



Video Games, Extended Reality, and Learning: Developing Decision-Making Skills for Corporate Environments through Extended Reality Gaming

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Resumo

Esta tese analisa se os videogames de realidade estendida desenvolvem competências de tomada de decisão de forma mais eficaz do que os jogos tradicionais. Embora investigações anteriores tenham demonstrado benefícios cognitivos gerais associados ao jogo, a contribuição específica de ambientes imersivos de XR continua pouco estudada.

Foi adotado um desenho de investigação quantitativo, comparativo e experimental com três grupos: Não Jogadores, Jogadores Tradicionais e Jogadores XR. A avaliação da competência na tomada de decisão recorreu a dois instrumentos validados: a bateria Adult Decision- Making Competence, centrada na resistência ao enquadramento, no reconhecimento de normas sociais e na resistência a custos irrecuperáveis; e o Cognitive Reflection Test, que distingue pensamento reflexivo de pensamento intuitivo.

Os resultados demonstram que os Jogadores XR superaram os outros dois grupos em medidas-chave. Revelaram maior resistência a efeitos de enquadramento e a falácias de custos irrecuperáveis, evidenciando raciocínio mais racional e capacidade acrescida de adaptação em decisões futuras. Além disso, alcançaram as pontuações mais elevadas no CRT, sugerindo um recurso mais consistente ao pensamento reflexivo e analítico. Estes achados indicam que a natureza imersiva e cognitivamente exigente dos ambientes XR promove um envolvimento mais profundo nos processos de decisão. Contudo, os Jogadores XR obtiveram resultados mais baixos no reconhecimento de normas sociais, o que sugere que, apesar de a XR fomentar independência cognitiva, poderá reduzir a sensibilidade a convenções de grupo.

Em conclusão, os videogames XR apresentam vantagens distintas no desenvolvimento de competências de decisão relevantes para contextos empresariais, ao proporcionarem simulações ricas em interatividade e feedback.

Título: Videogames, Realidade Estendida e Aprendizagem: Desenvolver Competências de Tomada de Decisão para Contextos Empresariais através do Jogo em Realidade Estendida

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Palavras-chave: XR, RV, RA, videogames, aprendizagem ativa, simulação, tomada de decisão

Abstract

This thesis examines whether extended reality (XR) video games enhance decision-making skills more effectively than traditional games. While prior studies have shown general cognitive benefits of gaming, the specific contribution of immersive XR environments remains underexplored.

A quantitative, comparative, and experimental design was employed with three groups: Non-Gamers, Traditional Gamers, and XR Gamers. Decision-making competence was assessed using two validated instruments: the Adult Decision-Making Competence (A-DMC) battery, focusing on resistance to framing, recognizing social norms, and resistance to sunk costs, and the Cognitive Reflection Test (CRT), which measures reflective versus intuitive thinking.

Results indicate that XR Gamers outperformed both Traditional and Non-Gamers on key measures. They showed greater resistance to framing effects and sunk cost fallacies, demonstrating stronger rational judgment and adaptability in forward-looking decisions. XR Gamers also achieved the highest CRT scores, suggesting enhanced reflective thinking. These findings imply that the immersive and cognitively demanding nature of XR environments fosters deeper engagement with complex decision processes. However, XR Gamers scored lower on recognizing social norms, suggesting that while XR promotes cognitive independence, it may reduce sensitivity to group-based conventions.

Overall, the study concludes that XR video games provide distinctive advantages for developing decision-making skills relevant to corporate environments. By simulating high-stakes, feedback-rich scenarios, XR fosters rational evaluation, adaptability, and bias resistance, positioning it as a promising tool for managerial training and organizational learning.

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Key words: XR, VR, AR, video games, active learning, simulation, decision making

Table of Content

1. Introduction	1
2. XR Video Games and Corporate Training	5
2.1 Understanding Extended Reality (XR) Technologies	5
2.1.1 Definition and Scope: VR, AR, MR	5
2.1.2 XR Technologies: Evolution and Trends	9
2.1.3 Application of XR in Corporate Training	12
2.2 Decision-Making in Corporate Environments	15
2.2.1 The Role of Decision-Making in Business	15
2.2.2 Cognitive Theories Related to Decision-Making	17
2.3 Gamification and Learning Theories in Corporate Training	20
2.3.1 Active Learning, Gamification, and Games in Business	20
2.3.2 Application of Active Learning in Corporate Training	23
2.3.3 XR video games for corporate training	25
2.3.4 XR Gaming and Psychological and Behavioural Drivers of Engagement in XR	27
2.4 XR Video Games and Decision-Making Enhancement	30
2.4.1 XR Video game for decision-making skill development	30
2.4.2 Research Question	34
3. Research Method	36
3.1 Nature of the Research	36
3.2 Research Design	36
3.2.1 Participant Groups	36
3.2.2 Decision-Making Skill Assessment	36
3.3 Logical Validation	39
4. Findings	43
4.1 Sample description	43
4.2 A-DMC Test Results	48
4.2.1 Resistance to Framing	49
4.2.2 Resistance to Sunk Cost	49
4.2.3 Recognizing Social Norms	50
4.2.4 Overall A-DMC Score	50
4.3 Cognitive Reflection Test (CRT) Results	52
4.3.2 CRT Score and A-DMC Subscales	53
4.3.3 CRT Score Across Gamer Groups	54
4.5 Average Profiles by Group	56
4.6 Effects of Demographic Variables	57
4.6.1 Gender effects	57
4.6.2 Age effects	58
5. Interpretation	59
5.1 Gaming Habits and Decision-Making Skills Level	59
5.1.1 XR Gaming and Decision-Making Skills	59
5.1.2 CRT Scores, Decision-Making, and Gamer Type	60
5.1.3 Group Decision-Making Profile	61
5.1.4 Gender, Age, and Decision-Making Skills	63
6 Conclusion	65
6.1 Answer to the Research Question	65
6.2 Limitations and Future Researches	67
Bibliography	69
Sitography	77

1. Introduction

Research objectives

Extended Reality (XR), an umbrella term that includes Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) technologies (Marr, 2019), represents one of the most significant disruptive technologies alongside artificial intelligence. By enabling unparalleled levels of immersion and facilitating transformative experiences, XR can drive innovation across multiple dimensions of human endeavor. (Antoniou, Economou, Bamidis, 2025). According to the European Commission's Staff Working Document on Web 4.0 and virtual worlds (2023), Extended Reality (XR) is projected to exert a transformative influence across diverse industries. By integrating physical and digital environments in real time, virtual worlds can redefine daily life in social and professional contexts, generating opportunities in education, healthcare, manufacturing, culture, communication, and beyond. The European Commission document shows that, although rigorous academic research on virtual worlds remains limited, existing evidence, market data, and emerging applications suggest a favourable technological growth and adoption environment. The global XR sector has reached a mature stage, with forecasts estimating a market value of up to EUR 766 billion by 2025 and a contribution of approximately EUR 1.3 trillion to the global economy by 2030. By 2026, it is expected that one in four individuals will spend at least one hour per day in virtual environments for work, shopping, education, social interaction, and entertainment. Industry sentiment is notably optimistic: 95% of surveyed business leaders anticipate a positive impact from virtual worlds within the next decade (European Commission, Web 4.0 and virtual worlds, 2023). This outlook is supported by substantial investment, with over EUR 120 billion committed globally in the first five months of 2022, more than double the total for the previous year. While technological advancements are emerging worldwide, innovation is heavily concentrated in the United States, South Korea, and China. US-based firms, including Meta, Apple, Microsoft, Nvidia, Unity, Roblox, Snap, and Epic Games, are key drivers in developing the infrastructure for future virtual worlds. In China, major players include Alibaba Group and Baidu. The gaming, media, and entertainment sectors dominate Europe's VR/AR market, with gaming alone accounting for nearly 29% of revenues. Beyond leisure, VR/AR technologies can transform communication, enhance experiential learning, and serve as foundational tools for future navigation and interaction systems across multiple domains (European Commission, Web 4.0 and virtual worlds, 2023).

The European Commission states that Virtual and Augmented Reality (VR/AR) are transforming how individuals interact with their surroundings and with one another, enabling novel modes of experience and communication. These technologies possess the capacity to disrupt multiple sectors, including education, significantly. Furthermore, their growing range of applications and technological maturity position them as strong candidates for becoming core navigation and interaction tools in the future.

This dissertation examines two sectors: corporate education, specifically employee training, and the XR video gaming industry, to evaluate how Extended Reality technologies are transforming corporate training practices. The research focuses particularly on developing decision-making skills within corporate environments through XR-based gaming, exploring the capacity of such games to facilitate skill acquisition via active learning. It investigates whether this technological and pedagogical approach offers advantages over conventional video games (non-XR) and traditional training methods. In addition, the study presents case analyses of organisations already implementing XR-based simulations, assessing their reported benefits in terms of cost reduction, time efficiency, and training effectiveness.

Relevance for management theory

By focusing on decision-making as a core managerial function and by examining it within the rich and interactive settings afforded by XR, this research aims to contribute to both the academic understanding and the strategic management literature by exploring how extended reality (XR) video games can be used to develop decision-making skills within corporate environments. It does so by framing decision-making competence as a strategic resource and dynamic capability, aligning the study with three foundational pillars of strategic theory: the Resource-Based View (RBV), Dynamic Capabilities, and the theory of Core Competencies.

According to the Resource-Based View, a firm's competitive advantage relies on acquiring and developing valuable, rare, inimitable, and non-substitutable resources (Barney, 1991). Among these, human capital resources such as decision-making under uncertainty and the training of the company's workers are increasingly considered strategic assets. XR video games simulate realistic and complex scenarios, allowing firms to cultivate this cognitive asset internally, thereby enhancing a resource that is both deeply embedded and difficult for competitors to replicate. Barney (2001) later emphasized that these resources are not limited to tangible assets, but also include "management skills, organizational routines, and knowledge", intangible

capabilities that XR learning environments are well-positioned to foster. Thus, XR-enabled decision training may serve as a strategic lever for firms seeking to convert individual skills into a scalable organizational advantage. This thesis aligns with Dynamic Capabilities Theory, which defines competitive advantage in fast-changing environments as the firm's ability to "integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece, Pisano, & Shuen, 1997, p. 516). In this context, decision-making skill is not static; it must evolve with technological, market, and organizational shifts. XR video games create environments where managers can practice adaptive learning and situational response, building the cognitive agility required to make timely, informed choices under uncertainty. These simulated experiences are particularly relevant to strategic management, where leaders must make path-dependent, high-impact decisions that shape the firm's future. Moreover, this thesis draws on the concept of core competencies, which defined as the "company's collective knowledge about how to coordinate diverse production skills and technologies" (Prahalad & Hamel, 2009: 1). By training employees to apply decision frameworks across diverse and evolving XR scenarios, organizations may develop not only individual skills but also a shared decision-making capability. This core competency enhances both responsiveness and innovation across business units.

In summary, this thesis investigates the **Research Question**: How are XR video games more effective than traditional video games for enhancing individuals' decision-making skills? We seek to contribute to the literature on how companies can leverage technological infrastructure to build strategic, cognitive, and behavioural competencies central to firm competitiveness and innovation.

Agenda

This dissertation presents six chapters. The introductory chapter outlines the scope of the research, its relevance, and the work's overall structure. Chapter Two examines three key thematic areas essential to the study: Extended Reality (XR), decision-making, and gamification with learning theories, and concludes by establishing the interconnections among them. The chapter begins with a review of the literature on XR technologies, tracing their evolution, identifying current trends, and exploring their applications in corporate training. It then analyses the role of decision-making skills in corporate environments, with particular emphasis on training approaches and cognitive theories related to decision-making. Subsequently, the discussion shifts to using games in business contexts and gamification

principles, highlighting the importance of active learning. This topic leads to exploring XR gaming and the psychological drivers of engagement in such environments. The chapter concludes by integrating these strands, focusing specifically on XR video games and their potential for developing decision-making skills. Chapter Three details the research methodology, describing the study's design, the tests conducted, and the sample selected to address the research questions. Chapter Four presents the results, including a profile of the participants, test outcomes, and a detailed data analysis. Chapter Five interprets these findings, offering insights into the participants' gaming habits and decision-making skills. Finally, Chapter Six summarises the key findings, discusses the study's limitations, and proposes directions for future research.

2. XR Video Games and Corporate Training

2.1 Understanding Extended Reality (XR) Technologies

2.1.1 Definition and Scope: VR, AR, MR

Extended Reality (XR) includes all immersive technologies that combine or simulate reality, as Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) (Image 1) (Marr, 2019). These technologies vary in how much they immerse users in digital environments, offering a continuum of experiences from entirely physical to fully virtual. XR transforms how individuals perceive digital content and enables new forms of interaction, learning, and training in professional and educational contexts (Kosko et al., 2021). For instance, XR supports situated learning (Chang, 2013), a theoretical perspective on knowledge and learning emphasizing that understanding emerges through active participation in real-life activities and social contexts. Rather than viewing knowledge as a static set of facts or representations transferred from one individual to another, this approach sees learning as a dynamic process of meaning-making shaped by the learner's ongoing engagement with their environment, tools, and community (Clancey, 1995)

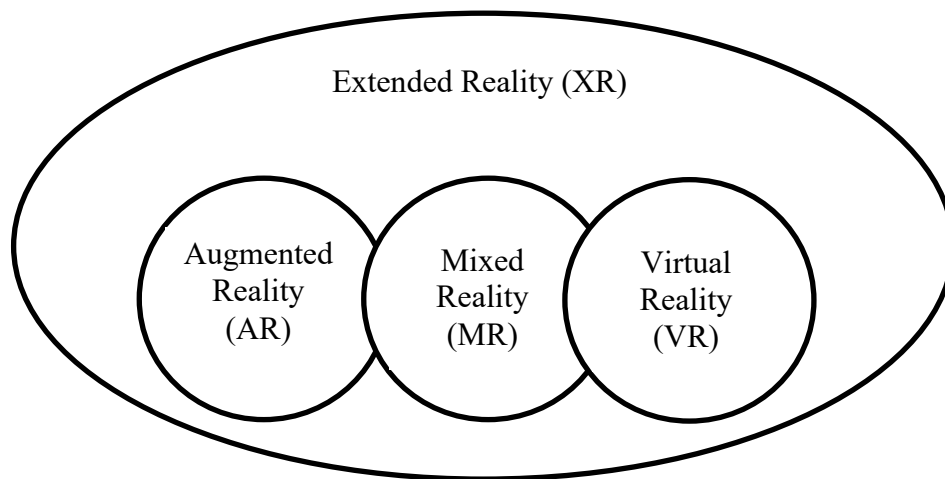


Image 1: Extended Reality (XR) umbrella

Augmented Reality

Augmented Reality (AR) overlays digital information on top of the physical world. Rather than replacing the real environment, AR enhances it with contextually relevant data, such as images, sounds, or 3D objects (Azuma, 1997). Users can access the experience via smartphones, tablets, or AR glasses (Marr, 2019). AR supports situated learning by enriching real-world scenarios with virtual annotations, guidance, or simulations (Chang, 2013). From a perceptual standpoint, AR combines physical sensory inputs with virtual enhancements, fostering continuity between the real and digital worlds, while VR is directly linked to just sensory inputs (Kosko et al., 2021). For this reason, AR users can still participate and observe what is happening in the real world. Snapchat filters that place virtual items like hats or glasses on a person's head and Pokémon GO, which adds virtual animals to the actual world, are well-known instances of augmented reality (Marr, 2019).

Virtual Reality

Virtual Reality (VR) is characterized by complete immersion into a computer-generated environment. Users wear head-mounted displays (HMDs) (Image 2) that isolate them from the real world and transport them into fully synthetic spaces where interaction occurs entirely within the virtual domain (Marr, 2019). Freina and Ott (2015) state that immersive VR enables users to perceive and navigate simulated spaces as physically present, enhancing cognitive and experiential engagement. In education and corporate training, experts leverage VR to simulate complex, risky, or costly environments (e.g., flight simulators, emergency response, medical procedures) (Marr, 2019), offering repeatable and engaging learning experiences (Freina & Ott, 2015).



Image 2: Example of head-mounted displays (HMDs)

Mixed Reality

Mixed Reality (MR) is a multifaceted concept encompassing various interpretations across academic and practical domains. At its core, MR refers to blending real and virtual environments, enabling interaction between physical and digital elements in real time. The literature presents six primary understandings or notions of MR (Image 3): (1) as a continuum between reality and virtuality, (2) as synonymous with Augmented Reality (AR), (3) as a medium for remote collaboration between AR and VR users, (4) as a combination of AR and VR systems, (5) as the alignment or synchronization of physical and virtual environments, and (6) as an advanced or "strong" form of AR characterized by deeper environmental interaction. These diverse perspectives reflect the evolving nature of MR technologies and their applications. (Speicher, Hall & Nebeling, 2019).

