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The Implementation of VR and AR Technologies as New Business Opportunities for FC Porto

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Abstract

The rapid digital transformation in the sports sector has led clubs to explore new ways of connecting with fans, and immersive technologies such as Virtual Reality (VR) and Augmented Reality (AR) are gaining prominence in this process. Major European clubs are already integrating these solutions into digital experiences and commercial strategies. This dissertation investigates how FC Porto—a historically significant club with more limited resources compared to football giants—can strategically implement VR and AR to strengthen fan engagement, generate new revenue streams, and differentiate itself in the global market.

Despite the clear potential, mid-sized clubs face significant challenges when adopting these technologies. Key obstacles include the absence of a clear strategic roadmap, high production costs, and uncertainty around fan acceptance.

The core proposal of this study is the implementation of immersive experiences at the FC Porto Museum, with a focus on VR simulations that allow visitors to relive historic moments or experience matchday from a player's perspective. A business model based on a paid ticket (€7) for these experiences proved to be viable, scalable, and aligned with supporter preferences, as supported by insights from both PESTEL and SWOT analyses that assessed the strategic, operational, and environmental feasibility of the initiative.

The results show strong fan interest in VR experiences and a clear willingness to pay for them. Financial analysis indicated short-term profitability, while expert interviews validated the technical feasibility of the proposed implementation. Thus, the dissertation concludes that VR and AR can be successfully integrated into FC Porto's strategy, supporting innovation, fan connection, and long-term sustainability.

Keywords: - Virtual Reality (VR), Augmented Reality (AR), Fan Engagement, Sports Marketing, Digital Transformation, Business Models

Resumo

A rápida transformação digital no setor desportivo tem levado os clubes a explorarem novas formas de se conectarem com os adeptos, e tecnologias imersivas como a Realidade Virtual (VR) e a Realidade Aumentada (AR) estão a ganhar destaque nesse processo. Grandes clubes europeus já integram essas soluções em experiências digitais e estratégias comerciais. Esta dissertação investiga como o FC Porto, um clube historicamente relevante, mas com recursos mais limitados em comparação com gigantes do futebol, pode aplicar VR e AR de forma estratégica para fortalecer o envolvimento dos adeptos, criar novas receitas e diferenciar-se no mercado global.

Apesar do potencial evidente, clubes de média dimensão enfrentam desafios significativos para adotar estas tecnologias. Entre os principais obstáculos estão a falta de um plano estratégico claro, custos de produção elevados e dúvidas quanto à aceitação por parte dos adeptos.

A proposta central deste estudo é a implementação de experiências imersivas no Museu do FC Porto, com enfoque em simulações em realidade virtual (VR) que permitam aos visitantes reviver momentos históricos ou experienciar um dia de jogo a partir da perspetiva de um jogador. Um modelo de negócio baseado num bilhete pago (€7) para estas experiências revelou-se viável, escalável e alinhado com as preferências dos adeptos, conforme demonstrado pelas análises PESTEL e SWOT, que avaliaram a viabilidade estratégica, operacional e ambiental da iniciativa.

Os resultados mostram forte interesse do público em experiências de VR e uma clara disposição para pagar por elas. A análise financeira indicou rentabilidade a curto prazo, e entrevistas com especialistas validaram a viabilidade técnica. Assim, a dissertação conclui que VR e AR podem ser integradas com sucesso no FC Porto, promovendo inovação, envolvimento e sustentabilidade.

Palavras-chave: Realidade Virtual (VR), Realidade Aumentada (AR), Envolvimento dos Adeptos, Marketing Desportivo, Transformação Digital, Modelos de Negócio

Abbreviations

AI	Artificial Intelligence
AR	Augmented Reality
CSM	Center for Sports and Management
EUFA	Union of European Football Associations
FC Porto	Futebol Clube do Porto
IPL	Indian Premier League
NFT	Non-Fungible Token
VR	Virtual Reality

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Chapter 1

Introduction

This chapter introduces the context, motivation, and objectives of the research, focusing on the integration of Virtual Reality (VR) and Augmented Reality (AR) into FC Porto's marketing and fan engagement strategies. It outlines the growing relevance of immersive technologies in the sports industry, highlights the opportunities and challenges facing football clubs, and presents the rationale behind this study. The chapter defines the research problem, establishes the main and secondary research questions, and sets clear objectives to guide the investigation. Finally, it provides an overview of the dissertation structure, explaining how each chapter contributes to the development of a strategic framework for FC Porto's digital transformation through VR and AR.

1.1 Context and Motivation

The sports industry is undergoing a digital transformation, largely driven by the integration of Virtual Reality and Augmented Reality. These technologies are reshaping fan experiences, marketing strategies, and revenue models in professional football clubs (Soma V., 2023). European football teams, such as Manchester City, Arsenal, Juventus, and Paris Saint-Germain, have already integrated immersive technologies into their engagement strategies, allowing global fans to participate in club activities remotely (Heidemann M. et al., 2024).

Recent research indicates that 81 % of sports fans are willing to pay for VR-based match experiences, showing a growing demand for interactive, immersive engagement (Akköse H., 2023). Additionally, AR-enhanced broadcasts have demonstrated a 15 % increase in audience engagement and a 20 % improvement in viewer retention (Pickman B., 2023).

Traditional fan engagement models, such as match attendance and television broadcasts are becoming less effective in meeting the expectations of modern sports audiences (Pickman B., 2023). Digitally engaged fans, especially the younger generation, increasingly prefer "interactive, gamified, and on-demand experiences". (Soma V., 2023).

One of the key limitations of traditional engagement strategies is geographical. Fans who are unable to attend the matches in person lack the ability to fully participate in the club's activities (Heidemann M. et al., 2024). AR and VR technologies provide a solution by

enabling remote fans to experience live matches in immersive virtual environments (CSM Research, 2023).

The integration of VR and AR in sports marketing is changing how clubs, sponsors, and fans interact (Heidemann M. et al., 2024). These technologies offer immersive environments where fans can engage with live and on-demand sports content in ways that go beyond traditional broadcasts (Soma V., 2023).

Research highlights that AR marketing significantly enhances brand engagement by inspiring users and positively influencing brand perception (Rauschnabel P. A. et al., 2019). Unlike traditional media formats, AR integrates digital content into real-world settings, making fan engagement more interactive, immersive, and memorable.

In sports marketing, AR and VR applications enable 360-degree matchday experiences, where fans can choose different perspectives of the game and interact with real-time player statistics and holographic replays (CSM Research, 2023). Additionally, gamification strategies, such as AR-based fantasy sports and interactive team-related mini-games, have been shown to drive higher engagement and fan loyalty (Akköse H., 2023).

Football clubs should adapt their business models to remain competitive in the digital age. Traditional revenue streams, such as ticket sales and broadcasting rights, are being supplemented by new digital monetization strategies (CSM Research, 2023).

One of the most promising new revenue models involves virtual ticketing, which allows fans to purchase access to live VR-streamed matches with personalized viewing angles (Heidemann M. et al., 2024).

Another important opportunity lies in AR-powered sponsorships, which allow brands to insert interactive advertisements into live match experiences. Research suggests that these digital sponsorships increase brand recall and engagement levels significantly more than static advertisements (Soma V., 2023). For FC Porto, developing an AR-driven sponsorship model could increase brand partnerships.

Despite its benefits, the adoption of VR and AR in sports marketing presents several challenges (Heidemann M. et al., 2024). High infrastructure costs and limited accessibility remain primary obstacles, as VR headsets and AR-compatible devices are not yet widely adopted by mainstream consumers (CSM Research, 2023).

Resistance from older fan demographics, who may be less inclined to embrace fully digital engagement models, is another challenge (Akköse H., 2023). However, gradual integration

strategies, such as offering hybrid experiences combining traditional and immersive content, can help the transition (Pickman B., 2023).

1.2 Problem definition and objectives

The integration of Virtual Reality and Augmented Reality in professional football presents an opportunity to enhance fan engagement, marketing strategies, and revenue generation. While these technologies have shown significant potential in transforming the sports industry, their adoption in football clubs remains limited and often lacks a clear strategic framework (Heidemann M. et al., 2024). Football clubs face challenges in defining how best to implement VR and AR in ways that deliver measurable commercial outcomes and long-term fan loyalty (CSM Research, 2023).

Clubs must overcome technological, financial, and cultural barriers to make VR and AR experiences accessible to a broad audience while ensuring these innovations enhance the sporting experience (Rauschnabel P. A. et al., 2019).

This dissertation addresses these gaps by developing a data-driven framework for FC Porto's VR and AR integration strategy, exploring how these technologies can effectively support the club's marketing, commercial, and fan engagement goals. By investigating the business potential, implementation challenges, and user adoption factors. This study aims to provide FC Porto with actionable insights for leveraging immersive technologies.

This dissertation aims to investigate how VR and AR technologies can create new business opportunities for FC Porto by enhancing digital engagement and diversifying revenue streams. The study will focus on developing a strategic framework that integrates immersive technologies into FC Porto's marketing, engagement, and commercial initiatives.

The specific objectives of this research are:

- To design a framework for VR and AR adoption that aligns with FC Porto's marketing and commercial objectives, ensuring these technologies deliver measurable results.

