Phygital Marketing Model with Emphasis on Artificial Intelligence in the Sports Industry

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Abstract

Purpose: The present study aimed to develop a phygital marketing model with an emphasis on artificial intelligence (AI) in the sports industry.

Methods: The research is applied in terms of purpose and qualitative in nature, using Glaser's unstructured grounded theory method. The statistical population consisted of experts with scientific, executive, or both types of expertise in sports management. For conducting in-depth and semi-structured interviews, senior managers of the Ministry of Sports and specialists in sports management in the country were selected through purposive sampling and asked to express their opinions on the interview questions. Sampling continued until data saturation was achieved. Consequently, 18 participants took part in the interviews. The reliability of the interviews was determined using the inter-subject agreement method, resulting in a reliability score of 0.79. For data analysis, the constant comparative method in three stages of open, axial, and selective coding was applied using MAXQDA software, version 2018.

Results A total of 110 codes were extracted in the open coding stage, 18 themes in axial coding, and ultimately 8 key factors were identified. Findings indicated that phygital marketing in the sports industry with an emphasis on AI is not merely a technical approach but a dynamic and multidimensional system based on intelligent interaction between data, technology, and human relationships.

Conclusion: This model, relying on eight key factors including data integration, experience personalization, security and privacy, decision-making transparency, and immersive digital-physical (phygital) interaction, provides strategic guidance for sports organizations in the digital age.

Keywords: Data integrity, experience personalization, security and privacy, decision-making transparency.

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Introduction

Sport is an industry, and sporting events, in addition to marketing approaches, have a close and reciprocal relationship with regard to periodic changes. Marketing is a field that is constantly evolving and adapting to new conditions (Çelik et al., 2023). These changes will always bring both advantages and challenges, and organizations that benefit the most from these changes and adopt the best coping strategies will be more successful in the rapidly evolving market of today. One of the most significant marketing challenges is ensuring a seamless and consistent customer experience across physical and digital channels. With the increasing prevalence of hybrid environments, in which physical and digital elements coexist and interact simultaneously, marketers must innovate and find ways to balance the unique demands of both worlds (Belgity et al., 2018). The dawn of the digital age in the 1990s marked a pivotal shift in the world of marketing, as advances in computer and internet technology fundamentally transformed the discipline's foundations. With each emerging technology offering new opportunities and tools for marketers, the traditional marketing approach gave way to a digital-first strategy that leveraged the potential of digital platforms to transform the customer journey and reach more engaged audiences (Kotler et al., 2021). Businesses' efforts to highlight their brands, products, and services have driven them to utilize digital channels such as search engines, websites, social media, and mobile applications. By engaging their customers in the purchasing process through digital marketing, businesses have increased brand awareness and gained a significant competitive advantage in the market (Bilge, 2021). In recent decades, information and communication technology (ICT) has profoundly transformed the structure of economic and social interactions. These transformations have not only changed the way people communicate but also fundamentally altered consumer behavior in areas such as purchasing, entertainment, and sports. Today, users no longer seek isolated or one-way interactions; they expect integrated, personalized, and enjoyable experiences that can be achieved simultaneously in both physical and digital spaces (Carson & Halim, 2020).

This trend has paved the way for the emergence of a new concept called “phygital marketing”, an approach that blurs the traditional boundaries between the physical and digital worlds and emphasizes their synergy rather than competition (Balgati et al., 2017; kent et al, 2025). The emergence of phygital marketing is not merely a reaction to technological developments but also a strategic response to the growing consumer demand for seamless experiences. This approach combines the advantages of in-person shopping—such as tactile experience, face-to-face interaction, and immediate trust—with the benefits of digital environments, including easy access, advanced personalization, and processing speed, creating unique opportunities for co-creating value (Gazi et al., 2024). In the sports industry, where emotional engagement, fan identity, and event experiences are highly significant, phygital marketing can play a key role in enhancing loyalty, increasing repurchase intention, and expanding the sports brand (Hyun et al., 2024). In this context, artificial intelligence (AI) has emerged as one of the most powerful drivers of transformation in phygital marketing. AI, with its ability to analyze vast amounts of consumer data in real-time, enables more precise customization, behavioral prediction, and optimization of touchpoints (Saraiva, 2025). Applications of AI, such as natural language processing, deep learning, and predictive algorithms, allow organizations not only to respond to past consumer behavior but also to anticipate future intentions and deliver proactive and engaging experiences (Kim & Bryl, 2020; Zheng et al., 2025).