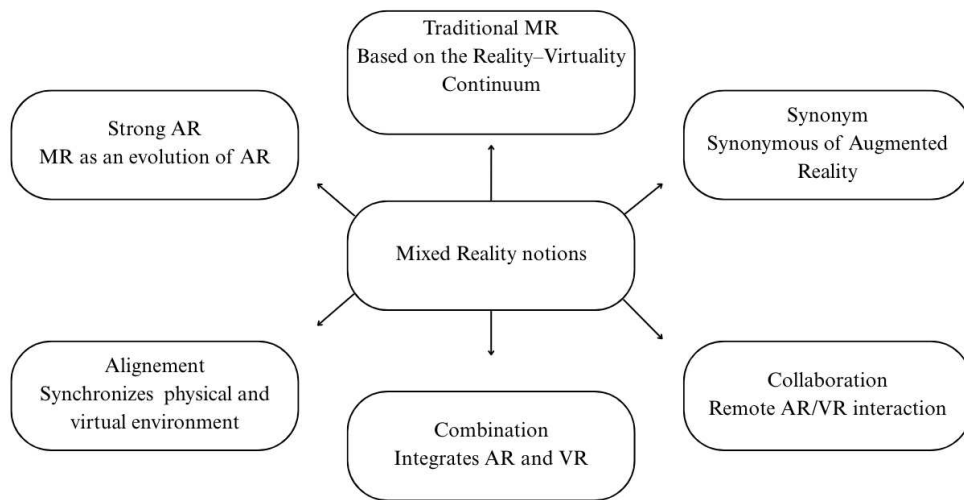


Image 3: Mixed Reality notions, source: Speicher, Hall & Nebeling, 2019

As defined in the XR-Ed framework (Yang et al., 2018), MR facilitates interactive simulations where users manipulate digital models in physical space, fostering deep cognitive processing through experiential learning. Experiential learning occurs when students actively participate in an experience that encourages the growth of new knowledge, skills, or viewpoints (Burch et al., 2019). Examples include the Microsoft HoloLens, which enables users to explore 3D models, collaborate remotely, or perform complex assembly tasks with real-time guidance (Kosko et al., 2021) (Image 4). The XR-Ed Design Framework (Yang et al., 2018) is a conceptual model developed to structure and guide the design of educational applications utilizing Extended Reality (XR) technologies, including Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). By making implicit design choices explicit, the XR-Ed framework serves as both an analytical lens and a practical tool to inform more learner-centered and instructionally grounded development of XR-based educational experiences.

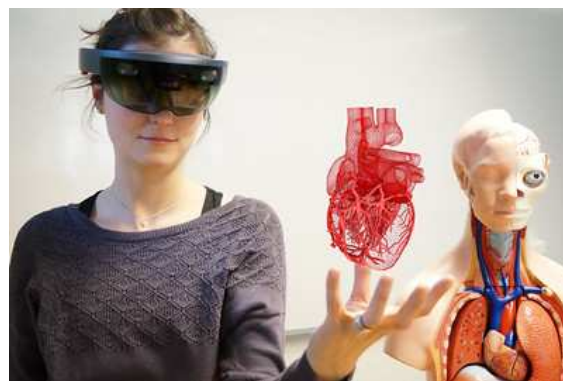


Image 4: A surgeon visualises an organ using the augmented reality technology Microsoft HoloLens (<https://creativecommons.org/licenses/by-nc-nd/2.0/deed.it>)

The dynamics of learning in XR environments will be explored in greater depth in the following sections of this dissertation. Furthermore, the most frequently reported issues regarding XR would be analysed, such as, for example, concerns regarding the lack of complex engagement during XR-based learning tasks, contradictory user experiences, rendering capacity limitations, discomfort episodes after viewing, accessibility issues, and restrictions on the availability of technological resources (Dreger & Ticknor, 2022).

2.1.2 XR Technologies: Evolution and Trends

Extended Reality (XR) first experiences were created several decades ago, following the early stages of computer graphics and human-computer interaction research. In the 1960s, pioneers conceptualized the first experiences through pioneering efforts. Sensorama then developed the first immersive simulation to offer multisensory experiences by combining visual imagery with motion and olfactory stimuli. A few years after the earliest head-mounted display (HMD), "The Sword of Damocles " (Image 5), was developed by Ivan Sutherland (Carter & Egliston, 2024), laying foundational principles for immersive visualization (Alnagrat et al., 2022).

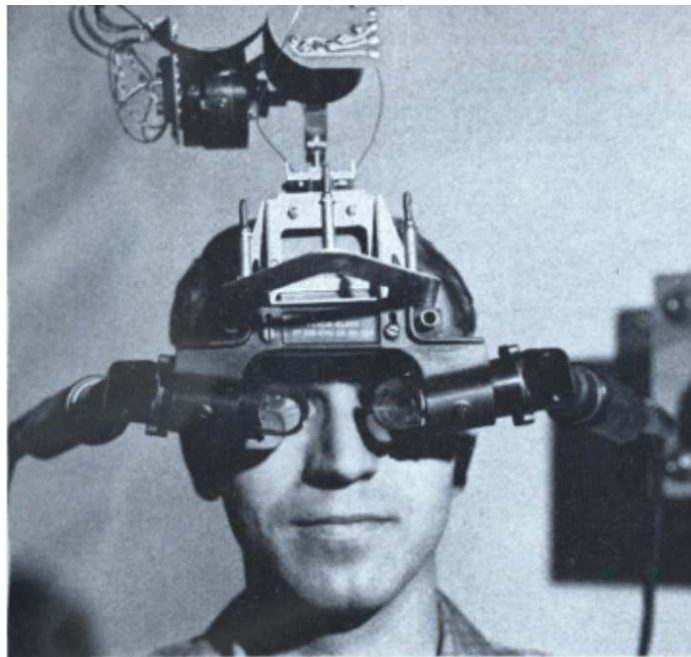


Image 5: "The Sword of Damocles " by Ivan Sutherland

In the 1980s and 1990s, advancements in computing power and graphics processing facilitated notable progress, notably in VR technology. Companies and research institutions invested heavily in creating immersive environments primarily for training and simulation purposes,

with the military and aviation sectors as early adopters. AR formally emerged in this period when Boeing researchers Caudell and Mizell coined the term while developing digital displays to aid assembly workers. These innovations evidence and start to prove XR's transformative potential in several professional settings (Rauschnabel et al., 2022; Liu & Chiang, 2023).

Later, the advancements in display technologies, computing power, and graphics fidelity favoured a significant expansion in consumer applications in the 2000s. For instance, releasing VR headsets such as Oculus Rift, HTC Vive, and Sony's PlayStation VR (Image 6) intensifies commercialization. This diffusion occurred because these devices provided increasingly realistic virtual experiences, significantly enhancing user immersion. Most importantly, these innovations allow XR to expand applicability into other sectors, such as gaming, entertainment, and consumer education (Johannesson & Karlsson, 2023). On the other hand, despite the rapid advancement, XR expansion faced significant barriers, including high hardware costs, limited content availability, fragmented development platforms, and physiological challenges such as motion sickness. Furthermore, terminological discrepancies confound the market positioning and the academic debate, preventing a wider adoption and a cohesive industry expansion (Rauschnabel et al., 2022; Liu & Chiang, 2023).



Image 6: Sony PlayStation VR

Nevertheless, XR technologies continue to evolve in the following years and have grown substantially in recent years, becoming essential in many corporate and educational environments. By 2022, the global XR market reached USD 42.83 billion and is projected to surge to approximately USD 345.09 billion by 2030, representing a CAGR of nearly 30%

(source: Statista). Technological improvements, increasing affordability, and rising market demand, particularly post-pandemic, fuel this growth (Johannesson & Karlsson, 2023). AR technology currently rules mobile-based interactions and is widely used in industries like retail, where applications allow consumers to visualize companies' products virtually. IKEA and Rolex represent, for instance, two successful implementations of AR technologies. These companies significantly enhance customer and purchase decision experiences through virtual "try-before-you-buy" capabilities (Marr, 2019). VR, meanwhile, has been widely used in immersive training simulations in high-risk industries such as industrial safety, healthcare, and aviation. As demonstrated by its extensive use in surgical simulations and pilot training, virtual reality's realistic simulations allow for the risk-free learning of complex processes (Hurter et al., 2025; Liu & Chiang, 2023). The integration with Artificial Intelligence (AI) and reliable connectivity possibilities like 5G technology have recently reshaped the prospects of XR. These innovative solutions enhance interactivity and adaptability, providing personalized, data-driven feedback within immersive environments. This result is a higher demand for XR corporate training experiences, especially for leadership development, scenario-based decision-making exercises, and remote collaboration, highlighting XR's important role in evolving workplace training practices (Spais & Jain, 2025; Tsaknaki, Electra, et al., 2024). XR's integration into educational and training is poised to expand further. Future trends indicate the growing use of XR to deliver more interactive learning experiences, foster real-time global collaboration, and enhance other skills like problem-solving (Alnagrat et al., 2022). Moreover, the development of the metaverse, a continuous, shared virtual space that seamlessly integrates physical reality with digital experiences, promises to transform the way businesses conduct meetings, training sessions, and product demonstrations. Offering immersive and interactive environments for multiple users will further bridge the gap between the physical and virtual worlds, reshaping the future of professional collaboration and communication (Mystakidis, 2022; Marr, 2019). Further studies additionally show that VR training improves executive functions, focus, and general cognitive abilities more effectively than traditional training, thanks to the increased realism that XR technologies allow users to experience. This technology characteristic has led governments and corporations worldwide to spend money on research and development to grow the XR ecosystem (Lee, 2024). On the other hand, due to these evolutions, ethical and regulatory considerations around data privacy, inclusion, and accessibility are at the centre of today's discussion and will become even more pronounced. Johannesson & Karlsson (2023) argue that policymakers and industry leaders should collaboratively address these issues to ensure XR's equitable and responsible use.

Looking ahead, XR's trajectory promises significant transformative potential across diverse sectors. Technological advances in hardware, such as lightweight and ergonomically optimized HMDs like Apple's Vision Pro and Meta Quest 3, are expected to accelerate mainstream adoption by reducing user discomfort and enhancing usability (Lee, 2024). Alliance4XR, a project co-funded by the European Union, reports that the evolution of XR technologies will significantly reshape the landscape of corporate training and professional development even more. Emerging trends such as improved hardware performance, enhanced sensing and tracking capabilities, and integrating multimodal interfaces are expected to deliver more immersive, accessible, and intuitive XR experiences. These advancements will accelerate the adoption of XR across sectors, particularly in education, engineering, and maritime industries, where realistic simulations and virtual prototypes are essential for skill acquisition. In corporate training, XR will increasingly support interactive and personalized learning environments, enabling learners to engage in high-impact, scenario-based decision-making without real-world risks (Tsaknaki et al., 2024). However, it is essential to underline that the widespread integration of XR still faces notable challenges, including high implementation costs, organizational resistance, technical complexity, and a growing demand for specialized expertise in XR design and assessment. Tsaknaki et al. (2024) state that to address these barriers, a focus on universal design principles, inclusive development, and sustainability is required, especially as concerns grow over the environmental footprint of XR infrastructure. Finally, as previously explained, the convergence of XR with other technologies such as artificial intelligence promises a new era of intelligent and adaptive learning systems, where AI-enhanced environments can personalize content, enable natural interactions through virtual agents, and seamlessly blend digital and physical realities. As these technologies mature, it will be vital for educators, corporate leaders, and policymakers to collaborate in shaping ethically responsible, user-centric XR training ecosystems that are both innovative and equitable (Tsaknaki et al., 2024). Again, the subsequent sections of this dissertation will delve more into the dynamics of learning in XR environments.

2.1.3 Application of XR in Corporate Training

Extended Reality (XR), which includes Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), is transforming corporate training. This disruptive technology enables firms to improve employee learning, skill acquisition, and decision-making abilities. By creating interactive and immersive learning environments, XR significantly enhances employee engagement, retention of knowledge, and practical skill development, thereby addressing

common limitations of traditional training methods (Marengo, Pagano, & Ladisa, 2018; Nunn, 2024).

The academic literature consistently emphasizes the transformative potential of XR technologies in training environments. The latter focuses mainly on XR technologies, such as cognitive skills development, engagement levels, and knowledge retention. Research by Freina and Ott (2015) highlights VR's ability to simulate realistic scenarios that enhance experiential learning and facilitate skill transfer to real-world contexts. Further studies state that immersive environments created by XR technologies significantly improve crucial factors for effective learning and long-term retention, such as learners' motivation and cognitive engagement (Chiang, Yang, & Hwang, 2014).

Focusing on Virtual Reality, VR technologies have emerged as a transformative tool in corporate training because they can simulate highly realistic scenarios that prepare employees for real-life tasks. Industries such as aviation have notably benefited from VR training due to the safety and cost-efficiency (Hurter, Causse, & Cordeil, 2025). For instance, Walmart utilizes VR to train new employees by simulating store environments, allowing employees to virtually practice customer interactions and product stocking without impacting actual operations. The result is reduced onboarding time and higher confidence among new hires (Nunn, 2024). Moreover, in leadership training, VR has shown exceptional potential. For example, in controlled scenarios, Bank of America uses VR to help its staff develop critical interpersonal skills, such as empathy and conflict resolution. Employees interact with realistic virtual avatars, practicing sensitive customer interactions repeatedly until desired proficiency is achieved (Nunn, 2024). Similarly, Intel's Electrical Safety Recertification VR course has shown outstanding success, demonstrating a 300% ROI over five years, significantly reducing electrical incidents, and improving trainees' engagement and knowledge retention (Nunn, 2024).

Also, Augmented Reality represents an effective training tool since it can overlay key digital information onto actual settings, enabling on-the-job training and immediate knowledge application. AR capability particularly impacts fields and industries where employees must develop and possess real-time problem-solving skills and precision, such as maintenance, assembly, and complex repairs (Marengo et al., 2018). For instance, Sematic-Wittur, an elevator manufacturing company, implemented AR training solutions that allow maintenance technicians to view procedural instructions overlaid directly onto elevator components,

improving task efficiency and reducing errors (Marengo et al., 2018). Another case of AR technologies working as an effective training tool is the case of Nestlé Purina, which innovatively uses AR. In a few words, the company uses AR to organise mobile virtual factory tours, significantly improving its sales team's knowledge about production processes. What's more, Nestlé, by providing these immersive factory experiences through AR, saved around \$100,000 annually in travel and productivity costs, and also enhanced employee retention and engagement (Nunn, 2024). Similarly, Accenture developed AR-based onboarding experiences, creating virtual campuses that allow new hires to understand company culture and values interactively, fostering stronger employee social connections from day one (Nunn, 2024).

When comparing differences and the distinct effects created by AR on the one hand, and VR on the other hand, Gavish et al. (2015) evaluated the comparative effectiveness of VR and AR training for industrial maintenance tasks. The study found no significant differences in final performance, suggesting both modalities benefit procedural skill acquisition equally. However, the research noted that AR provided advantages in contexts requiring physical object interaction, aligning more closely with real-world application scenarios.

Further studies analysed the potential of mixed reality, which allows for merging VR's immersive capabilities and AR's real-world contextual information. Thus, using MR creates unique learning opportunities that facilitate interaction between digital and physical worlds. Nunn 2024 shows how companies leverage MR to provide employees with hands-on, interactive experiences, particularly beneficial in technical training and remote collaborations. Aviation training company CAE employs MR to provide maintenance training for Gulfstream aircraft using digital twins. Technicians interact with virtual components in real time, significantly reducing safety risks and dependence on physical equipment availability (Nunn, 2024).

Despite the many advantages of XR, many obstacles prevent wider business implementation. The high upfront costs of XR hardware represent a barrier for many companies. Additionally, this technology entails several related costs, such as content development and necessary infrastructure. Costs pose a significant barrier, especially for small and medium-sized enterprises (Nunn, 2024). For instance, Tsaknaki et al. (2024) argue that the reliance on specific devices, such as the Microsoft HoloLens, can be prohibitive for organizations with limited funds or resources; thus, it is necessary to investigate less expensive or different options.

Additionally, usability issues and sickness associated with prolonged use of XR devices, such as physical discomfort and motion, present substantial adoption challenges (Nunn, 2024).

However, driven by rapid technological advancements, decreasing hardware costs, and growing familiarity with immersive technologies, the future outlook remains highly optimistic. Emerging trends also suggest an increased customization, scalability, and integration of XR with artificial intelligence and analytics tools, enabling adaptive, personalized training experiences (Tsaknaki et al., 2024). Companies are progressively adopting mobile AR solutions due to widespread smartphone penetration, significantly reducing entry barriers and accelerating employee adoption rates (Marengo et al., 2018).

2.2 Decision-Making in Corporate Environments

2.2.1 The Role of Decision-Making in Business

Decision-making is a fundamental process in the business world, characterized by selecting an optimal solution among multiple alternatives through systematic reasoning, analysis, and intuition. Decision-making skills are the cognitive and behavioural competencies required to evaluate different options effectively and choose the best possible action in varied and often complex business scenarios (Simon, 1979).