- To analyze VR and AR revenue models, exploring monetization strategies such as virtual ticketing and AR-enabled advertising.

- To evaluate fan perceptions of VR and AR, identifying key motivators, barriers to adoption, and user preferences regarding immersive experiences.

- To identify and address technological, financial, and cultural challenges in the implementation of VR and AR at FC Porto, proposing solutions to overcome these barriers.

- To provide strategic recommendations for FC Porto that leverage VR and AR as elements of its digital transformation strategy, ensuring sustainable growth.

Research Questions

To guide this research, the following questions will be explored:

Main Research Questions:

1. What are the most effective ways to integrate VR and AR into FC Porto's marketing and fan engagement strategies to maximize interaction and brand impact?
2. What specific VR and AR applications provide the highest value for improving fan experiences, and how do they influence audience loyalty and club engagement?
3. Which revenue models can effectively monetize FC Porto's VR and AR initiatives, ensuring financial sustainability?

Secondary Research Questions:

4. What are the main technological, financial, and cultural barriers to VR and AR adoption, and how can these challenges be mitigated?
5. How can FC Porto use VR and AR technologies to differentiate itself from competitors and strengthen its position in the global football industry?

By addressing these objectives and research questions, this dissertation will provide FC Porto with a strategic roadmap for integrating VR and AR into its business strategy, ensuring these technologies are implemented not only as engagement tools but also as revenue drivers.

1.3 Dissertation Structure

This dissertation is structured into six chapters. Chapter 1 introduces the research by outlining the context, motivation, and objectives of the study. It explores the growing role of immersive technologies such as Virtual Reality (VR) and Augmented Reality (AR) in sports marketing, digital engagement and frames the strategic relevance of these tools for football clubs like FC Porto. The chapter defines the core research problem, presents the main and secondary research questions, and sets out the overarching aim of creating a strategic roadmap for VR and AR adoption.

Chapter 2 provides the theoretical foundations for the study. It begins by defining VR and AR, explaining their key differences, and detailing their technological capabilities. The

chapter then examines how these technologies are being applied across sectors, with a special emphasis on their transformative impact in sports. It highlights their use in athlete training, fan engagement, broadcasting, and the development of new business models.

Chapter 3 presents the literature review. It synthesizes academic and industry-based research on immersive technologies in sports, focusing on fan interaction, marketing innovation, and revenue generation. The chapter identifies a notable research gap in existing studies, which have largely overlooked mid-tier football clubs like FC Porto. This sets the stage for the dissertation's contribution to both scholarly literature and practical application.

Chapter 4 outlines the research methodology, which adopts a mixed-methods approach. It includes benchmarking case studies of leading European football clubs, a structured online survey targeting football fans, and an expert interview with a VR/AR specialist. This multi-layered approach provides comprehensive insights into both the demand for and the feasibility of immersive experiences within FC Porto's institutional context, particularly at the club's museum and official store.

Chapter 5 presents empirical analysis and case study outcomes. It begins with a detailed interpretation of survey results, highlighting fan preferences, interest levels, and willingness to pay for immersive content. It then incorporates findings from the expert interview, which offers operational and technological insights into VR/AR implementation. The chapter concludes with PESTEL and SWOT analyses that evaluate strategic opportunities and risks, forming the basis for the business model proposed in the final chapter.

Chapter 6 focuses on financial feasibility and strategic implementation. It introduces a proposed immersive solution and presents a pricing strategy, usage estimates, and cost-benefit projections. Two production budget scenarios are compared to assess profitability, and operational guidelines are provided for sustainable delivery. The chapter concludes with strategic recommendations for FC Porto, emphasizing the role of immersive technologies in enhancing fan engagement, creating new revenue streams, and positioning the club as a digital innovator within European football.

Chapter 2

Theoretical Foundations

This chapter explores the transformative impact of immersive technologies in the sports industry, with a particular focus on Virtual Reality (VR) and Augmented Reality (AR). It begins by defining the core features and distinctions between VR and AR, highlighting how each creates unique modes of digital engagement. The chapter then examines their practical applications across key areas such as athlete training, live broadcasting, and fan engagement. Further, it discusses how these technologies are reshaping sports marketing and enabling the development of innovative business models. By strategically integrating VR and AR into their digital ecosystems, sports organizations can enhance audience experiences, deepen fan loyalty, and unlock new avenues for monetization.

2.1 Virtual Reality (VR) and Augmented Reality (AR): Definitions, Differences, Capabilities

Virtual Reality (VR) refers to fully immersive environments that simulate physical presence through headsets and sensory devices. In contrast, Augmented Reality (AR) overlays digital elements (such as statistics or 3D animations) onto the real world, typically through mobile screens or glasses (Soma V., 2023; Pickman B., 2023).

The key difference lies in the sensory experienceof the user: VR replaces the physical world, whereas AR enhances it. VR applications include immersive match viewing, athlete training simulations, and virtual stadium tours. AR, meanwhile, is especially effective for live broadcasts, offering overlays like player stats and interactive replays in real time (Goebert C., 2022; Mahajan R. et al., 2023).

These technologies unlock capabilities far beyond conventional media. AR supports product personalization and interactive advertising, while VR offers unique experiences such as virtual meet-and-greets, multi-angle match viewing, and fan-controlled environments. The synergy between these technologies creates a continuum of immersion, allowing fans to shift between viewing, interacting, and co-creating.

2.2 Virtual Reality (VR)

Virtual Reality (VR) is defined as a real or simulated environment in which a perceiver experiences telepresence, meaning the perception of being physically present in a digital environment (Steuer J., 1992). VR is influenced by two technological dimensions: vividness and interactivity (Steuer J., 1992; 1993). Vividness refers to the capacity to generate a rich and sensorially immersive experience. Interactivity determines the extent to which users can modify the form or content of the virtual world in real time. These dimensions establish the strength of telepresence, or the degree to which users feel present in a mediated environment rather than their immediate physical surroundings (Steuer J., 1992). A VR system with high vividness and high interactivity creates the most immersive experience.

VR is widely used in various fields, offering immersive solutions that enhance user experiences. In entertainment and gaming, VR enables the creation of virtual worlds that allow users to interact with digital content in real time. In medical training and therapy, VR is used for simulated surgeries, rehabilitation programs, and exposure therapy for psychological treatments. In education and training, VR-based learning environments provide hands-on experience in fields such as aviation, engineering, and military training, allowing users to practice skills in a risk-free setting.

2.3 Augmented Reality (AR)

Augmented Reality (AR) is a variation of VR that integrates digital objects into real-world environments in real time, enabling users to interact with both physical and virtual elements simultaneously. Unlike VR, which fully immerses users in a synthetic world, AR supplements reality rather than replacing it (Azuma R. T., 1997).

An AR system must satisfy three fundamental criteria. The first criterion is the combination of real and virtual elements, where digital objects are overlaid onto the real world. The second criterion is real-time interactivity, which allows users to manipulate virtual elements immediately. The third criterion is 3D registration, ensuring that virtual objects are aligned with real-world objects in three-dimensional space (Azuma R. T., 1997).

AR has significant applications in various domains, enhancing user experiences across different industries. In retail and e-commerce, AR enables virtual try-ons for clothing and accessories, allowing customers to visualize products before purchasing. In healthcare, AR-assisted surgeries provide real-time overlays of patient anatomy, enhancing precision during medical procedures (Azuma R. T., 1997). In education, AR facilitates interactive

learning experiences by overlaying digital information onto physical objects, making abstract concepts more tangible. In industrial and maintenance settings, AR provides real-time instructions for complex machinery repairs, reducing errors and increasing efficiency. In navigation and tourism, AR applications display real-time location-based information, offering interactive city guides and enhanced wayfinding tools (Azuma R. T., 1997).

Chapter 3

Literature Review

This chapter presents an overview of the role of immersive technologies in the digital transformation of the sports industry, with a particular focus on Virtual Reality (VR) and Augmented Reality (AR). It examines key applications, including fan engagement, marketing innovation, and emerging revenue models, drawing on both academic research and industry case studies. Special attention is given to the potential implementation of these technologies by mid-tier football clubs such as FC Porto, highlighting the strategic opportunities and challenges unique to such organizations.

3.1 Methodology

The methodology employed in this literature review adheres to a qualitative integrative approach, which involves synthesizing insights from diverse qualitative studies to construct a comprehensive understanding of the phenomenon under investigation. This approach allows for the integration of various perspectives and methodologies to identify themes and patterns. The review process utilized secondary sources consisting of both academic and industry-based studies, specifically chosen to represent a diverse array of perspectives on immersive technologies in sports. All sources were provided as part of the research and included peer-reviewed journal articles, white papers, and case-specific technical reports published between 2018 and 2024. The documents were selected based on their empirical relevance to the core themes of the study, including virtual reality (VR), augmented reality (AR), fan engagement, digital transformation and business model innovation in the context of professional sports.

Emphasis was placed on selecting sources that offered insights into the technological adoption by leading sports entities such as FC Barcelona, Manchester City, Real Madrid, and major American sports leagues like the NFL and NBA. Studies that examined less globally prominent clubs or regional contexts, such as Indian cricket franchises and fan engagement in Iranian sports, were also included to broaden the scope of analysis and identify existing research gaps. Theoretical contributions were favored when grounded in consumer behavior models, such as the Elaboration Likelihood Model (Goebert C., 2022),

or strategic innovation frameworks, such as business model evolution (Heidemann M., 2024).

