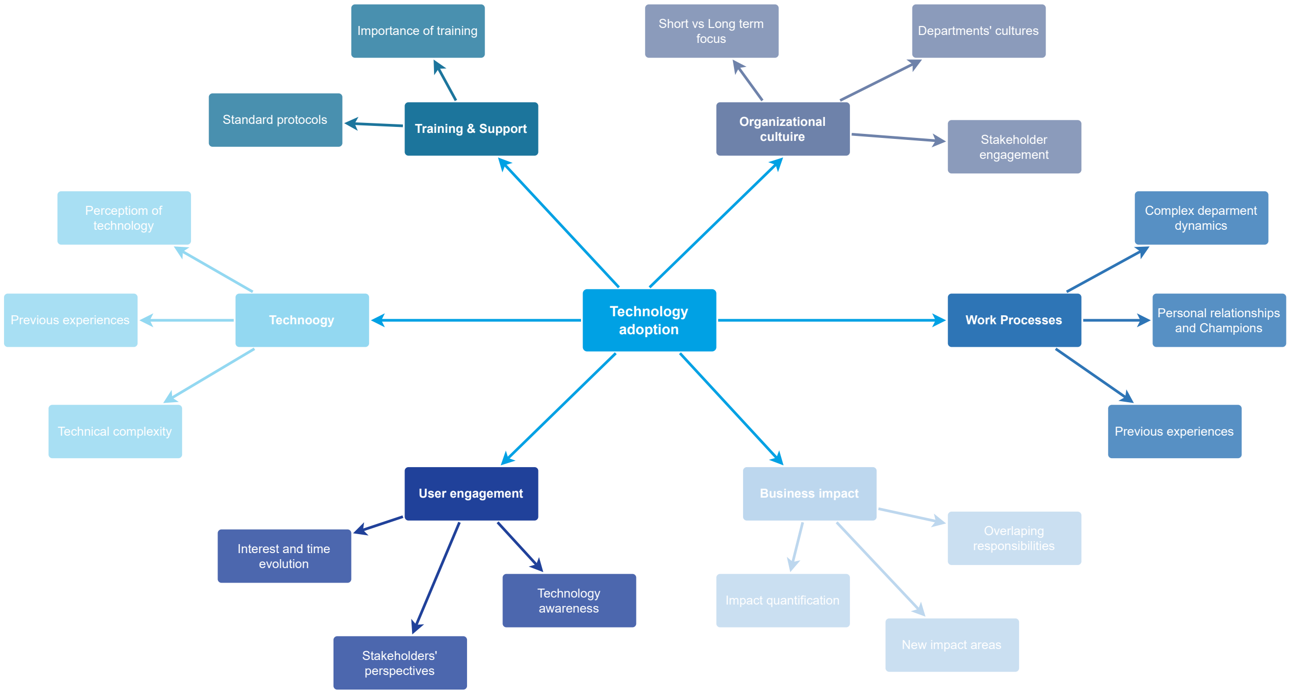

Figure 4.7: Thematic map of the direct observation results

In conclusion, the direct observations provide an additional perspective to the complex adoption and industrialization processes of VR technology and its impact within the organization. The insights were grouped across six key themes with their respective sub-themes, providing a deeper understanding of the diverse factors influencing VR's adoption and use. The results of this analysis, visually represented in Figure 4.7, underline the importance of a holistic approach in examining the adoption and impact of VR in an organizational setting.

5 Discussion

The aim of this research was to comprehend the process of VR technology adoption within a large airline, using AF-KLM as a focal case study. It sought to illuminate the challenges and complexities that might hinder such processes, and provide actionable insights and strategies to overcome these barriers, streamlining the adoption process. The final goal was to ensure that projects possessing considerable potential do not stagnate due to obstacles. A multi-method approach was employed to gather a comprehensive understanding of the situation, including interviews with various stakeholders involved in the process, an experiment on the VR for telepresence case, and the recording of direct observations. The findings from these diverse sources shed light on the intricacies of the adoption process and identified the factors that shape it, paving the way for a more effective industrialization of VR technology.

This chapter is structured to provide an in-depth discussion of the research findings, addressing the associated research sub-questions. The first two sections synthesize and triangulate the empirical findings, focusing on the barriers to adoption and the strategies for overcoming them. The third section takes a retrospective look, juxtaposing the empirical findings against the theoretical framework. This comparison is pivotal for crafting a technology adoption framework designed to guide organizations seamlessly through the adoption process. Closing off the chapter, the final section delves into the "Practical Implications for AF-KLM", offering tangible insights based on real-world situations encountered within the company.

5.1. Technology adoption barriers

By conducting the case study, one of the objectives was to answer the question: ***What are the main barriers for complete industrialization of VR innovations identified by employees at AF-KLM?***. The findings shed light on the challenges faced at different levels within the organization and throughout the adoption process. The categorize the barriers it was used the same classification as the one in the thematic analysis for the semi-structured interviews: technology, organization, individual (people), environment (external), and process. Each of which presents unique challenges to the industrialization of VR technology.

Before delving into the different categories, it was identified that varying barriers emerged as more relevant depending on the level of the organization or at the stage of the process. Generally, at early stages, the barriers were found in terms of aligning the use of the technology with the strategic direction of the department, and getting the commitment and involvement of all necessary stakeholders. In later stages, the main constraints appear by obtaining user acceptance of the products by the majority of employees. In both cases, perceptions of ease of use, effort, and performance were found to be critical for adoption.

The triangulation of methods used in this study significantly bolstered the conclusions drawn about these barriers. The semi-structured interviews, the experiment, and the direct observations each brought their unique lens to understanding the challenges, yet converged on similar findings around technology acceptance, organizational readiness, and individual perceptions. The semi-structured interviews shed light on the barriers from a perceptual standpoint, gleaning insights from employees' experiences and offering a broad organizational perspective. These interviews revealed overarching barriers such as general business case concerns and challenges in garnering universal buy-in.

In contrast, the experiment furnished a closer understanding, illuminating the tangible and explicit challenges encountered during real-world adoption. Here, technological constraints like connectivity and usability issues were pronounced, as were the varied acceptance levels among team members. Additionally, the experiment provided a window into the tangible struggles faced in constructing a compelling business case for VR.

Meanwhile, direct observations spotlighted the more implicit organizational barriers, unraveling the undercurrents of informal dynamics and cultural facets that subtly, yet profoundly, influenced the barriers brought to light in both the interviews and the experiment. Such an integrative approach, drawing from multiple methodologies, offers a comprehensive, multi-faceted view of the challenges, ensuring the identified barriers are rooted in a rich tapestry of data.

Now, diving deeper into the barriers encountered across the defined categories, it becomes evident how these findings intertwine to provide a holistic understanding of the challenges faced by AF-KLM in the adoption and industrialization of VR technology.

- **Technology:** Technological barriers primarily revolve around compatibility issues with legacy systems, the technical complexities of the technology, and the training and support needed. At the earlier stages of the process, these barriers are based on the technology's perceived performance and efficacy, with users needing to understand and appreciate the distinct benefits over existing methods. When it comes to the actual use of the technology, the experiment identified connectivity issues, hardware limitations, and the need for compatibility with existing systems as key challenges. Also, usability barriers as network infrastructure or hardware limitations can negatively impact user experience and acceptance.
- **Organization**: Organizational barriers highlight the inherent resistance to change present in many established entities. Incorporating a culture of innovation into more traditional departments, which are not commonly known for disruptive innovation, poses a significant challenge. The diverging operational procedures across various departments also add to the complexity, as the adoption of VR technology would demand some level of standardization. Differences between departments can also arise not only by discipline but also by location, with cultural differences between

different locations also relating to their views on innovation.

- **People:** Individual barriers relate to employees' perceptions, familiarity, and prior experiences with VR technology. The research indicated that some employees perceive VR as a niche gaming technology rather than a viable tool for professional use. Negative prior experiences with outdated or uncomfortable VR headsets can influence employees' views on the applicability of VR in the workplace. Lack of familiarity and understanding of VR technology can lead to scepticism and resistance.
- **Environment:** Environmental factors include the broader context in which the organization operates. This includes the industry's regulatory requirements, which might hamper the scope of technological experimentation. For instance, the airline industry's strict security protocols can pose a significant barrier to the adoption of disruptive technologies like VR. The societal standing of VR technology significantly impacts its perception within AF-KLM. Given that the technology is not yet widely diffused in the mass market, many employees within the company are unfamiliar with it and lack a clear understanding of its operation.
- **Process:** The process of VR adoption also has its unique set of challenges. Creating a compelling business case for VR requires a nuanced understanding of the potential benefits and the ability to communicate these benefits to diverse stakeholders. The challenge lies in making a convincing argument for the adoption of VR technology when the direct financial returns may not be immediate. Additionally, successful adoption depends on the effective engagement of stakeholders. Issues such as lack of involvement of the business in early stages and not engaging with the correct stakeholders can cause setbacks in the process. Finally, non-awareness among the company can hinder the growth of VR use within the company.

In conclusion, the barriers to VR technology adoption within AF-KLM are multifaceted, including technological, organizational, individual, environmental, and process factors. From the results of the case study, the interrelation between the categories can be appreciated, as well as the fuzzy difference between categories. For example, at the technological and individual barriers, some overlap can be found as individual perceptions and skills over the technology can be included in both categories. However, as noted by the literature review, categorizing the barriers at different levels provides a clearer perspective for organizations to focus on the different aspects that hinder technology adoption. Therefore, the categories should not be taken as fixed and immobile, but by understanding that there are barriers at different levels and stages, the organization can develop effective strategies to facilitate the adoption and industrialization of VR technology.

5.2. Strategies to overcome barriers

The second research sub-question to be answered by the case study was: ***What are the potential strategies identified by employees at AF-KLM to overcome the adoption barriers for complete VR innovation's industrialization?***.

The triangulation of methods employed in this research enabled a comprehensive exploration of the barriers and strategies associated with VR adoption within AF-KLM. By combining insights from semi-structured interviews, direct observations, and an experiment, a holistic view of the challenges and potential solutions was obtained. This multi-faceted approach ensured that the strategies identified were grounded in both the collective experiences of the interviewees and the tangible realities observed during the experimental phase.

Similar to the findings in the literature review, no one-size-fits-all strategy was deemed viable by the interviewees and participants. In fact, the most relevant advice was to be aware of the existence of barriers at various aspects and be able to address them. The awareness of these barriers was deemed crucial for the development of strategies. The responses also highlighted the context-dependent nature of these barriers and emphasized the need for adaptable strategies that could cater to each unique situation.

Although specific strategies were not provided, drawing upon insights from the different methods, several general strategies emerged to address technology adoption barriers.

- **Collaboration and Stakeholder Engagement:** Encouraging collaboration between the VR team and various departments, as well as actively involving stakeholders throughout the adoption process, can foster a sense of ownership and promote understanding of VR's potential benefits. Regular communication, feedback loops, and involvement in decision-making can enhance stakeholder engagement.
- **Comprehensive Training and Support Programs:** Developing comprehensive training and support programs that adapt to different teams and individuals, while considering varying levels of familiarity with VR, can increase adoption. These programs should focus not only on technical aspects but also consider the comprehensive implications VR would have on the different domains within the organization. For example, when developing a new VR product, it should also be established how the training and support would be delivered, as business departments need to know how it will affect their operations.
- **Change Management Strategies:** Implementing change management strategies that address employees' resistance and facilitate the acceptance of new technologies was found relevant. Steps like celebrating success, fostering teamwork, and phasing out old technologies were seen as critical to ensuring smooth transitions. Also, ensuring stakeholders' involvement and making people feel responsible were identified as key strategies to foster commitment within working teams.
- **Impact quantification:** Building positive business cases and setting metrics for success during the design phase of Proof of Concepts (POCs) and Minimum Viable Products (MVPs) were seen as crucial. This quantification of impact can secure commitment or allow for a conscious decision to stop the development of a product that doesn't deliver the necessary outcomes.
- **Iterative Development:** Encouraging a culture of continuous improvement and iterative development of VR solutions based on user feedback and experiences can enhance user satisfaction and ensure that VR technology evolves to meet the specific needs of the organization. Regular updates, bug fixes, and feature enhancements contribute to the overall success of VR adoption.
- **Awareness Campaigns and Success Stories:** Conducting awareness campaigns to educate employees about the existence of VR, its benefits and potential applications, along with sharing success stories, can generate interest and build confidence in VR technology. Highlighting the positive impact of VR adoption can help overcome initial skepticism and generate enthusiasm among employees.

Some of these strategies can already be seen in the activities of the XR-CoE, as they have learned from previous cases. For example, when ideating a new project, they seek the business's commitment and active involvement rather than merely informing them about their ideas and then delivering the results. Also, clear and transparent communication is aimed at setting realistic expectations due to the different ways of working. For instance, it was noted that some departments thought that an MVP was the full product that could be industrialized. By increasing the awareness of VR within the company, the number of believers is increasing, hence, the willingness to explore new VR use cases in different departments is growing.

In summary, while the findings did not provide a specific strategy to ensure the complete industrialization of VR products within AF-KLM, several general strategies could be drawn. Learning from past experiences is key, and being adaptable to the changing landscape of VR technology is crucial. These strategies provide a pathway for organizations to navigate the multifaceted challenges they may encounter during the adoption process, and provide a blueprint for successful integration of VR technologies into their operational activities.

5.3. Theoretical comparison and implications

The purpose of this research was to identify strategies that support the adoption of VR technology and facilitate the full industrialization of VR products within a large airline. In response to the research sub-question, ***"What implementation strategy could be proposed, informed by both theoretical insights and empirical findings, to support VR industrialization and overcome adoption barriers?"***, it is aimed to develop a technology adoption framework. This framework would serve as a guide for the companies such as AF-KLM, supporting new technology adoption and promoting the complete industrialization of VR products. The framework is informed by a synthesis of theoretical insights from established models of technology adoption and empirical findings gathered from the case study carried at AF-KLM, as presented in the previous chapters of this research.

5.3.1. Theoretical evaluation

The theoretical insights obtained from the study provided a robust understanding of technology adoption literature and its applicability in an organizational context. The Unified Theory of Acceptance and Use of Technology (UTAUT) emerged as a key model, encapsulating the nature of technology adoption. Despite providing an extensive overview of factors influencing intention and actual use of technologies, UTAUT lacks context identification, which is key in an organizational environment. This led to include theories such as the Technology-Organization-Environment (TOE) framework that categorizes influencing factors into different groups. Consequently, there were established four categories based on these findings: Technology, People, Organization, and Environment. Additionally, there were identified three crucial concepts drawn from the literature that significantly contribute to the framework: the importance of compatibility between new technology and existing systems, the role of time in differentiating intention from actual use, and the necessity of assessing the alignment of new technology projects with the organization's goals.

On the other hand, empirical findings underscore the intricate nature of the technology adoption process, emphasizing the diverse barriers and strategies pinpointed by stakeholders. Barriers spanned five categories, with "Process" augmenting the theoretical framework. At top organizational levels, strategies revolve around crafting strong business cases, budget allocation, and stakeholder management. In contrast, lower levels focus on user acceptance during technology deployment. Transparency is vital across levels, especially for operational alignment and expectation setting. Stakeholder buy-in is pivotal for adoption. The research underscores the distinction between projects directly addressing business issues, which have higher success rates, and tech-driven initiatives with unclear financial gains, which face challenges. These tech-centric projects require strategic framing, extensive stakeholder involvement, and evidence of benefits. The research accentuates the role of upper management and a dedicated innovation budget in bolstering technology adoption.