David J. Deming (2021) argues that the decline of routine task-based roles due to automation has elevated the importance of open-ended, judgment-intensive tasks within firms. These non-routine roles demand cognitive flexibility, situational awareness, and the ability to adapt to contextual variation, competencies that are foundational to decision-making. For companies, the implications are profound. As routine labour becomes increasingly commoditized or automated, value creation shifts toward roles requiring strategic foresight and real-time judgment. Firms that invest in training employees to navigate ambiguity, assess risks, and make informed decisions are better positioned to respond to market volatility and innovate effectively. Deming further notes that the share of jobs requiring decision-making in the U.S. rose from just 6% in 1960 to 34% in 2018, a trend that cuts across industries and firm types. This shift underscores that decision-making is no longer a skill reserved for top executives; it is becoming a core competency across the organizational hierarchy.

Academic literature consistently emphasizes the pivotal role of decision-making in shaping strategic, operational, and ethical outcomes in modern business environments. Herbert Simon's foundational work on rational decision-making has significantly influenced the theoretical understanding of decision-making within business contexts. Simon (1979) introduced the concept of "bounded rationality". Bounded rationality highlights the limitations of decision-making processes due to constraints such as incomplete information, limited cognitive processing capabilities, and resource limitations. Due to these limitations, Simon argues that individuals tend to "satisfice" rather than optimize, meaning they seek satisfactory rather than optimal solutions. Understanding this concept is crucial for managers navigating decisions in complex, real-world scenarios where perfect rationality is unattainable (Simon, 1979). Building on Simon's theory, Mettas (2011) introduced optimization strategies in educational and corporate settings, showing how structured evaluation of multiple criteria such as cost, feasibility, and strategic alignment can enhance decision outcomes. These frameworks promote systematic thinking and mitigate subjective bias by guiding users through a weighted selection of alternatives.

Effective decision-making in business is also profoundly influenced by emotional intelligence. Hess and Bacigalupo (2011) emphasize that emotional intelligence competencies such as self-awareness, empathy, and relationship management enhance the quality and ethical orientation. Decision-makers with high emotional intelligence are better equipped to assess the impact of their choices on stakeholders, manage conflict, and foster trust-based environments that support organizational cohesion. Additionally, decision-making skills in business encompass advanced communication and collaboration skills to implement decisions effectively and foster organizational alignment (Cooley, 1994). Cooley (1994) indicates that effective decision-making within interdisciplinary teams requires specific abilities such as clear communication, negotiation skills, and collaborative problem-solving. In complex organizations, the decision-making process often involves multiple stakeholders, each bringing different perspectives, expertise, and interests.

Training plays a critical role in developing these skills. In 1989, Mann et al. demonstrated the effectiveness of decision-making workshops specifically designed to boost confidence and skill through practical exercises. These workshops aimed to facilitate systematic thinking and the management of conflicting information, demonstrating improved decision-making coping patterns, such as reduced defensive avoidance and hypervigilance. For instance, workshop

participants used tools like decisional balance sheets and future diaries. These practical strategies significantly increased participants' confidence while reducing maladaptive decision patterns like avoidance and impulsivity. Furthermore, Kavathatzopoulos (1994) demonstrates that even short-term training focused on real-world ethical dilemmas can significantly enhance the managers' decision-making. For instance, rather than imposing prescriptive moral codes, Kavathatzopoulos' training emphasized critical reasoning and context-sensitive analysis, fostering sustained improvements in decision quality. More recent research and modern pedagogical approaches further analysed this focus on experiential learning. Liu and Olson (2011) highlight how engaging students in real-world consulting projects and simulations fosters higher-order decision-making skills. Their study shows that putting learners in executive roles encourages applying theoretical knowledge to complex, ambiguous scenarios, mirroring the cognitive demands faced by corporate leaders. Moreover, research by Volk et al. (2014) underscores the growing adoption of shared decision-making (SDM) frameworks in professional training. Their study proposes to promote inclusive decision environments where diverse viewpoints are integrated, reinforcing collaboration and accountability. The study shows that SDM improves individual competence and organizational legitimacy by ensuring critical decisions reflect collective values and preferences. Research by Goto et al. (2022) also emphasizes the effectiveness of shared decision-making (SDM) training programs. SDM training significantly enhanced professionals' decision-making competence, attitudes, and confidence. Such training promotes active involvement of multiple stakeholders, ensuring more holistic and inclusive decision processes. Finally, Colakkadioglu and Celik (2016) provide additional insights by highlighting the impact of structured decision-making training programs specifically on psychological dimensions such as self-esteem and decision-making styles. In their study, Colakkadioglu and Celik demonstrate the psychological benefits of structured training. After the training, participants show reduced decision-making anxiety and increased self-assurance.

2.2.2 Cognitive Theories Related to Decision-Making

Academic literature defines decision-making as a core cognitive process through which individuals select the most appropriate option or course of action among several alternatives based on a set of predefined criteria (Wang & Ruhe, 2007). This process is not random or purely intuitive; it is structured, sequential, and can be formally described using mathematical logic. For example, Wang et al. (2004) propose a decision-making model based on the Cartesian-

product rule, where alternatives and evaluation criteria are systematically matched to determine the best choice.

Wang and Ruhe (2007) further categorize decision strategies into four broad types: (1) intuitive (based on immediate judgments or preferences), (2) empirical (based on past experiences or expert advice), (3) heuristic (based on simplified rules or ethical principles), and (4) rational (based on maximizing utility or minimizing cost). Each category is linked to specific criteria, such as "common sense" for intuitive decisions or "scientific principles" for heuristic ones. This classification helps explain how different decisions may emerge under various circumstances, from instinctual to highly calculated reasoning (Wang & Ruhe, 2007).

An essential cognitive framework in decision research is the dual-process theory. Frederick (2005) explains that human thinking operates through two systems: System 1, which is fast, automatic, and intuitive; and System 2, which is slow, deliberate, and reflective. Frederick (2005) operationalizes this concept through the Cognitive Reflection Test (CRT), a three-item instrument designed to assess an individual's ability to suppress an incorrect intuitive answer in favour of a correct, more reflective one. With the test, Frederick shows how people often give impulsive and inaccurate answers without consciously engaging in analytical thinking. According to Frederick, individuals who rely more heavily on intuitive responses, labeled System 1 processes, tend to perform less on decision-making tasks requiring analytical reasoning, such as evaluating risk, time preference, and probabilistic logic. Building on this framework, Daniel Kahneman (2011) deepens and formalizes the distinction through his widely accepted model of the mind's two cognitive systems. In *Thinking, Fast and Slow*, Kahneman refers to System 1 as the fast, automatic, and associative mode of thinking responsible for instinctive judgments and emotional responses. In contrast, System 2 governs slow, effortful, and logical reasoning. The author explains that System 1 "effortlessly originates impressions and feelings that are the main sources of the explicit beliefs and deliberate choices of System 2" (Kahneman, 2011: 21). The interaction between these systems plays a central role in understanding decision-making competence. While System 1 excels in routine or high-speed judgments, such as reading facial expressions or responding to perceived threats, System 2 is responsible for deliberate correction, statistical reasoning, and inhibition of cognitive biases. Yet, as Kahneman notes, System 2 is often "lazy" and accepts the intuitive answer suggested by System 1 unless there is a clear signal of error or cognitive strain. Kahneman's framework also clarifies how these dual systems relate to decision-making in corporate environments.

Many business decisions, evaluating investment risks, managing crises, negotiating under pressure, and others, require the activation of System 2 to override emotional or heuristic-driven judgments. Yet, the everyday overload of managerial tasks may reinforce reliance on System 1, increasing vulnerability to cognitive shortcuts and systematic errors such as overconfidence, anchoring, and framing effects.

Both Frederick and Kahneman converge in arguing that effective decision-making depends not just on knowledge, but on the cognitive disposition to engage reflective processes when intuition fails. In the context of this thesis, this theoretical foundation helps explain why XR-based simulations, which deliberately induce situational complexity and uncertainty, may serve as powerful tools for triggering System 2 processes and thereby enhancing the decision-making capacities of professionals in corporate training environments.

Bogacz (2007) introduces another perspective by focusing on how the brain handles uncertain information. He explains that decision-making involves integrating noisy sensory inputs until a decision threshold is reached. This theory is known as the diffusion model, and experts consider it statistically optimal because it balances speed and accuracy. It is especially relevant in perceptual decision tasks, such as identifying patterns under uncertainty, where accuracy improves with more information accumulation over time (Bogacz, 2007). Extending this, van der Maas et al. (2011) bridge psychometrics and cognitive psychology by showing how the diffusion model relates to traditional item response theory (IRT). They argue that if people make decisions by gradually accumulating information (as the diffusion model suggests), their task accuracy and speed can be mathematically predicted. This connection allows researchers to better understand individual differences in decision-making by linking internal cognitive processes to observable performance measures (van der Maas et al., 2011).

Newell and Bröder (2008) highlight the importance of cognitive capacity limitations. They argue that decision-making should be seen through the lens of the “information processor” metaphor, which emphasizes how attention, memory, and learning influence judgment. Their work suggests that people use automatic and controlled thinking depending on task complexity and previous experience. For instance, when facing familiar problems, they may rely on quick memory-based decisions, whereas new problems require more effortful and structured processing (Newell & Bröder, 2008).

Bakken (2008) builds on multiple-process cognitive theory and focuses on dynamic decision environments, situations where the consequences of a decision unfold over time. He explains that people often fail to learn from feedback in these settings because such environments are complex and ambiguous. His findings show that intuitive thinking dominates unless people receive extensive exposure to complex simulations that help them refine their judgment. This affects how individuals improve their decision-making over time, especially in areas like air traffic control or system dynamics (Bakken, 2008).

Cristofaro (2020) offers a complementary perspective by integrating affective states, namely emotions, into decision-making theory. His Affect-Cognitive Theory emphasizes that emotions are not separate from thinking but are part of it. He explains that individuals develop affective responses based on past experiences, and these emotional states influence how information is interpreted and decisions are made. According to this view, a decision-maker is not only a rational evaluator but also an "emotional cognizer," whose judgments are shaped by feelings, memories, and social context (Cristofaro, 2020)

Finally, Haley and Stumpf (1989) explore how personality types influence decision processes. Based on Jungian theory, they argue that individuals with different personality profiles follow distinct "cognitive trails." For example, some people focus on specific details and logic (sensing-thinking), while others emphasize values and holistic thinking (intuition-feeling types). These preferences lead to habitual use of specific decision heuristics and mental shortcuts, which may result in biases such as anchoring or overconfidence. Understanding these cognitive trails helps explain why individuals may approach the same decision differently (Haley & Stumpf, 1989).

These theories show that decision-making is a complex interplay of logic, memory, emotion, personality, and environment. They offer unique insights into how and why people choose as they do, whether through structured analysis, intuitive shortcuts, or affect-driven interpretations.

2.3 Gamification and Learning Theories in Corporate Training

2.3.1 Active Learning, Gamification, and Games in Business

Active learning is broadly defined as an instructional approach in which learners actively participate in the learning process through meaningful tasks such as problem-solving, decision-

making, discussion, and reflection, rather than passively receiving information (Sziegat, 2024). In digital and corporate education contexts, interactive environments support active learning, encouraging learners to engage cognitively and emotionally through immersive experiences (Alsaleh, 2022). Active learning is widely recognized in educational research as a learner-centered approach that requires individuals to engage cognitively, emotionally, and behaviourally with content through tasks such as reflection, decision-making, collaboration, and problem-solving. Unlike passive forms of learning, such as lectures or rote memorization, active learning shifts the responsibility from the teacher to the learner, encouraging autonomy and deeper knowledge construction (Sziegat, 2024). Traditional instructional methods treat learners as recipients of knowledge. Learning is typically linear in such models, with a fixed curriculum and limited feedback cycles. Students must absorb information and demonstrate understanding through standardized tests or individual assignments. Even if deeply structured, these models often lack contextualization, personalization, and sustained engagement (Sziegat, 2024; Vasquez Bronfman, 2015). In contrast, active learning environments require learners to interpret, question, and apply knowledge meaningfully. As Vasquez Bronfman (2015) explains, effective learning occurs when learners encounter "breakdowns," namely, unexpected challenges that disrupt their initial understanding, forcing them to reflect in action and adjust their strategies accordingly. This reflective process enhances both conceptual understanding and long-term retention. Research in simulation-based learning further supports this view. For instance, Reynaldo et al. (2021) argue that learners exposed to interactive environments demonstrate improved outcomes in executive functioning, attentional control, and decision-making, compared to those taught through conventional means. The benefits of active learning are especially evident when learners engage in experiential tasks that mimic real-world complexity, such as simulations or games that require iterative experimentation and feedback processing (Reynaldo et al., 2021; Sziegat, 2024).

Gamified and game-based environments support a constructivist approach to learning, where contextual and iterative experiences actively construct knowledge (Sziegat, 2024). Gamification refers to using game design elements, such as points, badges, levels, and feedback, in non-game contexts to enhance user engagement, motivation, and behavior. In education and training, gamification increases participation and performance, especially when integrated into e-learning platforms, simulations, or professional development programs (Sziegat, 2024). Unlike serious games, which are full games with an educational purpose, gamification focuses

on modifying existing systems with game-based incentives to achieve specific learning or behavioural goals (Sziegat, 2024).

Serious games are digital or analog games developed to facilitate learning, training, or behavior change, rather than mere entertainment. These games simulate real-life situations and often incorporate tasks that mirror professional scenarios, allowing learners to acquire practical competencies in a risk-free virtual space (Liberona et al., 2022). As Sziegat (2024) highlighted, these games are especially valuable in business and entrepreneurship education for building skills like decision-making, collaboration, and resource management. Within serious games and simulations, learners engage in reflective decision-making and trial-and-error learning processes, which foster more profound understanding (Vasquez Bronfman, 2015). These environments often feature immediate feedback mechanisms and iterative challenges, enabling learners to evaluate their performance and adapt their strategies accordingly (Reynaldo et al., 2021). Vasquez Bronfman (2015) argues that serious games function as “breakdown creation machines,” repeatedly presenting players with surprises that trigger reflection and learning through action. This model is grounded in Donald Schön’s theory of reflective practice and aligns with James Paul Gee’s view that video games promote performance before competence, allowing learners to explore and experiment before achieving mastery (Vasquez Bronfman, 2015). Furthermore, gamified learning structures support “well-ordered problems” that build cognitive skills progressively through sequenced complexity and increasing difficulty (Vasquez Bronfman, 2015). In serious games and simulations, learners are not just passively reading or watching; they perform, manage resources, collaborate with teammates, navigate failures, and recalibrate their approach. These are not abstract skills; they mirror the competencies required in business and corporate decision-making environments (Sziegat, 2024). For example, in the simulation described by Vasquez Bronfman (2015), business students made strategic decisions as if they were real managers and experienced the ontological uncertainty of organizational life, a condition rarely replicated in traditional case-based teaching.

Video games, particularly those designed with educational or training purposes in mind, are natural platforms for active learning. In these environments, players interact with complex systems, make decisions under uncertainty, and receive continuous feedback about the consequences of their actions. Gee (2003) noted that learning in games aligns closely with best pedagogical practices because games require players to engage in goal-driven, context-rich, and socially situated learning activities. What sets video games apart is their ability to blend

cognitive challenge with motivational engagement. As learners navigate these virtual worlds, they receive real-time feedback, which not only aids skill development but also reinforces learning through emotional investment and a sense of achievement (Alsaleh, 2022). MMORPGs, for example, foster collaborative learning, linguistic development, and critical thinking by embedding players in complex social systems where communication, negotiation, and problem-solving are essential to progression (Ng et al., 2021; Alsaleh, 2022). In addition, digital games, including Massively Multiplayer Online Role-Playing Games (MMORPGs), have been recognized as effective environments for learning cognitive skills and decision-making strategies (Ng et al., 2021). MMORPGs are video games that encourage players to interact socially, communicate, and work together as they complete missions (quests) in the surrounding area.

2.3.2 Application of Active Learning in Corporate Training

Research has shown that MMRPGs can foster collaborative learning, promote self-regulated strategies, and improve vocabulary, attention, and task management (Alsaleh, 2022; Ng et al., 2021). Looking at the corporate contexts, these skills are foundational to effective leadership and managerial decision-making. Reynaldo et al. (2021) demonstrate that players of real-time strategy and simulation games consistently outperform non-gamers on tasks involving cognitive flexibility, attentional control, and risk assessment. Specifically, nurses, doctors, and undergraduate students trained using serious simulation games exhibited improved performance in scenarios that mirror professional environments (Reynaldo et al., 2021). Similarly, Sziegat (2024) notes that virtual simulation games, especially when powered by XR technologies. These immersive students in entrepreneurial roles require dynamic planning, forecasting, and resource allocation, core competencies in management training. Furthermore, Alsaleh (2022) highlights that MMORPGs naturally embed decision-making, strategic planning, and communication in complex social environments, allowing learners to acquire second-language skills and executive functions through goal-driven collaboration. Learners often engage in tasks requiring team-based negotiation, real-time coordination, and adaptive strategy development, reflecting corporate environment demands (Alsaleh, 2022).

