Universidade do Estado do Rio de Janeiro
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Instituto de Educação Física e Desportos

Vitor Ayres Principe

Web3 e esportes: como a tecnologia blockchain pode auxiliar os modelos de negócios nos esportes

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2024

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Tese apresentada, como requisito parcial para obtenção do título de Doutor, ao Programa de Pós-Graduação em Ciências do Exercício e do Esporte, da Universidade do Estado do Rio de Janeiro. Área de concentração: Aspectos Biopsicossociais do Esporte.

Orientador: Prof. Dr. Rodolfo de Alkmim Moreira Nunes

Coorientador: Prof. Dr. Tiago Miguel Patrício Ribeiro

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DEDICATÓRIA

Dedico este trabalho à Deus.

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“A única coisa permanente no mundo é a mudança.”

Heráclito 500 a.C.

RESUMO

PRINCIPE, Vitor Ayres. *Web3 e esportes:* como a tecnologia blockchain pode auxiliar os modelos de negócios nos esportes. 2024. 135 f. Tese (Doutorado em Ciências do Exercício e do Esporte) – Instituto de Educação Física e Desportos, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, 2024.

Introdução: A gestão esportiva está se tornando mais desafiadora com os avanços tecnológicos a partir das transformações significativas nos modelos de negócios e na interação entre fãs e clubes. A Web3 oferece uma oportunidade para melhorar essa gestão, trazendo maior eficiência, transparência e envolvimento das partes interessadas, podendo revolucionar a interação dos fãs e a monetização de equipes, permitindo uma participação mais ativa de seus torcedores. As Organizações Autônomas Descentralizadas (DAOs) representam uma inovação que pode promover maior transparência, engajamento dos fãs e eficiência na gestão esportiva, introduzindo um novo modelo de governança, possibilitando decisões mais democráticas e colaborativas. No entanto, a adoção dessas tecnologias ainda enfrenta desafios e requer uma mudança cultural no setor esportivo. Objetivo: Verificar, compreender e analisar como a aplicação da Web3 pode auxiliar no potencial dos negócios no setor esportivo com a adoção das tecnologias emergentes. Materiais e métodos: O primeiro estudo consistiu em uma revisão sistemática da literatura utilizando a metodologia PRISMA e EBSE, onde foram analisados 37 estudos primários sobre a aplicação da tecnologia blockchain no esporte. Esse levantamento permitiu um entendimento abrangente das aplicações atuais e do potencial futuro dessa tecnologia no setor esportivo. O segundo estudo, também baseado em uma revisão sistemática, analisou 25 artigos específicos sobre *fan tokens*, abordando suas características técnicas e seu papel na melhoria da participação dos fãs em decisões menores dos clubes esportivos. No terceiro estudo, foi realizada uma análise correlacional de 20 *fan tokens*, utilizando dados financeiros e de mercado coletados do site CoinGecko. A análise revelou que a avaliação totalmente diluída (FDV) dos tokens correlaciona-se significativamente com o preço e a capitalização de mercado, indicando que as expectativas futuras estão alinhadas com as avaliações de mercado. Entretanto, a proporção de capitalização do mercado (M/FDV) apresentou correlação negativa, sugerindo que uma menor M/FDV pode indicar uma tendência de aumento nos preços futuros devido à percepção de subvalorização. No quarto estudo, foi proposto um modelo conceitual para a criação e utilização de uma DAO para a gestão de uma entidade esportiva, baseado em princípios de governança e empoderamento da comunidade. Esse modelo destaca a importância de uma abordagem colaborativa entre clubes, fãs, desenvolvedores de tecnologia e reguladores para a concretização do potencial dessas inovações. Conclusão: A partir dos resultados encontrados nos artigos, observou-se que a tecnologia blockchain tem potencial para revolucionar a gestão esportiva, tornando-a mais inclusiva, transparente e eficiente. Os *fan tokens* destacam-se como uma ferramenta significativa para aumentar o engajamento dos fãs e gerar novas fontes de receita. No entanto, a concretização desse potencial depende de uma abordagem colaborativa entre clubes, fãs, desenvolvedores de tecnologia e reguladores. A dualidade desses ativos, enquanto promovem uma conexão entre os fãs, introduz complexidades técnicas, financeiras e regulatórias que requerem atenção. Pesquisas futuras devem focar na criação de diretrizes regulatórias específicas e na análise do impacto econômico e social dessas inovações para maximizar os benefícios e superar os desafios associados à sua adoção no setor esportivo.