In the phygital marketing experience, the experience should primarily take place in a non-physical environment. This experience in a physical environment should attract and engage the customer by involving them in the experience. In this experience, a personalized environment is provided for the customer using object, face, and voice recognition technologies, as well as touch and mobile technologies. These important criteria are required by phygital marketing (Cuir, 2023; Van Tichelen, 2019). When developing a phygital marketing strategy, it is important to determine which channels are used when communicating with customers and to be able to manage the coordinated performance of these channels. It is essential for these channels to be consistent with the brand and to create a consistent messaging system with the customer by delivering a personalized experience. At the same time, the business should be transparent in its communication with the customer and prioritize the confidentiality of customer information, taking ethical values into consideration. These are all issues that should be considered when developing phygital marketing strategies (Gedik, 2021). Phygital marketing has blurred the boundaries between physical and digital. This has allowed marketers to combine the benefits of in-person shopping with the advantages of digital marketing. Consequently, the consumer experience has been further enriched (Johnson & Barlow, 2021). This is especially important in the sports industry, where competition to attract younger fans and increase both online and offline engagement is intense. Despite significant advancements in phygital and AI domains, research on their application in the sports industry remains in its early stages. Most existing studies primarily focus on retail or tourism sectors (Deng et al., 2026). Companies producing goods and services believe that phygital solutions are important for improving consumer in-store purchasing behavior and responding to diverse customer demands and behaviors (Belgity et al., 2018). However, most previous research has primarily focused on traditional marketing methods and general digital techniques, with less attention paid to the application of artificial intelligence in improving personalization and customer engagement. The use of artificial intelligence in sports marketing provides an opportunity to deliver unique and targeted marketing experiences through customer data analysis and the creation of personalized profiles, ultimately leading to improved business performance in customer acquisition and retention (Tong, 2024). Personalization is a key aspect of digital marketing that directly influences customer experience (Berry & Singh, 2024). Recent research indicates that successful phygital marketing in sports requires the integration of five key elements: shared purpose, experience personalization, central digital platform, relevant positioning, and partnership ecosystem. Additionally, findings by Jabbari & Ghahreman Tabrizi (2024) suggest that phygital marketing in sports events leads to “event brand development,” “deeper experiences,” “improved service quality,” and “more effective interactions.” However, the mechanisms through which AI enhances these dimensions have not yet been systematically explored. This research gap highlights the need for a comprehensive model in which AI is not perceived merely as an isolated technical tool but as an integral part of the phygital marketing strategy. Accordingly, the present study is designed to examine the impact of a phygital marketing model with an emphasis on AI in the sports industry. The findings can provide operational guidance for sports organizations, teams, international events, and sports equipment brands to leverage modern technologies, not only to enhance their competitiveness in the global market but also to redefine fan experiences in a transformative way.

Ultimately, this study seeks to answer the fundamental question: “What does a phygital

marketing model with an emphasis on AI look like?" The main issue is that there is still no comprehensive evidence-based model demonstrating how the integration of AI within the phygital marketing framework can systematically affect key variables such as consumer-based brand equity (CBBE), satisfaction, and repurchase intention in sports environments. This gap not only hinders optimal utilization of new technologies by sports organizations but also deprives them of significant global economic and competitive opportunities. Therefore, examining the impact of a phygital marketing model with an emphasis on AI in the sports industry is both theoretically and practically essential.