By juxtaposing this framework against the empirical findings derived from the interviews, experiments, and direct observations, several insights emerge:

- **Intention vs Actual use:** the UTAUT emphasizes the difference between intention to use and actual use. This distinction was palpable in the empirical findings. While many interviewees expressed interest or intention to utilize VR, the actual use was contingent upon multiple factors, many of which were highlighted within UTAUT, such as perceived effort, performance, and social influence.
- **Contextual importance:** The empirical findings consistently mirrored the importance of context, a sentiment echoed by the TOE and HOT frameworks. AF-KLM's adoption challenges were multi-dimensional, they are not merely technological but also other aspects such as organizational.
- **Resistance to change:** Theoretically identified barriers, especially resistance to change, manifested clearly in the empirical observations. For instance, the direct observations revealed that some managers might view VR innovations as distractions, a clear indication of resistance to change.
- **Technology alignment:** The emphasis on aligning technology with objectives, as posited by the Task-Technology-Fit (TTF) framework, was visible in empirical data. The experiment highlighted how VR's potential impact on operational efficiency could make a compelling case for its adoption if properly aligned with the company's overarching goals.
- **Temporal dynamics:** The adoption process's temporal progression, while implicit in theoretical models, was explicitly evident during the direct observations and experiments. e adoption process is not instantaneous; it involves various stages, each presenting its own set of challenges and opportunities.
- **Specific tailoring:** The empirical findings and the theoretical concepts both underscore the necessity of a strategic, case-specific approach to overcome adoption barriers. As the literature suggests, while overarching strategies can be derived, their execution must be tailored to the unique context of each organization or department.

The empirical findings validated and enriched the theoretical insights. They brought to light the intricate nuances of the adoption process, emphasizing the importance of context, stakeholder involvement, and strategic alignment. Where the theoretical framework provided a foundation, the empirical findings added depth, offering a holistic view of technology adoption in complex organizational environments like AF-KLM.

5.3.2. Technology adoption framework

The integration of theoretical and empirical findings provides a comprehensive understanding of VR adoption. As aforementioned concepts from the theoretical framework are reaffirmed in the empirical findings, and new insights have been seen. This integration paves the way for the development of a technology adoption framework rooted in the realities of the organizational context.

Based on these findings, the following framework has been developed. It differentiates between organizational adoption, referring to the initial stages when focus is on obtaining higher management approval, and user acceptance, which comes into play post-intention. This strategic framework will contribute to the scientific knowledge of technology adoption and will support companies or technical departments like the XR-CoE to guide the next steps and provide a roadmap to facilitate VR adoption within an organization. The visual representation of the framework is shown in Figure 5.1.

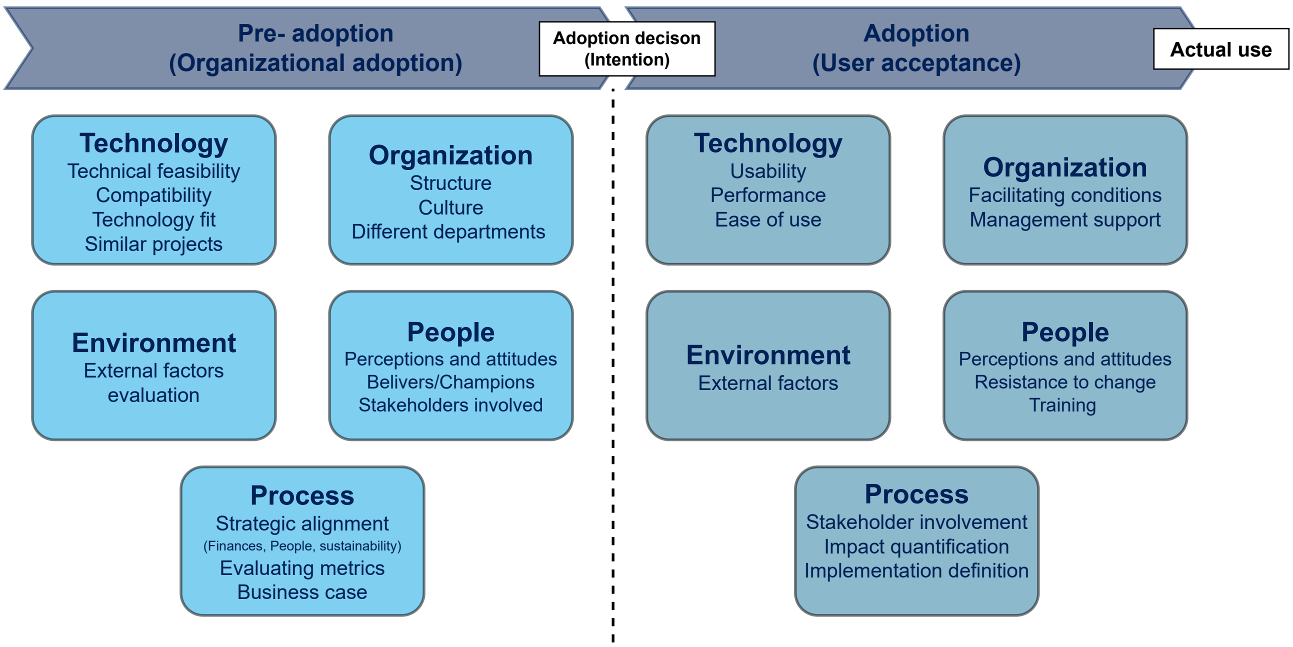

Figure 5.1: Strategic framework

The strategic framework used the five different factor categories identified in previous chapters to provide an overview of all the aspects that must be considered by the XR-CoE at each of the stages. This differentiation not only provides an exhaustive view of the adoption process but also allows for targeted strategies and interventions.

The initial stage of VR adoption requires the alignment of the new technology with the company's strategic objectives, culture, and existing technological infrastructure. The factors influencing this phase can be categorized as follows:

- **Technology:** In this stage organizations should focus on analyzing the technical feasibility of the project, and the fit of the technology with the required task. Also, it should be understood the compatibility of the VR product within the existing organization's systems, as business departments need to consider it when deciding. Finally, having similar projects will serve as a positive case to prove the technology performance.

- **Organization:** At the organizational level, it should be considered how the structure and cultural factors of the company can influence the adoption, or the other way around, would the technology suppose any change to the structure or culture of teh company? This structure and cultural difference,include addressing possible differences between departments that can hinder adoption.

- **Environment:** External factors that may influence the adoption decisions of the business units should be considered. For example, safety regulations that affect training programs, or external forces that might align with the implementation of VR such as the need of faster training due to workforce shortages.

- **People:** In this phase, the XR-CoE should consider what stakeholders need to be involved in the process and get them on board. It will be also important to asses the perception and attitudes of these stakeholders to be able to approach it correctly. Finally, it will probably be necessary to look for champions (believers of the technology) to speed up the process and influence other stakeholders.

- **Process:** Regarding the process, it will be necessary to align the technology with the strategic vision of the company, and build a compelling business case. It is necessary at this stage to define the necessary steps depending on previous factors (technology complexity, technology fit, or known impact), for instance, building a POC or directly building an MVP. Then, to asses the viability of the technology is necessary to establish some evaluating metrics.

After the adoption decision is taken, the focus shifts to the end-users who will be using the VR technology. This phase is guided by the following categories:

- **Technology:** In this stage greater importance is given to the usability (e.g. comfort, hardware and software integration, etc.), and ensure that the performance is ensured to meet the needs of the end-users.

- **Organization:** Organizational structures, processes, or culture that might influence user acceptance are assessed and adjusted. This might involve introducing new workflows, offering incentives, or promoting a supportive culture for technology use.

- **Environment:** Although apparently lower importance than in the previous stage, it should be considered any change in external factors that could affect adoption (e.g. industry standards, or regulatory requirements).

- **People:** End users' perceptions of the VR technology are essential for its attitude towards using the technology. For this, change management strategies mentioned in the previous chapter such as ensuring user's involvement or celebrating success, are relevant. Also, providing with training to acquire the necessary skills and knowledge will be necessary.

- **Process:** Finally, a structured process for managing the roll out of the VR technology to the end-users needs to be implemented. This includes establishing the continuous use process, keep all stakeholders involved, and tracking usage and performance over time to quantify impact.

Framework Strategy	Barrier Addressed	Description
	Organizational Adoption	
Analyze technical feasibility	Technical complexity; Incompatibility with existing systems	Evaluating the feasibility early on ensures that the technology is suitable for the organizational needs, reducing issues of technical mismatch and ensuring smoother integration.
Align technology with strategic objectives	Misalignment with company's goals	By ensuring that the VR initiatives resonate with the company's broader goals, we ensure a higher chance of stakeholder buy-in and a clearer ROI path.
Build a compelling business case	Insufficient financial resources; Unclear ROI	A strong business case provides clear financial projections, demonstrating potential ROI, and helping secure necessary budgets for the project.
Involve key stakeholders early on	Resistance to change; Lack of management support	Early involvement creates a sense of ownership among stakeholders, reduces resistance, and ensures that managerial support is garnered from the onset.
Assess viability with clear metrics	Demonstrating effectiveness; Ambiguity in project value	Clearly defined metrics allow for a tangible assessment of the project's value, offering data-driven insights into its effectiveness.
	User Acceptance	
Ensure usability and performance	Technical challenges; User resistance due to poor UX	A user-friendly interface, combined with needed performance, ensures that end-users can easily adapt to the new technology, reducing resistance stemming from usability issues.
Provide training and skill development	Lack of skills; Resistance due to unfamiliarity	Training sessions ensure users are equipped with necessary skills, reducing hesitancy due to unfamiliarity and ensuring more widespread adoption.
Celebrate successes and manage change	Resistance to change; Skepticism towards new technology	Highlighting early wins fosters a positive perception of the technology. Combined with effective change management, this strategy mitigates resistance and skepticism.
Establish continuous use process	Ensuring sustained use after initial adoption	A defined process for continued use ensures that the technology remains embedded in the organizational workflow, preventing decline in usage over time.
Track usage and performance over time	Demonstrating long-term value; Assessing continued relevance	Regular tracking provides insights into how the technology is performing and its ongoing relevance, ensuring that it continues to deliver value and remains aligned with organizational needs.

Table 5.1: Technology adoption framework strategies and barriers

The technology adoption framework presented offers a systematic and integrative approach tailored to address the unique barriers encountered in VR adoption. Its strength lies in its ability to provide companies with a clear roadmap, guiding them through the complexities and challenges inherent in adopting VR technologies. By drawing from both theoretical insights and empirical findings, the framework formulates specific strategies to tackle these barriers. Table 5.1 delineates these strategies and illustrates their direct relevance in mitigating the identified obstacles.

5.4. Practical implications for KLM

This research, undertaken in partnership with AF-KLM, has primarily focused on the data from two dominant VR use cases: telepresence and training. Drawing from the comprehensive findings and discussions presented thus far, this section elaborates on the practical implications associated with these cases. Additionally, the development of a strategic decision tool exemplifies the proactive approach to facilitate VR adoption in alignment with the organization's strategic objectives.

5.4.1. VR for training

The VR for training case, as previously detailed, involves the use of VR to train employees of AF-KLM at operational levels, such as the de-icing or fuelling workforce. These initiatives were born out of a necessity to tackle extended training periods and the limitations associated with training using real equipment. Due to the risks of damaging equipment, there were certain restrictions in place, which sometimes compromised a comprehensive understanding of the process for employees in training.

Historically, these training initiatives saw limited adoption by departments or trainers. According to the findings, there was a lack of commitment and involvement from all necessary stakeholders. Although the VR products were technically sound, they were not fully accepted by departments. This rejection was often due to limited participation in the production process, unmet needs in the final product, or the perception that the product was unnecessary. These barriers have been addressed by the XR-CoE by changing their working approach and leveraging the growing interest from operational departments in streamlining their operations.

The increased awareness of VR's capabilities and external factors such as workforce shortages have increased interest in using VR for training. Operational departments are recognizing the potential for more efficient and reliable training, especially in terms of the ability to practice a wide range of scenarios more frequently in VR and combine this training with real-world experiences.

Despite this growing interest, it appears there is still some resistance during the early stages of the adoption process. Adoption decisions may be slow due to concerns about return on investment and perceptions about the effort required to implement the VR product as part of standard training operations. Additionally, overlap in responsibilities between the XR-CoE and other departments involved in developing learning materials has been observed.

While at AF-KLM, it was noted that the company also sells its VR training products to third parties such as aviation schools. A call with an individual involved in the VR training at one such school revealed widespread use of the technology as part of their value chain. However, initial barriers were reported, such as initial reluctance from teachers and students. To overcome these challenges, the school gradually introduced the technology, allowing teachers and students to experiment with it. Upon seeing the positive impact on student performance and assessment outcomes, the teachers eventually accepted and adopted the VR training. This emphasizes the importance of demonstrating impact and aligning VR implementation with the objectives of end-users.

While this case serves as an example to AF-KLM, several key differences should be noted. The primary objective of the school is to provide a superior educational program, while AF-KLM's primary goal is to enhance operations to increase operational efficiency and reliability. While better training can contribute to this, the alignment is not as direct as in the educational context. Furthermore, the organization structure and decision-making process at the school are much simpler than those at a large company like AF-KLM.

In conclusion, the VR for training case provides valuable insights for overcoming adoption barriers and successfully integrating VR into existing processes. This case emphasizes the importance of stakeholder involvement, gradual implementation, and the demonstration of tangible benefits in fostering acceptance and adoption of VR technology.

5.4.2. VR for telepresence

The application of VR for telepresence serves as an illustration of technology being pushed by the technical department to address significant organizational challenges, such as extensive company travel and the difficulties of geographically distributed collaboration. However, from a business perspective, these issues are not necessarily perceived as urgent problems demanding immediate solutions.

The AF-KLM telepresence experiment showcased promising outcomes, demonstrating the potential of VR to improve team collaboration, increase engagement, and foster a sense of togetherness among geographically disparate teams. The experimental findings showed marked increases in Team Promoter Score (TPS), team engagement, and work engagement metrics following the VR implementation. Moreover, shifts in perceptions, as reflected by Likert scale responses, indicated the technology's potential to facilitate more effective communication, provide collaboration opportunities, and enhance motivation during meetings.

Nevertheless, the experiment also highlighted several challenges and areas for improvement. Technical issues such as connectivity problems and hardware limitations emerged as barriers to seamless VR usage. The need for VR to be integrated with existing enterprise software and tools, along with the provision of VR resources for new team members, were also emphasized. Although VR was generally perceived as positively impacting team collaboration and communication, concerns were raised about its suitability for specific project-related tasks. To maximize the benefits of VR for telepresence, these technical challenges must be addressed.

For VR telepresence to be widely adopted within the organization, overcoming technical issues is necessary but not sufficient. The XR-CoE may find resolving these issues easier than convincing the higher levels of the company to invest in this technological use case. Even though the experiment exhibited the benefits of enhanced team collaboration and work engagement, assessing the precise financial impact remains challenging. There's also a perception that other less technologically complex solutions could provide similar benefits.

The team participating in the experiment expressed a willingness to continue using VR, and colleagues who observed its use have shown increased interest in the technology. The XR-CoE could leverage this social influence to broaden the base of believers and carry out larger-scale experiments. These could provide a more comprehensive view of VR for telepresence's potential and help evaluate the financial benefits it could deliver by reducing travel costs and enhancing team productivity.