Palavras-chave: gestão esportiva; blockchain; organização autônoma decentralizada; token de fã; DAO.

ABSTRACT

PRINCIPE, Vitor Ayres. *Web3 and sports:* how blockchain technology can help sports business models. 2024. 135 f. Tese (Doutorado em Ciências do Exercício e do Esporte) – Instituto de Educação Física e Desportos, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, 2024.

Introduction: Sports management is becoming more challenging with technological advancements, driven by significant transformations in business models and the interaction between fans and clubs. Web3 offers an opportunity to enhance this management, bringing greater efficiency, transparency, and stakeholder engagement, potentially revolutionizing fan interaction and team monetization and enabling more active participation from supporters. Decentralized Autonomous Organizations (DAOs) represent an innovation that can promote greater transparency, fan engagement, and efficiency in sports management, introducing a new governance model that enables more democratic and collaborative decision-making. However, adopting these technologies still faces challenges and requires a cultural shift in the sports sector. Objective: To verify, understand, and analyze how the application of Web3 can enhance business potential in the sports sector by adopting emerging technologies. Materials and Methods: The first study consisted of a systematic literature review using the PRISMA and EBSE methodologies, analyzing 37 primary studies on the application of blockchain technology in sports. This review provided a comprehensive understanding of this technology's current applications and future potential in the sports sector. The second study, also based on a systematic review, analyzed 25 specific articles on fan tokens, addressing their technical characteristics and their role in improving fan participation in minor club decisions. The third study conducted a correlational analysis of 20 fan tokens using financial and market data collected from the CoinGecko website. The analysis revealed that the tokens' fully diluted valuation (FDV) significantly correlates with price and market capitalization, indicating that future expectations are aligned with market valuations. However, the market capitalization ratio (M/FDV) showed a negative correlation, suggesting that a lower M/FDV may indicate a trend of future price increases due to perceived undervaluation. In the fourth study, a conceptual model was proposed for creating and utilizing a DAO for managing a sports entity based on principles of governance and community empowerment. This model highlights the importance of a collaborative approach among clubs, fans, technology developers, and regulators to realize the potential of these innovations. Conclusion: Based on the results found in the articles, it was observed that blockchain technology has the potential to revolutionize sports management, making it more inclusive, transparent, and efficient. Fan tokens are a significant tool to increase fan engagement and generate new revenue streams. However, realizing this potential depends on a collaborative approach among clubs, fans, technology developers, and regulators. While promoting a connection between fans, the dual nature of these assets introduces technical, financial, and regulatory complexities that require attention. Future research should focus on creating specific regulatory guidelines and analyzing these innovations' economic and social impact to maximize benefits and overcome challenges associated with their adoption in the sports sector.

Keywords: sport management; blockchain; decentralized autonomous organizations; fan token; DAO.

SUMÁRIO

INTRODUÇÃO

Os esportes são uma parte importante da vida humana e têm um papel fundamental na sociedade (SEIPPEL, 2019). Com o crescente avanço da tecnologia e a sua influência no ambiente esportivo, a gestão do esporte tem se tornado cada vez mais complexa e desafiadora (RATTEN, 2019). Nesse contexto, a Web3 surge como uma oportunidade promissora para aprimorar a gestão esportiva de clubes profissionais, proporcionando uma maior eficiência, transparência e engajamento dos *stakeholders*, que são as partes interessadas envolvidas no setor esportivo (CARLSSON-WALL; NEWLAND, 2020).