Applying serious games and gamified learning models in corporate and management education has proven effective in fostering technical (hard) and interpersonal (soft) skills through active learning processes. In particular, virtual simulation games are increasingly used in entrepreneurship and management education to replicate complex real-world business

scenarios, allowing learners to take executive roles and engage in financial, strategic, and operational decision-making without the risks associated with real-world failure (Sziegat, 2024). These simulations enable learners to "experience the interdependencies among different business areas" and apply theoretical concepts in dynamic, interactive contexts (Sziegat, 2024). Vasquez Bronfman (2015), in a study involving master's in management students across several campuses of ESCP Europe, found that serious business simulations created unique opportunities for learners to develop strategic thinking, systems analysis, and adaptive decision-making. Learners practiced reflective learning as they encountered breakdowns, unexpected simulation outcomes that required reassessment and adaptation, encouraging them to reflect in and on action. The simulation also immersed students in team-based competition, simulating the uncertainty and time pressure typical of real business environments, and requiring them to work across functions such as marketing and production (Vasquez Bronfman, 2015). Importantly, Sziegat (2024) emphasizes that extended reality (XR) technologies enhance the learning value of business simulations by enabling embodied role-play, where learners not only simulate decision-making but also experience consequences in a highly immersive, feedback-rich digital space. For example, XR-enabled simulations such as *GoVenture Entrepreneur*, *SimVenture*, and *Harvard Business Simulations* allow learners to manage virtual companies, navigate market shifts, and adjust operations based on real-time visualized data, providing a scaffolded environment for executive development (Sziegat, 2024). Furthermore, research by Alsaleh (2022) and Ng et al. (2021) reports that immersive multiplayer environments support the development of transferable managerial skills such as time management, collaborative problem-solving, and risk evaluation. Alsaleh (2022) observed that players develop planning and communication competencies in MMORPG settings by engaging in large-scale team quests, mirroring the collaboration required in corporate projects. Ng et al. (2021) also showed that learners playing *Guild Wars 2* used metacognitive strategies, including goal setting, memory management, and real-time decision monitoring, essential for effective participation in corporate training programs focused on decision-making and leadership development.

These findings underscore the value of active learning tools, serious games, and gamified simulations as transformative instruments in corporate training. They promote experiential, contextualized learning where decision-making, cognitive agility, and interpersonal coordination are tested in environments that simulate the business world's volatility, complexity, and uncertainty. Through interactive challenges, embedded feedback, iterative learning cycles, and narrative engagement, these tools prepare learners to absorb information

and practice and internalize the skills needed for strategic leadership and organizational performance (Sziegat, 2024; Vasquez Bronfman, 2015).

2.3.3 XR video games for corporate training

Extended Reality (XR) technologies, which include Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), have revolutionized the domain of corporate training by enabling immersive, interactive, and learner-centred experiences. As a subset of serious games, XR video games are increasingly adopted in corporate learning environments to simulate decision-making under uncertainty, improve employee engagement, and foster experiential learning in high-stakes and complex business contexts.

Educational XR video games are defined as immersive, interactive, and game-based experiences developed using XR technologies to promote specific learning objectives (Oyelere et al., 2020). As Oyelere et al. (2020) explain, these games utilize 3D stereoscopic displays and head-mounted devices (HMDs) to create immersive environments where learners can embody roles, make decisions, and experience consequences in real time. Unlike non-immersive games, XR video games offer a heightened sense of presence, where users feel physically and cognitively embedded within the virtual scenario, enhancing motivation, engagement, and cognitive processing. Kaplan et al.'s (2020) meta-analysis provides robust empirical validation for XR's effectiveness. The study reviewed 25 XR training programs across diverse domains and found that XR training is at least as practical as traditional training regarding knowledge acquisition and performance transfer. Particularly in contexts where physical danger, cost, or logistical constraints limit real-world training, XR simulations offer a practical and efficient solution. The Transfer Effectiveness Ratio (TER) was introduced to quantify the reduction in real-world training time achieved through XR simulations, with several XR programs demonstrating up to 50% time savings (Kaplan et al., 2020).

In corporate settings, XR video games are increasingly used to develop several skills. Huff (2024), in a study for the U.S. Marine Corps, documented the integration of Perceptually Enabled Task Guidance (PTG) in AR/MR systems. In the study, the trainees make sequential decisions while interacting with AI-driven task environments. These AR/MR systems provided real-time, adaptive feedback, enhancing task execution, confidence, and operational readiness. The use of XR in this military training context, such as the Marine Corps, is a relevant parallel to corporate environments where high-stakes, fast-paced decisions must be simulated safely.

Also, Pringle et al. (2022) report the development of XR video games in forensic science teaching. In these games, students must use virtual geophysical instruments to solve simulated crimes and navigate multi-stage investigations. Asynchronous access, customizable progression, and reflective checkpoints are just a few of the characteristics found in these highly game-like settings. Their value lies in supporting learners otherwise excluded from physical training environments due to health, mobility, or access constraints. In cultural and soft skill training, VR heritage games offer further insights into XR's corporate application. Theodoropoulos and Antoniou (2022) reviewed VR game implementations in cultural institutions and concluded that well-designed XR experiences promote reflection, interpretation, and learning across diverse user groups. Dreger and Ticknor (2021) emphasize the importance of situational learning in XR-based environments. According to their study, XR video games allow learners to immerse themselves in authentic contexts and make decisions that have immediate virtual consequences. This approach enhances cognitive learning and behavioural and emotional skills, which are critical for a person working in the corporate world, for example, resilience, ethical judgment, and interpersonal skills. Dodds (2022) further argues for aligning XR game design with experiential learning theory and constructivist principles. She emphasizes that XR video games must involve "framed, activated, and reflected upon" (Dodds, 2021:71) learning experiences. For corporate training, this means providing learners with meaningful challenges, opportunities to fail safely, and mechanisms to reflect on their actions within the virtual context before applying them in the real world. As mentioned in this dissertation, the XR-Ed Framework (Yang et al., 2018) provides a comprehensive design model for instructional XR environments. The framework emphasizes six critical dimensions: Physical Accessibility, Scenario, Social Interactivity, Agency, Virtuality Degree, and Assessment. These principles are design ones to be followed in training programs to ensure that XR games are technologically advanced and pedagogically grounded. Instructional designers are encouraged to adopt backward design (Wiggins & McTighe, 2005), beginning with learning outcomes, designing aligned assessments, and embedding interactive content that promotes reflection and mastery.

Despite these successes, challenges remain. Freina and Ott (2015) note that XR systems must overcome usability barriers, such as simulator sickness, equipment costs, and technological accessibility. There is also the issue of skill gaps among developers and educators, as reported by Bennett & Murphy (2020). These gaps affect content quality and scalability. Thus,

integrating XR video games in corporate training requires investment in professional development, cross-disciplinary collaboration, and robust evaluation mechanisms.

2.3.4 XR Gaming and Psychological and Behavioural Drivers of Engagement in XR

Having established the growing use of XR video games in corporate training contexts, it is now essential to examine the underlying mechanisms of engagement these technologies employ and compare them with those found in traditional learning environments.

At the heart of XR gaming's unique psychological impact lies the capacity to generate immersive experiences and a heightened sense of presence. As Salimi (2024) and Hmoud et al. (2023) explain, XR technologies transport learners into a fully encompassing digital space that fosters the illusion of presence, where learners feel "there" in the virtual environment. This is a radical departure from classroom or screen-based learning, where the detachment between the learner and content often hinders engagement. In immersive XR games, the learner becomes the protagonist. The learners' cognitive, emotional, and behavioural responses are significantly amplified compared to other learning methods since they can manipulate digital tools, navigate virtual spaces, and make decisions with perceived consequences. Moreover, the level of immersion provided by head-mounted displays (HMDs) and embodied interactions through XR games supports deeper cognitive processing and engagement. This heightened presence, especially when accompanied by embodied actions and realistic feedback, enhances information retention, encourages strategic thinking, and fosters the development of problem-solving skills (Makransky & Lilleholt, 2018).

Focusing now on psychological Mechanisms of XR game engagement, Salimi's (2024) work demonstrates that XR gaming boosts motivation, interest, and agency, some key psychological drivers of engagement, through direct manipulation of content in immersive virtual environments. These environments increase user autonomy and self-efficacy, triggering intrinsic motivation as theorized by self-determination theory. XR does not merely deliver content; it crafts learning experiences that are contextual, narrative-driven, and emotionally compelling. Chuah (2018) reinforces this by mapping XR adoption to user motivations across fashion, media, and technology dimensions. XR is more than a tool; it is a transformative experience that engages users emotionally, cognitively, and socially. Individuals engaging with XR systems report feelings of pleasure, satisfaction, and confidence, contrasting with the often

passive, linear flow of traditional lectures or desktop-based e-learning. In XR games, every choice made and consequence faced enhances ownership of learning outcomes.

XR games redefine behavioural engagement by enabling full-body interaction, task-based learning, and social collaboration. XR's technical affordances, namely hand tracking, facial recognition, haptics, and motion sensing, allow learners to perform goal-oriented tasks through natural behaviours. This direct manipulation of the environment encourages exploration, repeated experimentation, and immediate response to stimuli (Wang et al. 2024). Schirmer-Mikalsen (2023) illustrates how tangible interaction in XR board games improved usability and social presence. Compared to static textbooks or pre-recorded video lessons, XR gaming fosters active participation and sustained attention. This result can be achieved by integrating physical and virtual gameplay, suggesting that multimodal interactions (e.g., moving pieces in XR chess) foster attention and motor learning. Moreover, behavioural responses in XR are physical and embedded in authentic scenarios. Analysing again forensic science training games (Pringle et al., 2022), learners were required to solve crimes using virtual tools, collaborating with peers, and navigating realistic challenges. This model mirrors the real-world complexity of decision-making, including ambiguity, pressure, and interpersonal coordination, variables often absent in traditional training modules.

Emotional and social engagement are the other two pivotal aspects. XR games use role-playing, storytelling, and virtual embodiment to engage learners and participants emotionally. Emotional engagement increases when learners feel strongly connected to their avatar or environment. Research identifies how XR fosters emotional intensity through presence and agency, promoting deeper cognitive investment. Emotions are not just by-products of gameplay—they are catalysts for sustained attention, curiosity, and personal meaning-making (Salimi, 2024). The illusion of body ownership, described in body swap studies (Bertrand, 2021), profoundly affects empathy and pro-social behavior. XR learners can embody roles that challenge their identity, seeing themselves as someone from another race, gender, or socioeconomic background, and experience situations that foster compassion and altruism. Such behavioural shifts go beyond what traditional moral or diversity education can offer. Social engagement is another critical aspect, particularly in multiplayer XR systems. As Wang et al. (2024) explain, XR enables rich multi-user social engagement (MSE) by supporting co-presence, communication, and shared decision-making. Users interact through avatars, simulate

collaboration under realistic constraints, and receive real-time social feedback. This dynamic, multisensory interaction is unattainable through most standard e-learning platforms.

Academic literature has extensively analyzed the comparative disadvantages of traditional learning environments, highlighting their limitations compared to more interactive and immersive approaches such as XR-based training. Experts consistently highlight the growing inadequacy of traditional learning environments in preparing learners for higher-order skills such as decision-making, collaborative problem-solving, and reflective thinking. Traditional instructional methods, characterized by lectures, static content, and passive information absorption, tend to fall short in promoting learner engagement, motivation, and adaptability in complex contexts (Hmoud et al., 2023). Research by Salimi (2024) points out that professionals often design conventional classrooms around rigid, one-size-fits-all pedagogical structures, which fail to accommodate the personalized, adaptive learning pathways that contemporary learners require. By contrast, XR immersive environments make learners feel actively involved in learning, promoting self-efficacy, motivation, and cognitive agency through immersive simulations and embodied experiences (Salimi, 2024). Another limit of traditional education is the lack of embodied interaction, a crucial component of cognitive and emotional engagement. Kourtesis (2024) argued that traditional environments typically separate cognition from physical interaction. In contrast, XR supports embodied cognition, allowing learners to interact with content through hand gestures, eye movement, and body tracking, engaging multiple cognitive and sensory systems simultaneously. This capacity for cognitive offloading and sensory-motor coordination is absent in lecture-based formats since they rely solely on verbal and textual instruction (Kourtesis, 2024). Furthermore, traditional learning offers limited cognitive adaptability. Panagiotis Kourtesis (2024) illustrates how XR learning environments dynamically adapt based on physiological and cognitive signals, such as gaze, heart rate, or stress indicators. In contrast, traditional formats are static and non-responsive, leaving learners without real-time feedback or personalized challenge levels. Kenwright (2023) adds that traditional environments lack emotional atonement and engagement. In immersive XR contexts, learners can engage in emotionally rich scenarios that stimulate reflection and empathy, whereas classroom settings rarely offer emotionally salient stimuli. This is especially relevant in leadership, ethics, and crisis training, where affective engagement is critical to effective learning outcomes (Kenwright, 2023). Also traditional models constrain the social dimension of learning. Wang et al. (2024) argue that screen-based and lecture-heavy environments provide minimal opportunities for interactive peer learning. By contrast, XR

technologies enable multi-user collaboration, realistic social cues through avatars, and synchronous interaction in virtual teams. These affordances foster the development of critical interpersonal skills that are difficult to cultivate through traditional teaching formats (Wang et al., 2024). Krauss et al. (2024) further problematize the traditional model by emphasizing that traditional digital tools can mask manipulative or opaque interaction patterns. Still, XR brings additional ethical risks if these environments are layered over conventional pedagogical methods. When professionals reduce learning to interface navigation or memorization, students remain passive, and new immersive tools risk becoming vessels for distraction or manipulation if not pedagogically guided (Krauss et al., 2024).

2.4 XR Video Games and Decision-Making Enhancement

2.4.1 XR Video game for decision-making skill development

Until now, the thesis shows how the academic literature has consistently emphasized the capacity of extended reality (XR) video games to provide immersive environments that foster some skills, particularly in high-stakes, professional contexts. XR, which includes virtual reality (VR), augmented reality (AR), and mixed reality (MR), creates embodied, interactive learning experiences that mirror real-world decision situations and enhance learners' perceptual and cognitive engagement (Kourtesis, 2024). This section builds on the previous analysis to explore more specifically what academic literature reveals about the connection between XR video games and the enhancement of decision-making skills.

In corporate contexts, immersive technologies have proven similarly impactful. Accenture's "Immersive Learning for the Future Workforce" report (2018) highlights XR as a strategic response to Industry 4.0's demand for dynamic skills training. XR creates experiential learning environments where learners practice decision-making in safe, replicable, high-fidelity simulations. A key advantage is the ability to learn through mistakes: for example, employees can train for high-risk scenarios such as chemical spills, equipment failures, or customer conflict management, without the consequences of the real world.

Let us now explore how this enhancement is achieved from a technical standpoint, focusing on XR technologies' specific features and affordances that enable more effective and immersive learning experiences. Accenture reports using VR headsets such as Oculus Rift, HTC Vive, and newer all-in-one devices like Oculus Quest, combined with 3D game engines to create immersive training modules. These systems support interactive 3D environments enhanced

with gesture tracking, eye tracking, and voice recognition, enabling the system to capture and assess decision-related behaviors in real time. One notable case involved Cognitive 3D analytics, which measured task completion time, decision accuracy, and learner interaction patterns. For example, in an internal training experiment on toilet replacement, users trained with interactive VR modules demonstrated 12% higher task accuracy and 17% faster completion time than their video-trained counterparts. Accenture also documents sector-specific use cases. In the retail industry, for instance, Walmart uses VR to simulate peak shopping periods such as Black Friday. Trainees are immersed in customer service scenarios, stocking challenges, and crisis simulations to test decision-making under pressure. The report then focuses on the medical sector, where doctors use VR training environments for surgical simulations at the Emory School of Medicine. Learners interact with virtual patients using haptic-enabled instruments and can repeat procedures until proficient. Compared to traditional training, these systems reduced error rates by 40%. Regarding Oil & Gas, at United Renta, XR-based field simulations replicate onshore and offshore environments, allowing operators to rehearse emergency responses and navigate logistical challenges. Hand-tracking controllers enable users to manipulate tools, activate safety protocols, and simulate maintenance operations in complex environments. Finally, the report argues that immersive learning systems are integrated with corporate Learning Management Systems (LMS) and supported by cloud-based rendering platforms for multi-user access to ensure scalability and efficiency. Furthermore, XR governance boards manage immersive training experiences, defining technical architecture, content repositories, security protocols, and performance analytics pipelines. In the aviation sector, Hurter et al. (2024) describe similar XR applications for air traffic controller (ATCO) training, where immersive analytics environments, featuring head-mounted displays (HMDs), haptic seats, 360-degree audio, and gesture-enabled interfaces, simulate congested airspace and require controllers to prioritize incoming aircraft, manage timing stacks, and coordinate landing sequences. These simulations leverage augmented paper strips, spatialized audio cues, and bi-manual interactions (e.g., FiberClay interface) to model real-time decisions in layered data environments (Hurter, 2024).