3.2 Applications of VR/AR in sports

The deployment of VR and AR in the sports industry has moved beyond experimental novelty to strategic implementation across multiple operational domains. Among the most salient applications is the transformation of live stadium experiences. Manchester City serves as a leading example of how immersive technology can redefine venue engagement. The club, in partnership with Sony, has developed a full-scale digital twin of its Etihad Stadium, allowing fans to participate in matchday activities through avatars and AI-enhanced 3D broadcasting systems. This initiative is part of a broader strategic shift toward metaverse-based fan interaction, positioning the club as a pioneer in immersive fan engagement (Heidemann M., 2024; CSM Report, 2023).

Similarly, FC Barcelona's recent redevelopment of Camp Nou integrates AR-based features to enrich in-stadium experiences with real-time player statistics, tactical animations, and interactive fan zones. These AR applications aim to appeal especially to younger, digitally native fans who demand heightened interactivity and personalization during live events (Soma V., 2023). In the Indian Premier League (IPL), the Fan Parks project further extends this model by creating stadium-like atmospheres in underserved regions using AR screens and real-time digital engagement features (Mahajan R. et al., 2023).

Through flying theatres, interactive exhibits, and lifelike simulations of football scenarios, the park reimagines the sports museum as an immersive, participatory journey (Mahajan R. et al., 2023).

Fan-player interaction has also been redefined through AR/VR integration. The NFL's OnePass application enables fans to engage with players virtually through real-time meet-and-greet functionalities, digital autographs, and gamified loyalty programs. These features not only foster emotional connection but also create new touchpoints for brand interaction and data capture (Mahajan R. et al., 2023). In the NBA, particularly during the COVID-19 pandemic, virtual fan attendance was implemented using VR screens, allowing fans to appear live in stadiums and react in real time, thereby preserving the community aspect of live sports consumption during periods of physical distancing (Pickman B., 2023).

3.3 VR/AR in Sports Marketing and Fan Engagement

Empirical research consistently shows that immersive technologies have a measurable impact on sports marketing outcomes. Pickman (2023) and Kim & Lee (2019) demonstrate that AR-augmented broadcasts result in higher viewer retention and brand recall. For instance, fans exposed to tactical AR graphics reported increased engagement, emotional involvement, and willingness to re-watch content.

Fan engagement, a cornerstone of sports branding, has evolved from passive consumption to interactive participation. According to (Mahajan R. et al.,2023), over 57 % of Indian sports fans consume content via digital platforms such as Hotstar, while 46 % express interest in real-time analytic overlays. This indicates a cultural shift in fan behavior favoring personalization and interactivity.

Numerous case studies validate this shift. The Chennai Super Kings' (CSK) AR selfie app allowed fans to create team-themed digital content, shareable across social platforms. Similarly, the NFL's OnePass app offers digital autograph cards, interactive games, and real-time notifications to strengthen fan-club connections (Mahajan R. et al., 2023).

Academic models such as Javornik's (2014) framework classify AR's marketing use into three categories: advertising/promotion, product management, and customer service. These domains now include sports-specific features such as live tactical overlays, virtual merchandise try-ons, and instant customer feedback systems (Goebert C., 2022).

Furthermore, the emotional appeal of VR has been linked to increased fan loyalty and brand affiliation. This is corroborated by Pickman's findings that immersive tech not only enhances fan satisfaction but also fosters community formation and brand advocacy.

3.4 Business Models in the Sports Tech Industry

The commercialization of immersive sports experiences hinges on diversified and innovative business models. The most prominent strategies include monetizing virtual attendance, integrating fan tokens, selling NFTs, and forging tech partnerships.

Fan tokens and NFTs are being rapidly adopted by clubs such as Juventus, PSG, and Borussia Dortmund in partnership with crypto firms (CSM Report, 2023). These assets offer holders unique perks, like voting rights and exclusive content, and represent a scalable digital revenue stream.

Another emerging model is the royalty-based metaverse. While projections are cautious due to regulatory ambiguity and shifts in platform policies (e.g., Opensea reducing creator fees),

many experts believe PFCs will adopt NFT royalty models as a solution to sponsorship market saturation and declining broadcast revenues.

The implementation of these models requires strategic partnerships between clubs, tech firms, and media platforms. For example, Adidas and Nike have entered the metaverse through digital collectibles and branded AR/VR games, illustrating how consumer goods and sports are co-evolving in digital arenas (Akköse H., 2023).

3.5 Fan Engagement and Revenue Models

AR and VR technologies are not merely tools for enhancing engagement; they are pivotal to the construction of new digital revenue streams in the sports industry. The shift from passive viewership to interactive fandom has enabled clubs and leagues to monetize fan behavior in innovative ways. This not only strengthened brand loyalty but also increased merchandise sales and digital engagement metrics (Mahajan R. et al., 2023).

Perhaps the most disruptive monetization mechanisms come from blockchain integration. Clubs such as Juventus, PSG, and Arsenal have introduced fan tokens—blockchain-secured digital assets that grant holders voting rights and access to exclusive content. These tokens have been marketed as tools of democratization and intimacy, yet they also serve as high-yield revenue products, especially among younger fans attracted to decentralized finance and digital ownership models (CSM Report, 2023; Heidemann M., 2024).

NFTs (non-fungible tokens) further expand this ecosystem by providing limited-edition digital collectibles, match highlights, and customizable avatars. These digital assets have become lucrative, with market forecasts estimating that NFT-based fan products will contribute significantly to clubs' revenue portfolios by 2025. However, the literature also acknowledges concerns about volatility, regulatory risks, and ethical questions surrounding data ownership and speculative trading (Heidemann M., 2024).

3.6 Discussion

While the existing literature offers insights into the application of immersive technologies by elite sports organizations, such as FC Barcelona, Manchester City, and the NFL, there is a noticeable scarcity of academic and industry-oriented work addressing how mid-tier European clubs like FC Porto can implement similar technologies within their own strategic, financial, and cultural context. FC Porto, despite being a historically significant and internationally competitive football club, has yet to be extensively studied in terms of

its potential integration of virtual reality (VR) and augmented reality (AR) technologies. This absence presents a clear research gap in both scholarly and practical dimensions.

The core objective of this dissertation is to evaluate how the implementation of immersive technologies can open new avenues of business development for FC Porto. Specifically, the research seeks to investigate how VR and AR can be embedded into the club's marketing, entertainment, and fan engagement strategies to generate new revenue streams, enhance brand visibility, and reinforce fan loyalty. This stands in contrast to the majority of existing studies, which concentrate on top-tier clubs with global fan bases and ample capital for technological experimentation and expansion.

Most empirical studies, including those by Goebert C. and colleagues (2020, 2022), address immersive technology adoption in relatively unconstrained environments, either within leagues supported by centralized investments (e.g., the NBA or NFL) or by clubs already embedded in a highly commercialized sports ecosystem (e.g., FC Barcelona). These studies often overlook the logistical, financial and organizational limitations that clubs like FC Porto must navigate. For example, while Manchester City has developed a fully functional digital twin of its stadium in partnership with Sony (Heidemann M., 2024), FC Porto must consider the technological and infrastructural investments required for even partial AR integration, such as interactive matchday experiences or VR-enhanced museum exhibits.

Equally underexplored are the nuances of fan behavior in local and regional contexts. Although there is significant documentation of fan reactions to immersive content in North American and Western European markets (Pickman B., 2023; Mahajan R. et al., 2023), few studies analyze how Portuguese fans would respond to immersive offerings like VR stadium tours, AR-based second-screen content, or interactive VR experiences. The present study aims to fill this void by utilizing a mixed-methods approach that includes online surveys and semi-structured interviews with FC Porto fans and stakeholders, allowing for a deeper understanding of their preferences, emotional engagement, and willingness to pay for immersive experiences.

Additionally, this study addresses the strategic challenge of implementation. The existing literature fails to provide a comprehensive roadmap for integrating immersive technologies into the day-to-day operations of clubs outside the financial elite. FC Porto must navigate complex questions about technological partnerships, platform development, content creation and fan education. This research will examine the institutional, technical, and cultural barriers to adoption, ranging from accessibility and digital literacy among fans to

limitations in current infrastructure and internal technical capabilities. These themes will be analyzed through stakeholder interviews and comparative case studies, producing a grounded, realistic set of recommendations tailored to FC Porto's operational landscape.

Lastly, the competitive differentiation enabled by immersive technologies has also been under-researched for clubs in FC Porto's tier. In markets where fan loyalty and brand equity are under constant pressure from better-resourced competitors, offering immersive experiences could become a powerful strategic asset. This study will assess how such technologies might enhance FC Porto's positioning not only among its domestic rivals but also within international competitions, thereby contributing to a more comprehensive understanding of the role of AR and VR in competitive branding and sports marketing.