In conclusion, promoting successful user experiences is crucial for the successful adoption and integration of VR technology for telepresence within AF-KLM. The right balance between addressing technical issues and emphasizing potential organizational benefits is paramount. This case serves as an example of the multiple levels at which the adoption process encounters barriers, illustrating the interconnections among them. At the higher levels of the company, the focus is on establishing a positive financial case, while at the operational levels, user acceptance and technological aspects gain prominence. In this case, if the technical challenges are addressed and the users' satisfaction improves, leading to increased productivity and efficiency, this could present a compelling business case to upper management.

5.4.3. Strategic decision tool

Empirical results indicated that the XR-CoE has already implemented several strategies based on their past experiences and identified barriers. These strategies seek early commitment from departments by securing budget allocation for the development of a MVP. If necessary, POC is built to validate the idea before proceeding to the MVP stage. In all cases, it is necessary to involve the business from the beginning of the project. The agile methodology is employed to incorporate regular business feedback, aiming to deliver a solution that best fits their requirements, thereby promoting greater user acceptance of VR products.

However, challenges in demonstrating the effectiveness of VR products and assessing project value persist. This is where a decision-making tool, rooted in the strategic framework, can come into play. Such a tool can help align VR products with the strategic goals of the businesses and assist the XR-CoE in assessing the potential of the product. The tool was ideated based on the strategic framework to help the XR-CoE at the organizational adoption stage. A mock-up of the tool is shown in Figure H.1.This interactive tool poses several questions related to factors influencing adoption, gauging the potential impact, and cost of the VR project. The goal is to provide preliminary estimates of potential impact, enabling the XR-CoE to set objectives and assess project viability.

The tool's output consists of a project advancement recommendation, represented by a green-red scale, supplemented with suggestions based on user input. For example, if no similar projects exist and the technology fit is uncertain, a proof of concept will be recommended. Based on case study results, financial performance carries more weight than aspects related to people and sustainability. In cases where clear financial outcomes are not apparent, such as VR for telepresence, the tool will not provide a green signal due to likely resistance from the business. However, if potential performance outcomes related to people and sustainability that could lead to financial benefits are identified, the tool will recommend further experimentation, expansion of the 'believers' base, and resolution of any technical complexities. In conclusion, once fully developed, this tool will offer an interactive framework that the XR-CoE can use to support their cases and present to the business, as well as to provide an overview of a project's feasibility.

A first version of the tool has been built in Python, and it is shown at the Figure H.3 and Figure H.4.

6

Conclusions & Recommendations

At the outset of this research, the primary problem centered around understanding the complexities of Virtual Reality technology adoption within the airline industry, particularly in the context of Air France-KLM. The investigation sought to not only comprehend the barriers of integrating VR technology into the industry but also to identify practical strategies that could facilitate the complete industrialization of VR innovations. Thus, the research question was posed: "How can VR technology adoption be effectively supported within the airline industry to achieve complete industrialization?" This question served as the guiding principle throughout this research, steering the careful examination of both theoretical and empirical facets of technology adoption within an industrial setting.

The methodology, mixing a comprehensive literature review and a detailed case study at AF-KLM, was meticulously chosen to provide both breadth and depth to the exploration. The literature laid the foundation, revealing established frameworks like UTAUT and hinting at the potential gaps in understanding VR adoption in the unique context of the airline industry. The empirical findings from AF-KLM added layers of depth, unveiling barriers at various stages and suggesting potential strategies to overcome them.

Guided by the structure of the thesis and the sub-research questions, it is presented a summary of the primary findings from the research:

- **Gaps in technology adoption theories** While the reviewed technology adoption theories serve as useful tools to comprehend and facilitate the adoption process, they present notable gaps. Particularly, in the contexts of the airline industry and VR, there has been found limited to none literature. Models like UTAUT, which focus predominantly on the individual level, overlook broader contextual factors. This research found value in classifying concepts into distinct categories. Additionally, elements like time, compatibility, and technology alignment emerged as crucial to fully grasp the intricacies of the adoption process.
- **Awareness of Barriers:** The case study illuminated the multi-dimensional nature of barriers faced when adopting new technologies. Categorizing these barriers proved beneficial for their systematic consideration and interpretation. It became evident that AF-KLM employees are acutely aware of various barriers, common to most technological changes or new implementations. While some barriers were specific to

technology, others, like organizational or process challenges, are ubiquitous across diverse changes.

- **Identification of General Strategies:** The case study underscored the value of drawing from past experiences and recognizing the inherent barriers in change programs. It's important to highlight that both theoretical and empirical examinations did not yield prescriptive strategies. Instead, the emphasis was on adaptable, overarching strategies tailored to specific scenarios.

- **VR technology adoption framework.** A comprehensive technology adoption framework for VR was formulated by merging theoretical insights with empirical findings from AF-KLM. This framework not only distinguishes between organizational adoption and user acceptance phases but also methodically categorizes influencing factors into five key domains: Technology, People, Organization, Environment, and Process.

This research, rooted in the airline industry, offers broader theoretical insights into VR technology adoption. Beyond highlighting the necessity of strategic alignment, managerial commitment, and user acceptance, the study pinpoints gaps in existing frameworks like UTAUT when applied to sectors steeped in tradition and regulation. The research underscores the multifaceted nature of technology adoption, emphasizing that it's not merely about technological compatibility, but also about organizational culture, stakeholder perceptions, and the inherent attributes of the technology itself. This work thereby expands the existing theoretical landscape and prompts a more tailored approach to understanding the integration of innovative technologies in established industries.

The developed technology adoption framework has been specifically tailored to suit AF-KLM's unique landscape but holds potential for wider applicability. This framework serves as a roadmap, guiding organizations through the maze of VR adoption, from initial managerial endorsement to sustained user assimilation. With actionable insights embedded throughout, it is a valuable tool, especially for entities such as AF-KLM's XR-CoE, ensuring that VR investments are effectively channeled into producing tangible benefits. Additionally, a strategic decision tool, anchored in the research's framework, was introduced to aid in aligning VR projects with overarching business objectives, offering a more structured approach to VR integration.

Every research initiative has its inherent limitations, and this study is no exception. The chosen case study methodology, while providing in-depth insights into VR adoption at AF-KLM, binds the findings closely to this specific airline's context, possibly limiting their broader applicability. Variabilities within the aviation sector mean that the experiences of one airline might not mirror another's, given their distinct organizational cultures, business models, and technological infrastructures. Additionally, while this research spotlighted VR, the dynamics of its adoption could differ from other emerging technologies. The qualitative nature of data collection, built on stakeholders' inherently subjective perceptions and experiences, introduces potential biases. Moreover, external factors, such as the ramifications of the COVID-19 pandemic on the airline industry, might have shaped some outcomes. Future studies should consider these limitations, aiming for a broader applicability and encompassing a more diverse range of emerging technologies and organizational contexts.

From the in-depth exploration and interpretation of the findings, a detailed understanding of technology adoption within the airline industry has emerged. Based on this, a set of recommendations can be delineated.

Recommendations for scientific/theoretical Knowledge:

- Future research should aim to validate the VR adoption framework in diverse industries beyond aviation, ensuring its adaptability and relevance across varied contexts.
- Besides VR, other emerging technologies should be the focus of technology adoption studies to anticipate potential challenges and strategies relevant for industries.
- Introduce quantitative research methods to complement qualitative findings, offering a more comprehensive understanding of VR adoption dynamics.
- Given the dynamic nature of technology and its adoption, longitudinal studies can offer insights into the evolving nature of barriers, strategies, and successful adoption practices over time.

Recommendations for AF-KLM and similar organizations:

- Put into practice the technology adoption framework developed in this study to guide the technology integration processes. Investigate its impact on the adoption process to understand its effectiveness and make necessary modifications.
- Continue the development and refinement of strategic decision-making tool, like the one introduced in this research, to assist in evaluating the feasibility and strategic alignment of potential technology use cases.
- Launch strategic communication campaigns to create awareness, highlight benefits, and dispel myths or misconceptions related to new technologies.
- Engage all relevant stakeholders, from the executive level to the operational teams, early in the technology adoption process to ensure alignment, commitment, and smoother integration.
- Continue partnerships with academic institutions to stay informed of the latest research findings, ensuring that organizational strategies are informed by both practical experiences and academic insights.

In conclusion, this research, centered on the adoption of VR within the airline industry, illuminates the balance between innovative potential and real-world challenges. While the journey of technology adoption is frequent with complexities, the strategic framework devised here offers a pragmatic compass for navigating this terrain. Beyond its specific context, the research enriches the academic discourse on technology adoption, presenting a tangible blueprint for industries aiming to harness emergent technologies.

In a world marked by swift technological advancements, the need for organizations to remain agile, informed, and strategic in their adoption endeavors is paramount. This research, by bridging theoretical insights with actionable strategies, aspires to empower organizations in translating tech-driven innovations into discernible business advantages. It thus stands as both an academic inquiry and a practical guide, prepared to support enterprises embarking on the intricate voyage of integrating emerging technologies.

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A Literature review I

A.1. Table of results

Table A.1: Table of results Literature Review I

	Year	Author	Methodology	Theretical foundation	Findings	Main factors	Notes
1	2016	Virdyananto, A.L et al.	Literature review + Questionnaires	UTAUT, Task Technology Fit (TTF) and symbolic adoption	Task-technology fit: If people see it as cool but don't see the applicability wouldn't accept it Social influence also plays an important role influencing the adoption	TTF, Social influence, ease of use, management support	In a mandatory environment symbolic adoption, as well as as use, happens before acceptance.
2	2016	Venkatesh, V., Thong, J. Y., & Xu, X	Literature review	UTAUT and UTAUT 2	UTAUT and its extensions provides a complete framework to analyze adoption, but some new contextual factors should be considered to expand its predictive powers.	Multi-level perspective to include contextual factors: Organizational, environment, location, technology and time. Social influence, both formal and informal norms, should be considered	-
3	2022	Xu, J. & Lu, W	Litearture study + Case Study	Human Organization Technology (HOT) based on adoption theories (e.g. TOE and UTAUT)	A new technology adoption framework is developed for organizations. IT adoption is a technical and social process.	Combination of factors of other theories grouped into H-O-T categories. The bi-party connections (OT,HT, OH) need to be established for an overall balance	-
4	2020	Hameed, M. A., & Arachchilage, N. A. G	Literature review	DOI, TAM, TPB and TOE	Different factors affect the organization's adoption process and at the individual user acceptance process	TOE is used to understand organization's context and the adoption decision. TAM+TPB (UTAUT) is used to analyze individual level of acceptance	-
5	2012	Sargent, K., Hyland, P., & Sawang, S.	Case Study (questionnaires)	UTAUT	Top management support, ease of use, and facilitating conditions are found to be the most important factors.In contrast performance expectancy showed to have fewer effect.	UTAUT base model + resistance to change and top management support	Adoption is madated, it depends on several stakeholders and it needs of training and support.
6	2018	Rehouma, M. B., & Hofmann, S	Literature review	UTAUT, TAM, TRA, TPB, ELM, and DeLone and McLean's IS success model	There were identified 7 main factors influencing the adoption of new IT solutions. Adoption is a process, not an isolated action (involvement of the different actors is needed)	The factors are grouped into Technology (Performance expectancy, ease of use, and usefulness); Individual (User's knowledge and skills, related to user experience and perceived usefulness; Organization (Economic health, culture, and management support); Environment (Social influence, and observability of the results)	Analyze the adoption of IT in the public sector, considered to be a bureocratic and complex environment as it has a lot of stakeholders involved in the adoption and established formal norms.

7	2011	Park et al.	Field study	UTAUT	Organizational facilitating conditions (fc) explain more variance in the individual technology acceptance than individual fc. Org. fc have a direct impact on the actual use, but it did not moderate the individual perceptions (e.g. performance expectancy have a very strong power and can be directly influenced by fc)	Organizational facilitating conditions	Org. fc are the factors supporting the acceptance of technology and has an impact on the perception of individuals. (e.g. instructor availability, infraestructure availbaility, and training). Suggests an assesment of org. fc to asses which groups need more actions for a more effective acceptance.
8	2007	Cho, S., & Mathiassen, L	Case study	Industry infrastructure for technological innovation (Van de Ven, 2005)	The concepts of the theory allow to understand the context of IT in healthcare, identifying barriers and allowing to assess actions	Institutional arrangements, resource endowment, market consumption, and proprietary activities	Little attention was given to the integration process in the businesses. Only businesses with highly skilled staff and good resources could use the innovation. There was a misalignment between the innovation and current processes.
9	2020	Park, K. O	Surveys	UTAUT + TOE	UTAUT and TOE factors used showed to have a strong influence on attitude and sustained use of Blockchain technology in logistics. TOE had a greater effect than UTAUT	UTAUT base model + Technological and Organizational context	-
10	2013	Miltgen, C. L., Popovič, A., & Oliveira, T	Online survey	TAM + DOI + UTAUT	Perceived ease of use did not have a clear effect on intention, but it was found an inhibitor of perceived usefulness. Compatibility influenced the perceptions and intentions of users. Facilitating conditions also had an effect on intention. And trust and privacy proved to have a direct effect on intention, but not an intermediate effect over the other constructs.	Compatibility, perceived ease of use and usefulness, social influence, facilitating conditions, privacy and trust. Perceived risks	-
11	2009	Isabelle, B., & Sandrine, O. H.	Online survey	UTAUT	Positive relation betwee UTAUT factors and intention. Also, org. strucure and time available positively influence intention. However, incentives showed to have an counteractive effect on intention	UTAUT base model + Org. structure, time available, culture and incentives	Social influence is splitted between different sources of influence
12	2014	Hong, W., Chan, F. K., Thong, J. Y., Chasalow, L. C., & Dhillon, G.	literature review + Case study	TAM	Context is important, but trade-offs must be done. Two general approaches for contextualization are explained. And there are presented 6 ways of including context into theory development. Decompsition and antecenteds methods are compared, and each of them fits better specific types of cases	-	Context is many times missed on the application of theories. Also, when studied they are sometimes studied in isolation. The paper evolves around the premise of the relevance of the interaction between technologies, users, and usage contexts.
13	2008	Yusof, M. M., Kuljis, J., Papazafeiropoulou, A. & Stergioulas, L. K.	literature review + Case study	HOT-fit (Human, organization, technology fit)	A new adoption model is proposed base on the IT organization fit framework. Mismatch of factors influence the real use of the technology. It should be taken as an informative framework for decision making	Technology (System, information and service quality), Human (system use and user satisfaction), and Organization (structure and environment). Net benefits of the new technology are also specified	Human, organizational and technical elements should also have a mutual alignment or 'fit' in order to ensure successful HIS implementation. Daily workload was found to be a great barrier for making the adoption
14	2021	Bryan, J. D., & Zuva, T.	Literature review	TAM + TOE	TAM provides provides more ability to clarify intention, whereas TOE can better predict adoption. Mixing both provides a more powerful framework	Perceived ease of use and perceived usefulness are influenced by external variables taken from TOE framework	-
15	2017	Brown, S. A., Massey, A. P., Montoya-Weiss, M. M., & Burkman, J. R.	Survey + interviews	TAM + TPB	Ease of use was the most relevant factor influencing use. Extrinsinc motivation plays a relevant role (not only intrinsic). There were differences between managers and employees in gains of the new system	Perceived ease of use and perceived usefulness.	Even in mandatory environments there is voluntariness of adoption. If there are alternatives, people may choose one technology/system over the other
16	2006	Kamal, M. M.	Qualitative multiple case study	Adoption and project management models	The author identifies several premises that must occur for a successful innovation adoption, and from them draws up the main 42 succes factors that shape adoption at organizations	Technology, organizational, support, collaboration and external factors	It establishes a adoption process in which pre-adoption and post adoption stages occur, differenciated separeted by the moment in which the adoption decision is made
17	2016	Hwang, Y., Al-Arabiat, M., & Shin, D. H.	Literature review	TRA + TPB + TAM + UTAUT	The main literature gaps identified are the temporal aspects, mandatory environments and leadership effects over technology acceptance. Literature has also ignored the implementation aspects of IT projects	Temporal: How the attitudes changes over time. Time has been only conceptualized as experience. Mandatory settings may pose challenges over attitude and behaviour misallignments. Leadership at different levels of organizations is missing	-