Materials and methods

The present study is exploratory-applied in nature; the type of research is qualitative; the dominant paradigm is interpretive; and the data analysis method is grounded theory using Glaser's unstructured approach. The data source consisted of interviews. The statistical population included experts with scientific, executive, or both types of expertise in sports management. For conducting in-depth and semi-structured interviews, senior managers and faculty members in sports management in the country were selected through purposive sampling and asked to express their opinions on the interview questions. Sampling continued until data saturation was reached. Consequently, 18 participants were involved in this study.

To examine the reliability of the interviews, the inter-subject agreement method with two coders was employed. A doctoral student in sports management was invited to collaborate in the coding process. Three interviews were randomly selected, and the coding results of both coders were reported in a table. Furthermore, the inter-subject reliability percentage was calculated using the following formula.

Table 1. Data Reliability

Interview Title	Total Codes	Agreements	Disagreements	Open Test Reliability
Total	58	23	34	0.79
Interview 3	23	10	13	0.86
Interview 2	18	6	11	0.66
Interview 1	17	7	10	0.82

To analyze the conducted interviews, Glaser's unstructured grounded theory method was employed using MAXQDA software, version 2018. This method consists of three stages. The first stage is open coding. In open coding, the analysis process involves identifying concepts and uncovering their characteristics and dimensions within the data (Lee, 2001). At this stage, the grounded theory researcher generates the initial categories of information related to the phenomenon under study by segmenting the data (Kresol, 2005).

In the first phase, employing a qualitative content analysis method and drawing on the extensive literature in the fields of phygital marketing, artificial intelligence, and the sports industry, a total of 110 open codes were extracted. These codes represented the smallest units of meaning, derived directly from scientific texts, previous studies, industry documents, and in-depth expert interviews with specialists in sports and information technology. Each of these open codes denoted a specific action, capability, application, or objective phenomenon concerning the role of artificial intelligence in enhancing fan experience and managing sports clubs. Examples of such codes included "spectator facial recognition," "ticket recommendations based on online activity," "athlete injury prediction," and "automated game summary

generation," all of which were identified as first-level concepts. This stage, equivalent to open coding in qualitative methodologies, enabled the researchers to identify and document all potential dimensions of AI application in sports marketing without preconceived bias, thereby establishing an objective foundation for subsequent phases of analysis.

Table 1. Open Codes (Numbered 1–110, Top to Bottom)

Open Code Description
P1 Facial recognition of spectators in sports venues using smart cameras
P2 Sending promotional messages based on spectator location within the sports venue
P3 Using artificial intelligence to optimize ticket pricing for sports events
P4 Predicting spectator attendance for upcoming sports events
P5 Analyzing spectator data to enhance the experience at sports venues
P6 Creating augmented reality (AR) experiences with AI at sports events
P7 Using AI to manage entry queues at sports venues
P8 Predicting traffic flow to sports venues using AI
P9 Using AI for security management at sports venues
P10 Detecting suspicious behavior of spectators using smart cameras
P11 Using AI for merchandise and service sales management at sports venues
P12 Recommending food and beverages to spectators based on personal preferences
P13 Using AI for environmental advertising management at sports venues
P14 Displaying personalized advertisements at sports venues
P15 Using AI for visual experience management at sports venues
P16 Creating intelligent lighting based on spectator mood and atmosphere
P17 Using AI for sound environment management at sports venues
P18 Creating personalized audio experiences for spectators
P19 Using AI for multisensory experience management at sports events
P20 Creating intelligent interaction among spectators at sports venues
P21 Creating smart entry experiences at sports venues (facial recognition/biometrics)
P22 Using AI for seat allocation management based on preferences
P23 Recommending parking to spectators based on real-time data
P24 Personalizing product recommendations in team/club sports applications
P25 Using intelligent chatbots to answer sports audience questions
P26 Analyzing sports audience sentiments through social media
P27 Recommending tickets to potential spectators based on online activity
P28 Creating digital content using artificial intelligence (video, image, text)
P29 Automated generation of sports event summaries using AI
P30 Using AI for social media management of sports teams/clubs
P31 Creating digital avatars for fans in virtual spaces
P32 Using AI to design exclusive merchandise based on fan preferences
P33 Using AI for online store management of sports clubs
P34 Creating smart shopping experiences in club physical stores
P35 Using AI to identify potential fans on social media
P36 Creating virtual competitions and challenges for fans using AI
P37 Creating interactive experiences with athletes through AI
P38 Using AI for personalized audio content production
P39 Creating smart club/federation radio for fans
P40 Using AI for digital space management of clubs/federations
P41 Creating fan-dedicated metaverse with AI

