

Virtual Reality and the Financial Metaverse in Emerging Economies: Evidence from West Africa

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Abstract

This article examines the transformative potential of virtual reality (VR) in redefining customer experience within financial institutions in West Africa, while situating the findings in a broader international perspective. Using two analytical frameworks, the ATM (Minimal Technological Alignment) and CAPE (Capacity for Absorbing Emerging Potentials), the study evaluates the technological maturity of Senegalese institutions. Results show a CAPE score of 25%, revealing a structural gap between financial inclusion and digital readiness. While banking penetration provides a strong foundation, low levels of digitalization and AI adoption hinder immersive integration and delay the emergence of a sustainable financial metaverse. Comparative insights highlight that Asia, with advanced infrastructures and strong AI adoption, demonstrates how the financial metaverse can rapidly move from vision to reality. In contrast, Latin America mirrors West Africa, combining high levels of inclusion with insufficient technological maturity. These global lessons underscore that inclusion alone is not enough: robust digitalization, AI diffusion, and proactive regulation are essential to unlock immersive finance. This research contributes to the international debate on immersive finance and the metaverse, positioning emerging economies as key laboratories for inclusive and sustainable innovation.

Keywords: Virtual Reality; Financial Metaverse; Artificial Intelligence; Customer Experience; Digital Sovereignty.

JEL Classification: G20; O33; O16; L86; C8.

Introduction

The rapid pace of digital transformation has placed customer experience at the heart of financial innovation. Institutions are increasingly challenged to deliver services that are not only efficient but also immersive, personalized, and accessible. Within this context, virtual reality (VR) has emerged as a disruptive technology capable of redefining how clients interact with financial products and institutions. Yet, a paradox remains: while VR offers unprecedented opportunities to enrich customer journeys, its integration into financial institutions in West Africa is still limited. This raises a critical question: do these institutions possess the technological maturity required to embed VR into their service ecosystems? The central objective of this article is to assess the readiness of financial institutions to absorb immersive innovations such as VR, while considering the broader role of AI and digital ecosystems in shaping sustainable financial

services. We hypothesize that technological maturity (measured through indicators such as banking penetration, digitalization, and AI adoption) directly influences the ability of institutions to integrate VR into customer experience. To test this hypothesis, we employ two complementary models:

- ATM (Minimal Technological Alignment), adapted from Henderson & Venkatraman (1993), which evaluates whether institutions meet the minimum technological thresholds for VR adoption.
- CAPE (Capacity for Absorbing Emerging Potentials), inspired by Parasuraman (2000), which examines technological maturity across four dimensions: coverage, digital accessibility, technological predisposition, and sectoral extension.

Empirical evidence from Senegal (2023) reveals a CAPE score of 25%, indicating low technological maturity. While banking penetration exceeds the

required threshold, digitalization and AI adoption remain insufficient. These findings suggest that, despite promising foundations for financial inclusion, institutions are not yet prepared for widespread VR integration. This calls for a broader reflection on the conditions necessary for building a financial metaverse that is inclusive, secure, and aligned with principles of digital sovereignty.

1. Literature Review

Customer experience in financial services has undergone profound changes under the influence of immersive technologies. VR, in particular, is part of a larger wave of digitalization where personalization, accessibility, and interaction are strategic levers of differentiation (Pine & Gilmore, 1999; Parasuraman et al., 2000). Building on the seminal work of Bitner (1992) on service environments and Prahalad & Ramaswamy (2004) on value co-creation, recent studies emphasize the role of engagement in digital customer journeys. VR transcends traditional interfaces by offering rich, contextualized, and interactive experiences (Zhu et al., 2022; Zhang et al., 2023). Crego et al. (2023) show that VR enables financial institutions to simulate complex environments such as trading floors, virtual branches, or investment portfolios, thereby enhancing product understanding and decision-making. The ability to visualize and personalize financial products in 3D strengthens trust and deepens customer engagement (FeaSeo, 2023). Sabine (2025) highlights the growing adoption of VR in banking, supported by next-generation immersive headsets (Oculus, HTC Vive, Microsoft Mixed Reality). These innovations are increasingly combined with AI, which adapts virtual environments to user preferences and behaviors (Anastasia et al., 2024). VR also plays a crucial role in employee training, offering immersive simulations for crisis management, banking security, and customer advisory services (Zhang et al., 2023; Crego et al., 2023). Such applications foster active learning and skill development in risk-free environments. Nevertheless, challenges remain. Scholars (Zhu et al., 2022; Sabine, 2025; FeaSeo, 2023) point to infrastructure constraints, high implementation costs, employee training needs, and data protection concerns. The absence of specific

regulation for the financial metaverse, combined with risks of cyberattacks and manipulation, underscores the need for ethical and secure governance (Crego et al., 2023; Anastasia et al., 2024). Looking ahead, VR paves the way for a new generation of immersive financial services that integrate crypto-assets and collaborative ecosystems. By placing the user at the center of intelligent, inclusive, and evolving digital environments, VR contributes to the construction of a financial metaverse aligned with principles of sustainability and digital sovereignty (Zhang et al., 2023; Sabine, 2025).