Gilardi et al. (2022) illustrate the effective design and implementation of an XR video game, Nursing XR, developed to train nursing students in clinical decision-making. Through an iterative co-design process with students and faculty, the development team created a branching narrative scenario involving triage, wound assessment, and treatment in a simulated home environment. The VR system allowed students to make sequential decisions influencing patient

outcomes, offering immediate clinical performance and communication feedback. The platform was implemented using VR headsets and controller interfaces. These technologies enable students to navigate the environment and interact with virtual tools and patients from a first-person perspective.

In sports training, trainers use immersive technologies to refine perceptual-cognitive skills. Panchuk et al. (2018) showed that immersive 360° video could train elite basketball players in situational awareness and passing decisions. Players exposed to immersive video scenarios exhibited performance gains in lab assessments and live small-sided games, demonstrating how realistic virtual representations can sharpen tactical thinking and judgment (Panchuk et al., 2018).

Beyond industry case studies, the XR-Ed framework developed by Yang, Zhou, and Radu (2020) provides a research-based instructional lens to guide the design and implementation of immersive learning systems. Their six-dimensional model encourages XR designers to consider: (1) Physical Accessibility of content, (2) Formality of the learning scenario, (3) Social Interactivity, (4) Learner Agency, (5) Degree of Virtuality, and (6) Seamless Integration of Assessment. The XR-Ed framework aligns with Accenture's emphasis on meaningful instructional design, affirming that immersive learning is most effective when grounded in structured educational models. For instance, immersive modules designed using backward design principles, starting from clear learning goals and embedded performance-based assessments, are more likely to yield long-term improvements in analytical reasoning, ethical judgment, and adaptive decision-making (Yang et al., 2020). These findings challenge companies to move beyond "edutainment" and instead adopt pedagogically sound, instruction-centered strategies for XR training. Moreover, the ability to personalize learning content and align it to individual decision styles, as promoted by the XR-Ed framework's "Learner Agency" and "Assessment" dimensions, is also critical. Whether applied to onboarding, compliance, technical training, or leadership development, immersive platforms offer flexible, multisensory learning environments that reinforce reflection and experimentation, two cognitive processes fundamental to decision-making development (Yang et al., 2020).

The literature reviewed by Reynaldo et al. (2021) offers robust evidence supporting video games, including serious games and simulations, as powerful tools to enhance decision-making capabilities, a core competency in corporate training environments. The review demonstrates that video games can improve cognitive functions such as perception, attentional control, and

decision-making, especially when designed with clear pedagogical goals and embedded challenge–response cycles. The article shows that decision-making is enhanced most effectively when learners are engaged in strategic and real-time decision contexts. For instance, real-time strategy (RTS) players outperform players of other game genres in cognitive flexibility, an essential component of decision-making in dynamic work environments. These players developed the ability to process multiple information streams and quickly revise their strategies under uncertainty, mimicking the cognitive demands of fast-paced corporate roles (Reynaldo et al., 2021). In particular, the review highlights that serious games designed to replicate professional scenarios, such as medical simulations for nurses and doctors, or business strategy games for traders and managers, significantly improve users’ ability to assess risks, anticipate consequences, and choose practical courses of action. This genre of game mirrors the structure of Extended Reality (XR) environments in corporate learning, which combine immersive visuals, real-time feedback, and scenario-based interaction to simulate job-specific challenges. One compelling study cited in the review compared the effectiveness of video game-based training with traditional video instruction. The results showed that game-based interventions reduced decision-making biases (e.g., confirmation bias, anchoring, projection) by 32% immediately and 24% over the long term, while traditional video methods achieved lower improvements (25% and 19%, respectively). These findings underline the value of active, participatory learning environments, precisely what XR platforms aim to provide in modern corporate training settings (Reynaldo et al., 2021). Furthermore, games can simulate real-world business environments, such as crisis management, negotiations, or strategic planning, challenging users to prioritize tasks under time constraints and make fast, impactful choices. These immersive learning scenarios encourage employees to refine their analytical reasoning and confidence in their decisions, traits that are critical in leadership development and project execution. (Reynaldo et al., 2021). The article also reports that decision-making benefits are not limited to young learners. The articles suggest that XR-based decision-making games could be valuable across multiple generations within the corporate workforce. The study also demonstrates that older adults who underwent structured video game training exhibited improved executive functioning and memory (Reynaldo et al., 2021).

In summary, video games and immersive environments could represent a powerful platform for developing, assessing, and refining decision-making skills, even if no specific research has been conducted across corporate training, aviation, healthcare, and education. When combined with pedagogically sound design frameworks, sensor-rich hardware, and embedded analytics, XR

enables scalable, high-impact learning experiences tailored to the cognitive demands of professional decision-makers. Nevertheless, XR simulations' accuracy is still an essential component for effectiveness. Le Noury et al. (2023) argue that "representative design", the extent to which an XR environment accurately replicates perception–action couplings from the real world, is essential for skill transfer. Without accurate physics, realistic interaction feedback, and scenario diversity, XR risks training skills that are contextually mismatched. Nonetheless, the potential for XR to track user actions, generate performance data, and adapt content dynamically makes it a powerful tool for long-term cognitive development (Le Noury et al., 2023).

2.4.2 Research Question

Following the literature review on XR technologies, active learning, cognitive skill development, and video games, this research explores the intersection between immersive technologies, games, and executive training outcomes in corporate contexts. Academic evidence supports the use of immersive video games and XR simulations to strengthen various managerial capabilities. For instance, immersive XR scenarios have proven effective for training soft skills such as empathy, leadership, communication, and client conflict resolution, particularly when embedded in role-based environments promoting safe, repeatable learning cycles (Accenture, 2018). Furthermore, studies by Reynaldo et al. (2021) have shown that game-based simulations improve cognitive flexibility and attentional control and reduce decision-making biases such as anchoring and confirmation error, which are frequent in real-world business situations. While existing literature provides compelling evidence that traditional video games can enhance decision-making skills (Reynaldo et al., 2021), the specific contribution of extended reality (XR) video games remains underexplored. Despite the growing adoption of XR in corporate training environments, researchers have not yet investigated whether immersive XR games, encompassing virtual reality (VR), augmented reality (AR), and mixed reality (MR), offer a benefit in fostering decision-making competence and if the benefits are similar or superior to those of playing video games.

Thus, the next logical step is to assess whether the immersive and embodied nature of XR games leads to a measurable improvement in decision-making abilities, and how this improvement compares to that achieved through traditional, non-immersive video games.

Given this growing body of evidence and the increasing use of immersive and game-based

training modules within corporate learning ecosystems, the central question guiding this dissertation is the following:

Are XR video games more effective than traditional video games in enhancing individuals' decision-making skills?

3. Research Method

3.1 Nature of the Research

This thesis adopts a quantitative, comparative, and experimental approach to investigate whether extended reality (XR) video games have a measurable and distinct effect on developing decision-making skills compared to traditional, non-immersive video games.

The rationale for this study stems from prior research confirming the general cognitive benefits of video gaming, particularly in decision speed, risk assessment, and attention control (Reynaldo et al., 2021). However, the specific contribution of immersive XR video games to these outcomes remains underexplored. In this context, the present study seeks to empirically assess whether the immersive, embodied, and interactive features of XR environments contribute to greater gains in decision-making competence than standard gaming formats.

3.2 Research Design

3.2.1 Participant Groups

To assess the relationship between XR gaming and decision-making, the study will include three distinct groups of participants:

Group 1 – Non-Gamers: Individuals with no significant experience playing traditional or XR video games in the past year.

Group 2 – Traditional Gamers: Participants who play conventional (non-XR) video games regularly (more than once per week) but have no exposure to XR environments.

Group 3 – XR Gamers: Participants who play XR video games regularly (more than once per week) using VR headsets or AR/MR applications.

This group-based design allows a direct comparison between immersive and non-immersive gaming experiences, isolating the unique contribution of XR technologies to decision-making skill development. Participants will be matched based on age distribution and educational background, although the only criterion for grouping is their gaming exposure.

3.2.2 Decision-Making Skill Assessment

All participants will be evaluated using a standardized psychometric battery to measure adult decision-making competence. Two instruments will be administered:

- Adult Decision-Making Competence (A-DMC) developed by Bruine de Bruin, Parker, and Fischhoff. The test assesses participants' decision-making level, measuring different aspects of the decision-making process (Bruine de Bruin, Parker, & Fischhoff, 2007).
- Cognitive Reflection Test (CRT), developed by Frederick, is used here to conduct further analysis and to assess the participants' cognitive ability by testing their tendency to engage in reflective (System 2) vs intuitive (System 1) thinking (Frederick, 2005).

The structure and positioning of each question and its respective subcategories were designed following the original guidelines established by the test developers. For example, the “resistance to framing” subscale items are organized into distinct sets based on their framing type, positive or negative. These sets follow different item sequences and are interspersed with other tasks from the Adult Decision-Making Competence (A-DMC) battery to prevent cognitive bias and ensure methodological rigor.

To control for the individual's cognitive processing style, participants will complete the Cognitive Reflection Test (CRT). This brief test presents problems that intuitively suggest a wrong answer, requiring deliberate cognitive override (Kahneman, 2011).

The CRT will be administered before the A-DMC to minimize potential priming effects. To control for familiarity bias, given the widespread recognition of the CRT, a question will ask participants whether they have previously encountered the test. After completing the A-DMC, participants will also answer a brief set of demographic questions to allow for more nuanced analysis of the results.

To ensure feasibility while maintaining scientific rigor, the following three subscales of the A-DMC have been selected, based on their theoretical and practical relevance to corporate decision-making:

1. Resistance to Framing

This subscale measures whether individuals make consistent choices when presented with logically equivalent options framed in either positive or negative terms. Performance is the

mean absolute difference between preferences across gain/loss frames (Bruine de Bruin, Parker, & Fischhoff, 2007).

Framing effects can significantly influence managerial decisions under uncertainty (e.g., risk communication, stakeholder management). A manager's ability to resist framing bias reflects sound judgment and strategic objectivity (Bruine de Bruin, Parker, & Fischhoff, 2007).

2. Recognizing social norms

This subscale assesses a person's ability to estimate what behaviours are considered socially acceptable or typical. It consists of 16 items, and participants are asked both what they would do in a given situation and what most people would do. Performance is calculated based on how closely individual estimates match population norms frames (Bruine de Bruin, Parker, & Fischhoff, 2007).

Social awareness and the ability to anticipate collective behavior are crucial in team leadership, stakeholder engagement, and organizational decision-making. Managers who accurately perceive social norms are better equipped to align their decisions with group expectations, culture, and reputation-sensitive contexts. As automation continues to reduce the need for routine, task-based roles, greater emphasis is placed on open-ended, judgment-intensive responsibilities within firms. As previously discussed in this thesis, these non-routine roles demand competencies such as situational awareness and adaptability to contextual variation, capabilities that are foundational to effective decision-making (Deming, 2021).

3. Resistance to Sunk Costs

This subscale evaluates the participant's ability to disregard prior investments when making forward-looking decisions. Respondents rate their likelihood of choosing normatively correct vs. biased actions across multiple decision scenarios. (Bruine de Bruin, Parker, & Fischhoff, 2007).

Sunk cost fallacy is particularly relevant in project management and strategic investment. Due to emotional or reputational commitments, leaders often face pressure to continue investing in failing initiatives. This test captures their ability to avoid such irrational escalation (Bruine de Bruin, Parker, & Fischhoff, 2007).

3.3 Logical Validation

This section aims to anticipate the range of possible results emerging from the Adult Decision-Making Competence (A-DMC) and Cognitive Reflection Test (CRT) to establish the interpretive framework through which these results will be interpreted. Logical validation ensures that, regardless of the observed patterns, the implications for the research question remain coherent, theoretically grounded, and directly connected to the role of video games in enhancing decision-making skills.

This logical validation establishes a structured interpretive framework for the present study anticipating the full range of potential outcomes across the A-DMC subscales and the CRT:

1. Resistance to Framing

If XR Gamers score significantly higher than Traditional Gamers and Non-Gamers, this would suggest that immersive XR environments strengthen individuals' ability to maintain consistency in judgments despite superficial changes in how options are presented. In corporate settings, this would indicate that XR gaming enhances strategic objectivity, reducing susceptibility to persuasion techniques or biased risk communication.

If Traditional Gamers outperform XR Gamers, the result suggests that regular exposure to strategic trade-offs in conventional games may already provide sufficient training in recognizing equivalency across gain/loss frames. This would imply that XR's immersion does not necessarily add incremental value in overcoming framing biases.

If Non-Gamers perform at similar levels to gamers, this could mean that resistance to framing is relatively stable as a cognitive trait, less sensitive to gaming experiences. Such a finding would challenge the assumption that gaming environments meaningfully affect susceptibility to framing effects.

If XR Gamers show lower resistance to framing, the interpretation may be that immersive experiences intensify emotional involvement, increasing susceptibility to contextual manipulations, a potential cognitive cost of immersion.

2. Recognizing Social Norms

If XR Gamers achieve the highest scores, this would suggest that immersive and embodied play promotes greater sensitivity to collective expectations and social dynamics. In managerial contexts, this would support the claim that XR gaming trains leaders to anticipate group behavior and align decisions with stakeholder expectations.

If Traditional Gamers perform better than XR Gamers, this could indicate that repeated participation in multiplayer environments, often prevalent in non-XR platforms, is more influential for social norm recognition than immersion itself. Thus, the social architecture of the game may matter more than the technology.

If Non-Gamers perform similarly to Gamers, this may suggest that social norm recognition is less influenced by gaming and more by everyday real-world interactions. In this case, XR and traditional video games may not significantly transfer to this skill.

If XR Gamers perform worse, the interpretation could be that XR's high cognitive load detracts from attention to subtle social cues, prioritizing sensory and task-based engagement over reflective social estimation.

3. Resistance to Sunk Costs

If XR Gamers score highest, this would imply that XR environments help players practice detaching from prior investments, as immersive games often involve rapidly changing scenarios where persistence in failing strategies is punished. This would strongly support XR as a training ground for adaptive, forward-looking decision-making in business contexts.

If Traditional Gamers score higher, it may suggest that conventional games, with their repeated “trial-and-error” mechanics, provide more exposure to cost–benefit reasoning and abandoning sunk investments. XR's immersion may then not uniquely contribute to overcoming escalation of commitment.

If Non-Gamers perform comparably, the implication would be that sunk cost resistance may be influenced more by personality traits (e.g., cognitive flexibility) than by gaming experience.

If XR Gamers score lowest, this would indicate that immersion increases psychological attachment to prior actions, making individuals more prone to escalation of commitment. For managers, this would highlight a possible unintended risk of XR training.

4. Cognitive Reflection Test (CRT)

If XR Gamers score highest on CRT, this would support the hypothesis that XR environments foster deeper engagement with problems, training individuals to override intuitive but incorrect responses in favor of reflective, analytical thinking. This aligns with Kahneman's (2011) distinction between System 1 and System 2 processing.

If Traditional Gamers outperform XR Gamers, it suggests that fast-paced, rule-based problem-solving in traditional games may foster reflection more effectively than immersive interaction.

If Non-Gamers score similarly, this may indicate that CRT performance is largely independent of gaming experience and reflects broader cognitive dispositions such as numeracy or need for cognition.

If XR Gamers perform worse, the explanation may be that immersion fosters intuitive, experiential decision-making at the expense of analytical override, potentially beneficial in fast, embodied contexts but detrimental in tasks requiring deliberation.

5. Cross-Pattern Interpretations

The most meaningful insights may arise not from individual subscales but from patterns across tests:

Consistently superior performance of XR Gamers across A-DMC and CRT would validate the hypothesis that immersive gaming environments uniquely enhance decision-making skills relevant to corporate contexts.

If Traditional Gamers outperform XR Gamers across multiple measures, it suggests that exposure to structured, strategy-driven gameplay matters more than immersion. The role of XR may then lie in engagement or motivation, not cognitive skill development.

If Non-Gamers perform comparably to gamers, this would challenge the assumed link between gaming and decision-making competence, suggesting that cognitive style or education may play a stronger role.

If XR Gamers excel in social norm recognition but underperform in cognitive reflection, this may indicate that XR develops situational awareness and empathy but at the cost of analytical reasoning, a nuanced finding with implications for designing XR-based leadership training.

If XR Gamers excel in sunk cost resistance but not framing resistance, this would suggest that XR environments foster adaptability and future-oriented thinking but may not help players detach from emotional framing effects.

4. Findings

4.1 Sample description

The total number of participants is 80. The participants are distributed in the three groups (Group 1: Non-Gamers, Group 2: Traditional Gamers, Group 3: XR Gamers) with the following distribution (Table 1):

Group1- Non-Gamers (n = 29)

Group 2- Traditional Gamers (n = 25)

Group 3- XR Gamers (n = 26)

	Frequency	Percent
Group 1-Non-Gamers	29	36.3
Group 2-Traditional Gamers	25	31.3
Group 3-XR Gamer	26	32.5
Total	80	100.0

Table 1: Participants' distribution

43.8% of the sample is under 26, while 27.5% is between 26 and 35. Only 12.5% of the participants are between 36 and 45 years old, and 10% are between 46 and 55. The remaining 6.3% of the sample is older than 55 (Table 2). The Group 1- Non-Gamers group has an estimated age of 31, Group 2- Traditional Gamers of almost 29 years old, and Group 3-XR Gamers of nearly 36 years old. The average age for each group has been estimated by recoding the age group variable into a new variable by assigning an approximate central value to each age group.