A Web3 de forma conceitual surge como evolução da internet (Web 1.0), onde os sites eram estáticos, apenas para leitura, com pouca interação do usuário, para um ambiente mais dinâmico (leitura e escrita) e de código aberto (conteúdo criado pelo usuário) chamado Web 2.0 (THRUL *et al.*, 2022). A Web3 apresenta uma nova perspectiva aos usuários: como leitura-escrita-propriedade, ela imagina uma internet descentralizada (propriedade), sem permissões (acesso igualitário) e sem confiança em um código centralizado ou terceirizado (RUDMAN; BRUWER, 2016). A Web3 oferece mais construção de comunidade e empoderamento do que importância econômica, no entanto, ainda está em estágios iniciais (LIU *et al.*, 2021).

Essa relação a indústria esportiva, a Web3 tem o potencial de transformar a forma como os fãs interagem com o conteúdo, como as equipes, com os jogadores e como ligas gerenciam sua presença digital e monetização, como uma oportunidade única, ao permitir que os fãs participem ativamente desse ecossistema e obtenham recompensas pelo seu engajamento (BAKER; PIZZO; SU, 2022).

A utilização da Web3 pode ser aplicada em diversas áreas, desde a gestão de bilheteria até a transmissão de eventos esportivos em plataformas digitais. A Web3 pode trazer uma maior democratização do acesso ao esporte, permitindo que pessoas de todo o mundo possam participar e desfrutar dos benefícios que o setor oferece. Além disso, a Web3 pode proporcionar uma maior transparência na gestão dos recursos e na distribuição das receitas geradas pelo esporte (CARLSSON-WALL; NEWLAND, 2020)

A tecnologia da Web3 e as organizações autônomas descentralizadas (Decentralized Autonomous Organizations - DAOs) estão mudando a forma como as pessoas interagem e participam de esportes. A Web3 permite a criação de aplicativos descentralizados que permitem aos usuários controlar e gerenciar seus dados e ativos de forma segura e privada, enquanto as

DAOs permitem a criação de organizações governadas coletivamente por seus membros (WANG *el al.*, 2019). Em conjunto, ambas podem transformar a forma como as organizações desportivas, as sua gestão/governança e as interações digitais funcionam.

Com a crescente adoção da Web3, as DAOs se tornam uma opção cada vez mais viável para a gestão de projetos, organizações e comunidades online. A Web3 é considerada uma plataforma que promove a cooperação e a confiança entre seus usuários, fatores essenciais para o sucesso das DAOs. As DAOs são organizações baseadas em blockchain e contratos inteligentes que permitem a tomada de decisões de forma descentralizada e transparente (HASSAN; DE FILIPPI, 2021).

A criação das DAOs usando as tecnologias da Web3 oferece outras vantagens como a interoperabilidade entre diferentes blockchains e a possibilidade de utilizar criptomoedas para recompensas e incentivos. A Web3 está impulsionando a evolução das DAOs, permitindo uma maior participação e controle dos usuários e criando novas oportunidades de negócios e colaboração em rede (RUDMAN; BRUWER, 2016).

As DAOs representam uma inovação significativa com potencial para transformar diversas áreas, incluindo o esporte. No contexto esportivo, as DAOs podem revolucionar a governança, proporcionando maior transparência, eficiência e redução de custos em comparação com os modelos tradicionais de gestão (MARKO; KOSTAL, 2022). Além disso, elas permitem uma gestão mais democrática e participativa, redefinindo o engajamento de fãs e participantes (WRIGHT, 2021). Através da tokenização e de estratégias financeiras inovadoras, as DAOs podem oferecer modelos de recompensa personalizados para jogadores e técnicos, aumentando o envolvimento e a lealdade (ZHENG *et al.*, 2018).

Exemplos práticos da aplicação das DAOs no esporte incluem a gestão coletiva de clubes de golfe (LinksDAO - linksdao.io), a co-propriedade de equipes de vela (SailGP DAO - sailgp.com), a democratização da propriedade de equipes da NBA (KrauseHouse - krausehouse.club), e o gerenciamento de equipes e jogadores em jogos de eSports baseados em blockchain (BlackPool - blackpool.finance), entre outros. Assim, as DAOs abrem novas possibilidades para a criação de valor econômico e social dentro das organizações esportivas, ao mesmo tempo em que diversificam suas fontes de receita e fortalecem a conexão com a base global de fãs (SINGHAL *et al.*, 2023; ZHANG, 2022).