18	2012	Ciganek, A. P., Haseman, W., & Ramamurthy, K.	Questionnaires and model testing	TOE	Risk-taking organizations were found to accelerate adoption decisions. Also, the hypothesis that adoption is influenced by normative pressures was supported. Perceived limitations of the technology were found to restrict the decision. Pressure from suppliers was found to be a strong force for the need for adoption. Top manager support was found to delay the adoption decisions as it may add extra bureaucracy to the process, whereas autonomy at the local level can agilize processes	Innovation, organization, and environment facotrs are considered. As well as control variables	Awareness to decision and need to decision. Missmatch between the characteristics of the innovation and the desired solution to the problems can hinder the adoption process. If the innovation is completely compatible may mean that the solution is not adding enough value
19	2016	Van Lancker, J., Mondelaers, K., Wauters, E., & Van Huylenbroeck, G.	Literature review	Innovation system frameworks	Using a innovation systems approach for organizations provides a framework for organizing innovation processes	Structural components, functions, and failures of the systems	-
20	2022	Ortt, J. R., & Kamp, L. M	literature review + Case study	Innovation system frameworks	System building blocks and influencing conditions are defined. The framework can help explore the context around an innovation during the early stages of the process, and identify barriers and ptential strategies	System building blokcks and the respective influencing conditions	-

B

Literature review II

B.1. Selection criteria results

Table B.1: Selection requirement criteria table

	Title	Year	Author	RQ1	RQ2	RQ3	RQ4	RQ5	RQ6
1	Barriers and enablers of technology adoption in the mining industry	2021	Ediriweera, Amali, and Anna Wiewiora	No	Yes	Yes	Yes	Yes	No
2	A Systematic Review of Organizational Factors Impacting Cloud-based Technology Adoption Using Technology-Organization-Environment Framework	2021	Al Hadwer, Ali, et al	No	Yes	Yes	No	No	Yes
3	Accelerating technology adoption: A benchmarking study of organisational innovation adoption culture in upstream oil and gas	2021	Roberts R.; Flin R.; Corradi L.	Not available					
4	Adoption of collaborative technology to enhance master data quality across municipal administrations - Identifying drivers and barriers	2018	Meske C.; Heidekrüger R.; Brockmann T.; Czerwonka M.; Stieglitz S.	No	Yes	No	Yes	No	No
5	Adoption of Health Information Technology Among US Nursing Facilities	2019	Vest J.R.; Jung H.-Y.; Wiley K., Jr.; Kooreman H.; Pettit L.; Unruh M.A.	No	Yes	No	Yes	No	No
6	Adoption of health information technology in the mobile emergency care service	2019	Wendland J.; Lunardi G.L.; Dolci D.B.	No	Yes	Yes	Yes	No	No
7	Adoption of innovative technologies in the South African construction industry	2021	van Wyk L.; Kajimo-Shakantu K.; Opawole A.	Not available					
8	Adoption of modern technologies for implementing industry 4.0: an integrated MCDM approach	2022	Javaid M.; Khan S.; Haleem A.; Rab S.	Not available					
9	Adoption of sustainable technology in the Malaysian SMEs sector: Does the role of government matter?	2020	Bakar M.F.A.; Talukder M.; Quazi A.; Khan I.	No	Yes	No	No	Yes	No
10	Application Layer Challenges and Adoption Barriers to Internet Based Advanced Communication Technologies in SME	2018	Kuruwitaarachch N.	No	Yes	No	Yes	No	No
11	Barricades in the Adoption of Block-Chain Technology in Supply Chain Management: Challenges and Benefits	2021	Akhtar P.; Azima N.; Ghafar A.; Din S.U.	No	Yes	No	Yes	Yes	Yes
12	Barriers Affecting Higher Education Institutions' Adoption of Blockchain Technology: A Qualitative Study	2022	Mohammad A.; Vargas S.	No	Yes	Yes	Yes	No	Yes
13	Barriers to information and digital technology adoption in humanitarian supply chain management: a fuzzy AHP approach	2023	Kabra G.; Ramesh A.; Jain V.; Akhtar P.	Not available					
14	Barriers to the digitalisation and innovation of Australian Smart Real Estate: A managerial perspective on the technology non-adoption	2021	Ullah F.; Sepasgozar S.M.E.; Thaheem M.J.; Al-Turjman F.	No	Yes	Yes	Yes	No	Yes
15	Blockchain technology adoption barriers in the Indian agricultural supply chain: an integrated approach	2020	Yadav V.S.; Singh A.R.; Raut R.D.; Govindarajan U.H.	No	Yes	No	Yes	No	Yes
16	Blockchain technology and the sustainable supply chain: Theoretically exploring adoption barriers	2021	Kouhizadeh M.; Saberi S.; Sarkis J.	No	Yes	Yes	Yes	No	Yes
17	Blockchain technology and vaccine supply chain: Exploration and analysis of the adoption barriers in the Indian context	2023	Yadav A.K.; Shweta; Kumar D.	No	Yes	Yes	Yes	No	Yes
18	Business financing and blockchain technology adoption in agroindustry	2020	Rijanto A.	No	Yes	Yes	Yes	No	Yes
19	Complex analysis of information technologies integration and adoption into medical organizations	2021	Mikhailova A.A.; Efimova A.K.; Shestakov A.V.; Bobrysheva A.A.; Motlokhova E.A.; Zvonareva O.I.	Not available in english					
20	Construction technology adoption cube: An investigation on process, factors, barriers, drivers and decision makers using NVivo and AHP analysis	2018	Sepasgozar S.M.E.; Davis S.	Yes	Yes	Yes	Yes	yes	Yes
21	Development of a techno-humanist model for e-health adoption of innovative technology	2018	Razmak J.; Bélanger C.H.; Farhan W.	Yes	Yes	Yes	Yes	Yes	No
22	Digital Technology Adoption in SMEs: What Technological, Environmental and Organizational Factors Influence SMEs' ICT Adoption in Emerging Countries?	2023	Shahadat M.M.H.; Nekmahmud M.; Ebrahimi P.; Fekete-Farkas M.	Yes	Yes	Yes	Yes	No	No

23	Digital transformation of healthcare sector. What is impeding adoption and continued usage of technology-driven innovations by end-users?	2022	Iyanna S.; Kaur P.; Ractham P.; Talwar S.; Najmul Islam A.K.M.	Yes	Yes	No	Yes	No	No
24	Drivers and barriers of Industry 4.0 technology adoption among manufacturing SMEs: a systematic review and transformation roadmap	2022	Ghobakhloo M.; Iranmanesh M.; Vilkas M.; Grybauskas A.; Amran A.	No	Yes	Yes	Yes	Yes	Yes
25	Empirical study on influencing factors of biogas technology adoption in Khyber Pakhtunkhwa, Pakistan	2020	Amir S.M.; Liu Y.; Shah A.A.; Khayyam U.; Mahmood Z.	Not available					
26	Evaluate the barriers of blockchain technology adoption in sustainable supply chain management in the manufacturing sector using a novel Pythagorean fuzzy-CRITIC-CoCoSo approach	2022	Han X.; Rani P.	Yes	Yes	No	Yes	No	Yes
27	Exploring the experiences of mental health professionals engaged in the adoption of mobile health technology in Irish mental health services	2021	Melia R.; Monahan L.; Duggan J.; Bogue J.; O'Sullivan M.; Young K.; Chambers D.; McInerney S.	Yes	Yes	Yes	Yes	Yes	No
28	Factors affecting organizations' resistance to the adoption of blockchain technology in supply networks	2020	Choi D.; Chung C.Y.; Seyha T.; Young J.	Yes	Yes	Yes	Yes	No	Yes
29	Factors affecting the implementation, use, and adoption of real-time location system technology for persons living with cognitive disabilities in long-term care homes: Systematic review	2021	Grigorovich A.; Kulandaivelu Y.; Newman K.; Bianchi A.; Khan S.S.; Iaboni A.; McMurray J.	No	Yes	No	Yes	No	No
30	Identification of factors influencing the adoption of health information technology by nurses who are digitally lagging: In-depth interview study	2020	De Leeuw J.A.; Woltjer H.; Kool R.B.	Yes	Yes	Yes	Yes	Yes	No
31	Identifying institutional barriers and policy implications for sustainable energy technology adoption among large organizations in California	2020	Wang L.; Morabito M.; Payne C.T.; Robinson G.	No	Yes	No	Yes	No	No
32	Impact of E-Commence Technology Adoption in Dubai SMEs	2019	Almtiri Z.H.A.; Miah S.J.	No	Yes	No	Yes	No	No
33	Information Technology Adoption Barriers in Public Sector	2022	Abdelhakim M.; Abdeldayem M.M.; Aldulaimi S.H.	Yes	yes	Yes	Yes	No	No
34	Integrated Model Development in Information Technology Adoption	2019	Sanco S.; Harmein N.; Rahim M.; Nazaruddin	Yes	No	No	Yes	No	No
35	Level of agreement on health information technology adoption and use in survey data: A mixed-methods analysis of ambulatory clinics in 1 US state	2019	Rudin R.S.; Shi Y.; Fischer S.H.; Shekelle P.; Amill-Rosario A.; Shaw B.; Ridgely M.S.; Damberg C.L.	No	No	No	No	No	No
36	Perceived barriers to information and communication technology (ICT) adoption in Ivorian SMEs	2022	Assiélou N.G.; Bourgault M.	Npt available					
37	Perceived Barriers to the Adoption of Smart Farming Technologies in Piedmont Region, Northwestern Italy: The Role of User and Farm Variables	2020	Caffaro F.; Cavallo E.	No	Yes	No	Yes	No	No
38	Perspective of Information Technology Decision Makers on Factors Influencing Adoption and Implementation of Artificial Intelligence Technologies in 40 German Hospitals: Descriptive Analysis	2022	Weinert L.; Müller J.; Svensson L.; Heinze O.	Yes	No	No	Yes	No	Yes
39	Prioritizing barriers for the adoption of Industry 4.0 technologies	2022	Senna P.P.; Ferreira L.M.D.F.; Barros A.C.; Bonnín Roca J.; Magalhães V.	No	Yes	Yes	Yes	No	Yes
40	Project management processes in the adoption of smart building technologies: a systematic review of constraints	2020	Ghansah F.A.; Owusu-Manu D.-G.; Ayarkwa J.	No	Yes	No	Yes	No	No
41	Psychological factors influencing technology adoption: A case study from the oil and gas industry	2021	Roberts R.; Flin R.; Millar D.; Corradi L.	Yes	Yes	No	Yes	No	No
42	Small and Medium Enterprises (SMEs) facing an evolving technological era: a systematic literature review on the adoption of technologies in SMEs	2022	Zamani S.Z.	Yes	Yes	Yes	Yes	No	No
43	Sociocultural constraints on the transfer and adoption of agricultural technologies in low income countries	2019	Flinn W.L.; Buttel F.H.	Not available					
44	Stagewise Overview of Issues Influencing Organizational Technology Adoption and Use	2021	Saghafian M.; Laumann K.; Skogstad M.R.	Yes	Yes	Yes	Yes	Yes	No
45	Technologies for safety and health management in construction: Current use, implementation benefits and limitations, and adoption barriers	2020	Nnaji C.; Karakhan A.A.	No	No	No	Yes	No	No
46	Technology adoption and use in not-for-profit sport: a case study of an Australian state sporting association	2021	Best A.; Sibson R.; Morgan A.	No	Yes	Yes	Yes	No	No
47	Technology-organization-environment model and technology acceptance model in adoption of social media marketing on SMEs tourism	2019	Sugandini D.; Effendi M.I.; Istanto Y.; Arundati R.; Rahmawati E.D.	Not available					
48	Towards understanding healthcare professionals' adoption and use of technologies in clinical practice: Using Q-methodology and models of technology acceptance	2018	Ladan M.A.; Wharrad H.; Windle R.	Yes	No	No	Yes	No	No
49	What are the barriers to information technology adoption in Moroccan SMEs? An empirical investigation using the structural equation modelling	2022	Chouki M.; Khadrouf O.; Talea M.; Okar C.	Not available					