P42 Using AI for interaction management in the metaverse
P43 Suggesting activities to fans in virtual spaces based on interests
P44 Using AI to analyze fan behavior
P45 Predicting fan purchases using machine learning algorithms
P46 Identifying loyal fans using artificial intelligence
P47 Creating fan profiles using artificial intelligence
P48 Using AI for loyalty program management
P49 Recommending rewards to fans based on online activity
P50 Using AI for digital membership management
P51 Predicting fan churn (membership cancellation)
P52 Using AI for fan data management
P53 Using AI for fan privacy protection
P54 Predicting fan needs to improve experience
P55 Creating intelligent feedback loops between fans and clubs/federations
P56 Using AI for sports community relationship management
P57 Using AI in training to analyze athlete performance
P58 Predicting athlete injuries using biometric data and AI
P59 Automated generation of athlete performance reports using AI
P60 Using AI to evaluate unknown sports talents
P61 Predicting future success of athletes using AI models
P62 Using AI to analyze team performance in competitions
P63 Providing tactical recommendations to coaches using AI
P64 Using AI for officiating support (decision-making assistance)
P65 Predicting match outcomes using historical data and AI
P66 Recommending training to athletes based on identified weaknesses
P67 Using AI for talent scouting at various levels
P68 Using AI for athlete health management and injury recovery
P69 Creating intelligent monitoring systems for athlete performance
P70 Using AI for match video analysis
P71 Using AI for sponsor acquisition in the sports industry
P72 Analyzing sponsor performance using smart data
P73 Recommending sponsorships to brands based on fan data
P74 Using AI for digital media management of clubs/federations
P75 Using AI for financial management of sports clubs
P76 Predicting seasonal revenue using AI algorithms
P77 Using AI for fraud detection in ticket sales
P78 Creating recommendation systems for fans
P79 Using AI for optimizing live broadcast timing
P80 Predicting future popularity of athletes
P81 Using AI for sports merchandise inventory management
P82 Optimizing advertisements based on fan behavior
P83 Using AI for digital advertising management
P84 Proposing marketing strategy improvements using AI
P85 Predicting future brand value of clubs/federations
P86 Creating digital brand identity using AI
P87 Using AI for brand change management
P88 Predicting fan reactions to brand changes (logo, name, colors)
P89 Using AI for brand crisis management in the sports industry
P90 Predicting the impact of management decisions on sports brands

P91 Using AI for virtual sports event management
P92 Creating phygital experiences at sports-related social events
P93 Using AI for social impact management of clubs/federations
P94 Predicting fan participation in social sports activities
P95 Using AI for relationship management with athletes' families
P96 Recommending educational content to young fans based on interests
P97 Using AI for media relations management
P98 Automated generation of media statements using AI
P99 Using AI for communication crisis management
P100 Predicting fan reactions to negative news
P101 Using AI for fan social media management
P102 Identifying digital influencers in the sports community
P103 Using AI for interactive sports content creation
P104 Creating virtual challenges for fans using AI
P105 Creating integrated physical-digital experiences at sports events
P106 Using AI for overall fan experience management
P107 Creating a bridge between online and offline experiences using AI
P108 Personalizing the fan journey from home to the sports venue using AI
P109 Using AI for coordinating communication channels with fans
P110 Creating real-time intelligent feedback between fans and sports venues