A implementação de DAOs representa uma mudança significativa na gestão organizacional e na condução de negócios, proporcionando aos usuários uma maior autonomia e descentralização (BELLAVITIS; FISCH; MOMTAZ, 2022). Essas organizações eliminam a necessidade de uma autoridade central, permitindo que as decisões sejam tomadas de maneira

mais democrática e transparente, com regras codificadas em contratos inteligentes que garantem a segurança e a imutabilidade dos processos (MARKO; KOSTAL, 2022).

As DAOs têm o potencial de aprimorar a eficiência operacional, reduzindo custos associados à comunicação e gestão através da automação de processos por meio de contratos inteligentes (WANG *el al.*, 2019). As DAOs se diferenciam das organizações tradicionais por não possuírem uma hierarquia clara ou liderança centralizada, o que, em teoria, permite uma governança mais inclusiva e democrática (WANG *et al.*, 2019). Todos os membros podem participar das decisões através de mecanismos de votação baseados em tokens, o que promove uma forma de gestão mais transparente e descentralizada (HASSAN; DE FILIPPI, 2021). No entanto, apesar dessas promessas, essa democratização das DAOs pode ser limitada pela concentração de poder em poucas entidades, o que representa um desafio à descentralização efetiva (AXELSEN; JENSEN; ROSS, 2022; CASTELLO; GADZINSKI, 2022). O processo de governança descentralizada ainda enfrenta problemas complexos, como a coordenação de atualizações de software e a resposta a crises, que podem comprometer a autonomia prometida pelas DAOs (LACITY, 2022).

Projetos como "BuyTheBroncos" ilustram o potencial das DAOs para transformar setores tradicionais, como o esporte, ao permitir que fãs comuns se tornem proprietários de times esportivos. No caso do "BuyTheBroncos", a DAO tentou adquirir o time de futebol americano Denver Broncos, demonstrando como a tecnologia pode permitir maior participação dos fãs na gestão de times (SIGALOS, 2022). No entanto, desafios como barreiras legais, governança complexa e aceitação por parte das entidades tradicionais ainda são obstáculos significativos (FILIPPI; MANNAN; REIJERS, 2022).

A transparência e a imutabilidade das ações garantidas pela blockchain são outras vantagens notáveis, dificultando manipulações e fraudes (WRIGHT, 2021). Contudo, a descentralização efetiva ainda é difícil de alcançar, com muitas decisões permanecendo sob o controle de um pequeno grupo de participantes (APPEL; GRENNAN, 2023). Entretanto, a descentralização efetiva continua sendo um desafio, já que muitas decisões permanecem sob o controle de um pequeno grupo de participantes, o que pode limitar o potencial democrático das DAOs (KRISHNAN, 2020). Além disso, a ausência de uma liderança centralizada pode complicar a tomada de decisões em momentos de crise ou de necessidade de ação rápida (SHEVKO; YANOVICH; ZHUKOVA, 2023).

A falta de clareza legal e regulatória também representa uma barreira à plena adoção das DAOs, exigindo estruturas (*frameworks*) legais mais robustos para garantir sua viabilidade (TSE, 2020). Por fim, a questão da escalabilidade dessas organizações ainda precisa ser

abordada, dado que o crescimento das DAOs pode enfrentar desafios relacionados à eficiência no processamento de transações e ao consumo de energia (BELLAVITIS; FISCH; MOMTAZ, 2022).

Outro desafio significativo é a falta de clareza legal e regulatória, o que representa uma barreira à plena adoção das DAOs. As leis atuais frequentemente não estão adaptadas para lidar com a natureza descentralizada dessas organizações, exigindo frameworks legais mais robustos para garantir sua viabilidade e sustentabilidade no longo prazo (FILIPPI; MANNAN; REIJERS, 2022). A questão da escalabilidade também é crítica, já que o crescimento das DAOs pode enfrentar desafios relacionados à eficiência no processamento de transações e ao consumo de energia (BELLAVITIS; FISCH; MOMTAZ, 2022).