Chapter 4

Methodology

This chapter outlines the research methodology employed to explore the potential integration of immersive technologies at the FC Porto Museum and official store. A mixed-methods approach was adopted, combining benchmarking, case studies, surveys, and expert interviews to gather both qualitative and quantitative insights. The benchmarking focused on leading European football clubs to identify best practices, while a structured survey assessed fan expectations and digital behavior. Complementing this, a professional interview provided practical knowledge about VR/AR implementation. Together, these methods ensured that proposed solutions were not only innovative but also feasible and aligned with fan interests and institutional capabilities.

4.1 Methodology of proposal research

This research was guided by a benchmarking and case study approach, with the objective of identifying innovative experiences implemented by other major football clubs that could inspire and inform new technological offerings for FC Porto's museum and official store. The central aim was to explore how immersive and interactive technologies, particularly virtual reality (VR) and augmented reality (AR), are being used in the football industry to enhance fan engagement and to assess which of these strategies could be realistically adapted to the FC Porto context.

The first step involved selecting benchmark clubs known for their pioneering efforts in digital transformation and fan experience within museum and retail environments. FC Barcelona served as a primary case study due to its well-known Camp Nou Experience, which includes large-scale audiovisual elements and immersive storytelling techniques. In addition, the research examined Bayern Munich and Paris Saint-Germain (PSG), both of which have integrated advanced digital features into their stadium tours and fan zones. These clubs were chosen not only for their technological leadership but also for their strong brand identities and similar needs in balancing tradition with innovation.

The analysis of these clubs was structured around key criteria: the type of technology used (such as VR simulations, AR layers, interactive games, or digital archives), the level of fan interaction (from passive observation to active participation), the technical and operational complexity of the solutions, their monetization models (free, freemium, or ticketed access),

and the alignment between the experience and the club's identity and history. This structure allowed for a comparative understanding of what works, what challenges arise, and how fans respond to various formats of engagement.

Following the collection and synthesis of these examples, the research focused on adaptation. Each idea was evaluated against FC Porto's specific characteristics, including the spatial constraints of its museum, the profile of its fan base, and the club's cultural and historical narrative. Ideas that relied heavily on large physical infrastructure (like Barcelona's giant projection walls) were reconsidered in favor of more compact and scalable formats, such as individual VR headset stations that could deliver similarly powerful emotional experiences with less logistical demand.

Through this benchmarking and case study methodology, several key insights emerged. First, the integration of VR and AR technologies significantly enhances the appeal of traditional museum spaces, transforming them into dynamic and emotionally engaging environments. Second, interactive and gamified experiences are particularly effective in attracting younger audiences and increasing the time spent within the museum or store. Lastly, the most impactful experiences are those rooted in the club's history — allowing fans to relive iconic moments, feel closer to their idols, or step into the shoes of a player — thereby reinforcing their emotional bond with the club.

Description of Proposed Options for FC Porto Museum and Store

Following the benchmarking of major football clubs such as FC Barcelona, Bayern Munich, and Paris Saint-Germain, a set of four experience-based options was developed for potential implementation at the FC Porto Museum and official store. Each proposal aims to modernize the club's fan engagement strategy by integrating immersive and interactive technologies, while remaining aligned with FC Porto's identity and operational realities.

Option 1: VR Experience – Reliving FC Porto's Greatest Moments

This option proposes the development of a virtual reality (VR) station within the museum that allows visitors to relive FC Porto's most iconic victories and moments. Wearing VR headsets, fans would be fully immersed in historical match footage, such as the 2004 UEFA Champions League final, narrated and enhanced with immersive sound and visual effects. The experience would blend archival footage with digital reconstructions to recreate the intensity and atmosphere of each milestone.

The objective is to deepen the emotional connection between fans and the club's legacy, creating a sense of presence within FC Porto's historical triumphs. This also adds a digital, archival component to the museum, transforming static history into a living, interactive narrative. The experience could be monetized as a premium add-on to the museum visit.

Option 2: VR Experience – "Be a Player" First-Person Match Perspective

This concept builds VR technology to provide a different kind of immersive experience: allowing fans to feel what it's like to step onto the field as an FC Porto player. Using 360-degree video capture and spatial audio, fans would wear headsets and experience a game from a first-person perspective, complete with locker room preparation, tunnel entrance, and live match moments.

This option appeals particularly to younger audiences and fans seeking unique, behind-the-scenes access. It also creates potential for corporate sponsorship, as brands could be integrated into the visual environment. While technically demanding, this experience sets a new standard for club-fan interaction by offering a rare and deeply personal view of life on the pitch.

Option 3: Interactive VR Game – Play Alongside FC Porto Players

This option introduces a gamified VR experience where fans can interact virtually with digital avatars of FC Porto players. Whether it's a penalty shootout challenge, a training simulation, or a co-op football mini-game, users would actively participate in a fictional scenario that allows them to "play with" their favorite stars. The experience could evolve over time, with updated rosters, new challenges, and seasonal content.

The purpose is to blend entertainment with emotional engagement, turning passive fans into active participants. This concept responds to the growing popularity of eSports and virtual interactivity, especially among younger demographics. It also opens the door for social sharing features, competitive leaderboards, and additional club merchandise integration.

Option 4: Interactive Game (Non-VR) – Casual Fan Engagement Without Headsets

Recognizing that not all visitors are comfortable with VR technology, this fourth option offers an interactive game experience that does not require headsets or complex equipment.

Using touchscreens, motion sensors, or simple control panels, fans could play themed games involving FC Porto players and club scenarios. For example, fans might compete in a digital dribbling challenge or complete trivia rounds to win points.

One of the key advantages of this option is accessibility: it can be used by all ages and requires minimal operational oversight. Additionally, it can be easily placed in the museum or store as a standalone station. Incentives such as discounts on merchandise or match tickets could be linked to player performance, encouraging more participation and increasing store sales. The game could also be integrated with social media platforms, encouraging fans to share their scores and experiences online, thereby amplifying the club's digital presence.

4.2 Evolution of Visitor Numbers at the FC Porto Museum

To understand the context and potential impact of implementing immersive technologies at the FC Porto Museum, it was important to begin by analyzing its visitor trends over time. This historical data provides insight into the museum's growth trajectory, its appeal to both national and international audiences, and its relevance as a space for technological innovation. By tracing the evolution of visitor numbers, especially before and after the COVID-19 pandemic, it becomes possible to identify periods of peak engagement and to estimate the feasibility and scalability of introducing VR and AR experiences as part of the museum's ongoing development. This step helps frame the proposal within a realistic operational setting, grounded in the museum's actual audience reach.

Since its inauguration in 2013, the FC Porto Museum has recorded remarkable growth in visitor numbers, establishing itself as one of the main cultural attractions in the city of Porto. In 2023, the museum surpassed the symbolic milestone of 1.5 million cumulative visitors, precisely on its 10th anniversary (Futebol Clube do Porto, 2023a; Jornal de Notícias, 2023). In the early years, the growth was steady. In 2014, the museum received around 120,000 visitors (Futebol Clube do Porto, 2015). The following year, that number more than doubled, reaching about 265,000 visits, 70 % of which were Portuguese nationals (Futebol Clube do Porto, 2015). In 2016, visits increased to approximately 410,000, with a significant rise in international guests, who then represented 40 % of the total (Futebol Clube do Porto, 2016).

By 2018, the museum had accumulated over 735,000 visits, with 30 % coming from abroad (Futebol Clube do Porto, 2018). In 2019, during its sixth year of operation, it recorded 186,000 annual visits, 41 % of which were from international tourists .

The COVID-19 pandemic significantly reduced visitor numbers in 2020. Still, that year marked the milestone of 1 million cumulative visits to the FC Porto Tour (Futebol Clube do Porto, 2020). A recovery was seen in 2022, when the museum welcomed more than 50,000 visitors in August alone, setting a new daily record of 2,900 entries (Futebol Clube do Porto, 2022).

In 2023, the FC Porto Museum broke another record by receiving 3,370 visitors in a single day (August 2), the highest number since its opening (Futebol Clube do Porto, 2023b). That year, over 60 % of visitors were foreigners, coming from more than 180 countries, highlighting the museum's increasing international appeal (Futebol Clube do Porto, 2023a).

4.3 Survey Methodology

To assess the demand, readiness, and expectations of football supporters regarding immersive technologies, a quantitative survey was conducted. Although the study was originally intended to focus on FC Porto's fan base, the survey was instead directed toward football fans in general due to the need for high-level approval from FC Porto management, which could have delayed data collection. This approach allowed for a broader and more time-efficient gathering of insights relevant to football club's contexts. The choice of a structured online questionnaire enabled efficient data collection across a diverse population. This method was essential to capture first-hand insights into fan preferences, digital behavior, and willingness to pay for VR/AR experiences. By analyzing demographic variables and usage patterns, the survey helped identify key user segments and informed the design of a more targeted and viable immersive offering. The goal was to ensure that any proposed experience would not only be technologically impressive but also aligned with actual fan interest and behavior.

This study adopted a quantitative, descriptive survey design to investigate the interest and receptiveness of football fans toward the use of Virtual Reality (VR) and Augmented Reality (AR) technologies within the context of a club museum. The primary objective was to assess individuals' prior exposure to immersive technologies, their willingness to engage with such technologies in a museum environment, and the extent to which they would be willing to pay for this type of experience.