2. Methodology

To rigorously and contextually assess the impact of virtual reality (VR) on customer experience in financial institutions, this study mobilizes two complementary analytical frameworks: the ATM model (Minimal Technological Alignment), inspired by Henderson & Venkatraman (1993), and the CAPE model (Capacity for Absorbing Emerging Potentials), derived from Parasuraman (2000) on technological maturity and innovation adoption.

These two models provide distinct yet convergent perspectives on the actual capacity of financial institutions to integrate VR as a lever for enhancing customer journeys. The ATM model is based on a binary threshold logic (aligned/not aligned), while the CAPE model offers a gradual reading of technological maturity across four structuring dimensions.

Both models rely on the same fundamental variables, drawn from recent operational data (UEMOA/Senegal - 2023):

- Banking penetration rate: 55% (source: OQSF);
- Digitalization rate: 27% of firms use digital tools;
- AI adoption rate: 3% of SMEs, 12% of large firms;
- AI penetration rate: 6% of firms have integrated AI solutions.

ATM Model: Minimal Technological Alignment

This model evaluates each variable against a minimum threshold required for effective VR integration into customer journeys.

Table 1. Assessment of Minimal Technological Alignment (ATM) for VR Integration in Senegalese Financial Institutions

Variable	Minimum Threshold	Observed Value	Alignment	Justification
Banking penetration	≥ 50%	55 %	■ Yes	Sufficient base of access to financial services
Variable	Minimum Threshold	Observed Value	Alignment	Justification
Digitalization	≥ 40%	27%	+ No	Low use of digital tools among SMEs
AI adoption	≥ 15%	12%	+ No	Adoption remains marginal, concentrated in large firms
AI penetration	≥ 10%	6%	+ No	Limited diffusion in banking services

Source: Author's calculations based on data from the BCEAO (2023), OQSF (2023); UEMOA Bulletin (2023); ANSD (2023).

The ATM model shows that only one out of four variables meets the required threshold. This suggests that while financial institutions benefit from a solid base of financial inclusion, they are not yet ready for widespread VR integration.

CAPE Model: Capacity for Absorbing Emerging Potentials This second model provides a more nuanced reading of technological maturity, evaluated across four dimensions:

Table 2. CAPE-Based Assessment of Technological Maturity in Senegalese Financial Institutions

Dimension	Definition	Indicator	Observed Value	Interpretation
C - Coverage	Access to financial services	Banking penetration	55%	Strong coverage, solid base
A - Digital Accessibility	Use of digital tools	Digitalization rate	27%	Barrier to immersive integration
P - Technological Predisposition	Adoption of intelligent technologies	AI adoption rate	12%	Limited predisposition
E - Sectoral Extension	Diffusion in financial services	AI penetration rate	6%	Early-stage extension, still embryonic

Source: Author's calculations based on data from the BCEAO (2023), OQSF (2023); UEMOA Bulletin (2023); ANSD (2023).

The CAPE model reveals an intermediate global score, with only one dimension above the 50% threshold. This indicates that significant reinforcement is needed before large-scale VR adoption can be considered.

CAPE Calculation (Senegal, 2023):

$$(C + A + P + E) / 4 = (55 + 27 + 12 + 6) / 4 = 25\%$$

This CAPE score of **25%** reflects low technological maturity, meaning that Senegalese financial institutions are not yet prepared for generalized VR integration into customer experience. Targeted efforts are required to strengthen digitalization, AI

adoption, and sectoral diffusion. The combined use of ATM and CAPE provides a dual reading: one normative (minimum alignment required) and the other evolutionary (relative technological maturity). This cross-approach offers decision-makers a robust framework for identifying priority levers: digitalization of processes, targeted AI adoption, and experimentation with immersive solutions in already digitized institutions.

3. Discussion

Applying the CAPE model to the Senegalese context highlights a global score of 25%, derived from four

key variables: banking penetration (55%), digitalization (27%), AI adoption (12%), and AI penetration (6%). This score, obtained through a simple average, reflects low technological maturity, well below the threshold required for smooth and generalized VR integration into financial customer journeys. The results reveal a structural dissociation between relatively advanced financial inclusion and the limited technological capacity of institutions to absorb immersive innovations. While banking penetration provides a solid foundation for extended digital services, weak levels of digitalization and AI adoption significantly hinder the operationalization of VR in financial services and delay the emergence of a financial metaverse. This situation calls for a strategic reflection on the levers needed to bridge the technological gap. It underscores the urgency of strengthening digital infrastructures, stimulating innovation among financial SMEs, and accelerating the diffusion of intelligent technologies across the sector. In this perspective, the metaverse is not simply a futuristic concept but a systemic horizon where immersive finance, AI, and digital sovereignty converge.