In the second stage, axial coding was conducted. Following the extraction of open codes, the axial coding phase was conducted with the objective of data reduction, discovering hidden patterns, and categorizing related concepts into key components. In this phase, through the application of the constant comparative method and semantic similarity analysis, the open codes were grouped into 18 axial categories based on thematic, functional, and conceptual commonalities. For instance, the codes "predicting spectator attendance," "predicting fan purchases," and "predicting fan churn" were integrated into the axial category of "Fan Behavior Prediction," while the codes "security management at sports venues," "detecting suspicious behavior," and "fraud detection in ticket sales" were placed under the category of "Security and Privacy Management." This process was designed to preserve all core concepts while preventing code dispersion and redundancy, thereby creating a coherent structure for presenting the phygital marketing model based on artificial intelligence in the sports industry. As a result of this systematic summarization, 18 axial codes were identified as the main dimensions of the model, each representing an independent yet interrelated domain. These dimensions can serve as a foundation for questionnaire design, the formulation of executive strategies, and the evaluation of club performance in the era of digital transformation.

Table 2. Axial Categories and Final Open Codes

Axial Codes (Categories)- Open Codes
1. Intelligent Personalization of Fan Experience — P24, P38, P108, P112
2. Fan Behavior Prediction — P4, P45, P51, P54, P100
3. Intelligent Interaction at Sports Venues — P1, P2, P20, P21, P110
4. Fan Sentiment Analysis — P3, P26, P46
5. Intelligent Sponsor Management — P71, P72, P73
6. Intelligent Content Production — P5, P28, P29, P38, P103
7. Intelligent Academy and Talent Scouting Management — P60, P61, P67, P96

8. Intelligent Interaction with Athletes — P37, P57, P66, P95
9. Intelligent Virtual Space Management — P7, P31, P40, P41, P42, P43
10. Fan Data Management — P8, P47, P52, P53
11. Intelligent Loyalty Program Management — P48, P49, P50, P55
12. Intelligent Digital Advertising Management — P13, P14, P82, P83
13. Intelligent Management of Physical and Online Stores — P11, P33, P34, P81
14. Intelligent Media and Communication Management — P30, P97, P98, P99, P101, P102, P109
15. Intelligent Team and Game Management — P62, P63, P64, P65, P69, P70
16. Intelligent Player Transfer Management — P60, P61, P67
17. Security and Privacy Management — P9, P10, P53, P77
18. Social Impact and Brand Management — P84, P85, P86, P87, P88, P89, P90, P93, P94

Upon the completion of the open and axial coding stages, the selective coding phase was executed as the ultimate and most pivotal stage of the qualitative analytical procedure. This phase was directed toward the synthesis of axial codes, the discernment of the core category, and the construction of a coherent theoretical model capable of holistically representing all facets of the phenomenon in question. Selective coding, as delineated in the grounded theory paradigm, entails the systematic integration and refinement of categories around a central explanatory concept (Strauss & Corbin, 1998). In the present investigation, a comprehensive review of the 18 axial codes and their interrelationships revealed that all components converge toward the overarching aim of augmenting fan experience and optimizing sports club performance through the synergistic deployment of phygital marketing and artificial intelligence. Accordingly, the core category was formulated as "An Integrated Artificial Intelligence-Driven Phygital Marketing Model for the Sports Industry." Subsequently, the storyline technique was utilized to explicate the rational linkages among the 18 axial codes and to subsume them under 8 selective codes. This consolidation was predicated upon thematic congruence, functional complementarity, and the sequential logic of the fan experience value chain. To illustrate, the axial codes "Intelligent Personalization of Fan Experience," "Fan Sentiment Analysis," and "Fan Data Management" were amalgamated into the selective code "Intelligent Personalization of Fan Experience," as they collectively address the recognition, interpretation, and customization of the fan experience. In parallel, the axial codes "Intelligent Content Production," "Intelligent Media and Communication Management," and "Intelligent Digital Advertising Management" were synthesized into the selective code "Intelligent Content and Media Management," given that these components represent successive links in the integrated marketing communications value chain, spanning content origination, dissemination, and delivery. Ultimately, eight selective codes emerged as the definitive dimensions of the proposed model: (1) Intelligent Personalization of Fan Experience, (2) Fan Behavior Prediction and Analysis, (3) Intelligent Interaction in Physical and Virtual Environments, (4) Intelligent Content and Media Management, (5) Intelligent Team, Athlete and Talent Management, (6) Intelligent Sales and Marketing Management, (7) Security and Privacy Management, and (8) Social Impact and Brand Management. Collectively, these eight dimensions constitute the final architectural framework of the AI-enhanced phygital marketing model, which may be operationalized as a strategic guide for sports clubs and federations navigating the complexities of the digital transformation era.