Data collection was conducted through an online questionnaire administered via Google Forms. The survey remained open throughout May 2025 and was distributed through digital platforms targeting football supporters. Participation was entirely voluntary, and no personally identifiable data were collected, thereby ensuring the anonymity and confidentiality of all respondents. The questionnaire included a combination of closed-ended and multiple-choice questions designed to capture demographic details, patterns of digital engagement with football clubs, awareness and experience with VR and AR, intentions to visit club museums, interest in immersive experiences during museum visits, preferred types of VR/AR content, willingness to pay for such experiences, and the probability of participating in immersive museum activities.

A total of 141 responses were collected from individuals representing various age groups and geographic locations. The age categories included participants aged 18–24, 25–34, 45–54, and 55 and over. Most respondents resided in different cities across Portugal, which contributed to a geographically diverse sample.

The data were analyzed using Microsoft Excel. Pivot tables and cross-tabulations were employed to identify trends and relationships among variables. Specific attention was given to the correlation between demographic characteristics and interest in VR/AR, the influence of previous experience with immersive technologies on future intentions, and the relationship between willingness to pay and preferred types of experiences. These analyses aimed to generate actionable insights into user preferences and inform future decisions regarding the integration of immersive technologies into museum experiences.

All participants were informed about the purpose of the study and gave implicit consent by submitting their responses. No incentives were offered for participation. The study complied with ethical standards concerning informed consent, voluntary participation, and data confidentiality.

4.4 Interview Methodology

While quantitative data provided broad trends, it was equally important to gain expert insights into the technical and strategic realities of VR and AR implementation. To this end, a qualitative interview was conducted with João Neto, a leading practitioner in immersive technology development in Portugal. His professional experience in delivering VR/AR projects within cultural and institutional settings offered valuable knowledge about production logistics, cost structures and content feasibility. This method was chosen to

complement the survey data with grounded, real-world perspectives, helping to bridge the gap between conceptual ideas and practical execution. The interview played a key role in shaping realistic, scalable recommendations for FC Porto's context.

As part of the qualitative approach adopted in this study, an expert interview was conducted to gather insights into the practical application and strategic potential of immersive technologies. The objective was to understand, from a professional standpoint, the feasibility, development processes, and institutional implications of implementing Virtual Reality and Augmented Reality experiences, particularly within the context of sports and cultural organizations.

The interview was carried out with João Neto, a specialist in VR and AR and a key figure at Hubduction, a Portuguese company known for its high-quality immersive content, often developed in partnership with public and cultural institutions. His role and experience in designing and executing VR/AR projects made him a relevant informant for the study's thematic focus.

The interview was conducted in a semi-structured format, allowing for consistency across research themes while providing flexibility for deeper exploration of relevant topics that emerged during the conversation. The session took place via Zoom, ensuring a direct and dynamic exchange. Prior informed consent was obtained from the interviewee, and the session was recorded in full for accuracy. Following the interview, the recording was transcribed to produce a detailed textual record for analysis.

The interview script was designed to cover several key thematic areas aligned with the research framework, including organizational positioning, sectoral demand, technological tools, production logistics, budgetary constraints, audience impact, and strategic advice for institutions adopting immersive solutions. While the script guided the flow of the discussion, open-ended questions allowed the interviewee to expand freely and introduce practical examples drawn from real-world project experiences.

This interview methodology enabled the collection of rich, contextualized data directly informed by industry practice contributing to the understanding of technical insight.

Chapter 5

Empirical Analysis / Case Study Outcomes

This chapter presents the core empirical findings and strategic analysis supporting the proposed implementation of Virtual Reality (VR) and Augmented Reality (AR) technologies at the FC Porto Museum. It integrates data collected through a structured online survey of football fans, an expert interview with a leading VR/AR developer, and a comprehensive strategic framework.

Section 5.1 analyzes the survey responses, revealing fan attitudes, preferences, and willingness to pay for immersive experiences. Section 5.2 offers practical insights from João Neto, a professional immersed in the development of cultural VR/AR projects, regarding technological feasibility, operational design, and cost considerations. Finally, Section 5.3 employs PESTEL and SWOT analyses to evaluate the internal and external factors shaping the strategic viability of immersive technologies in this context. Together, these sections provide a multidimensional assessment of both demand and feasibility, guiding the formulation of actionable recommendations in subsequent chapters.

5.1 Survey Analysis

Descriptive Analysis of Survey Results: VR and AR in Club Museum Experiences

Demographics and Digital Engagement

Respondents spanned a wide range of age groups, with the largest segment (32 participants) falling in the 18–24 years category. This was followed closely by individuals aged 25–34 years (27 respondents) and 55+ years (25 respondents). This distribution shows a healthy mix of younger and older fans, suggesting a broad appeal across generations. When asked about their engagement with digital content from their club, responses varied. A significant portion of participants (45 individuals) reported consuming digital content daily, indicating strong habitual engagement. However, the largest group (52 respondents) stated they rarely consumed content, pointing to a substantial portion of the fanbase that is digitally passive or selective in their interactions.

Regarding digital platforms used to follow club updates, Instagram emerged as the most frequently mentioned platform. Other popular choices included Facebook, YouTube,

TikTok, and the official club application or website. Many respondents selected multiple platforms, reflecting a trend toward diversified media consumption.

Awareness and Experience with VR/AR

An overwhelming majority of respondents (127 out of 141) indicated that they have heard of VR and AR technologies, demonstrating high general awareness. However, prior experience using VR/AR is much less common. Most respondents (around 60 %) said they had never interacted with these technologies before, highlighting a significant opportunity to introduce them to immersive tech through the museum context.

Museum Visitation and Interest in VR/AR

When asked if they had ever visited the club's museum, responses were mixed, with many answering "No". Despite this, there is substantial interest in future visits, with the majority responding "Yes" or "Maybe" to whether they plan to visit the museum in the future.
Importantly, when asked about their interest in using VR or AR during such a visit, the vast majority indicated a "very high" level of interest. This points to a strong potential demand for immersive experiences in the museum setting.

Preferred VR/AR Experiences

The most frequently desired experience was the ability to "relive the club's greatest achievements using VR headsets." This suggests that fans are particularly drawn to emotionally resonant, nostalgic content. Other desired experiences included:

1. Simulated matchday experiences
2. Behind-the-scenes access to locker rooms or stadium area
3. Virtual interactions with legendary players or staff

These preferences reflect a desire for deeply immersive and emotionally meaningful content, rather than superficial entertainment.

Monetization and Willingness to Pay

When asked whether they would be willing to pay extra to access VR experiences at the museum, most respondents said "Yes" or "Depends on the price". Very few respondents were completely unwilling to pay.

Among those open to payment, the most common acceptable price range was between €5 and €10, followed by up to €5. A smaller segment was willing to pay €10–€15, indicating that while fans see value in the experience, affordability is key.

Likelihood of Participation

The final question asked about the likelihood of participating in an immersive experience if offered at the museum. Responses leaned heavily positive, with most selecting "Very Likely" or "Likely." This reaffirms the earlier indicators of enthusiasm and openness toward immersive technologies.

Concluding remarks

The survey results clearly show that fans are open, curious, and enthusiastic about the introduction of VR and AR technologies into their club's museum. While many have not previously used these technologies, their strong interest (especially in emotionally rich, historically significant experiences) suggests that immersive content could significantly enhance visitor engagement.

Additionally, a large portion of the fanbase is willing to pay a modest fee for such experiences, provided the quality and emotional relevance are high. With a broad demographic reach and solid digital awareness, the integration of VR/AR in the club museum has the potential to elevate the fan experience and create new revenue opportunities.

5.2 Expert Interview Analysis

Expert Testimony: João Neto, VR/AR Specialist at Hubduction

As part of the research into immersive technologies in the sports industry, an expert interview was conducted with João Neto, a Virtual Reality (VR) and Augmented Reality (AR) specialist at Hubduction. Hubduction is a spin-off from the company Critec and is recognized for its specialization in high-quality, customized VR and AR experiences.

Company Profile and Market Focus

Hubduction primarily engages in producing immersive content within the cultural sector. The organization emphasizes long-term and complex collaborations with public institutions, particularly museums and cultural entities. According to Neto, this focus

enables the development of richer, more inclusive experiences rather than commercial or entertainment-centric outputs.

Although some industrial clients are served, the bulk of Hubduction's portfolio centers on publicly funded cultural initiatives. One example cited was the filming of a regatta to produce a VR experience, aimed at making the event accessible to those who are physically unable or financially incapable of participating in such activities.

Technologies and Tools

Hubduction utilizes a range of technologies, favoring open-source tools and frameworks. WebGL and React are commonly used for front-end development. For 3D modeling and design, platforms such as Unity, Blender, and Adobe Photoshop are employed. These choices support both flexibility in development and cost efficiency.

Application in Sports Contexts

The interview explored the feasibility of applying immersive technologies in a sports context, with a particular focus on football. After being shown the four possible implementations, Neto identified two primary avenues for implementation. The first involves virtual tours of historic moments. While conceptually appealing, this approach faces a major hurdle: the quality of historical imagery. Neto emphasized that the success of immersive experiences is highly dependent on the visual fidelity of the source material. Unfortunately, archival footage or content supplied by third parties often falls short of the standards required for compelling virtual environments. As a result, the execution of these tours is limited by the inadequacy of existing assets.