B.2. Results

Table B.2: Table of results Literature Review II

	Authors	Year	Theory	Technology focus	Study context	Methodology	Barriers and Strategies	Key findings and implications
1	Abdelhakim, M., Abdeldayem, M. M., & Aldulaimi, S. H.	2022	-	Information technology	Public sector	Literature review	Main barriers include lack of top management support, lack of IT project management, resources or involvemnet, change resistance, and culture and structure changes. It proposes change management practices to overcome them	Public sector organizations need to be aware of the barriers and take proactive steps to address them following change management practices if they want to successfully adopt new technologies.
2	Akhtar, P., Azima, N., Ghafar, A., & Din, S. U.	2021	-	Blockchain	Supply chain management	Literature review	The main barriers are focused on technical aspects due to inmmaturity of the technology, and the high costs it carries.	The paper suggests that managers can prepare their organizational structure to adopt blockchain by automating existing technologies, conducting a business review, system integration, staying educated on the latest developments in blockchain technology and seeking financial support
3	Al Hadwer, A., Tavana, M., Gillis, D., & Rezania, D	2021	TOE	Cloud-base technology	-	Literature review	Barriers include security concerns, complexity, and uncertainty. TOE is suggested for a comprehensive approach addressing these barriers, taking into account technical aspects and internal and external organizational factors.	Factors like top management support, relative advantage, cloud complexity, and competitive pressure affect attitudes towards cloud adoption. It suggests practitioners focus on key organizational elements to address adoption barriers
4	Best, A., Sibson, R., & Morgan, A	2021	DOI	-	Sport association in Australia	Case study	The paper finds organizational and financial as main aspects for non-adoption. Some key strategies are the focus in training and digital skills of new employees	The papers establish several factors to take into account during the adoption decision making process to achieve maximum potential of technology
5	Choi D, Chung CY, Seyha T, Young J	2020	TAM + TOE	Blockchain	Supply chain networks	Questionnaires + Quantitative analysis (SEM)	The papar refers to barriers as perceived constraints on incentives, efficient infraestructure, or regulations.	A theoretical model is developed for understanding resistance factors, and help organizations overcome the barriers.
6	De Leeuw, J. A., Woltjer, H., & Kool, R. B.	2020	FITT-framework	E-health innovations	Health organizations in The Netherlands	Interviews + Thematic Analysis	Lack of digital knowledge and skills, negative attitudes towards computer use, ineffective digital training can be compensated with acknowledgement from management, training and peer-to-peer learning, and on-the-job help	Hospital management and nurse leadership should be informed about the importance of the fit between technology, task, and the individual for adequate adoption
7	Ediriweera, A., & Wiewiora, A.	2021	TOE	-	Mining industry in Australia	Semi-strcutured interviews	Highlighted barriers including engagement, operational uncertainty, geographic dispersion, capital-intensiveness, unproven technology risks, limited trust, and low employee involvement. Recommended strategies encompass cultivating a learning culture, knowledge sharing, external stakeholder engagement, incentive programs, and employee empowerment.	General recommendations offered based on identified barriers and enablers, with specific policy implications for the mining industry
8	Ghobakhloo, M., Iranmanesh, M., Vilkas, M., Grybauskas, A., & Amran, A	2022	TOE	Industry 4.0	Manufacturing SMEs	Literature review	The study highlights the importance of financial resources, skilled workforce, awareness and understanding of Industry 4.0 technologies, and resistance to change as key factors that influence technology adoption among SMEs.	The papers builds a transformation roadmap that provides a guide for SMEs to successfully adopt Industry 4.0 technologies
9	Han, X., & Rani, P.	2022	CRITIC-CoCoSo	Blockchain	Supply chain management in the manufacturing industry	Case study	Barriers for blockchain adoption involve both internal and external organizational factors, as well as regulatory changes.	The study proposes an innovative model to identify and evaluate the barriers to blockchain. It is suggested a more holistic approach when implementing the technology
10	Iyanna, S., Kaur, P., Ractham, P., Talwar, S., & Islam, A. N.	2022	-	E-health innovations	Healthcare organizations in the United Kingdom	Open-ended surveys and thematic analysis	Identified multi-level barriers related to healthcare providers, organizations, patients, and end-users. Suggested strategies include enhanced training, improved user design, and secure data management protocols.	Grouped identified barriers into functional, psychological, and context-specific categories, forming the basis for a model on technology adoption in healthcare.
11	Kouhizadeh, M., Saberi, S., & Sarkis, J.	2021	TOE	Blockchain	Supply chain	Survey + Qualitative analysis (DEMATEL)	Identified multiple barriers under each category of the TOE framework, mainly due to technological immaturity, privacy concerns, and organizational support. Strategies include aligning technology values and enhancing collaboration for development and privacy.	Found the main cause for non-adoption to be technological barriers. Recommended focus on supporting factors (O & E) during the technology's early stages.
12	Melia, R., Monahan, L., Duggan, J., Bogue, J., O'Sullivan, M., Young, K., & McInerney, S.	2021	DOI	Mobile health technology	Health organizations in Ireland	Semi-strcutured interviews + Thematic analysis	The main barriers identified are trust in the technology and the organization using it, as well as proper training and technical support. Overcoming these barriers can be achieved with transparent communication and collaboration between professionals and patients	The papers suggests that theories like DOI can provide a good framework to overcome barriers and support a wider adoption of the technology

13	Mohammad, A., & Vargas, S.	2022	TOE	Blockchain	Higher education institutions in the EU	Interviews + Thematic Analysis	The most challenging issues reported by participants were privacy, legality, and lack of adequate skills. No specific strategies are given	The most challenging issues are analyzed, and suggests the need of understanding the obstacles to properly act and support adoption
14	Razmak, J., Bélanger, C. H., & Farhan, W. (2018).	2018	THM	E-health innovations	Healthcare in Canada	Survey + Quantitative analysis (regression)	Barriers to adoption include awareness, privacy concerns, system interoperability, and provider resistance. Strategies include improving awareness, enhancing system compatibility, addressing privacy issues, incentivizing providers, and increasing patient involvement.	Promoting technology adoption necessitates a comprehensive approach, factoring in various aspects such as psychological, sociological, technological, and organizational perspectives
15	Rijanto, A	2020	TOE	Blockchain	Agricultural industry	Case study	The adoption is challenged by the organizational complexity of the industry and regulations	The paper only mentions the relevance of blockchain for the industry and need to work on supporting adoption
16	Roberts ,R., Flin, R., Millar, F.& Corradi, L.	2021	Psychological Technology Adoption Framework (P-TAF)	Well sealent, non-intrusive inspection, and well construction.	Oil and gas industry in the United Kingdom	Multiple case study	Identified 15 psychological barriers, sorted into six categories, and proposed strategies such as early involvement of decision-makers, user training, organizational adjustments, and monitoring external factors.	Found decision-makers and stakeholder collaboration to be essential for successful VR technology adoption in changing market conditions
17	Saghafian, M., Laumann, K., & Skogstad, M. R.	2021	-	-	-	Literature review + thematic analysis	The paper organizes the barriers in three stages of the technology adoption process: pre-change, change, and post-change.	The paper demonstrates a system in which elements are in a dynamic interaction and are not mutually independent, and the relevance of timing is emphasized .
18	Senna, P. P., Ferreira, L. M. D., Barros, A. C., Roca, J. B., & Magalhães, V.	2022	TOE	Industry 4.0	Industry 4.0 in Portugal	Literature review + Focus group + Quantitative analysis (ISM)	Identified and classified fourteen barriers within the TOE model. And a general overview of industry implications provided	Highlighted the lack of standardization and off-the-shelf solutions as major barriers, suggesting a focus on the environmental level to support technology adoption.
19	Sepasgozar, S. M., & Davis, S.	2018	-	Digital technologies	Construction industry	Multiple exploratory mehtods	Complexity and high-risk nature of construction companies, conservative character of these companies, lack of widespread adoption of advanced digital technologies	The study presents a novel methodological cube for investigating the Construction Technology Adoption Process (CTAP), covering technology adoption, acceptance, diffusion, and implementation concepts
20	Shahadat, M. H., Nekmahmud, M., Ebrahimi, P., & Fekete-Farkas, M.	2023	TOE + DOI	Digital technologies	SMEs in Bangladesh	Survey + Quantitative analysis (PLS-SEM)	Financial costs and support are found as main barriers. To overcome them, government policies and incentives can encourage SMEs to adopt digital technology. As well as training programs and partnerships with technology providers.	The paper underscores the importance of recognizing barriers, impliying the necessity for SMEs to foster an innovative culture, leverage government incentives, and invest in training and tech partnerships.
21	Ullah, F., Sepasgozar, S. M., Thaheem, M. J., & Al-Turjman, F	2021	TOE	Industry 4.0	Real state industry in Australia	Literature review + Questionnaires	Barriers include lack of awareness, resistance to change, inadequate IT infrastructure, high costs, and a lack of skilled personnel. Proposed strategies include education and training, IT infrastructure investment, stakeholder collaboration, and policy support.	The study highlights the need for increased awareness of new technologies and a multi-faceted approach to address challenges, and giving importance of digitalization and innovation for successful technology adoption
22	Weinert, L., Müller, J., Svensson, L., & Heinze, O.	2022	-	Artificial Intelligence	Health organizations in Germany	Survey + descriptive statistics	Lack of resources and compatibility with the existing IT infrastructure were identified as barriers.	Although interest in the technology, the adoption is hindered by the challenges. The paper suggest to invest in resources, infraestructure, and building partnerships
23	Wendland, J., Lunardi, G. L., & Dolci, D. B.	2019	IS Success Model (Maillet et al. (2015))	Mobile devices in the mobile emergency care service (MECS)	Health organizations in Brazil	Multi-method study	Data privacy and security was found to be key barrier for adoption. The proposed strategies focus on policies and regulations, but also staff training	The study proposed a model containing antecedents and consequences of the adoption and use of mobile devices
24	Yadav, A. K., & Kumar, D.	2023	TOE	Blockchain + IoT	Vaccine suply chain in India	Litearture review + semi structured interviews + questionnaires + quantitative analysis (DEMATRL)	Identified and classified 19 barriers into the TOE framework. Suggested the early consideration of barriers and strategic definition to aid later adoption.	Identified the need for organizational structure and policy change, as well as strengthened stakeholder links, as the most prominent barriers to VR adoption.
25	Yadav, V. S., Singh, A. R., Raut, R. D., & Govindarajan, U. H.	2020	-	Blockchain	Agricultural supply chain in India	Literature review + Quantitative analysis (Interpretive Structural Modelling (ISM))	Identified barriers including lack of awareness, trust, and standardization, along with cost, regulatory, tradition, and scalability concerns. Proposed solutions focused on each barrier, such as education, cost-effective plans, standards establishment, and incentives	Offered general recommendations to overcome identified barriers, highlighting the significance of addressing awareness and uncertainty to foster greater VR technology adoption
26	Zamani, S. Z.	2022	-	-	SMEs	Literature review	Barriers adoption include lack of strategy, resources, skills, resistance to change, and government support. Strategies to overcome these involve clear planning, resource allocation, training, cultivating openness to innovation, and leveraging regulatory support.	The study identified 11 influential categories impacting technology adoption in SMEs. SMEs should consider various factors, considering the whole context, to successfully implement new technologies

C

Theoretical Framework

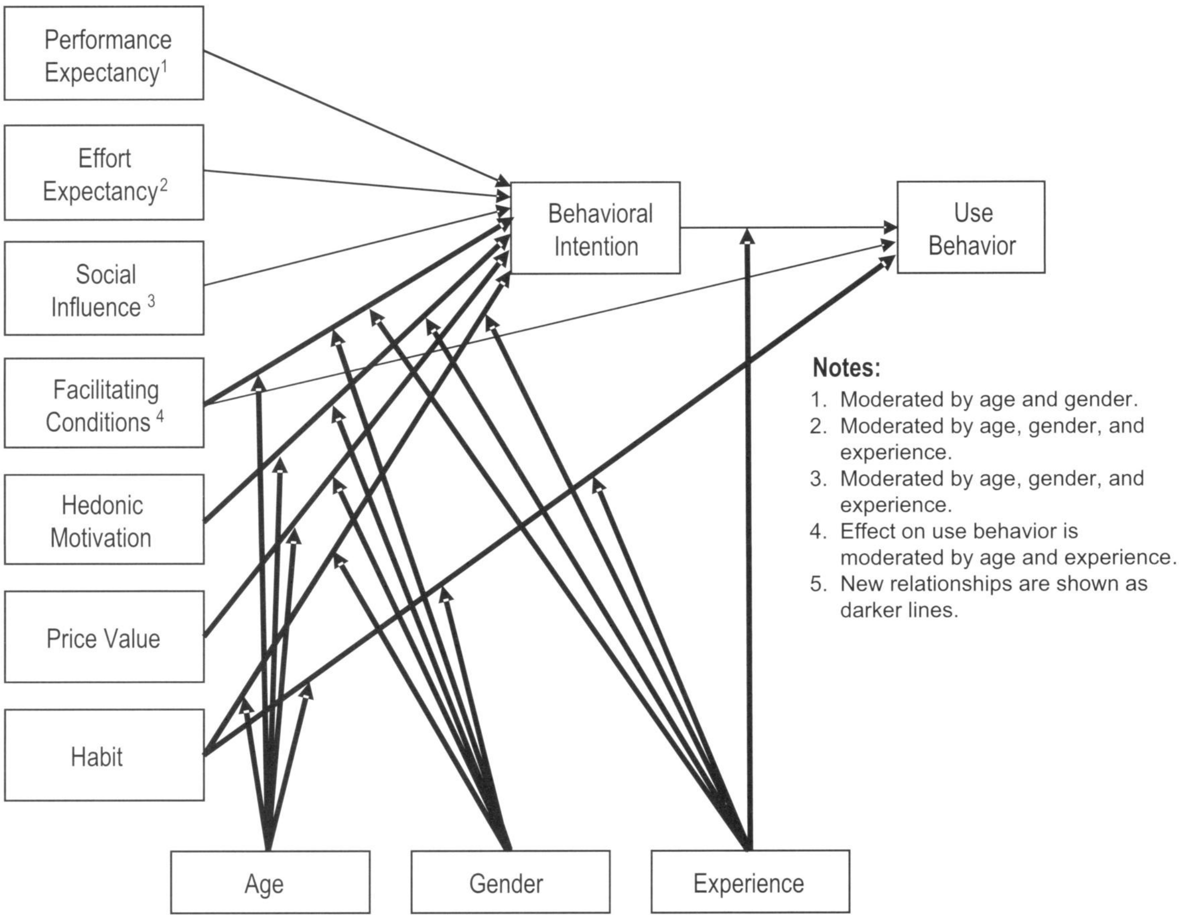

Figure C.1: Research Framework: UTAUT2 (Venkatesh et al., 2011)

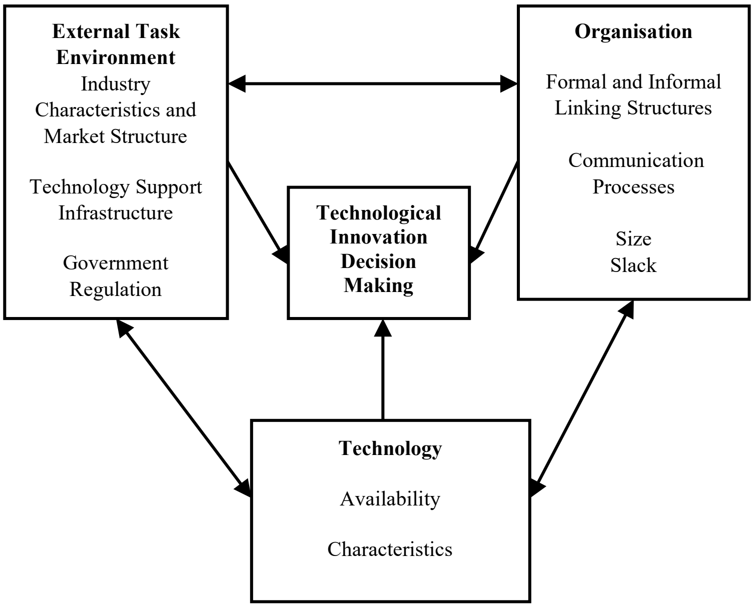

Figure C.2: Research Framework: TOE (Bryan and Zuva, 2021)

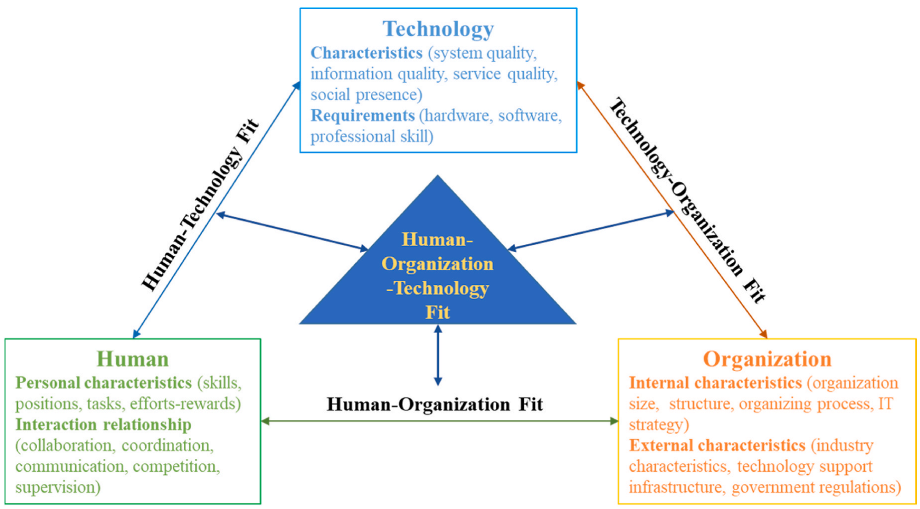

Figure C.3: Research Framework: HOT (Xu and Lu, 2022)

D

Ethical Approval

Figure D.1: Ethical Committee Letter of Approval

Date 21-Apr-2023
Contact person Dr. Cath Cotton, Policy Advisor Academic Integrity
E-mail c.m.cotton@tudelft.nl

TU Delft Delft University of Technology

Human Research Ethics Committee TU Delft
(http://hrec.tudelft.nl)

Visiting address
Jaffalaan 5 (building 31)
2628 BX Delft

Postal address
P.O. Box 5015 2600 GA Delft
The Netherlands

Ethics Approval Application: Barriers and overcoming strategies to support VR technology adoption. A collective case study at AF-KLM
Applicant: Jaime Sanchez, Francisco Ángel

Dear Francisco Ángel Jaime Sanchez,

It is a pleasure to inform you that your application mentioned above has been approved.