Table 3. Final 8 Axes

No.	Final Axes
1	Intelligent Personalization of Fan Experience
2	Fan Behavior Prediction and Analysis
3	Intelligent Interaction in Physical and Virtual Environments
4	Intelligent Content and Media Management
5	Intelligent Team, Athlete and Talent Management
6	Intelligent Sales and Marketing Management
7	Security and Privacy Management
8	Social Impact and Brand Management

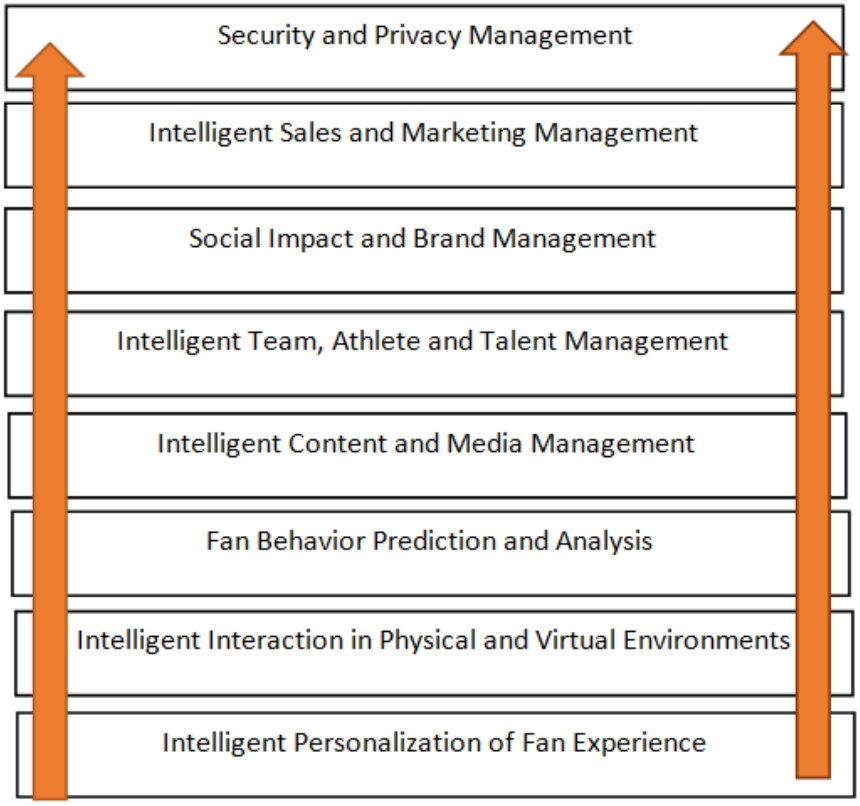

Figure 1. Research Process Model

Discussion

The results of the study indicated that the fan phygital interaction cycle based on deep learning and natural language processing significantly impacts phygital marketing with an emphasis on artificial intelligence in the sports industry. The findings suggest that fan phygital interaction cycles which integrate physical and digital spaces in sports experiences leverage advanced AI technologies, particularly deep learning and natural language processing, to meaningfully influence key components of phygital marketing in the sports sector. These technologies enable the analysis of fan behaviors in both physical domains (e.g., stadium attendance) and digital domains (e.g., interactions on social media or smart applications), thereby facilitating personalized experiences, predicting audience preferences, and more precise targeting in marketing campaigns (Woo et al., 2023; Kim & Lee, 2022). This