Ademais, a efetividade das DAOs em alcançar seus objetivos propostos, como descentralização e transparência, ainda precisa ser mais bem avaliada na prática. Embora as DAOs prometam maior democratização e inclusão, a concentração de poder e a necessidade de uma governança complexa podem limitar esses benefícios (ELLINGER *et al.*, 2023). É necessário um entendimento mais profundo sobre como essas organizações podem superar barreiras práticas e tecnológicas para atingir seu potencial total.

Embora as DAOs apresentem um grande potencial para revolucionar diversos setores, ainda enfrentam desafios substanciais que precisam ser abordados. A adoção de DAOs em uma escala mais ampla dependerá de como essas organizações conseguirão superar as barreiras relacionadas à governança, regulamentação, e efetiva descentralização, bem como de como irão lidar com as limitações práticas e tecnológicas atuais (DAVIDSON, 2018). A reflexão crítica sobre esses aspectos e o desenvolvimento de frameworks robustos serão essenciais para o sucesso das DAOs a longo prazo.

Portanto, a implementação de DAOs no esporte pode trazer diversas vantagens, como a descentralização da tomada de decisão, a transparência na gestão de recursos e a maior participação dos *stakeholders* (LIU *et al.*, 2021), que precisam enfrentar desafios pertinentes. As DAOs podem ser utilizadas em diversas áreas do esporte, desde a gestão de clubes e times até a organização de eventos e competições esportivas (CARLSSON-WALL; NEWLAND, 2020). Além disso, as DAOs podem ser utilizadas para a criação de programas de incentivo e recompensas para jogadores, treinadores e torcedores, contribuindo para o engajamento e fidelização dos fãs (BAKER; PIZZO; SU, 2022).

Apesar das possibilidades oferecidas pela Web3, a sua implementação no esporte ainda é um desafio, sendo necessário que haja uma mudança cultural e de mentalidade (*mindset*) no setor esportivo para que a Web3 possa ser efetivamente utilizada precisando estabelecer

parcerias e colaborações entre empresas, instituições e especialistas em tecnologia para garantir o sucesso da implementação da Web3 no esporte incluindo as DAOs (ZATTI, 2022).

No entanto, pela Web3 ainda está em estágios iniciais onde a sociedade em gerar experimenta o seu desenvolvimento diversas lacunas são encontradas no que diz respeito às aplicações do uso dessa tecnologia e especialmente a utilização das DAOs no esporte.

DESCRIÇÃO DA SITUAÇÃO PROBLEMA

A elaboração de uma questão de pesquisa é um dos primeiros passos essenciais na condução de uma pesquisa científica. A formulação de hipóteses é uma das formas de se elaborar uma questão de pesquisa, pois as hipóteses podem fornecer direções para a investigação (RATAN; ANAND; RATAN, 2019). Porém, a análise exploratória, que é realizada no início da pesquisa, dispensa a formulação de hipóteses, sendo possível que ao longo do desenvolvimento da pesquisa, hipóteses surjam e sejam testadas (KLEIN, 2023).

Outros autores que discutem a formulação de questões de pesquisa defendendo que uma questão de pesquisa deve ser clara, concisa e específica o suficiente para ser respondida em um estudo limitado. Além disso, a questão deve ser relevante e significativa para a área de estudo em questão (DHIR; GUPTA, 2021).

No entanto, a formulação da questão de pesquisa deve ser guiada por um quadro teórico, que pode ajudar a definir as variáveis relevantes e as relações entre elas. Desta forma, a questão de pesquisa deve ser significativa, enfocar um problema específico e ser aberta o suficiente para permitir a exploração de diferentes perspectivas (HEALE; NOBLE, 2019).

A elaboração de uma questão de pesquisa é um processo que requer reflexão cuidadosa. A formulação de hipóteses pode ser útil, mas não é obrigatória. A clareza, relevância e significado da questão são elementos importantes a serem considerados, juntamente com a orientação de um quadro teórico.