What is your age group?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	less than 18	2	2.5	2.5	2.5
	18-25	33	41.3	41.3	43.8
	26-35	22	27.5	27.5	71.3
	36-45	10	12.5	12.5	83.8
	46-55	8	10.0	10.0	93.8
	more than 55	5	6.3	6.3	100.0
	Total	80	100.0	100.0	

Table 2: Participant Groups

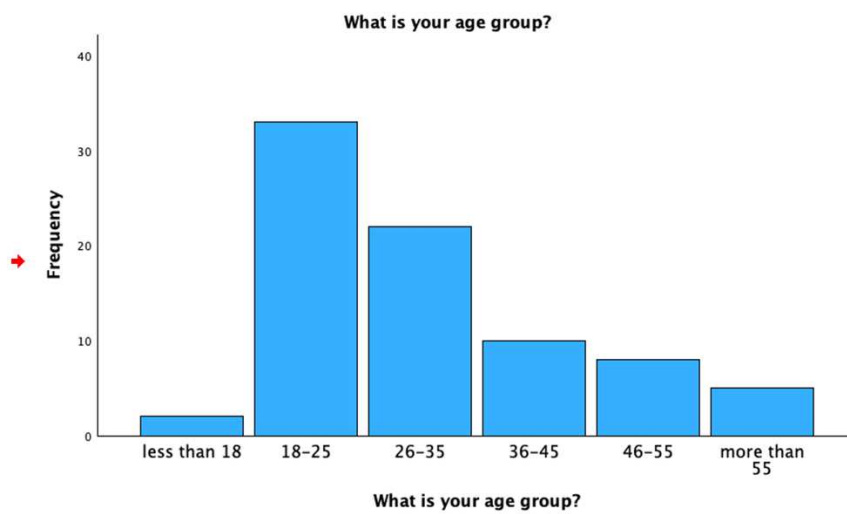


Figure 1: Participant Groups Graph

Analysing the gender of the participants, one participant recognises themselves as non-binary. On the other hand, 47 participants identify themselves as male; the remaining 40% of the population, namely 32 participants, recognize themselves as female (Table 3). Further data analysis shows that only in Group 1 are female gender participants more prevalent than male ones; on the other hand, in the other two groups, there is a prevalence of male participants (Table 4).

How do you identify your gender?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	47	58.8	58.8	58.8
	Female	32	40.0	40.0	98.8
	Non-binary	1	1.3	1.3	100.0
	Total	80	100.0	100.0	

Table 3: Participants' Gender

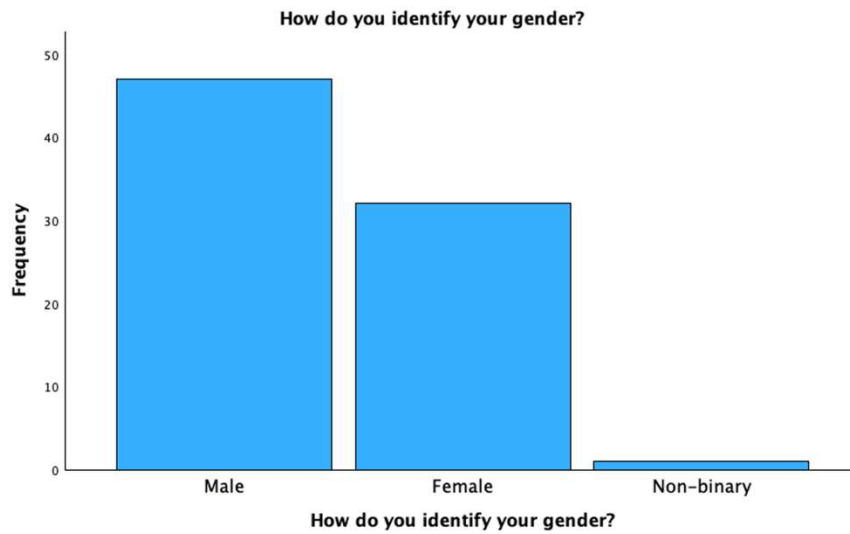


Illustration 2: Participants' Gender Graph

GROUP * How do you identify your gender?

		Crosstab				Total
		How do you identify your gender?				
		Male	Female	Non-binary		
GROUP	Non-Gamers	Count	7	22	0	29
		Expected Count	17.0	11.6	.4	29.0
		% within How do you identify your gender?	14.9%	68.8%	0.0%	36.3%
	Traditional Gamers	Count	19	5	1	25
		Expected Count	14.7	10.0	.3	25.0
		% within How do you identify your gender?	40.4%	15.6%	100.0%	31.3%
	XR Gamers	Count	21	5	0	26
		Expected Count	15.3	10.4	.3	26.0
		% within How do you identify your gender?	44.7%	15.6%	0.0%	32.5%
Total		Count	47	32	1	80
		Expected Count	47.0	32.0	1.0	80.0
		% within How do you identify your gender?	100.0%	100.0%	100.0%	100.0%

Table 4: Group Gender

It can be noticed that, overall, most of the participants, 65%, are employed, and 30% are still studying (Table 5).

Which of the following best describes your current employment status?

		Frequency	Percent	Valid Percent	Cumulative Percent
→ Valid	Employed	52	65.0	65.0	65.0
	Student	24	30.0	30.0	95.0
	Unemployed	2	2.5	2.5	97.5
	Retired	2	2.5	2.5	100.0
	Total	80	100.0	100.0	

Table 5: Participants' Employment Status

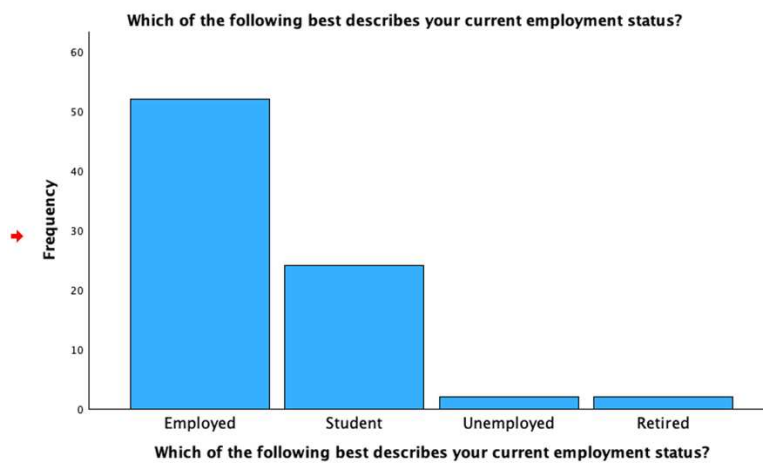


Illustration 3: Participants' Employment Status Graph

Crosstab

Which of the following best describes your current employment status?

			Employed	Student	Unemployed	Retired	Total
→ GROUP	Non-Gamers	Count	17	10	0	2	29
		Expected Count	18.8	8.7	.7	.7	29.0
		% within Which of the following best describes your current employment status?	32.7%	41.7%	0.0%	100.0%	36.3%
	Traditional Gamers	Count	12	12	1	0	25
		Expected Count	16.3	7.5	.6	.6	25.0
		% within Which of the following best describes your current employment status?	23.1%	50.0%	50.0%	0.0%	31.3%
	XR Gamers	Count	23	2	1	0	26
		Expected Count	16.9	7.8	.7	.7	26.0
		% within Which of the following best describes your current employment status?	44.2%	8.3%	50.0%	0.0%	32.5%
Total		Count	52	24	2	2	80
		Expected Count	52.0	24.0	2.0	2.0	80.0
		% within Which of the following best describes your current employment status?	100.0%	100.0%	100.0%	100.0%	100.0%

Table 6: Groups' Employment Status

Regarding the level of education, 31.3% of the sample have a bachelor’s degree, 27.5% have a master’s degree, and 13.8% have a doctorate or a higher level than a master’s degree. The remaining 23.8% of the participants have a high school diploma, except for 3 participants, who make up 3.8% of the total sample, who do not have a high school diploma (Table 7). XR Gamers Group shows the highest number of participants with the highest level of education (Table 8).

What is the highest level of education you have completed?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than high school	3	3.8	3.8	3.8
	High school diploma or equivalent	19	23.8	23.8	27.5
	Bachelor’s degree	25	31.3	31.3	58.8
	Master’s degree	22	27.5	27.5	86.3
	Doctorate or higher	11	13.8	13.8	100.0
	Total	80	100.0	100.0	

Table 7: Participants’ Education Level

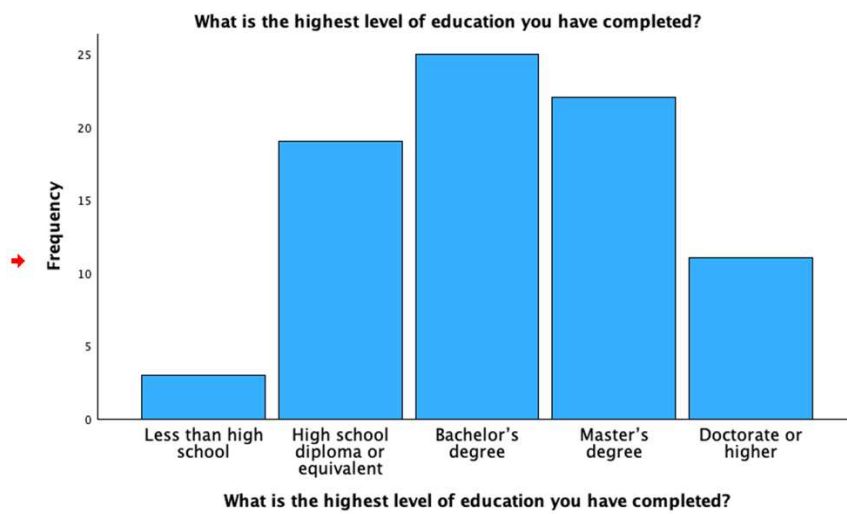


Illustration 4: Participants’ Education Level Graph

GROUP * What is the highest level of education you have completed?

Crosstab
What is the highest level of education you have completed?

			Less than high school	High school diploma or equivalent	Bachelor's degree	Master's degree	Doctorate or higher	Total
GROUP	Non-Gamers	Count	2	7	8	9	3	29
		Expected Count	1.1	6.9	9.1	8.0	4.0	29.0
		% within What is the highest level of education you have completed?	66.7%	36.8%	32.0%	40.9%	27.3%	36.3%
Traditional Gamers	Count	1	4	13	7	0	25	
	Expected Count	.9	5.9	7.8	6.9	3.4	25.0	
	% within What is the highest level of education you have completed?	33.3%	21.1%	52.0%	31.8%	0.0%	31.3%	
XR Gamers	Count	0	8	4	6	8	26	
	Expected Count	1.0	6.2	8.1	7.2	3.6	26.0	
	% within What is the highest level of education you have completed?	0.0%	42.1%	16.0%	27.3%	72.7%	32.5%	
Total	Count	3	19	25	22	11	80	
	Expected Count	3.0	19.0	25.0	22.0	11.0	80.0	
	% within What is the highest level of education you have completed?	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	

Table 8: Groups' Education Level

4.2 A-DMC Test Results

A one-way Analysis of Variance (ANOVA) was conducted on the Adult Decision-Making Competence (A-DMC) test scores, including subscale and total scores, to evaluate whether participants' decision-making abilities differed significantly across varying gaming exposure. Adult Decision-Making Competence (A-DMC) test, as described in section 3.2.2 Decision-Making Skill Assessment, was conducted to evaluate participants' decision-making level (Bruine de Bruin, Parker, & Fischhoff, 2007). In particular, three aspects of the A-DMC test were measured: Resistance to Framing, Resistance to Sunk Cost, and Recognising Social.

Participants (N = 80) were classified into three mutually exclusive groups: Non-Gamers, Regular Gamers, and Extended Reality (XR) Gamers, based on their self-reported gaming habits. The goal was to examine whether these three groups exhibit statistically significant differences in decision-making performance.

Before performing the ANOVA, statistical assumptions were carefully tested and confirmed. In fact, each participant was assigned to only one group, with no overlap. This ensured the independence of observations. Additionally, data were screened, and no significant outliers were identified, preserving the integrity of the results. Levene's Test for Equality of Variances indicated no significant violation of this assumption, confirming that the variance across groups

was comparable. Given these conditions, a one-way ANOVA was deemed appropriate for the analysis.

4.2.1 Resistance to Framing

The Resistance to Framing subscale measures an individual's ability to remain consistent when options are presented differently but are logically equivalent. The ANOVA revealed a statistically significant difference between the three groups ($p < 0.05$), suggesting that gaming habits may influence susceptibility to framing effects. Post-hoc comparisons using the Tukey HSD test indicated that XR Gamers scored significantly higher than Non-Gamers and Traditional Gamers, with a marked difference between XR Gamers and Non-Gamers (Table 11). However, the difference between Non-Gamers and Regular Gamers is not significant ($p = 0.236$) (Table 8).

Post Hoc Tests

Multiple Comparisons

Dependent Variable: RC_SCORE_NORM
Tukey HSD

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Non-Gamers	Traditional Gamers	-.04975	.03037	.236	-.1223	.0228
	XR Gamers	-.16734*	.03005	<.001	-.2392	-.0955
Traditional Gamers	Non-Gamers	.04975	.03037	.236	-.0228	.1223
	XR Gamers	-.11758*	.03117	<.001	-.1921	-.0431
XR Gamers	Non-Gamers	.16734*	.03005	<.001	.0955	.2392
	Traditional Gamers	.11758*	.03117	<.001	.0431	.1921

*. The mean difference is significant at the 0.05 level.

Table 8: Resistance to Framing Anova

4.2.2 Resistance to Sunk Cost

The Sunk Costs subscale assesses the tendency to continue an endeavor based on previously invested resources, rather than on current rational evaluation. ANOVA results demonstrated a significant overall effect of gaming group ($p < 0.05$). XR Gamers again showed the highest competence (Table 11), indicating better resistance to the sunk cost fallacy. However, no significant difference was found between Non-Gamers and Regular Gamers ($p = 0.898$) (Table 9).

ANOVA

SC_SCORE_NORM

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.130	2	.565	17.914	<.001
Within Groups	2.428	77	.032		
Total	3.558	79			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: SC_SCORE_NORM
Tukey HSD

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Non-Gamers	Traditional Gamers	-.02138	.04846	.898	-.1372	.0944
	XR Gamers	-.26292*	.04796	<.001	-.3775	-.1483
Traditional Gamers	Non-Gamers	.02138	.04846	.898	-.0944	.1372
	XR Gamers	-.24154*	.04974	<.001	-.3604	-.1227
XR Gamers	Non-Gamers	.26292*	.04796	<.001	.1483	.3775
	Traditional Gamers	.24154*	.04974	<.001	.1227	.3604

*. The mean difference is significant at the 0.05 level.

Table 9: Resistance to Sunk Cost Anova

4.2.3 Recognizing Social Norms

For the Recognizing Social Norms subscale, which captures awareness and understanding of prevailing behavioral expectations in social settings, the ANOVA yielded no statistically significant differences across the three groups ($p > 0.05$). The mean scores across the three groups remained relatively similar, indicating a comparable performance in this particular aspect of decision-making. Although XR gamers presented slightly higher average scores, the difference was not statistically meaningful. Post-hoc comparison, Tukey HSD confirmed that none of the group differences reached significance.

ANOVA

SN_SCORE_NORM_NUM

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.184	2	.092	1.945	.150
Within Groups	3.650	77	.047		
Total	3.834	79			

Table 10: Resistance to Sunk Cost Anova

4.2.4 Overall A-DMC Score

When analyzing the total score across all A-DMC subscales to provide a global measure of decision-making competence, a significant difference emerged between the three groups ($p < 0.05$). Extended Reality Gamers displayed the highest mean scores, followed by Regular Gamers, with Non-Gamers scoring the lowest (Tables 11 and 12). Post-hoc analysis confirmed

that XR gamers performed significantly better than both video gamers and non-gamers. However, no significant difference was found between non-gamers and video gamers ($p = 0.654$) (Table 13).