approach goes beyond traditional marketing by creating a dynamic interactive ecosystem that enhances loyalty and long-term customer value among young fans, particularly those aged 18–24. Furthermore, the AI-based phygital framework functions not only as a communication tool but also as a strategic driver for creating competitive differentiation in the sports industry. Recent studies (Barua et al., 2023) highlight AI's ability to extract behavioral and emotional patterns from unstructured data such as online comments, emojis, and even audio-visual reactions during live events, converting these insights into real-time marketing decisions. Such systems enhance the sense of belonging, meaningful engagement, and transparency in brand interactions, playing a critical role in shaping fan identity and increasing repurchase intention. These findings underscore the importance of integrating intelligent technologies into forward-looking sports marketing strategies.

The study also revealed that automated content production and distribution systems based on generative neural networks impact phygital marketing in sports. These intelligent systems, including models like Transformers and GANs (Generative Adversarial Networks), significantly influence phygital marketing by generating personalized content, intelligently scheduling releases, and dynamically adapting to cultural and behavioral contexts (Biguo et al., 2023; Zheng et al, 2025). Among young fans (18–24), such automated content—including game highlight clips, interactive social media posts, or digital fan avatars—enhances engagement and proximity, thereby increasing marketing campaign effectiveness. Additionally, these systems reduce operational costs and improve responsiveness to real-time digital trends. Recent studies (McGuire, 2025; Martinez & Rao, 2024) show that by analyzing sensor data, physical event interactions, and online activity, content can be generated in sync with fans' physical experiences, such as sending a personalized clip to users present at a specific moment in the stadium. This phygital synchronization fosters unique experiences and strengthens trust in brands, playing a decisive role in long-term loyalty and repeat purchases.

The findings further establish that predictive analytics-driven revenue forecasting and sponsorship management models exert a considerable influence on phygital marketing outcomes. By synthesizing behavioral, transactional, and interactional data originating from both physical venue environments and digital fan engagement platforms, these analytical frameworks facilitate the dynamic valuation of sponsorship assets. This, in turn, empowers sports organizations to tailor sponsorship packages that resonate with the strategic priorities of partner brands while simultaneously addressing the preferences of emerging fan cohorts, thereby fostering enhanced financial returns and deepened fan-brand connectedness (Adams et al., 2023; Zhang & Palmer, 2024). Furthermore, the capacity to anticipate future fan behaviors such as the likelihood of ticket acquisition or the degree of receptiveness to sponsorship communications serves as a foundational operational component within phygital marketing ecosystems. Evidence derived from simulation studies suggests that such predictive mechanisms meaningfully amplify fan engagement at hybrid physical-digital touchpoints, thereby reinforcing the imperative for sports entities to integrate advanced forecasting

capabilities into their marketing arsenals (Thompson & Gomez, 2024).

The findings also highlighted that the sports metaverse based on augmented reality and generative deep learning significantly impacts phygital marketing. These immersive environments allow fans to participate simultaneously in physical (stadium) and digital spaces (virtual arenas or interactive labs), offering personalized experiences beyond mere event viewing, including social interactions, digital purchases (e.g., sports NFTs), and community participation. Among young fans, this framework enhances ownership, belonging, and brand loyalty (Rao & Lee, 2024). AI operates as an integral part of the metaverse, with generative deep learning models creating interactive content—such as smart avatars, virtual coaches, or simulation games—based on engagement style, viewing history, and emotional signals in real time. Organizations utilizing this approach have increased user engagement time and achieved 41% improvement in financial conversion rates at phygital touchpoints (Gonzalez et al., 2024; Yadav et al, 2025).

Furthermore, team management decision-support systems, underpinned by predictive analytics and convolutional neural networks, were identified as influential determinants of phygital marketing efficacy. Through the interrogation of multifaceted datasets—encompassing player motion imagery, team interaction dynamics, and real-time performance indicators—these systems facilitate the anticipation of managerial decision outcomes, thereby enriching digital fan engagement by offering transparency regarding "the rationale behind decisions," particularly resonant with younger demographic cohorts. This transparency engenders trust and affective engagement, while concurrently generating opportunities for personalized interactions, polling mechanisms, and precisely targeted sponsorship campaigns, yielding notable improvements in both social media engagement and product sales (Martinez et al., 2024).