A descrição do problema de pesquisa apresentado neste trabalho conta com à elaboração de uma questão de pesquisa que o pesquisador quer ver respondida na conclusão de sua pesquisa.

Portanto, questões tais como:

I) Quais são as principais tendências, inovações e desafios na implementação da tecnologia blockchain e as soluções Web3 no setor esportivo?

II) Os *fan tokens* podem auxiliar a gestão e a economia no esporte?

III) Como a tecnologia blockchain e as soluções Web3 podem ser usada para promover o engajamento dos fãs, melhorar a governança e a gestão de clubes esportivos?

Em outras palavras, é preciso um melhor entendimento que envolve as novas tecnologias presentes junto a Web3 e mais especificamente como podemos utilizar essa tecnologia para benefício do progresso da gestão das organizações esportivas.

Portanto, este estudo constitui uma contribuição original para o campo da Ciência do Esporte, em particular na Gestão do Esporte, tanto do ponto de vista teórico quanto metodológico. Ele levanta uma discussão sobre tecnologia no esporte, particularmente tecnologias aplicadas para a gestão do esporte.

Além disso, a natureza multidisciplinar do estudo deve ser apontada, pois abrange temas pertencentes às áreas de Ciência da Computação, Gestão da Informação, Educação Física, Gestão Esportiva, Matemática, Administração, Marketing e Direito.

OBJETIVOS DA TESE

Os objetivos estão divididos em duas categorias, gerais e específicas, conforme descrição a seguir.

OBJETIVO GERAL

O objetivo geral desta pesquisa é verificar, compreender e analisar como a aplicação das tecnologias emergentes, associadas à Web3, pode auxiliar no potencial dos negócios e na inovação na gestão e governança do setor esportivo.

OBJETIVOS ESPECÍFICOS

Os objetivos específicos derivam do objetivo geral e são os seguintes:

a) Identificar e analisar as tendências emergentes, inovações tecnológicas, e desafios práticos na adoção e implementação da tecnologia blockchain e das soluções Web3 no setor esportivo;
b) Avaliar como os *fan tokens* podem ser utilizados como uma ferramenta estratégica na gestão de clubes esportivos, abordando os desafios regulatórios e suas implicações;

c) Analisar o impacto econômico dos *fan tokens* na economia digital dos esportes, explorando como esses ativos digitais podem gerar novas receitas e criar novas oportunidades para o envolvimento econômico dos fãs;
d) Explorar como a implementação da tecnologias blockchain e soluções Web3 pode transformar a governança e a gestão de clubes esportivos.

ORGANIZAÇÃO DO ESTUDO

Esta pesquisa foi desenvolvida por quatro estudos sob a forma de artigos científicos. Esses artigos estão organizados em capítulos desta tese e seguirão a seguinte estrutura:

Capítulo 1: Será apresentado o Estudo 1 intitulado ***"A Systematic Literature Review of Blockchain Technology and the Sports Industry",*** que buscou identificar as lacunas da literatura atraves de uma revisão da literatura para determinar os tópicos mais estudados sobre a identificação das principais tendências e inovações que utilizam a tecnologia da blockchain no cenário esportivo.

Capítulo 2: Depois desse primeiro estudo de revisão existiu a necessidade de aprofundar sobre a temática dos *fan tokens*, que são uma porta de entrada para a utilidade da blockchain no contexto do esporte. Nesta linha de pesamento, o Estudo 2 denominado de ***"Blockchain and Sports Industry: A systematic literature review of Fan Tokens and their Implications",*** para identificar os usos e utilidades dos tokes. Este segundo estudo está aceito e aguardando publicação na revista Retos nuevas tendencias en educación física, deporte y recreación.

Capítulo 3: Com base nesta segunda revisão o Estudo 3 com o título de ***"Avaliando o impacto e as perspectivas futuras dos Fan Tokens na economia digital dos esportes: Uma análise correlacional"*** onde a discusão sobre o impacto do fan token na economia da indústria esportiva. Este terceiro estudo está publicado na revista Lecturas: Educación Física y Deportes (PRINCIPE et al., 2024).