Thanks very much for your submission to the HREC which has been approved. We do additionally note/advise the following.

In addition to any specific conditions or notes, the HREC provides the following standard advice to all applicants:
• In light of recent tax changes, we advise that you confirm any proposed remuneration of research subjects with your faculty contract manager before going ahead.
• Please make sure when you carry out your research that you confirm contemporary covid protocols with your faculty HSE advisor, and that ongoing covid risks and precautions are flagged in the informed consent - with particular attention to this where there are physically vulnerable (eg: elderly or with underlying conditions) participants involved.
• Our default advice is not to publish transcripts or transcript summaries, but to retain these privately for specific purposes/checking; and if they are to be made public then only if fully anonymised and the transcript/summary itself approved by participants for specific purpose.
• Where there are collaborating (including funding) partners, appropriate formal agreements including clarity on responsibilities, including data ownership, responsibilities and access, should be in place and that relevant aspects of such agreements (such as access to raw or other data) are clear in the Informed Consent.

Good luck with your research!

Sincerely,

E

Data collection

E.1. Semi-structured interviews

Figure E.1: Interview script

Presentation of myself and the research. Ask for their consent to participate and record the interview.

Questions

1. You are the _________ (e.g. VP of IT) what is your experience in this role, and what tasks?

→ Understand his/her role and the decision power they have

2. Considering AF/KLM what do you think is the vision of the company?

As I explained, in my research I am analyzing the adoption process of new technologies, focusing on VR. But in general, …

3. What do you think about the pace of development of new technologies?

4. What do you think about the implementation of these technologies in the value chain of the company?

5. How do you think these technologies relate to the vision of the company?

→ Secondary question: Why?

6. What is your experience introducing changes in the way of working of the business?

6.1 What are the motives/objectives of introducing changes?

6.2 Did any of these changes involve introducing new technologies?

6.3 Did any of these changes face resistance?

6.4 Why do you think XX changes faced resistance?

- ➔ How did you do it on the past?
- ➔ Now, how do you face new changes?
- ➔ For the future, what is your experience?

6.5 Who are the actors involved in the process?

→ How does the coordination between those occur?

7. What factors are considered when deciding to adopt or not a new change, as it can be implementing a new technological product?

7.1 The core pillars of AF/KLM are finances, sustainability, and people. How does a change need to asses in these three aspects for deciding the adoption?

7.2 For example, a VR product like [Give an example: VR for telepresence or VR for training] that meets the three aspects

- ➔ Why do you think the technology is not adopted?
- ➔ How based on the three pillars of AF/KLM the adoption can be supported?

6. We have taken a look at the changes introduced by new technologies, and the factors that influence it. So, summarizing how would it be needed to asses the new technologies and support the adoption?

7 . Is there something about the adoption of new technologies that you didn't though before that occurred during this interview?

Figure E.2: Technical department interview script

Ask for consent (both interview and recording). Introduction of the objectives of the interview.

Questions

Could you tell me about the main design aspects of a VR product?

- ➔ When you are developing a new product, which are the aspects you have to focus on the most?
- ➔ Do the focus of the design vary over time?

How do the design characteristics affect users' experience? What factors contribute the most to the experience?

From a design perspective, which are the main characteristics of each of the products under analysis? [GO ONE BY ONE]

Glue: https://www.youtube.com/watch?v=GsoBQd850mM

Push-back: Video available at the bottom of the webpage

JetBridge: https://www.youtube.com/watch?v=jMM3TB73aF0

- ➔ From here, point out the main differences and similarities between the products
- ➔ Do these differences translate into big differences in the users' experience?

How do you think the design characteristics influence the actual use of VR products?

Transition to the industrialization process

How would you describe the development process of a new VR product?

- ➔ How does it start? How does the interaction happen within the team?
- ➔ How does communication with the business (the customer) happen?
- ➔ If you recall, how often do the requirements usually change along the process?

Aside from designing the VR products, what is your experience implementing them in the business units of the company?

From your perspective, what aspects influence adoption decisions at other business units and their actual use of the technology?

- ➔ Dig into the given answer. to identify his/her perspective on the possible barriers hampering the industrialization process.
- ➔ Use the past (what went wrong), and the now (what are they doing now)

After having these experiences, what strategies do you think are the strategies/actions to support the adoption and actual use of the product?

- ➔ Explore the possible strategies. How?
- ➔ Maybe suggest a case (e.g. Telepresence: how to assess if it is successful and if proven how to support the adoption)

Is there anything you would like to ask me?

Figure E.3: Participants' consent form

Informed consent form

Title: Analysis of technology adoption and industrialization process of VR products at AFKL

Researcher: Francisco Angel Jaime Sanchez, student at TU Delft Faculty of Technology, Policy and Management and intern at AF-KLM.

Purpose of the study

For the Master's thesis project in cooperation with KLM, insights about the adoption of VR technology and the industrialization process of VR will be gathered. This will help to understand the VR adoption process within the organization and identify needs and factors influencing the process. It will be investigated how VR products can be assessed to enhance company operations, and how adoption can be supported afterward. The expected duration of the subject's participation is 1 hour per session. The subject will be asked open-ended questions, and the interview will be recorded for its posterior analysis.
The information gained in the study will be translated into eventual recommendations and requirements to include during the different steps of VR products' industrialization.

Data management and privacy

Participants' data and interview outputs (notes and transcripts) will be recorded on protected hardware which can only be accessed by the researcher. This information will be stored for the duration of the project. The findings of this research will be handled anonymously. The personal data will be processed to demark the collected insights. The name will only be indicated on the consent form, each subject will only be identified by an ID number.
The participant can request access and rectification to his/ her personal data, transcripts, and recordings at any time during the project. After 4 weeks of the end of the project all personal data, research transcripts and recordings will be deleted and only the consolidated insights in the form of a final will be kept. The personal data will not be retained or sent/ sold to a third party for further research.
The results of the research will be presented during a final presentation at TU Delft and at KLM using anonymous presentations.

The researcher may be contacted for answers to pertinent questions about the research. The subject has the opportunity to ask questions and to withdraw at any time from the research without consequences.

Francisco A. Jaime Sanchez +34 647197796. Francisco.JaimeSanchez@klm.com

I have read and understood the study information, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.

Signature:

____________________	_____________________	___.___.2023
Name of participant	Signature	Date
____________________	_____________________	___.___.2023
Name of researcher	Signature	Date

E.2. Questionnaires

E.2.1. 1st questionnaire

Figure E.4: 1st questionnaire questions setting

AIRFRANCE KLM

TU Delft Delft University of Technology

Identification number:

Age: , Working experience (years): , Occupation:

Information

For the Master's thesis project in cooperation with KLM, insights about the adoption of VR technology and the industrialization process of VR will be gathered. This will help to understand the VR adoption process within the organization and identify needs and factors influencing the process. It will be investigated how VR products can be assessed to enhance company operations, and how adoption can be supported afterward. The expected duration of the subject's participation is 2 weeks. The subject will be asked initial questions, then he/she will make use of VR during the weekly meetings and then again, a questionnaire will be answered at the end.

The information gained in the study will be translated into eventual recommendations and requirements to include during the different steps of VR products' industrialization. Participants' data will be recorded on protected hardware which can only be accessed by the researcher. The findings of this research will be handled anonymously. The results of the research will be presented during a final presentation at TU Delft and at KLM.

The researcher may be contacted for answers to pertinent questions about the research. The subject has the opportunity to ask questions and to withdraw at any time from the research without consequences.

Francisco A. Jaime Sanchez   +34 647197796.   Francisco.JaimeSanchez@klm.com

☐By marking the box on the right I declare that I have read and understood the study information, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.

<u>1st questionnaire</u>

1. From your experience, what are the main characteristics influencing work in international teams?

Click or tap here to enter text.

2. What do you think about including technology in the working experience?

Click or tap here to enter text.

3. How do you feel about using VR technology as part of your work?

Click or tap here to enter text.

4. Were you aware of the use of VR in AFKL?

Click or tap here to enter text.

`

5. Do you have prior experience using Virtual Reality (VR) technology? If yes, in which context have you used it?
   Click or tap here to enter text.

`

Several questions are shown below, which you have to evaluate from totally disagree to totally agree:

Question	Totally disagree	Disagree	Neutral	Agree	Totally agree
Do you think VR will facilitate communication between the team?	☐	☐	☐	☐	☐
Do you think VR will help improve the quality of the work?	☐	☐	☐	☐	☐
Do you think VR will provide more collaboration opportunities in the future?	☐	☐	☐	☐	☐
Do you think AFKL should invest in hardware resources to use VR?	☐	☐	☐	☐	☐
Do you think AFKL should invest in training and support?	☐	☐	☐	☐	☐
Do you think it would be beneficial to include VR in your meetings?	☐	☐	☐	☐	☐
Is your management team interested in adopting VR products?	☐	☐	☐	☐	☐
Does your management team perceive that VR is necessary to conduct successful meetings?	☐	☐	☐	☐	☐
Do you think it will be easy to use VR in the meetings?	☐	☐	☐	☐	☐
Is your interaction with VR clear and understandable?	☐	☐	☐	☐	☐
Do you think that VR fits its purpose for the future team's collaboration?	☐	☐	☐	☐	☐
Do you like the decision of using VR in the workplace?	☐	☐	☐	☐	☐
Would you like to be part of the total development of the VR telepresence implementation?	☐	☐	☐	☐	☐
Do you think the use of VR will be compatible with work tasks?	☐	☐	☐	☐	☐
Do you think the use of VR would replace certain work processes?	☐	☐	☐	☐	☐

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`

6. What do you think are the challenges of the team using VR (Glue) in the coming two weeks? Please give three challenges

   Click or tap here to enter text.

7. What do you think personally are the challenges of using VR in the coming two weeks? Please give three challenges

   Click or tap here to enter text.

8. Anything else you would like to comment?

   Click or tap here to enter text.

Thank you for your participation and good luck!

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E.2.2. 2nd questionnaire

Figure E.5: 2nd questionnaire questions setting

AIRFRANCE KLM

TU Delft Delft University of Technology

Identification number:Click or tap here to enter text.

Information

Hello again! Thank you for your ongoing participation in the Virtual Work experiment. Your dedication and commitment during the experiment are truly appreciated. While challenging, we hope it has also been stimulating and enjoyable, as you've been part of a very innovative initiative!

Over the past months, you've incorporated VR technology into your daily work routine, helping us explore the potential and practicality of this immersive technology. This second questionnaire is designed to gather insights about your personal experience, and how the use of VR has impacted your work. We would also like to know about any challenges or difficulties you may have faced, as your feedback will be invaluable in helping us refine and improve this technology for future use.

Your responses will be kept confidential and anonymous and only used for the purpose of this study. Please answer as honestly and thoroughly as possible, there are no right or wrong answers. We value your unique perspective and insights. If you have any questions regarding the content of the questionnaire do not heasitate to contact me at Francisco.JaimeSanchez@klm.com or MS Teams.

Once again, thank you for your time and contribution to this research. Let's get started with the questionnaire!

2nd questionnaire

1. How was your experience with Virtual Reality in general as technology?

Click or tap here to enter text.

2. Before using virtual reality in team meetings, what were your initial thoughts or expectations regarding its potential benefits and impact on your work experience?

Click or tap here to enter text.

3. How do you feel about using VR technology as part of your work?

Click or tap here to enter text.

4. What and where did you use VR mostly as a team in the virtual reality environment?

Click or tap here to enter text.

5. Now that you have a better perception of virtual reality and its possibilities, what do you see as the main objective of using it as part of your working routine?

Click or tap here to enter text.

6. Which tasks do you personally think VR technology will fit best to these objectives?

Click or tap here to enter text.

7. From 1 to 5, being 1 very dissatisfied and 5 very satisfied, how would you rate your experience in the experiment?

Click or tap here to enter text.

Several questions are shown below. Based on your experience using VR please evaluate each of them from totally disagree to totally agree:

Question	Totally disagree	Disagree	Neutral	Agree	Totally agree
Do you think VR facilitated communication between the team?	☐	☐	☐	☐	☐
Do you think VR helped improve the quality of the work?	☐	☐	☐	☐	☐
Do you think VR will provide more collaboration opportunities in the future for AFKL?	☐	☐	☐	☐	☐
Do you think AFKL should invest in hardware resources to use VR?	☐	☐	☐	☐	☐
Do you think AFKL should invest in VR training and support?	☐	☐	☐	☐	☐
Do you think it was beneficial to include VR in your meetings?	☐	☐	☐	☐	☐
Is your management team interested in adopting VR products?	☐	☐	☐	☐	☐
Does your management team perceive that VR is necessary to conduct successful meetings?	☐	☐	☐	☐	☐
Do you think it was easy to use VR in the meetings?	☐	☐	☐	☐	☐
Was your interaction with VR clear and understandable?	☐	☐	☐	☐	☐
Do you think that VR fits its purpose for the team's collaboration?	☐	☐	☐	☐	☐
Do you like the decision of using VR in the workplace?	☐	☐	☐	☐	☐
Would you like to be part of the total development of the VR telepresence implementation?	☐	☐	☐	☐	☐
Do you think the use of VR will be compatible with your work tasks?	☐	☐	☐	☐	☐
Do you think the use of VR would replace certain work processes?	☐	☐	☐	☐	☐

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Question	Totally disagree	Disagree	Neutral	Agree	Totally agree
Do you think a wider use of VR within the company would encourage you more to use VR?	☐	☐	☐	☐	☐
Do you think VR supported better team interaction?	☐	☐	☐	☐	☐
Do you think VR makes you feel more connected to the team and objectives?	☐	☐	☐	☐	☐
Do you think VR can positively impact overall team productivity?	☐	☐	☐	☐	☐
Do you think VR helped in creating a more creative environment during meetings?	☐	☐	☐	☐	☐
Do you think VR enhanced your motivation during meetings?	☐	☐	☐	☐	☐

Do you have any extra comments or want to elaborate further on any of the questions before?

Click or tap here to enter text.

8. Which specific aspects of the virtual reality experience do you think were most beneficial for the team?

Click or tap here to enter text.

9. What were the main challenges or limitations of Virtual Reality for the team?

Click or tap here to enter text.

10. What were the main challenges of using Virtual Reality for you personally?

Click or tap here to enter text.

11. Taking aside the technical limitations of Virtual reality or Glue environment, how would you envision that VR can be used as part of your working routine?

Click or tap here to enter text.

12. After the completion of the experiment, what do you think would be the next steps for the use of Virtual Reality for telepresence at KLM?

Click or tap here to enter text.

13. Anything else you would like to comment?

Click or tap here to enter text.