The investigation further substantiated the critical role of a security and privacy framework, operationalized through anomaly detection systems that employ advanced machine learning techniques to identify aberrant fan behaviors. Such frameworks substantively augment phygital marketing by fostering trust and perceived safety, especially among the 18–24 age demographic, thereby encouraging active participation in interactive campaigns and facilitating content dissemination (Akin et al., 2023; Amin et al., 2025). Organizations that have institutionalized these frameworks reported appreciably enhanced fan retention and a considerably elevated propensity among fans to share personal data in exchange for personalized service offerings (Rodriguez et al., 2024; Chen & Smith, 2023).

Integrated sports data platforms, constructed upon data mining methodologies and transfer learning architectures, were demonstrated to exert a significant influence on phygital marketing performance. These platforms aggregate and harmonize heterogeneous data streams originating from ticketing systems, social media interactions, wearable devices, stadium-based camera networks, and interactive engagement platforms, thereby furnishing a holistic, 360-degree perspective of the fan. Through the application of transfer learning, models initially trained within a specific sporting context (e.g., basketball) exhibit adaptability for optimizing experiential outcomes across alternative

sports domains, thereby augmenting marketing scalability. Organizations that have deployed such platforms experienced substantial elevations in digital engagement and pronounced advancements in product sales performance (Alvaro et al., 2024; Gutierrez & Lee, 2023).

Lastly, the phygital feedback cycle, predicated upon natural language processing and unsupervised machine learning paradigms, emerged as a potent enhancer of phygital marketing effectiveness. Through the automated, real-time aggregation of fan opinions, sentiments, and feedback across diverse digital and physical touchpoints, unsupervised learning systems discern meaningful clusters and latent behavioral patterns, thereby informing content generation strategies, optimizing interaction timing, and refining touchpoint design (Taylor et al., 2023; O'Brien & Rezaei, 2024). Empirical field studies indicate that organizations adopting this approach realized considerable improvements in fan satisfaction and discernible increases in subsequent engagement with future initiatives (Kawamura et al., 2024; Harvey & Galloway, 2023). These findings collectively underscore that contemporary phygital marketing transcends the conventional boundaries of content dissemination, instead necessitating the cultivation of an intelligent, self-adaptive, bidirectional dialogue that is fundamentally grounded in fan-generated data.

Conclusion

Recent research findings clearly indicate that artificial intelligence and other data-driven technologies are not merely supportive tools but are emerging as strategic infrastructures for phygital marketing in the sports industry. From fan interaction cycles based on natural language processing and deep learning to automated content production systems, revenue prediction models, sports metaverses, managerial decision-making systems, intelligent security frameworks, and integrated data platforms, all point to a fundamental transformation in how sports organizations engage with fans. These technologies, by integrating physical and digital data, enable dynamic personalization, behavior prediction, decision transparency, and immersive experiences, especially for young audiences (ages 18–24) whose expectations for meaningful and fast engagement in both online and offline environments have increased substantially. To practically harness this potential, sports organizations should take targeted, actionable steps. First, they should develop an integrated data platform that collects phygital data from diverse sources and adapts it across different sports or markets using transfer learning architectures. Second, they should implement a self-learning feedback cycle based on unsupervised learning that analyzes fan opinions in real time and directly converts them into marketing strategies. Third, they should design interactive experiences in metaverse environments or real-world events using augmented reality and generative models. Fourth, they should integrate security and privacy as core components of the experience design to strengthen fan trust. Fifth, they should translate managerial decision insights, such as tactical or operational rationales, into story-driven content to enhance transparency and emotional engagement. Ultimately, success in this domain requires a shift from a technology-centered approach to an intelligent, experience-centered ecosystem, in which AI does not replace

humans but rather facilitates deeper, more sustainable connections between the team and its fans.

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