Based on the CAPE score and ATM results, several recommendations emerge:

- Strengthen digitalization of processes in financial institutions, particularly SMEs,

through fiscal incentives, targeted subsidies, and technological partnerships.

- Accelerate AI adoption via awareness programs, certified training, and progressive integration into high-value services.
- Deploy VR pilot projects in already digitized banks to test customer experience impacts and adjust solutions before scaling.
- Use ATM and CAPE models as diagnostic tools in digital audits to guide investment decisions and prioritize transformation axes.
- Promote proactive regulation of the financial metaverse, in collaboration with supervisory authorities, to frame immersive technologies and ensure data protection.

Looking beyond West Africa, the story of immersive finance unfolds differently across regions. In Asia, the pace is striking: Chinese banks experiment with VR-based customer journeys, while South Korean institutions combine artificial intelligence with immersive environments to deliver highly personalized services. India, with its booming fintech sector, is also testing virtual branches that allow clients to simulate credit scenarios in real time. These examples show that when digital infrastructures and regulation are strong, the financial metaverse can move from vision to reality at remarkable speed.

Table 3. Comparative overview of VR adoption in financial services across West Africa, Asia, and Latin America.

Region	Financial Inclusion (Banking Penetration)	Digitalization (Use of Digital Tools)	AI Adoption	VR Experimentation	Main Challenges
West Africa (Senegal)	55% (OQSF, 2023)	27% of firms	12% large firms, 3% SMEs	limited pilot projects	Low technological maturity, weak infrastructure
Asia (China, India, South Korea)	% (China, India)	>70% of financial institutions digitalized	40%+ integration in banking (South Korea)	VR for virtual branches, trading floors, personalized services	Rapid regulatory adaptation, high implementation costs
Latin America (Brazil, Mexico, Chile)	70-80% (Brazil, Mexico)	Uneven digitalization (strong in large banks, weak in SMEs)	Partial adoption, concentrated in fintechs	VR for financial education and credit simulation	Fragile infrastructure, slow regulation

Source: OQSF (2023); UEMOA Bulletin (2023); ANSD (2023); Zhang et al. (2023); Sabine (2025); Crego et al. (2023); FeaSeo (2023)

Latin America tells another story. Brazil and Mexico have achieved impressive levels of financial inclusion, yet the digital divide remains visible. Fintechs in Mexico and Chile are piloting VR for credit education and customer engagement, but uneven infrastructure and regulatory delays slow down adoption. In many ways, Latin America mirrors West Africa: strong foundations in inclusion, but technological maturity still catching up. Placed side by side, these regions highlight a global lesson: inclusion alone is not enough. Without robust digitalization and AI integration, the metaverse remains aspirational. Asia demonstrates what is possible, while Latin America and West Africa remind us of the urgent need to bridge the gap. Emerging economies, despite their constraints, are becoming laboratories of innovation, testing how immersive finance can be inclusive, sustainable, and aligned with digital sovereignty within the evolving financial metaverse.

Conclusion

This article set out to evaluate, within the Senegalese context, the capacity of financial institutions to integrate virtual reality (VR) as a lever for enhancing customer experience and as a foundation for the financial metaverse. By hypothesizing that technological maturity (measured through levels of banking penetration, digitalization, AI adoption, and AI diffusion) directly conditions the ability to absorb immersive innovation, we employed a dual methodological approach based on the ATM and CAPE models. The results reveal a clear dissociation between financial inclusion, which is relatively advanced (banking penetration at 55%), and other technological dimensions that remain underdeveloped (digitalization at 27%, AI adoption at 12%, AI penetration at 6%). The CAPE score of 25% confirms low technological maturity, suggesting that Senegalese financial institutions do not yet meet the minimum conditions for generalized VR integration into customer journeys and, by extension, for the emergence of a sustainable financial metaverse. This finding calls for a strategic reconfiguration of priorities. VR should not be viewed merely as a disruptive technology, but rather as part of a systemic transformation requiring supportive conditions for adoption. Strengthening

digital infrastructures, supporting SMEs in their digital transition, and promoting proactive regulation of the financial metaverse are essential steps to ensure inclusive and secure innovation. The comparative perspective reinforces this conclusion. Asia demonstrates that when digitalization and AI adoption are strong, the financial metaverse can move rapidly from vision to reality. Latin America, by contrast, mirrors West Africa in showing that financial inclusion alone is insufficient without technological maturity. These global lessons highlight that emerging economies, despite their constraints, are becoming laboratories of innovation—testing how immersive finance can be inclusive, sustainable, and aligned with digital sovereignty. In this perspective, the ATM and CAPE models serve not only as diagnostic tools for Senegal but also as frameworks for international comparison, guiding investments and policy choices. Ultimately, the financial metaverse represents a horizon of transformation where VR, AI, and digital infrastructures converge to redefine customer experience and build pathways toward inclusive innovation in developing economies.

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