The second avenue, which Neto regarded as significantly more feasible, centers on 360-degree player perspective experiences. Unlike historical reconstructions, these can be fully controlled by the production team from the outset, allowing for high-quality image capture and greater creative flexibility. Neto suggested that filming should ideally take place during team presentations or similar events, where regulatory or logistical barriers are minimal. He proposed an especially engaging use-case: giving young fans the chance to experience a day in the life of a youth academy player. Such an experience, he noted, would be both technically viable and emotionally resonant, offering a powerful connection to the club's development pathway.

Neto further observed that these kinds of immersive applications remain largely unexplored within football. To his knowledge, no club has yet implemented a comparable initiative. This opens the door for first-mover advantage, presenting an opportunity for innovation in fan engagement through immersive media that is not only practical but also pioneering within the industry.

Logistical Considerations

For the successful implementation of immersive experiences, Neto offered several best practices based on operational and user-experience considerations. He advised maintaining a supply of backup VR headsets to ensure hygiene standards are upheld and to provide operational continuity in the event of technical issues. Cleanliness is especially important in high-traffic environments where multiple users interact with the same equipment.

He also recommended physically securing the headsets to prevent accidental drops or falls, which could damage the devices and interrupt the experience. Safety and durability, he noted, are essential for maintaining long-term functionality.

To enhance user comfort, Neto suggested conducting the experience while standing rather than sitting. This setup tends to reduce the likelihood of motion sickness, a common issue in immersive environments. Finally, he emphasized the importance of allowing users to engage with the experience at their own pace. Removing time pressure not only makes the interaction more enjoyable but also helps users fully absorb the content, leading to a more meaningful and memorable experience.

Project Development and Client Interaction

Project timelines vary depending on team size and client responsiveness. Importantly, Neto emphasized that initial deliveries are always subject to post-delivery iterations. Clients often better understand the technology's potential only after interacting with a prototype.

Strategically, clubs should align immersive experience development with key calendar events, such as the team's pre-season presentation. These moments provide ample opportunity for content capture and strategic deployment.

Cost Drivers and Budget Management

According to Neto, the largest cost component in immersive project development is image acquisition, particularly travel and accommodation for film crews. Editing and

post-production also represent significant expenditures. Hubduction frequently employs an inverse costing model—clients set a budget, and the team maximizes output within that constraint.

Evaluation and Metrics

Impact is assessed qualitatively and quantitatively. The most immediate measure is user feedback during live usage. Additionally, follow-up requests from clients for enhancements indicate active use and satisfaction. In marketing applications, Hubduction employs tools such as Google Analytics to track user engagement and downstream effects on client performance metrics.

Strategic Recommendations for Sports Institutions

Neto strongly advocates early adoption. He encourages sports institutions to pilot immersive experiences to evaluate their potential with minimal upfront investment. Revenue-sharing models can be negotiated following proof-of-concept success.

Willingness to Collaborate

Neto concluded by affirming Hubduction's openness to future collaborations, particularly with leading Portuguese football clubs interested in pioneering VR/AR solutions.

5.3 Strategic Framework: PESTEL and SWOT

A PESTEL and SWOT analyses were conducted to evaluate the strategic feasibility of introducing immersive VR/AR experiences at FC Porto's Museum. The PESTEL analysis helps identify and understand the broader external factors (political, economic, social, technological, environmental and legal) that could influence the project's success or present potential risks. Meanwhile, the SWOT analysis offers an internal and competitive perspective by assessing FC Porto's strengths and weaknesses, as well as external opportunities and threats. Together, these frameworks provide a well-rounded foundation for informed decision-making and strategic planning.

PESTEL Analysis

Political

- EU Digital Policies: EU's support for digital transformation and cultural innovation can provide funding or policy incentives. (European Commission, n.d.-b)
- Public funding & grants: Museums in Portugal may be eligible for cultural or tech innovation grants. (ABGi, n.d.)

Economic

- Tourism-driven revenue: Porto's international tourism supports monetization through VR/AR (€7 ticket model).
- Scalable ROI: Financial models show profitability even in conservative scenarios (e.g., 60 users/day → €151,620/year).
- Cost concerns: Initial investments (€91,850–€141,850) may strain club resources unless supported by partnerships or phased rollout.

Social

- Diverse visitor demographics: Growing international audience (60 % foreigners in 2023) shows global appeal and digital readiness.
- Generational adoption gaps: Younger fans embrace tech; older demographics may resist.
- Emotional resonance: Strong interest in reliving historical matches and player perspectives indicates social-emotional engagement potential.

Technological

- High-quality VR/AR feasibility: Tools like Meta Quest 3 and Unity allow controlled, immersive experiences (e.g., "Be a Player").
- Production quality matters: Historical footage may limit immersive fidelity; 360° filming offers better results.
- Maintenance and hygiene logistics: Operational needs include headset cleaning, tech support, and user safety protocols.

Environmental

- Low carbon footprint vs. physical exhibitions: Digital content minimizes environmental impact compared to physical installations or expansions. (Interreg Central Europe, 2024)
- E-waste & energy consumption: Long-term hardware management and power use must be monitored. (European Commission, n.d.-a)

Legal

- Data privacy regulation (GDPR): Compliance is crucial, especially when collecting data through immersive experiences. (Assembleia da República, 2021)

The **PESTEL analysis** highlights the multifaceted environment in which FC Porto's immersive VR/AR initiative would operate. Politically, the project is well-positioned to benefit from EU digital transformation policies and public funding opportunities, though it must strictly adhere to GDPR compliance due to data collection. Economically, Porto's strong tourism sector and the scalability of the VR/AR model suggest solid revenue potential, but initial investment costs pose a financial challenge. Socially, the project aligns with growing digital interest among younger fans and international visitors, although adoption gaps may appear among older demographics. Technologically, current tools make immersive experiences highly feasible, but attention to production quality and operational logistics is essential. Environmentally, the initiative offers a low-impact alternative to physical exhibits yet must account for energy use and e-waste. Legally, content licensing and accessibility are key compliance areas that require proactive management. Overall, the external landscape appears favorable, provided risks are managed strategically.

SWOT Analysis

Strengths

- Strong fan interest & willingness to pay: High receptivity to immersive experiences, especially emotional, historical content.
- Operational scalability: Feasible to serve 60+ users daily with minimal strain; can expand during peak periods.
- Strategic alignment with brand: Experiences like matchday simulations support FC Porto's identity and deepen fan loyalty.
- Benchmarking validated by elite clubs: Successes from FC Barcelona, Manchester City, and PSG provide proven templates.

Weaknesses

- High upfront investment: VR content and hardware require significant capital, especially with limited historical video quality.
- Technological literacy gap: Some museum visitors, particularly older fans, may avoid or struggle with VR/AR.

- Dependence on external expertise: FC Porto may lack in-house capacity to develop or maintain immersive tech content.

Opportunities

- First-mover advantage in mid-tier clubs: FC Porto differentiates from similar-sized European clubs.
- New sponsorship and branding channels: AR/VR can support branded virtual placements and gamified advertising.
- Content expansion: Seasonal or themed VR updates (e.g., anniversary events) boost return visits and revenue.

Threats

- Fast-evolving tech landscape: Hardware/software obsolescence may require frequent upgrades.
- Visitor fatigue or novelty decay: Initial enthusiasm could wane without continuous innovation.

The SWOT analysis provides insight into FC Porto's internal capabilities and external prospects regarding the implementation of immersive VR/AR experiences. Strengths such as strong fan interest, brand alignment, and scalability indicate that the club is well-positioned to deliver meaningful and profitable digital experiences. The success of similar initiatives by top European clubs also validates this direction. However, weaknesses like high upfront costs, reliance on external tech expertise, and potential tech barriers for older visitors could hinder smooth implementation. On the upside, opportunities exist. FC Porto can establish itself as a digital pioneer among mid-tier clubs, leverage new sponsorship avenues, and offer evolving content to maintain fan engagement. Yet, threats such as rapid technological changes and the risk of novelty wearing off underscore the need for continuous innovation and adaptability. Overall, the SWOT reveals a promising but demanding path that requires strategic investment and ongoing content development.

Chapter 6

Financial Feasibility and Strategic Implementation of the Porto Player VR Experience

This chapter outlines the economic and logistical framework behind the implementation of the Porto Player VR Experience at the FC Porto Museum. It begins by detailing the rationale behind the recommended ticket price of €7, drawing directly from survey data on visitor's willingness to pay. The chapter then presents a conservative yet achievable estimate of daily participation, supported by actual museum attendance figures and operational capacity. Finally, a comprehensive financial plan is introduced, comparing two production cost scenarios—low-cost and high-end—while projecting revenue, fixed and variable costs, and long-term profitability. The analysis demonstrates that the initiative is not only feasible but also financially sustainable, with strong potential for growth and return on investment from the second year onward.