	Group 1 Non-Gamers	Group 2 Traditional Gamers	Group 3 XR Gamers
Resistance to Framing	67.88	72.86	84.62
Resistance to Sunk Costs	57.86	60.00	84.15
Recognizing Social Norms	42.61	42.43	32.28
Decision-Making Level Score	56.12	58.43	67.02

Table 11: A-DMC Subscale and Total Score x100

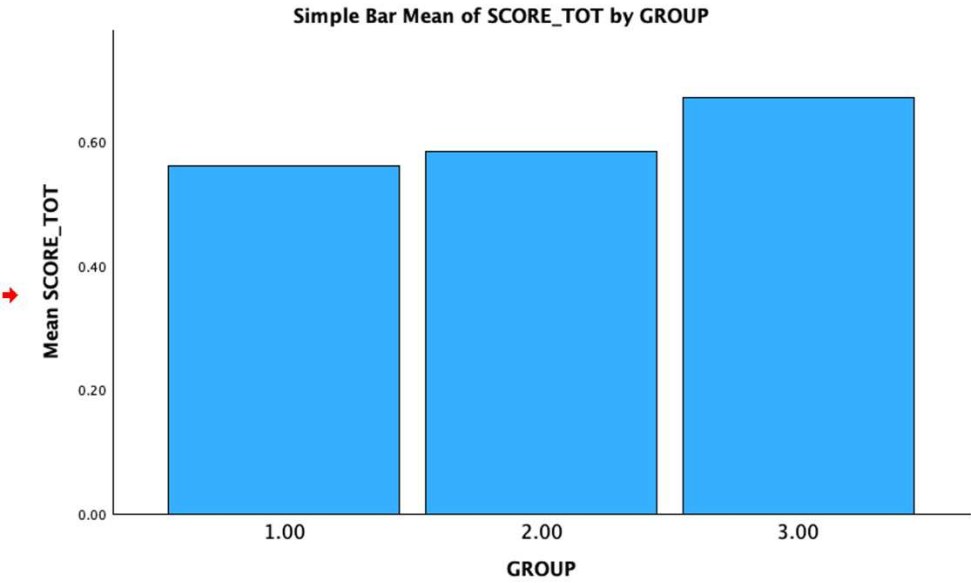


Table 12: A-DMC Total Score per Group

ANOVA						
SCORE_TOT						
	Sum of Squares	df	Mean Square	F	Sig.	
Between Groups	.177	2	.088	9.528	<.001	
Within Groups	.714	77	.009			
Total	.891	79				

Post Hoc Tests

Multiple Comparisons						
Dependent Variable: SCORE_TOT						
Tukey HSD						
(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Non-Gamers	Traditional Gamers	-.02313	.02628	.654	-.0859	.0397
	XR Gamers	-.10899*	.02601	<.001	-.1711	-.0468
Traditional Gamers	Non-Gamers	.02313	.02628	.654	-.0397	.0859
	XR Gamers	-.08585*	.02697	.006	-.1503	-.0214
XR Gamers	Non-Gamers	.10899*	.02601	<.001	.0468	.1711
	Traditional Gamers	.08585*	.02697	.006	.0214	.1503

*. The mean difference is significant at the 0.05 level.

Table 13: Total Score Anova

4.3 Cognitive Reflection Test (CRT) Results

The Cognitive Reflection Test (CRT) assessed participants' ability to suppress an intuitive and spontaneous wrong answer in favor of a more deliberate and reflective one (Frederick, 2005). The CRT consisted of three items, each with a correct and an intuitive (incorrect) answer:

1. A bat and a ball cost \$1.10 in total. The bat costs \$1 more than the ball. How much does the ball cost?

Correct answer: 5 cents

Intuitive answer: 10 cents

2. If it takes 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

Correct answer: 5 minutes

Intuitive answer: 100 minutes

3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take to cover half the lake?

Correct answer: 47 days

Intuitive answer: 24 days

(Frederick, 2005)

Following Frederick's directions on how to analyse the results of the Cognitive Reflection Test, given their answers, the participants were divided into 3 groups representing their level of cognitive ability. Participants' scores ranged from 0 to 3, based on the number of correct answers. Table 13 shows the distribution of scores across the sample (N = 80). Participants who scored 0 out of 3 were assigned to the “low group”, those who scored 1 or 2 were assigned to the “intermediate group”. Finally, those who scored 3 out of 3 were assigned to the “high group”.

After the analysis, the data show that 48.8% of participants, 39 out of 80, have a high level of cognitive ability. The intermediate group instead represents 32.5% of the sample, namely 26 participants. Finally, the remaining 18.8% (15 participants) were assigned to the low group (Table 14).

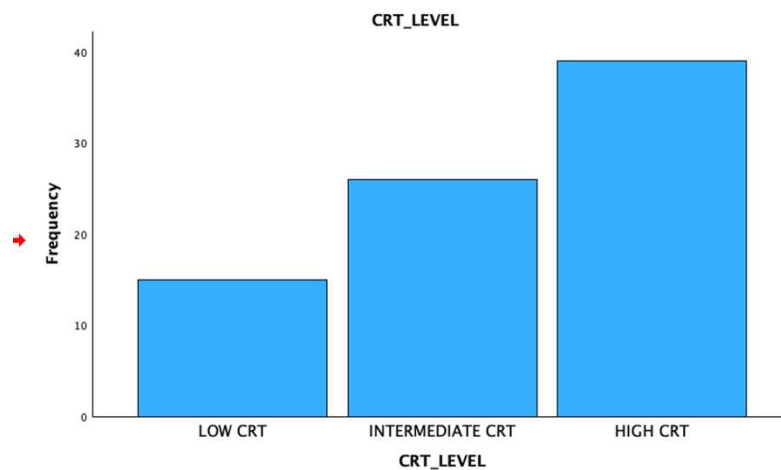


Table 14: CRT Participants Distribution

4.3.2 CRT Score and A-DMC Subscales

To examine whether performance on the CRT was associated with decision-making abilities, one-way ANOVAs were conducted using CRT score groups (1, 2, 3) as independent variables and A-DMC subscale scores as dependent variables.

Resistance to Framing (RF): No significant relationship found between CRT level and RF score.

Sunk Costs (SC): No significant relationship found between CRT level and RF score.

Social Norms (SN): No significant relationship found between CRT level and RF score.

4.3.3 CRT Score Across Gamer Groups

The next step of the analysis was to understand whether the CRT levels change according to the participants' gaming habits. Consequently, to compare and to examine whether CRT scores differed across the three gamer groups (Non-Gamers, Regular Gamers, XR Gamers), a one-way ANOVA was conducted with CRT total score as the dependent variable.

The test shows that the XR Gamers group reached the highest level on the CRT test with respect to the other two groups. On the other hand, Table 15 shows the difference in the mean CRT scores across gamer groups, which is not statistically significant.

➔ Oneway

Descriptives								
CRT_SCORE								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
NON GAMERS	29	1.7241	1.19213	.22137	1.2707	2.1776	.00	3.00
GAMERS	25	2.1600	1.02794	.20559	1.7357	2.5843	.00	3.00
XR GAMERS	26	2.3077	1.15825	.22715	1.8399	2.7755	.00	3.00
Total	80	2.0500	1.14627	.12816	1.7949	2.3051	.00	3.00

Tests of Homogeneity of Variances					
CRT_SCORE					
		Levene Statistic	df1	df2	Sig.
	Based on Mean	.717	2	77	.491
	Based on Median	.354	2	77	.703
	Based on Median and with adjusted df	.354	2	62.827	.703
	Based on trimmed mean	.544	2	77	.583

ANOVA					
CRT_SCORE					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.108	2	2.554	1.943	.143
Within Groups	98.692	77	1.282		
Total	103.800	79			

Table 15: CRT Scores and Groups

After having explored the numerical means through this analysis to address the question “Does the average CRT score vary by gamer type?”, to which the data suggest a negative answer, we now turn our attention to the question “Is there an association between gamer type and CRT

level?'. To answer this, a chi-square test was conducted to examine the association between gamer type and CRT level, and to analyse the distribution pattern across categories.

Table 16 shows how the groups' participants (Non-Gamers, Traditional Gamers, XR Gamers) are distributed according to their CRT level (Low, Intermediate, High).

	Low Group	Intermediate Group	High Group
Non-Gamers	8	12	9
Traditional Gamers	3	10	12
Xr Gamers	4	4	18

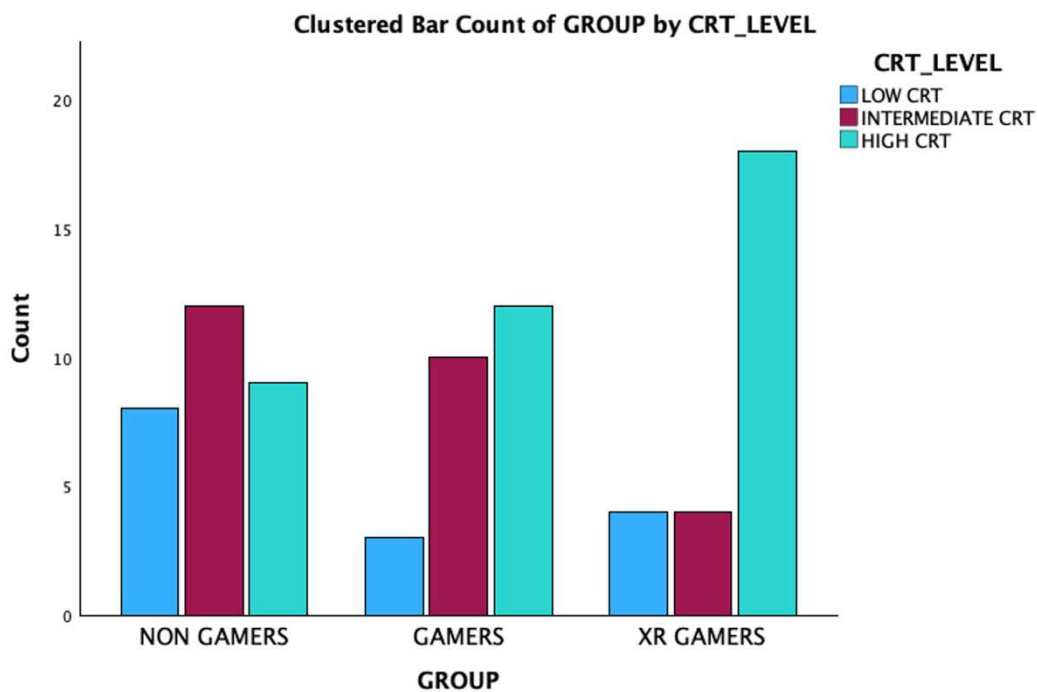


Table 16: CRT Score for each Group

Table 17 shows the Chi-square test result, demonstrating a significant association between the gamer group and CRT level distribution.

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.559 ^a	4	.049
Likelihood Ratio	10.010	4	.040
Linear-by-Linear Association	5.942	1	.015
N of Valid Cases	80		

a. 2 cells (22.2%) have expected count less than 5. The minimum expected count is 4.69.

Table 17: CRT and Groups Association

The results of the two analyses suggest that, given the significant Chi-square test, there is evidence of an association between gamer type and cognitive reflection level (CRT). However, the non-significant ANOVA indicates that the mean CRT scores do not differ significantly across gamer types.

4.5 Average Profiles by Group

This analysis aims to understand the decision-making profile of each group (Non-gamers, Traditional Gamers, and XR Gamers). Table 18 shows the results gained by this research.

XR Gamers scored the highest on Resistance to Framing ($M = 0.8462$), followed by Traditional Gamers ($M = 0.7286$), and Non-Gamers ($M = 0.6788$). This pattern suggests that XR Gamers are more adept at resisting irrelevant contextual influences when making decisions. Similarly, XR Gamers obtained the highest mean score on Resistance to Sunk Cost ($M = 0.8415$), indicating a greater ability to disregard prior investments when evaluating future options. Traditional Gamers ($M = 0.6000$) and Non-Gamers ($M = 0.5786$) scored lower, suggesting less resilience against the sunk cost fallacy among these groups. In contrast to the other measures, XR Gamers demonstrated the lowest score in Recognizing Social Norms ($M = 0.3228$), indicating reduced sensitivity to prevailing social expectations. Traditional Gamers ($M = 0.4243$) and Non-Gamers ($M = 0.4261$) performed comparably and at a higher level, suggesting that XR gaming may be associated with diminished conformity or lower awareness of societal behavioral standards.

The A-DMC Total Score, which represents a composite of decision-making competencies, was highest among XR Gamers ($M = 0.6702$), followed by Traditional Gamers ($M = 0.5843$) and Non-Gamers ($M = 0.5612$). This indicates a cumulative advantage in decision-making performance for individuals engaged in XR gaming environments.

Finally, XR Gamers also scored highest on the Cognitive Reflection Test ($M = 2.5385$), which measures the propensity to override intuitive but incorrect responses in favor of reflective thought. Traditional Gamers ($M = 2.3600$) and Non-Gamers ($M = 2.0345$) followed. This further supports the notion that XR gaming may enhance cognitive deliberation and reflective reasoning skills.

Overall, XR Gamers consistently outperformed the other groups in most decision-making measures, particularly in areas requiring analytical processing and cognitive flexibility. However, their lower performance is in Recognizing Social Norms. The significance of these differences has already been studied in this thesis.

	Resistance to Framing	Resistance to Sunk Cost	Recognizing Social Norms	A-DMC Tot Score	CRT Level
Non-Gamers	0.6788	0.5786	0.4261	0.5612	2.0345
Traditional Gamers	0.7286	0.6000	0.4243	0.5843	2.3600
XR Gamers	0.8462	0.8415	0.3228	0.6702	2.5385
Total	0.7488	0.6707	0.3920	0.6038	2.3000

Table 18: Groups' Decision-Making Profile

4.6 Effects of Demographic Variables

4.6.1 Gender effects

This test examines whether men and women have different CRT and A-DMC scores. An independent samples t-test was conducted on the scores obtained in the A-DMC subscales and the total CRT score to determine whether there are significant differences between males and females in cognitive and decision-making abilities.

Results show that men performed better than women at the CRT level and all the A-DMC subscales, except for Recognizing Social Norms (Table 19). On the other hand, the test shows that these differences are not statistically relevant considering both the A-DMC scores and the CRT ones (Table 20).

	Male	Female
Resistance to Framing	0.7672	0.7219
Resistance to Sunk Cost	0.7030	0.6219
Recognizing Social Norms	0.3938	0.4014
A-DMC Total Score	0.6213	0.5817
CRT Level	2.3830	2.1563

Table 19: Scores per Gender

		Levene's Test for Equality of Variances		t-test for Equality of Means							
		F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						One-Sided p	Two-Sided p			Lower	Upper
RC_SCORE_NORM	Equal variances assumed	3.302	.073	1.514	77	.067	.134	.04530	.02993	-.01430	.10489
	Equal variances not assumed			1.598	76.265	.057	.114	.04530	.02834	-.01115	.10174
SC_SCORE_NORM	Equal variances assumed	.008	.930	1.677	77	.049	.098	.08110	.04837	-.01521	.17742
	Equal variances not assumed			1.676	66.599	.049	.098	.08110	.04840	-.01551	.17772
SN_SCORE_NORM_NUM	Equal variances assumed	.003	.954	-.152	77	.440	.880	-.00762	.05010	-.10738	.09215
	Equal variances not assumed			-.152	66.031	.440	.880	-.00762	.05025	-.10795	.09272
SCORE_TOT	Equal variances assumed	2.436	.123	1.647	77	.052	.104	.03960	.02404	-.00828	.08747
	Equal variances not assumed			1.739	76.277	.043	.086	.03960	.02276	-.00574	.08493
CRT_LEVEL	Equal variances assumed	.343	.560	1.289	77	.101	.201	.22673	.17584	-.12341	.57687
	Equal variances not assumed			1.290	66.795	.101	.202	.22673	.17579	-.12418	.57763

Table 20: Gender effects t-test

4.6.2 Age effects

This analysis aims to examine whether higher age is associated with better performance. To investigate the relationship between age and cognitive/decision-making performance, correlations were calculated between participants' age and scores on the various subscales.

The analysis revealed no significant correlations between age and CRT scores, the total A-DMC score, or the Resistance to Framing subscale. However, a positive and significant correlation was found between age and the Resistance to Sunk Costs subscale ($r = 0.258$, $p = 0.021$), suggesting that older participants tend to resist sunk cost bias more. Conversely, a negative and significant correlation was observed between age and the Recognizing Social Norms subscale ($r = -0.28$, $p = 0.042$), indicating that younger participants may be more adept at identifying shared social norms.