Thank you for your participation and good luck!

F

Experiment pictures

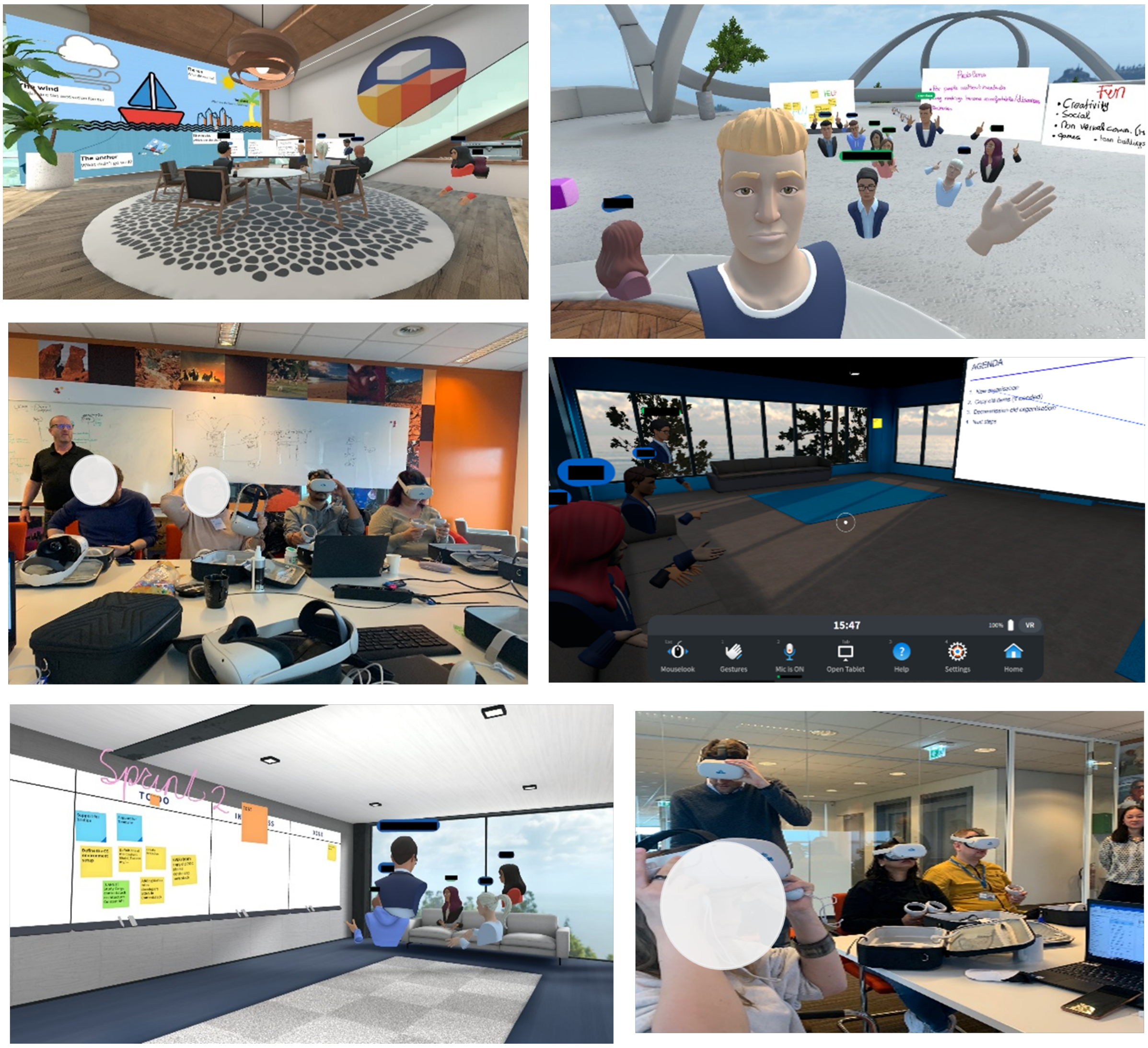


Figure F.1: Experiment pictures

G

Results

G.1. Semi-structured interviews - Barriers identification

Code	Participants	Percentage			
		Total	Tech.	Bus.	Top Mgmt.
Compatibility	T2,T3,B1,B2,B3,B4,TM1,TM2,TM3	52.9%	40.0%	50.0%	75.0%
Technology fit	T1,T2,T3,B1,B2,B3,TM1,TM2,TM3,TM4	58.8%	60.0%	37.5%	100.0%
Perceived effort	T1,T2,T3,B1,B3,TM1	35.3%	60.0%	25.0%	25.0%
Perceived performance	T1,T2,T3,T5,B1,B2,B3,TM1,TM3,TM4	58.8%	80.0%	37.5%	75.0%
Department differences	T1,T4,T5,B1,B2,B5,B7,TM4	47.1%	60.0%	50.0%	25.0%
Cultural differences	T1,T2,T4,B1,B2,B5	35.3%	60.0%	37.5%	0.0%
Structure constraints	T1,T2,B2,B5,TM4	29.4%	40.0%	25.0%	25.0%
Attitudes towards tech.	T1,T2,T5,B1,B4,TM1,TM4	41.2%	60.0%	25.0%	50.0%
Personal concerns	T1,T2,B1,B3,B4,B5,TM1	41.2%	40.0%	50.0%	25.0%
Habit	T1,T2,T3,B1,B2,B3,B4,B6,TM1,TM2	58.8%	60.0%	62.5%	50.0%
Regulatory requirements	B2,TM3	11.8%	0.0%	12.5%	25.0%
VR diffusion in society	T1,T2,T3,B4,TM2	29.4%	60.0%	12.5%	25.0%
Traditional business cases	T1,T2,B1,B2,B5,B7,TM2,TM3,TM4	35.3%	40.0%	50.0%	75.0%
Impact quantification	T2,B1,B5,B7,TM2,TM3,TM4	41.2%	20.0%	37.5%	75.0%
Costs estimations	T4,B1,B3,B5,B7,TM1,TM3	41.2%	20.0%	50.0%	50.0%
Stakeholders engagement	T1,T3,T5,B1,B2,B4,B6,TM2,TM3,TM4	58.8%	60.0%	50.0%	75.0%
Lack of commitment	T1,T5,B1,B2,B4,TM1,TM2,TM3,TM4	52.9%	40.0%	37.5%	100.0%

Table G.1: Codes quantification overview

The table indicates which participants explicitly mentioned each of the codes during the interview. First, the percentage of interviewees referencing each code is calculated based on the total number of participants (17). Subsequently, percentages are computed for each organizational level: technical (5 participants), business (8 participants), and top management (4 participants).

In the main text's table, Table 4.1 (shown below as Table G.2), averages for each theme are derived based on the codes comprising it. For instance, the "technology" theme consists of the following codes: compatibility, technology fit, perceived effort, and perceived performance. Therefore, the average for the "technology" theme is calculate by averaging the percentages of these constituent codes.

	Overall	**Technical**	**Business**	**Top Management**
Technology	51.5%	60.0%	37.5%	68.8%
organization	37.3%	53.3%	37.5%	16.7%
People	47.1%	53.3%	45.8%	41.7%
Environment	20.6%	30.0%	12.5%	25.0%
Process	45.9%	36.0%	45.0%	75.0%

Table G.2: Themes quantification overview

G.2. Experiment

G.2.1. TPS surveys

Concept	Item	Before	After
Work engagement items	Mean	3.675	4.150
	Standard Deviation	0.096	0.173
	Minimum	3.6	4.0
	Maximum	3.8	4.4
Team engagement	Mean	3.025	3.9
	Standard Deviation	0.395	0.141
	Minimum	2.7	3.8
	Maximum	3.6	4.1

Table G.3: TPS survey decriptive statistics

Work Engagement Items:

Before:

- Mean (3.675): On average, the scores related to work engagement items before the intervention were 3.675 on the scale. This suggests a moderately positive perception towards work engagement.
- Standard Deviation (0.096): This is a measure of the amount of variation or dispersion in the scores. A low standard deviation like 0.096 indicates that the scores tend to be very close to the mean.

After:

- Mean (4.150): The average score increased to 4.150 after the intervention. This indicates an improvement in the perception of work engagement.
- Standard Deviation (0.173): The standard deviation has increased, suggesting that while the average perception has improved, there's a wider dispersion in the scores. This could indicate that while many might have had a more positive shift, there might be some whose perceptions did not change as much or even declined.

Team Engagement:

Before:

- Mean (3.025): On average, the scores related to team engagement before the intervention were 3.025. This indicates a somewhat neutral to positive perception towards team engagement.
- Standard Deviation (0.395): The relatively higher standard deviation compared to the work engagement items suggests a wider spread in the team engagement scores. This means there's a more diverse range of opinions or experiences among respondents regarding team engagement.

After:

- Mean (3.900): The average score increased significantly to 3.900 after the intervention. This indicates a marked improvement in the perception of team engagement.
- Standard Deviation (0.141): Interestingly, while the average perception has improved, the standard deviation has decreased. This means the scores are now more closely packed around the mean, suggesting a more uniform positive perception among respondents.

Implications of Standard Deviation Changes:

Work Engagement Items: The increase in standard deviation after the intervention implies that while many individuals' perceptions might have improved, there might be some variability or outliers that didn't experience the same positive shift. It would be worth investigating further to understand the reasons for this variability.

Team Engagement: The decrease in standard deviation post-intervention indicates a more consistent positive shift among the respondents. The intervention seems to have had a more uniformly positive impact on team engagement perceptions.

In summary, both work and team engagement perceptions improved after the intervention. However, while team engagement perceptions became more uniformly positive, there's a broader range of reactions to the intervention in the realm of work engagement. This might suggest that while team dynamics and collaboration improved consistently, individual experiences or perceptions related to personal job roles or tasks might have varied more.

G.2.2. Questionnaires

The answers to the questions, based on a Likert scale, from both the first and second questionnaires are displayed in Table G.4. This table presents the average scores for each question, ranging from 1 to 5, and highlights the variation between the two questionnaires.

Question	Q1	Q2	Variation
Do you think VR will facilitate communication between the team?	3.89	4.00	3%
Do you think VR will help improve the quality of the work?	3.67	3.38	-8%
Do you think VR will provide more collaboration opportunities in the future for AFKL?	4.00	4.00	0%
Do you think AFKL should invest in hardware resources to use VR?	4.00	3.88	-3%
Do you think AFKL should invest in training and support?	3.67	3.75	2%
Do you think it would be beneficial to include VR in your meetings?	3.78	4.00	6%
Is your management team interested in adopting VR products?	3.44	3.75	9%
Does your management team perceive that VR is necessary to conduct successful meetings?	3.33	2.88	-14%
Do you think it will be easy to use VR in the meetings?	3.89	3.69	-5%
Is your interaction with VR clear and understandable?	4.11	4.31	5%
Do you think that VR fits its purpose for the future team's collaboration?	4.00	3.75	-6%
Do you like the decision of using VR in the workplace?	4.22	4.25	1%
Would you like to be part of the total development of the VR telepresence implementation?	4.25	4.38	3%
Do you think the use of VR will be compatible with your work tasks?	3.67	3.75	2%
Do you think the use of VR would replace certain work processes?	3.22	3.25	1%

Table G.4: Overview of Likert scale question results

To analyze the responses, descriptive statistics were applied to the results presented above. The outcomes of this analysis can be found in Table G.5.

Concept	Before	After
Mean	3.81	3.8
Median	3.89	3.75
Standard Deviation	0.31	0.4
Minimum	3.22	2.88
Maximum	4.25	4.38

Table G.5: Questionnaire likert scale descriptive statistics

Based in te results of the descriptive statitistics performed already some insights could be drawsn, but to further examine the questions and establish the significance of the answers and variations it was decided to carry out t-tests. The t-test is a useful statistical test to determine if there's a significant difference between the means of two groups. The null hypothesis (H_0) for the paired t-test is that there's no difference between the means of the paired observations (i.e., the differences come from a population with a mean difference of 0). The results of the paired t-test are:

- t-statistic: 0.146
- p-value: 0.869

Given a common significance level of 0.05, the p-value of 0.886 is much greater than this threshold. This means that the null hypothesis can't be rejected, suggesting that there is no statistically significant difference between the means of Q1 and Q2. However, this doesn't mean individual questions didn't have significant shifts in opinion. The t-test is applied to the entirety of Q1 vs Q2 and significant differences in individual questions might be masked when looking at the overall average.

To determine which specific questions had significant changes, it can be used a confidence interval approach to the average variations. If the difference for a particular question (from Q1 to Q2) falls outside a specific confidence interval around the average difference, it can be considered as significantly different. Firstly, it's necessary to note the average difference, which stands at -0.0092. This value, being very close to zero, aligns with the t-test results, suggesting that the overall difference between Q1 and Q2 isn't significant. With a 95% confidence interval, the derived range is (-0.117, 0.0989). Upon examining the differences for each question, it's observed that 9 out of 15 questions fall outside this range. The following questions present differences outside the confidence interval:

- "Do you think VR will help improve the quality of the work?" with a difference of -0.29
- "Do you think AFKL should invest in hardware resources to use VR?" with a difference of -0.12
- "Do you think it would be beneficial to include VR in your meetings?" with a difference of 0.22
- "Is your management team interested in adopting VR products?" with a difference of 0.31
- "Does your management team perceive that VR is necessary to conduct successful meetings?" with a difference of -0.45
- "Do you think it will be easy to use VR in the meetings?" with a difference of -0.20
- "Is your interaction with VR clear and understandable?" with a difference of 0.20
- "Do you think that VR fits its purpose for the future team's collaboration?" with a difference of -0.25
- "Would you like to be part of the total development of the VR telepresence implementation?" with a difference of 0.13

These questions show differences that are notably different from the average change, potentially indicating more significant shifts in opinions for these topics. While these findings are invaluable for understanding the responses, it's important to recognize that statistical significance doesn't always translate to practical significance. Thus, these results should be viewed as estimates rather than being deemed conclusively significant.

G.3. Direct observations

Table G.6: Direct observations results overview

	Type	Event/Context	Observation	Insights	Potential impact
1	Business impact	Weekly meetings	Discussions on the effectiveness of some changes implemented in a new VR product	There are no quantitative analysis of the impact of VR products, as it is difficult to quantify intangibles	If there are no metrics of the impact or effectiveness of the products it is difficult to demonstrate it to the businesses
2	Organizational culture	Informal chat over the lunch break	Chat about colleague's experience in other departments of the company	Sometimes the managers are more focused on putting off fires rather than looking on the long-term opportunities	Managers see new initiatives as a distraction from their current tasks focus
3	Organizational culture	Informal chat over the lunch break	Chat about colleague's experience in other departments of the company	There are salaries ranges depending on value employees bring to the company	Managers can see their position threatened by introducing new products, rather than seeing them as an enhancement
4	User engagement	Coffe break	Talk on previous failure cases	Highly dependence in champions and personal relations, no higher levels of the company are involved	If there is no commitment of the department or if the managers have to leave, the new initiatives are usually completely stopped
5	User engagement	Observation of VR team activity	The team carried several demos and VR demonstrations, and althug it generates first interest, sometimes products don't get to the next step or it takes too long	It is time consumming to work in these demos isntead of being able to work on real projects, as no decisions are made from the business side.	Demotivation on the technical team and delay in project, what is seen as a waste of resources invested in VR.