6.1 Financial and Operational Planning

Recommended Ticket Price

The decision to set the ticket price for the "Porto Player VR Experience" at €7 was based on a combination of survey insights and strategic pricing considerations. According to the responses collected, most participants expressed a willingness to pay between €5 and €10 for a virtual reality experience during a museum visit. A smaller portion of respondents indicated they would even be open to paying between €10 and €15, while only one person explicitly stated they would not be willing to pay extra. Based on this distribution, €7 was selected as an ideal midpoint. It is a price point that remains affordable to most visitors, particularly when compared to other museum add-ons or themed experiences across Europe, while also reflecting the added value and exclusivity of the immersive content.

Expected Daily Participation

The estimated daily usage of the VR experience (60 participants per day) was established by analyzing visitor flow at the FC Porto Museum. The museum has shown remarkable growth in recent years, with record-breaking days such as August 2, 2023, which brought in 3,370 visitors in a single day. On average, particularly during peak months, daily visitor

numbers now often range between 1,500 and 2,000. Even with a conservative adoption rate of just 3 % to 5 % of total visitors opting into the VR experience, this equates to approximately 45 to 100 users per day. Therefore, a target of 60 users per day was selected as a moderate and realistic estimate. It aligns with anticipated interest, leaves room for growth, and provides a sustainable operational target that the museum can manage effectively without placing undue strain on staff or equipment.

From an operational standpoint, reaching 60 users per day is entirely feasible. With 30 Meta Quest 3 headsets available, the museum would only need each headset to be used two times per day to meet the target. The open space, standing setup eliminates the need for booths and allows the experience to run smoothly with one trained support staff member. This design also accommodates flexible pacing, charging cycles, and cleaning routines without limiting throughput. Additionally, the structure is scalable, meaning that on busier days, especially during the summer or school holidays, the system can support significantly more than 60 users, if needed.

Financial Plan

The financial plan for the Porto Player VR Experience is based on a combination of realistic attendance data from the FC Porto Museum, pricing insights gathered from a survey, and conservative usage projections. The revenue model relies solely on an optional add-on ticket for the virtual reality experience, priced at €7 per user.

The museum is open 361 days per year, closing only four days annually. We estimate that 60 visitors per day will opt for the VR experience. This represents a modest conversion rate of around 3 to 4 % of daily museum visitors, well within reason given the museum's average footfall and the high interest in VR shown in the survey. At a rate of €7 per ticket, with 60 tickets sold per day across 361 days, the total projected annual revenue is calculated as follows: 7 euros per user multiplied by 60 users per day, multiplied by 361 days of operation, results in a total of €151,620 in annual revenue.

The project includes fixed and variable costs. Fixed costs that repeat each year include hygiene supplies and the salary of one full-time employee responsible for equipment setup, assistance, and cleaning. These recurring costs amount to €12,600 per year, €12,000 for the staff member and €600 for hygiene and cleaning materials.

Initial Year 1 costs also include the purchase of 30 Meta Quest 3 VR headsets and 15 backup units, which together cost €24,750 (€550 per unit). Additional setup costs, such as

foam flooring, safety tethers, and a basic spatial design, are budgeted at €2,500. Staff training and onboarding are expected to cost €2,000. These initial equipment and setup expenses, excluding the VR content itself, total €41,850.

The major variable in the business model is the cost of producing the VR content. Two pricing scenarios are considered: a low-cost production of €50,000 and a high-end production costing €100,000. In the low-cost scenario, the total Year 1 investment becomes €91,850 (that is, €41,850 for setup and equipment plus €50,000 for content production). In the high-cost scenario, the Year 1 investment rises to €141,850 (€41,850 plus €100,000).

In the low-cost scenario, Year 1 profit is calculated by subtracting the total Year 1 cost of €91,850 from the annual revenue of €151,620, resulting in a net profit of €59,770 in the first year. In Years 2 and 3, since the initial investment has already been made and the only recurring expenses are the staff salary and hygiene costs (€12,600), the profit in each of those years is €151,620 minus €12,600, which equals €139,020 annually.

In the high-cost scenario, Year 1 profit is reduced due to the more expensive content. Subtracting €141,850 in Year 1 costs from the same annual revenue of €151,620 yields a first-year profit of €9,770. Just like the low-cost scenario, Years 2 and 3 benefit from minimal recurring expenses. Therefore, the profit for each of these years is also €139,020.

Table 1 - Separation and explanation of the fixed and variable costs for the Porto Player VR Experience.

Cost Category	Item Description	Type	Cost	Notes
Recurring Annual Costs	Staff Salary	Fixed (Recurring)	12000€	For equipment setup, assistance, and cleaning
	Cleaning supplies	Fixed (Recurring)	600€	Annual cost of consumables for headset hygiene
Initial Setup	30 Meta Quest	Fixed (Initial)	24750€	550€ per unit
	Foam flooring, safety tethers,	Fixed (Initial)	2500€	Physical space setup

	space design			
	Staff training	Fixed (Initial)	2000€	One-time cost for preparing personnel
VR Content Production	VR content (low-cost scenario)	Variable (Initial)	50000€	
	VR content (high-cost scenario)	Variable (Initial)	100000€	

In conclusion, under both budget conditions, the project generates substantial profitability from Year 2 onward. The low-cost version already delivers strong financial results in Year 1, while the high-cost version remains viable, breaking even shortly after the first year. Both cases reflect a robust and scalable financial model based on conservative usage and pricing, with no need for additional revenue streams to remain profitable.

6.2 Discussion

The integration of Virtual Reality (VR) and Augmented Reality (AR) into FC Porto's Museum ecosystem represents a significant strategic opportunity to enhance fan engagement, foster deeper emotional connections with the club's legacy, and generate sustainable revenue. This discussion evaluates the viability of such an investment by synthesizing the findings from primary data (survey and expert interview), benchmarking research, financial analysis, and existing academic literature.

In addition to the financial and operational findings, the strategic feasibility of the project is reinforced by the conducted PESTEL and SWOT analyses. The PESTEL analysis highlighted favorable external conditions such as supportive EU digital policies, rising international tourism in Porto, and strong technological readiness for immersive experiences, while also identifying manageable risks related to data privacy and content licensing. Meanwhile, the SWOT analysis underscored key internal strengths—including high fan interest, strong brand alignment, and operational scalability—and revealed opportunities for FC Porto to differentiate among mid-tier European clubs. These strategic

frameworks provide a robust foundation for the proposed VR implementation, validating its alignment with both external market conditions and internal capabilities.

The data collected through the survey indicates that FC Porto's supporters exhibit a strong appetite for immersive experiences, even though many have not yet interacted directly with VR or AR technologies. A notable majority of the 141 survey respondents expressed a very high level of interest in engaging with immersive museum experiences, particularly those centered on reliving the club's most iconic moments, such as its victory in the 2004 UEFA Champions League final. The emotional pull of such historic narratives emerged as a key motivator, suggesting that fans seek not just entertainment, but meaningful reconnections with the club's heritage.

Although more than half of the respondents had never used VR or AR before, the general awareness of these technologies was widespread, and respondents demonstrated an open and curious attitude toward trying them in a museum setting. This finding is consistent with prior academic work emphasizing the potential of immersive technologies to elicit emotional resonance and loyalty in sports fans. Studies confirm that immersive experiences are more likely to cultivate brand affinity and repeat engagement (Pickman B., 2023). These insights highlight a clear opportunity for FC Porto to offer fans a digitally enriched form of participation that goes beyond static displays or traditional museum exhibits.

Beyond interest, the survey also provided encouraging signs regarding the commercial viability of immersive experiences. The vast majority of participants indicated a willingness to pay for VR or AR content, with the most acceptable price point being between five and ten euros. Only a single respondent expressed an outright refusal to pay for such an experience. This broad willingness to pay, combined with a preference for emotionally impactful and exclusive content, supports the adoption of a premium but accessible pricing model. Considering this data, a price point of €7 per ticket was chosen for the proposed "Porto Player VR Experience." This strikes a balance between affordability and perceived value and aligns with comparable experiences in other sports institutions, as outlined in industry research (Heidemann M. et al, 2024).

Financial projections based on museum visitation patterns further reinforce the viability of this initiative. In 2023, the FC Porto Museum reached a peak of 3,370 visitors in a single day, with an annual trend of 1,500 to 2,000 visitors on average during peak months. Even assuming a conservative participation rate of 3 to 5 % of visitors opting for the VR experience, an estimated 60 daily users is a realistic and operationally manageable target.

Under these assumptions, annual revenues could reach €151,620, while fixed recurring costs such as staffing and hygiene are kept at a modest €12,600. The initial Year 1 costs, including hardware, setup, and either low- or high-budget VR content production—would range from €91,850 to €141,850, depending on production quality. Even under the higher-cost scenario, the project would achieve profitability within its first year, with subsequent years generating significant profit margins. These projections are particularly robust given that they do not rely on any supplementary revenue streams such as merchandising or sponsorship integrations, which could further enhance profitability.

The financial plan aligns closely with recent academic literature that positions immersive technologies as high-margin, scalable assets within sports organizations. According to the (CSM Report, 2023), immersive experiences reduce reliance on traditional matchday revenues and enable year-round fan monetization. Moreover, (Rauschnabel P. A. et al., 2019) emphasizes that AR-driven sponsorships and digital ticketing models increase brand engagement and commercial value, opening further possibilities for long-term monetization.