5. Interpretation

5.1 Gaming Habits and Decision-Making Skills Level

5.1.1 XR Gaming and Decision-Making Skills

The results of the Adult Decision-Making Competence (A-DMC) test (Table 11) indicated that Extended Reality (XR) Gamers consistently outperformed both Regular Gamers and Non-Gamers across multiple subscales. Specifically, XR gamers demonstrated significantly higher scores in the Resistance to Framing and Sunk Cost subscales. In contrast, Regular Gamers and Non-Gamers did not significantly differ from one another in these subscales. This result suggests that immersive, interactive environments such as XR may enhance cognitive flexibility and critical reflection, reducing the impact of framing effects, flexibility, and resistance to superficial contextual manipulation, an essential skill in complex decision environments. Furthermore, Resistance to Suck Cost A-DMC subscale findings imply that immersive game experiences may contribute to enhanced rationality in abandoning unproductive decisions. This means that XR-based interactivity, which often requires rapid reevaluation of prior choices, may train individuals to disengage from past investments when they no longer serve present objectives, a key skill in fast-paced, resource-sensitive corporate contexts. The lack of significant differences in the Recognizing Social Norms subscale suggests that gaming behavior influences this decision-making dimension less. This is consistent with the idea that social norm recognition may require real-world interpersonal interactions rather than simulated or virtual experience. Given that it is more contextually tied to real-world social exposure and interpersonal experience, it is plausible that gaming experiences, regardless of their immersiveness, do not substantially shape this dimension of decision-making. A-DMC Total Score findings reinforce the pattern observed in the subscales: Extended Reality gaming environments cultivate superior decision-making abilities, particularly in cognitive resilience and cost evaluation, which are critical for complex decision-making in corporate settings. XR environments' extended interactivity and immersive feedback loops foster improved cognitive engagement and judgment across decision-making domains. Several relevant theoretical perspectives can explain the findings of this study. Salimi (2024) highlights that XR environments enhance motivation, interest, and agency by enabling users to manipulate immersive virtual contexts directly. This aligns with self-determination theory, which posits that autonomy and self-efficacy are key drivers of intrinsic motivation. Unlike traditional formats, XR environments are not passive; they offer rich, narrative-driven, and emotionally engaging experiences that support sustained psychological engagement. Evidence from educational and corporate training research further supports these findings. XR has been shown

to improve learner engagement, knowledge retention, and practical skill development, addressing key limitations of traditional methods (Marengo, Pagano, & Ladisa, 2018; Nunn, 2024). Alsaleh (2022) notes that active learning is strengthened through interactive, immersive environments promoting cognitive and emotional involvement. These benefits are especially pronounced when learners engage in realistic simulations requiring iterative feedback and adaptive problem-solving (Reynaldo et al., 2021; Sziegat, 2024). XR and serious games also embody a constructivist approach to learning, where knowledge is actively constructed through context-rich, experiential tasks (Sziegat, 2024). Serious games often simulate professional scenarios and provide safe spaces for risk-free decision-making and trial-and-error learning (Liberona et al., 2022; Vasquez Bronfman, 2015). In these environments, learners actively perform, collaborate, manage failures, and refine strategies and competencies aligned with real-world decision-making demands (Sziegat, 2024). Dodds (2022) further argues that XR design should align with experiential and constructivist learning theories, emphasizing that learning must be “framed, activated, and reflected upon” (Dodds, 2021, p. 71). Decision-making includes exposure to meaningful challenges, opportunities for safe failure, and mechanisms for reflection within the virtual context. Finally, XR offers a level of adaptability absent in traditional learning environments. Kourtesis (2024) explains that XR systems can adjust to learners' cognitive and physiological states in real time, offering personalized feedback and challenges. In contrast, traditional formats are static and lack emotional engagement (Kenwright, 2023), limiting the depth of reflection and adaptability crucial to decision-making, especially in complex domains such as leadership, ethics, or crisis response.

5.1.2 CRT Scores, Decision-Making, and Gamer Type

The Cognitive Reflection Test (CRT) results revealed no significant correlation between CRT scores and A-DMC subscales. This may suggest that reflective thinking alone cannot predict complex decision-making behavior in domains such as sunk cost avoidance or resistance to framing. Also, when participants were categorized into low vs. high CRT scorers, no clear pattern emerged: high CRT scorers tended to perform slightly better on decision-making subscales, resistance to framing, and to sunk costs, while low and intermediate CRT scorers performed better than high CRT in recognizing social norms, but not significantly in statistical terms. Although the mean CRT scores did not differ significantly across the three gaming groups, the distribution of scores (as tested by Chi-square) was significantly associated with gaming type. XR gamers were overrepresented among high CRT scorers and underrepresented among low scorers.

The data indicate that XR Gamers predominantly engage in cognitive processing aligned with System 2, characterized by deliberate, reflective, and analytical thinking, rather than System 1, which is fast, automatic, and intuitive (Frederick, 2005). XR Gamers exhibit significantly higher scores on the Cognitive Reflection Test (CRT) than the other two groups, suggesting a greater reliance on System 2 reasoning. In addition, as just analyzed, XR Gamers show superior decision-making abilities, as evidenced by their higher total scores on the A-DMC (Adult Decision-Making Competence) scale. This pattern aligns with Frederick's (2005) findings, which demonstrate that individuals who rely more on intuitive, System 1 processes typically perform worse on decision-making tasks requiring analytical reasoning. This interpretation is further supported by Kahneman's (2011) dual-system framework, which distinguishes between the automaticity of System 1 and the effortful control of System 2. System 2 activation is crucial for overriding heuristic-driven errors and biases in complex decision-making contexts, particularly within organizational or managerial settings. However, the cognitive demands of day-to-day decision-making often promote reliance on System 1, increasing susceptibility to systematic errors such as framing effects. The elevated decision-making performance observed among XR Gamers suggests a greater ability or tendency to engage System 2 processes effectively, thereby reducing vulnerability to such cognitive biases. This aligns with prior research suggesting that video games are powerful tools to enhance decision-making capabilities, especially when designed with clear pedagogical goals and embedded challenge–response cycles (Reynaldo et al. 2021). Moreover, it is vital to consider the potential for skill transfer from immersive virtual environments to real-world contexts. Building upon the findings of Freina and Ott (2015), who emphasize the capacity of virtual reality to simulate realistic scenarios that enhance experiential learning, the higher scores observed among XR Gamers suggest that even VR game environments may contribute to the development of cognitive and decision-making skills that are transferable to everyday situations.

5.1.3 Group Decision-Making Profile

Analyzing average profiles across groups (Table 18) allowed for identifying distinct patterns in cognitive and decision-making competencies among Non-Gamers, Traditional Gamers, and XR Gamers. The findings suggest that immersive technologies (MR, VR, AR) may positively impact decision-making performance.

Specifically, XR Gamers achieved the highest average score in Resistance to Framing ($M = 0.8462$), indicating a greater capacity to disregard irrelevant contextual cues when making

decisions. This reflects stronger analytical processing and increased evaluative independence. Traditional Gamers ($M = 0.7286$) and Non-Gamers ($M = 0.6788$) demonstrated comparatively lower resistance, suggesting higher susceptibility to framing effects.

Similarly, in the Resistance to Sunk Cost scale, XR Gamers again scored the highest ($M = 0.8415$), reflecting a superior ability to avoid being influenced by previous investments when considering future options. This suggests enhanced economic rationality and cognitive flexibility. Traditional Gamers ($M = 0.6000$) and Non-Gamers ($M = 0.5786$) showed lower resilience to the sunk cost fallacy, a common decision-making bias.

In contrast to the other measures, XR Gamers recorded the lowest score in Recognizing Social Norms ($M = 0.3228$), which may indicate reduced sensitivity to socially shared behavioral expectations. Traditional Gamers ($M = 0.4243$) and Non-Gamers ($M = 0.4261$) performed at similar and higher levels, suggesting a stronger awareness or alignment with normative social cues. This finding could point to greater individualism or a tendency toward norm-transcending behavior among XR participants, potentially influenced by the more fluid or abstract social dynamics in virtual environments.

The overall A-DMC Total Score, representing a composite index of decision-making competence, was also highest among XR Gamers ($M = 0.6702$), followed by Traditional Gamers ($M = 0.5843$) and Non-Gamers ($M = 0.5612$). This reinforces the notion that immersive experiences can improve decision-making skills.

Finally, XR Gamers outperformed the other groups on the Cognitive Reflection Test (CRT) ($M = 2.5385$), demonstrating a greater tendency to inhibit intuitive but incorrect responses, favoring deliberate, reflective reasoning. Traditional Gamers ($M = 2.3600$) and Non-Gamers ($M = 2.0345$) followed in rank.

These results suggest that XR Gamers display a more advanced cognitive-decision profile, particularly in domains requiring analytical thinking, cognitive flexibility, and resistance to decision biases. However, their lower performance in recognizing social norms highlights an area that may require further investigation, especially within corporate training contexts, where social awareness and team dynamics play a key role.

5.1.4 Gender, Age, and Decision-Making Skills

To examine potential gender-based differences in cognitive reflection and decision-making abilities, an independent samples t-test was conducted comparing male and female participants on the CRT total score and the subscales of the A-DMC.

Although male participants scored higher than females on the CRT and across all A-DMC subscales, except for Recognizing Social Norms, where women slightly outperformed men, these differences did not reach statistical significance. Thus, the analysis does not provide sufficient evidence to conclude that gender plays a substantial role in this sample's cognitive reflection or decision-making competence. This result aligns with previous research suggesting that while minor gender differences may exist in specific cognitive domains, they are often not statistically meaningful in adult decision-making performance, particularly when other factors such as education or experience are not controlled. Furthermore, correlation analyses were performed to explore whether age is associated with better decision-making performance, between participants' age and scores on the CRT and A-DMC subscales. The study revealed no significant correlation between age, CRT performance, total A-DMC scores, or the Resistance to Framing subscale. A positive and significant correlation between age and Resistance to Sunk Costs was found, suggesting that older participants tend to demonstrate greater ability to disregard sunk cost fallacies. A negative and significant correlation between age and Recognizing Social Norms, indicating that younger participants may be more attuned to commonly accepted social behaviors or group norms. These findings suggest that age-related improvements in specific rational decision-making processes, such as resistance to sunk costs, may emerge with life experience. At the same time, social norm sensitivity might be more prevalent among younger individuals due to greater social connectivity, peer influence, or exposure to contemporary cultural norms. It must also be said that this result may be attributable solely to the sample primarily comprising younger participants. Since the 'social norm' is defined as the average response within the sample, if a large proportion of younger individuals provide one type of response while only a small number of older individuals offer a different one, it will appear as though the older participants are misaligned. However, this apparent misalignment simply results from how the data were collected.

As previously discussed, the data show that participants in the XR Gamers group exhibit the highest decision-making skills. At the same time, it is noteworthy that Group 3– XR Gamers (M=35.007 years old) has the highest average age among participants when compared to Group 2 (M= 28.84 years old) and Group 1(M=31.3103 years old) (Table 21). Although the average age still falls within the range of young to middle adulthood rather than older adulthood, these findings partially support the theory demonstrated by Reynaldo et al. (2021), as previously outlined in this thesis. Reynaldo et al. (2021) article reports that the benefits of immersive learning scenarios, which encourage employees to refine their decision-making skills, are not limited to young learners but, instead, XR-based decision-making games could be valuable across multiple generations within the corporate workforce.

Group	Age Mean
Non-Gamers	31.3103
Traditional Gamers	28.8400
XR-Gamers	35.8077

Table 21: Estimated Age per Group

Taken together, the analyses indicate that gender does not appear to affect decision-making competence or reflective thinking significantly in this context. However, age may influence specific dimensions of decision-making, particularly the ability to resist irrational investment behavior and the recognition of socially normative actions. These nuances should be considered when designing training interventions or cognitive enhancement programs in immersive environments, especially in age-diverse professional populations.

6 Conclusion

6.1 Answer to the Research Question

Are XR video games more effective than traditional video games in enhancing individuals' decision-making skills?

Based on the findings of this study, it can be concluded that XR video games are indeed more effective than traditional video games in enhancing individuals' decision-making skills. XR Gamers achieved the highest scores across all cores cognitive and decision-making performance measures, including the A-DMC subscales and the Cognitive Reflection Test (CRT). That means that, because XR gamers consistently outperformed the other groups, XR gaming demonstrably supports the development of decision-making competence.

More specifically, XR Gamers outperformed both Traditional and Non-Gamers on the Resistance to Framing and Resistance to Sunk Cost subscales, which means that they are better able to avoid systematic decision biases that typically impair rational judgment. This logical link exists because the A-DMC is explicitly designed to capture susceptibility to such biases, so higher scores directly reflect stronger decision-making skills. They also demonstrated the highest overall A-DMC composite score, which indicates that XR Gamers possess a broader and more integrated decision-making competence across multiple dimensions compared to the other groups.

Additionally, XR Gamers scored highest on the CRT, a measure of cognitive reflection and analytical reasoning. That means that XR Gamers were more capable of overriding intuitive but incorrect responses in favor of deliberate, reflective reasoning. Since the CRT specifically measures the tendency to engage System 2 processes (Frederick, 2005; Kahneman, 2011), this result can be logically interpreted as evidence that XR environments cultivate reflective thinking capacities. Such performance advantages may be attributed to XR environments' immersive, cognitively demanding, and feedback-rich nature, which challenges users to process complex information, manage multitasking, and make rapid decisions in simulated high-stakes scenarios.

However, it is noteworthy that XR Gamers scored lower on the Recognizing Social Norms subscale than Traditional and Non-Gamers. That means that XR Gamers, while strong in analytical and bias-resistant reasoning, may be less attuned to collective expectations and group conventions. This deduction follows logically because the social norms subscale directly

measures alignment between individual judgments and population-level norms, where lower scores indicate weaker social calibration. This finding may suggest that while XR environments foster cognitive independence and flexibility, they might also reduce sensitivity to social conventions, potentially due to altered or less explicit social dynamics in virtual spaces.

The results' interpretations indicate that XR video games hold superior potential for enhancing decision-making skills, particularly in contexts requiring rational evaluation, bias resistance, and reflective thinking. That means that, because XR Gamers achieved the strongest performance on these critical measures, XR games provide unique cognitive benefits that extend beyond those offered by traditional formats. While traditional video games also show positive associations with cognitive performance, XR technologies offer unique advantages, positioning them as promising tools in corporate training and mental development. These results can be explained by the fact that traditional games do not provide gamers with those immersive game characteristics, for instance, an increased sensation of presence, in which users experience the virtual environment both mentally and physically, which improves gamers' cognitive processing, motivation, and engagement (Olyelere et al., 2020). As stated in this dissertation, every choice and consequence faced in XR games enhances ownership of learning outcomes (Chuah, 2018).

These findings are particularly relevant to the scope of this research, which aims to explore how XR gaming can be leveraged to develop decision-making competencies in corporate contexts. The superior performance of XR gamers in decision-related tasks means that XR training simulations can be logically expected to provide employees with stronger judgment, reduced bias, and improved rationality under pressure. Resistance to framing and sunk cost fallacies is typically relevant in business decision-making (e.g., project continuation, strategic framing, budgeting under uncertainty). Because XR gamers showed greater resistance to these biases, it follows that XR-based training would directly strengthen managerial decision-making in such contexts. Training that embeds these decision skills in immersive, engaging environments could yield higher retention and transferability than traditional learning approaches. Thus, extended reality gaming emerges as a pedagogical innovation and a viable strategy for cultivating high-order cognitive and behavioral skills in complex organizational environments.

6.2 Limitations and Future Researches

This study presents several methodological and contextual limitations that must be considered when interpreting its findings.

First, 17 participants were already familiar with the CRT, which may have influenced their performance. While the results still provide helpful insights, prior exposure to the test raises the possibility that participants' scores may partly reflect memory or test-specific strategies rather than genuine cognitive reflection or decision-making ability. Furthermore, it is impossible to categorically exclude that the observed effects are attributable to other factors unrelated to the XR gaming experiences, such as, for example, the participants' specific job or educational path.

Second, the sampling procedure was non-randomized and potentially subject to self-selection bias. Participants who voluntarily joined the study may have had a pre-existing interest in XR technologies or video games, thereby limiting the generalizability of the results to the broader population. Moreover, the measurement was conducted at a single point in time, preventing the assessment of decision-making skill changes over the long term.

Third, although the study aimed to control for prior experience, it is possible that uncontrolled variables, such as earlier exposure to XR environments, familiarity with managerial simulations, or general gaming habits, may have influenced the results. This limitation is particularly relevant when considering that the study design did not differentiate between individuals who had never engaged with XR games and those with minimal or moderate prior exposure.

Furthermore, performance on the 'Recognizing Social Norms' subscale was assessed following the A-DMC scoring procedure, which evaluates the degree to which individual estimates correspond to established population norm frames. In this study, however, the norm frames were derived from the study participants' responses rather than from a broader population sample.

Future research, or conducting tests again with more participants, could address these limitations and further expand the understanding of XR-based learning and its impact on decision-making skills. In particular, several promising avenues can be identified. Future studies should adopt longitudinal designs to track participants' decision-making skills over extended periods. This would make it possible to assess whether improvements are retained

over time and whether different game genres or simulation types produce distinct learning curves. A particularly valuable approach would involve recruiting participants who have never played XR-based games and comparing their performance on the CRT-A and DMC tests before and after engaging with XR simulations. Ideally, this would include managerial or problem-solving scenarios and a follow-up assessment after a substantial interval, enabling the evaluation of lasting cognitive changes. This design would also make it possible to identify the specific types of games or simulations that yield the most significant improvements. Extending the research into real-world corporate contexts would allow testing XR paradigms with professionals engaged in decision-making under realistic constraints. This could also include applications to managerial roles, where the cognitive and strategic demands are comparable to those in the experimental scenarios. Complementing quantitative measures with qualitative tools, such as in-depth interviews, behavioral observation, and reflective self-reports, would offer a richer understanding of how XR experiences shape decision-making processes. These methods could uncover nuanced changes in reasoning strategies, motivation, and confidence that standard tests might overlook. By addressing these methodological considerations and broadening the scope of research settings, future investigations could provide more robust and generalizable evidence on the potential of XR-based learning to foster cognitive and managerial skills.

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