


Chapter 7

AI in Sports Analytics: Enhancing Performance, Fan Engagement, and Immersive Experience in the Metaverse and Digital Twin Era

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ABSTRACT

The integration of Artificial Intelligence (AI) into sports analytics has transformed how performance, strategy, and fan engagement are managed in modern sports. This chapter highlights the synergy of AI, Digital Twin, and Metaverse technologies in creating a smart and immersive sports ecosystem. AI facilitates real-time tracking, injury prediction, personalized training, and tactical analysis using machine learning and computer vision. Digital Twins simulate athletes and game scenarios for optimization and decision-making. The Metaverse enhances fan interaction through virtual stadiums, avatars, and personalized content. Smart wearables and

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edge computing further boost data quality and immediacy. Case studies such as FIFA's AI-assisted VAR and immersive metaverse experiences illustrate real-world applications. The chapter also addresses challenges in data privacy, algorithmic bias, and equitable technology access. It proposes a comprehensive framework and future directions to guide the ethical and strategic adoption of AI and immersive technologies in sports.

1. INTRODUCTION

Sports analytics has advanced significantly over the past decade, evolving from basic manual statistics such as goals, assists, and shooting percentages used primarily for post-match evaluations into a sophisticated data-driven discipline. Early analytical methods were largely descriptive and provided limited insight for strategic decision-making. However, around 2020, the field experienced a major transformation as teams, organizations, and analysts began adopting big data analytics and predictive modeling. This shift integrated business intelligence and information technology principles into sports management, allowing stakeholders to forecast performance trends, optimize player strategies, and enhance overall competitive outcomes. Then, a systematic review by (Bhatnagar & Babbar, 2022) although some of the originals date back to 2019, they have become an important foundation for research that has evolved into 2022. They describe the transition from simple statistics to the use of AI and prescriptive systems in professional sports. Unfortunately

Not only that, (Hayduk, 2020) Introducing the future of sports data analytics highlighting trends in real-time data tracking, the use of wearable sensors, and the application of artificial intelligence for more efficient decision-making. In line with recent developments, articles published in the lead-up to 2023–2024 underline the importance of integrating AI technologies and big data visualization in sports analytics, with convolutional neural network models capable of achieving high accuracy in sports video classification and tactical analysis (A. Liu et al., 2023). Ultimately, the evolution of sports analytics has gone beyond just historical statistical reports. Modern systems use machine learning, computer vision, and AI-based event detection to predict athletes' performance, detect injury risks, and automatically analyze game tactics. The latest breakthroughs in the field of action spotting and video event detection using deep learning and transformers expand analytics capabilities in various sports from 2022–2025 (Xu et al., 2025).

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