From an operational perspective, the implementation of VR and AR in the FC Porto Museum is feasible, both technically and logistically. João Neto, an immersive technology expert interviewed for this study, confirmed that a modular, standing-use VR system would be the most efficient solution. Neto emphasized that the primary challenge lies in the quality and preparation of content, particularly when historical footage is concerned. He concluded that the most feasible option is the creation of 360-degree, first-person matchday simulations during player presentations, scenarios that offer high engagement and can be filmed with full quality control. Neto's recommendations for hygiene procedures, user pacing, and headset security provide a practical foundation for seamless day-to-day operations, supported by training and lean staffing. His strategic suggestion to align production and rollout with key calendar events, such as preseason campaigns, further supports the implementation roadmap.

Complementing these insights is the benchmarking analysis of leading clubs such as Manchester City, FC Barcelona, and Paris Saint-Germain. These clubs have incorporated VR and AR into their stadium tours, fan zones, and branded applications, with significant success. Manchester City, for example, offers a full digital twin of its stadium, while FC Barcelona has integrated AR overlays and large-scale audiovisual storytelling into its Camp Nou experience. However, these examples also underscore the importance of scalability.

For a club like FC Porto, which lacks the capital of global giants, the focus must be on compact, cost-effective implementations that retain the emotional intensity of these immersive experiences without relying on large infrastructure. The adaptation of best practices proves to be a pragmatic approach.

Importantly, the profile of FC Porto's Museum visitors provides a compelling case for this investment. Since its opening in 2013, the museum has recorded consistent growth, reaching over 1.5 million cumulative visitors by its 10th anniversary. Moreover, the demographic trend is increasingly international: in 2023, more than 60 percent of museum visitors came from outside Portugal, representing over 180 nationalities. This trend reflects the club's expanding global appeal and suggests that immersive experiences could resonate with a tech-savvy, international audience that is already accustomed to interactive and gamified content. Younger and international fans are more receptive to immersive formats, particularly those that involve interactivity (Akköse H., 2023; Mahajan R. et al., 2023).

In addition to the commercial and technical feasibility, the proposed immersive offerings align closely with FC Porto's cultural identity and branding strategy. Unlike generic VR exhibits, the experiences proposed, whether reliving key historical moments, stepping into a player's boots, or participating in gamified challenges are deeply rooted in the club's narrative. This alignment is crucial, as emotional authenticity enhances user satisfaction and strengthens brand loyalty. Immersive sports branding is most effective when grounded in emotional resonance and community values, and the proposed VR experiences at the FC Porto Museum achieve precisely that (Pickman B., 2023).

Some potential risks must be acknowledged. Resistance from older demographics, initial capital expenditure, and the need for continuous content updates are all valid concerns. However, the proposed multi-option strategy includes a non-VR interactive game that offers an alternative for less tech-inclined users, thus expanding accessibility. The financial model accommodates amortization of setup costs within the first year, and content refreshes can be scheduled strategically to coincide with milestones, anniversaries, or seasonal campaigns. These measures, coupled with phased rollouts and data-driven feedback loops, mitigate the risk of user disengagement or underperformance.

To conclude the discussion, it is recommended that FC Porto prioritize option 2 of the VR implementation possibilities (the "Be a Player" First-Person Match Perspective VR Experience) as the initial immersive project to implement. This recommendation is based primarily on insights from the expert interview with João Neto, who emphasized that

experiences where the production team controls image capture (such as first-person simulations) ensure higher content quality and fewer technical constraints. Unlike historical reconstructions, which rely on existing footage that may lack immersive fidelity, option 2 allows for the creation of original, high-quality, and emotionally engaging content filmed under optimal conditions. This makes it both a technically feasible and strategically impactful choice for launching FC Porto's entry into immersive fan engagement.

Taken together, the evidence presented through this study strongly supports the conclusion that the investment in immersive technology at the FC Porto Museum is viable. Fan demand is high, willingness to pay is strong, and operational logistics are manageable. The financial model is profitable even under conservative assumptions, and the strategic fit with the club's identity and digital transformation goals is clear. Moreover, this initiative positions FC Porto as a forward-thinking, digitally capable club within an increasingly competitive and globalized football landscape. By offering emotionally compelling, technologically sophisticated experiences, FC Porto can deepen its bond with current fans, attract new ones, and set a precedent for immersive innovation among mid-tier European clubs.

Chapter 7

Conclusion

This dissertation has examined how Virtual Reality (VR) and Augmented Reality (AR) technologies can be integrated into FC Porto's strategy to enhance fan engagement, increase brand value, and generate sustainable revenue. Based on the findings from fan surveys, expert interviews, and case study analysis, several conclusions can be drawn that directly address the core research questions of this study.

To ensure that the findings of this study contribute meaningfully to both academic understanding and practical decision-making, this conclusion explicitly reflects on the research questions that guided the investigation. By aligning the final insights with each core question, the study offers clear, evidence-based responses that support the strategic implementation of VR and AR technologies within FC Porto.

Concerning question 1, which considers how best to integrate VR and AR into FC Porto's marketing and fan engagement strategy, the most effective approach is to embed immersive experiences within existing physical and digital touchpoints, particularly the FC Porto Museum. Rather than pursuing large-scale or infrastructure-heavy deployments, the club can adopt compact, emotionally rich experiences that leverage its history and brand identity. Immersive content should focus on storytelling, interactivity, and personalization, allowing fans to experience matchday from a player's perspective, explore behind-the-scenes environments, or relive iconic victories. These applications blend entertainment with meaning, maximizing both interaction and brand impact.

In response to research question 2, which asked what specific VR and AR applications provide the highest value for improving fan experiences and how they influence loyalty and engagement, the study found that immersive, emotionally resonant experiences offer the greatest impact. Fans expressed strong interest in VR simulations that allow them to relive the club's most iconic moments and in first-person experiences that simulate stepping onto the pitch as an FC Porto player. These applications create a sense of presence and emotional immersion, which strengthens fan loyalty and encourages repeat interactions with the club, especially among younger and international audiences.

Regarding research question 3, which focused on revenue models capable of effectively monetizing VR and AR initiatives while ensuring financial sustainability, the analysis demonstrates that a pay-per-use model is both viable and scalable. A €7 add-on ticket for a

VR experience, for example, was found to strike the right balance between affordability and perceived value. With an estimated 60 users per day, only a small fraction of total museum visitors, annual revenue could exceed €150,000. Even in higher-cost production scenarios, profitability can be achieved within the first year, with significant profits expected in subsequent years. Moreover, additional monetization avenues such as branded sponsorships, digital collectibles, and seasonal content updates present opportunities for further financial growth.

In addressing research question 4, which explored the main technological, financial, and cultural barriers to VR and AR adoption and how they can be mitigated, several key challenges were identified. Technologically, the high cost of developing high-quality immersive content, particularly for historical reconstructions, was seen as a primary constraint. This can be addressed by focusing initially on experiences where the club has full control over production, such as filming new first-person simulations. Financially, the up-front investment may pose risks for a mid-tier club like FC Porto, but the conservative financial models presented in this dissertation show that the investment is likely to be recovered quickly, especially with a lean, phased rollout. Culturally, while some resistance is expected from older or less tech-savvy audiences, this can be mitigated by offering hybrid formats such as non-VR interactive games, ensuring accessibility for all demographics.

While the main emphasis of this research was on museum-based implementations, the insights gained here offer broader strategic value. The effective use of VR and AR allows FC Porto to differentiate itself in the increasingly competitive football landscape. Thus partially answering research question 5, which concerns how immersive technologies can help strengthen FC Porto's global positioning. By delivering emotionally rich, technologically sophisticated, and financially viable fan experiences, the club can enhance its brand and establish itself as an innovator among mid-tier European clubs.

In summary, this dissertation concludes that VR and AR technologies, when thoughtfully implemented, can significantly advance FC Porto's engagement, commercial, and branding objectives. The recommendations provided,based on clear evidence and practical financial modeling, offer a roadmap for the club to transition from traditional engagement methods to immersive, future-ready experiences that resonate deeply with fans and ensure long-term sustainability.

While this dissertation demonstrates the strategic and financial viability of integrating immersive technologies into the FC Porto Museum, several avenues remain open for

further development. A logical next step would be the creation of a functional prototype of the proposed VR experience, allowing for pilot testing during off-peak periods or special events. This would enable the collection of real user feedback to refine both the technical and experiential dimensions of the installation. Future developments may also focus on expanding the scope of content beyond the initial simulation, introducing seasonal updates, recreations of historic matches, or behind-the-scenes narratives to encourage repeat visits and sustain long-term engagement.

From an operational standpoint, there is value in developing a comprehensive implementation plan that includes spatial layout, staff training, hygiene protocols, and maintenance routines to ensure smooth day-to-day management. In parallel, exploring partnerships with local technology firms, academic institutions, or creative studios could help reduce production costs while maintaining high-quality standards in content development. Finally, to assess the long-term value of immersive technology within the club's broader strategy, future initiatives should consider establishing an evaluation framework. This could track key performance indicators such as visitor engagement, satisfaction, return visits, and revenue contribution, ensuring that immersive experiences remain both adaptable and aligned with FC Porto's strategic objectives over time.

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