6	User engagement/ Work processes	Chat on the lunch break	Talked with colleagues on the history of the VR lab	The past experience with the department, that gone through big changes, has impacted the view people has on the current department	The view of employees on the previous cases of VR and how things were done has an impact on their perceptions towards VR products
7	Technology	General interaction with AF-KLM's employees	Employees sharing their individual perspectives on the general use of VR technology	Technology is not diffused yet to the mass market and it is yet seen as a high tech niche gaming product. Also, many employees had a very bad experience with veryh old and uncomfortabel headsets	The lack of use of VR in daily lifes as well as bad prior experiences is shaping perspective of VR inside the company
8	Business impact	Participation as organizer in a career event	The VR products of the company were showcased to people in the event, getting people's view on the technology	In general, people was interested in the technology and wanted to try it. The fact that KLM was using the technology was interesting for potential new employees.	Developing and using VR products can be attractive for talent and increase the interest in new positions, reducing the cost of talent acquisition
9	Work processes	Attending to a new project meeting	Interaction between the different stakeholders in the project	The implementation of VR overlaps with the responsibilities and systems managed by other departments	The involvement and acceptance of overlaping departments add extra complexity to the process. The terms of effective and efficiency could be used for the new systems
10	User engagement	Innovation brainstroming meeting	Talk with one of the innovation project managers on the use of AI	There are many possibilities of the use of new technologies, but it was highlighted the need to consider absorbtive capacityh of business and individuals	People need to be aware of the possibilities new technologies bring. Also, innovation departments need to understand what businees and individual can absorb (e.g. how disruptive and how many changes over time)
11	Work processes/ Organizational culture	Interacting with different deparments	Observed the different cultures of the different departments (e.g IT vs Ground Services)	In operational deaprtments, there are more strict ways of working and needs, while in IT it is followed a more agile and flexible approach	The speed of acceting changes is not the same in all departments
12	User engagement	Different stakeholders reaction to VR	Comparisson between cases, in which stakeholders with similar roles had different views on the technology	The doctors in the company are willing to embrace VR, while trainers are not. In both cases the technology is supossed to serve as an enhancement for their work	The differences poses some question on what are the reasons or incentives of the use of VR
13	Work processes	New project meeting	Meeting to set up the next steps after a successful proof of concept	A balance needs to be achieved between best (and easiest) technical solutions and what fits the business, taking into account budget	As a cost center, it is challenging to establish correct budget, what can influence later stages of the development
14	Work process	Observation of VR team activity	Interaction between interested departments and the VR team	The point of contact is not clear, or it is too much for one person to be responsible for all possible new initiatives	Lack of resources or not standarized process can hamper the development of the project
15	Organization culture	Particpant selection	It was a difficult task to know who was the ideal person to tal, and the involvement in different porceses	The complexity of the structure at AF-KLM suposes a challenge when engaging with the relevant stakeholders	Identifying the levels of the organization that needs to be involved is key in each of the projects

16	Work processes/ Support	Building the experiement	It was needed to arrange things with different stakeholders, alligning different needs and ways of working	It was difficult to set the logistics of the VR for telepresence as there were not established protocol or supporting resources for it	It would be needed to have more systematic system for carryng out experiments
17	User engagement/ Training & Support	Teams interaction	Influence of different cultures, different perceptions to change, and personal traits in teams interaction	These differences should be taken into account, but also consider that there is always going to be some misallignment within teams	Accounting for these differences can be done by training and supporting the use of new technologies with evidence
18	User engagement	Showcasing VR simulations to IT employees at KLM	The reaction of people to the technology, and their interaction with it	Some employees from the IT department were not aware of the existance of the XR-Lab, or they didn't know what they were doing. Most of the employees found the technologies very cool, and found it a nice and fun experience to do at work	If people is not aware of the existance of the technology is more difficult that they are going to support is adoption, or think about possible uses. Also, it demonstrated the attraction to employees that the use of this technology supose.
19	Technology/ Training & Support	Showcasing VR simulations to IT employees at KLM	During the demo some technical problems arise with the technology	The technical complexity of VR system can lead to unknown problems, as well an strong technical knowledge	The reliance of core operation on VR would need the necessary training and support for the employees so they feel in control of the system, and steps to follow in case of failure

H

Strategic Framework

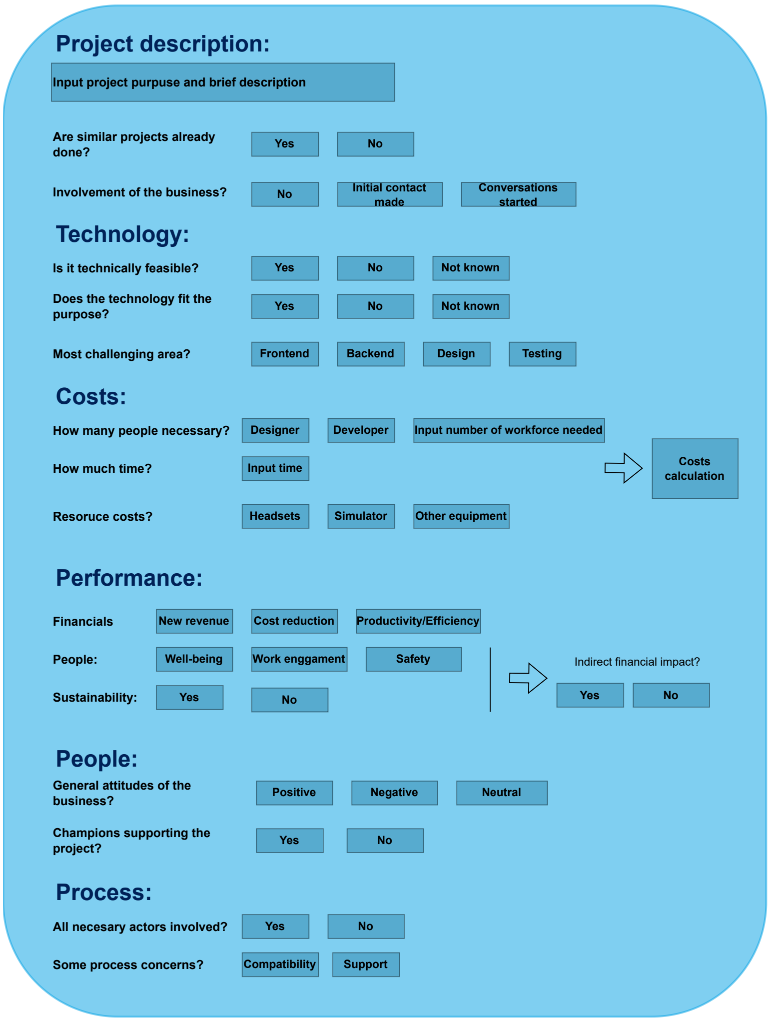


Figure H.1: Strategic decision-making tool based on the framework

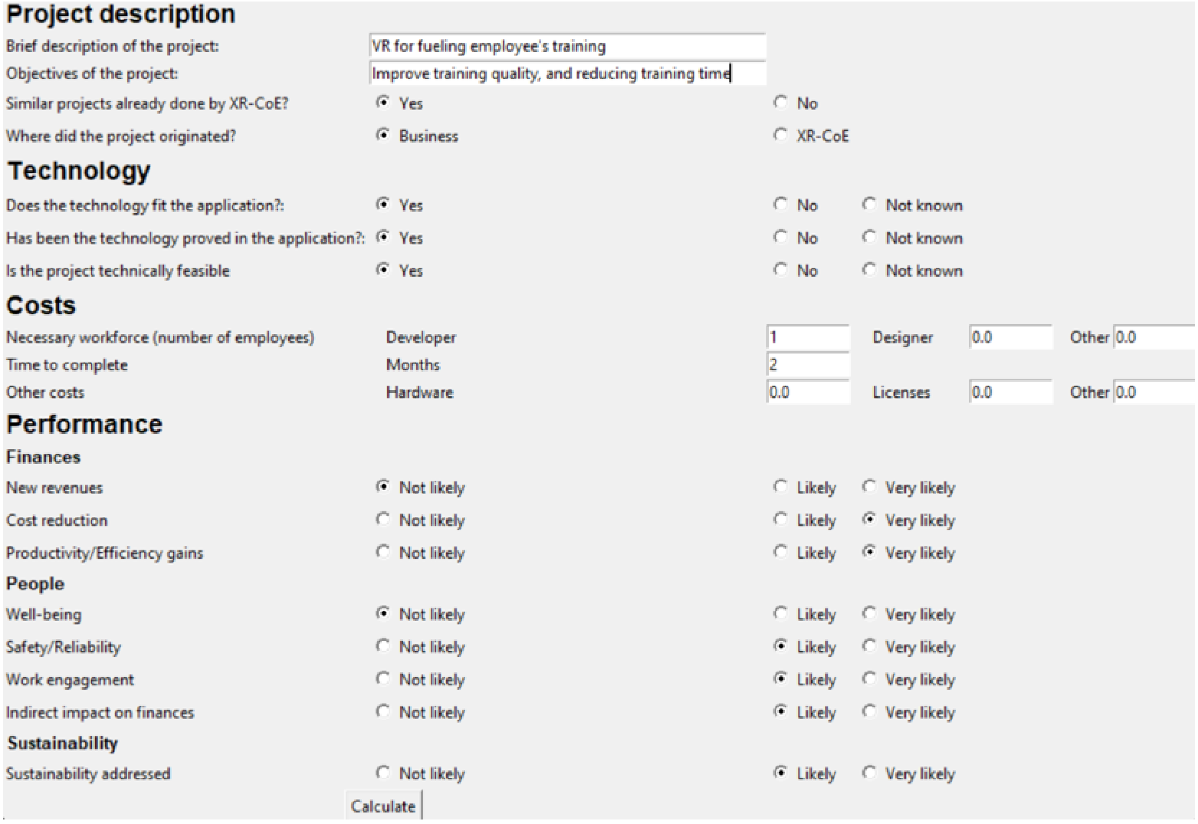
Reasons:

Explain the reason for giving that punctuation to the project. E.g. not having a strong financial case, not sure if the technology aligns with the purpose, or the impact is not clear.

Recommendations:

Based on the input and the outcome some actions are recommended. For instance, developing a POC, directly going to an MVP, or need of looking for sponsors.

Figure H.2: Strategic decision-making tool outcome description



Project description

Brief description of the project:	VR for fueling employee's training		
Objectives of the project:	Improve training quality, and reducing training time		
Similar projects already done by XR-CoE?	(•) Yes	( ) No	
Where did the project originated?	(•) Business	( ) XR-CoE	

Technology

Does the technology fit the application?:	(•) Yes	( ) No	( ) Not known
Has been the technology proved in the application?:	(•) Yes	( ) No	( ) Not known
Is the project technically feasible	(•) Yes	( ) No	( ) Not known

Costs

Necessary workforce (number of employees)	Developer	1	Designer	0.0	Other	0.0	
Time to complete	Months	2					
Other costs	Hardware	0.0	Licenses	0.0	Other	0.0	

Performance

Finances

New revenues	(•) Not likely	( ) Likely	( ) Very likely
Cost reduction	( ) Not likely	( ) Likely	(•) Very likely
Productivity/Efficiency gains	( ) Not likely	( ) Likely	(•) Very likely

People

Well-being	(•) Not likely	( ) Likely	( ) Very likely
Safety/Reliability	( ) Not likely	(•) Likely	( ) Very likely
Work engagement	( ) Not likely	(•) Likely	( ) Very likely
Indirect impact on finances	( ) Not likely	(•) Likely	( ) Very likely

Sustainability

Sustainability addressed	( ) Not likely	(•) Likely	( ) Very likely

Calculate

Figure H.3: First version of the strategic decision-making tool

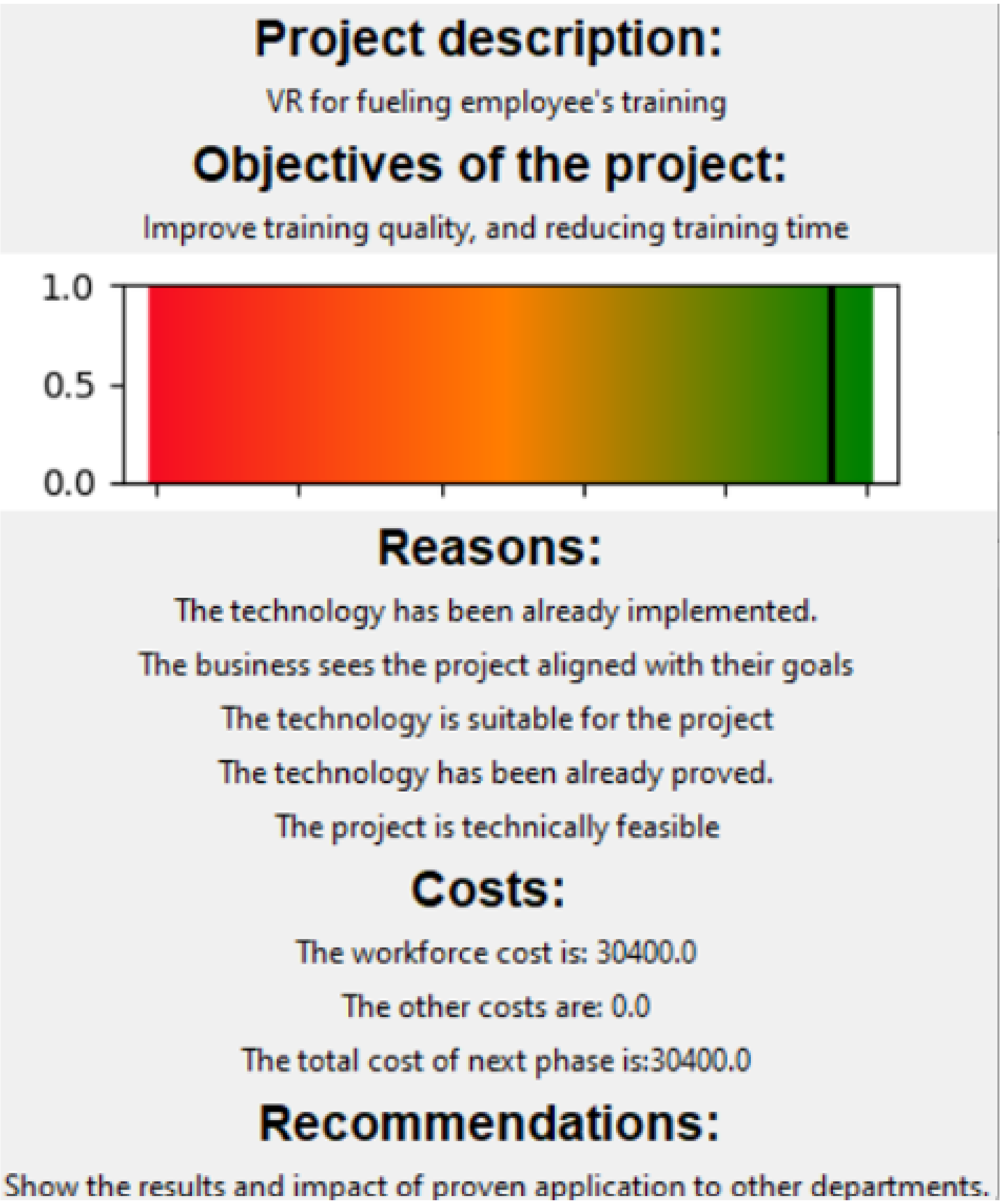


Figure H.4: First version of the strategic decision-making tool outcome description