Capítulo 4: A partir dos tópicos emergentes encontrados neste primeiro e no segundo estudo de revisão buscou-se aprofundar a temática sobre as organizações descentralizadas e se o modelo de gestão descentralizado utilizando as tecnologias existentes da Web3 são um novo modelo a ser utilizado. Portanto o Estudo 4 com o título de ***"Decentralizing sport management: a conceptual model for utilizing Decentralized Autonomous Organizations in sports clubs"*** busca trazer a discussão sobre como a blockchain pode auxiliar os modelos de negócios no esporte.

REFERENCIAL TEÓRICO

A Web3 é um ambiente descentralizado na internet que permite maior segurança e privacidade nas transações online. Baseada na tecnologia blockchain, uma espécie de livro de contabilidade digital, a Web3 garante que os registros das transações sejam seguros, transparentes e auditáveis (LACITY, 2022). Desta forma, a Web3 traz uma nova forma de interação com internet, com um forte senso de comunidade e empoderamento por parte do usuário da propriedade gerada pela descentralização, com acesso igualitário e de confiança (LIU *et al.*, 2021; RUDMAN; BRUWER, 2016).

Uma das áreas mais comuns de aplicação da tecnologia Web3 é o setor financeiro. Com a popularização das criptomoedas, muitas empresas estão adotando tecnologias Web3 para criar novos modelos de negócios e sistemas financeiros mais justos e transparentes (MEYER; WELPE; SANDNER, 2022; VOSHMGIR, 2020).

Um relatório publicado pelo Fórum Econômico Mundial em janeiro de 2020, discute se as possíveis implicações da emissão de moedas digitais pelos bancos centrais e como a tecnologia blockchain pode ser usada para melhorar a segurança e a eficiência dessas moedas (LANNQUIST; WARREN; SAMANS, 2020).

Outra área de aplicação da Web3 é na criação de novos modelos de governança e democracia digital. Com a descentralização da internet é possível criar sistemas mais justos e transparentes de tomada de decisão, onde cada indivíduo tem uma voz igualitária, a Web3 pode ser usada para criar sistemas de votação online seguros e confiáveis, o que pode ajudar a aumentar a participação dos cidadãos nas decisões políticas por exemplo (ALVI *et al.*, 2022; HUANG *et al.*, 2021).

A Web3 também tem um grande potencial no setor de saúde, permitindo que os pacientes tenham maior controle sobre seus dados de saúde e garantindo uma maior segurança e privacidade das informações, podendo ser usada para criar sistemas de registro de saúde digital mais eficientes e seguros, garantindo que as informações dos pacientes sejam armazenadas de forma segura e que possam ser acessadas apenas pelos profissionais autorizados (KAUR; BANSAL; DATTANA, 2023).

Além disso, a Web3 também pode ser usada na criação de novos modelos de economia colaborativa e compartilhada. Com a descentralização da internet, é possível criar sistemas de compartilhamento de recursos mais eficientes e justos, que beneficiem tanto os usuários quanto a comunidade como um todo. A Web3 pode ser usada para criar sistemas de compartilhamento

de energia renovável, permitindo que as comunidades locais produzam e compartilhem energia de forma mais eficiente e sustentável (WANG el al., 2023).

A tecnologia Web3 têm sido cada vez mais utilizada pelo setor esportivo com as mais diversas aplicações. A tecnologia na Web3 pode ser usada para criar sistemas de ingressos digitais que garantam a autenticidade e a segurança das transações, reduzindo assim a possibilidade de fraudes (HEILMANN *et al.*, 2023; REGNER; SCHWEIZER; URBACH, 2022).

Além disso, a Web3 também pode ser usada para melhorar a experiência dos fãs, permitindo o acesso a conteúdos exclusivos, interação com os atletas e até mesmo a possibilidade de possuir ativos digitais exclusivos, como cartões colecionáveis e outras mercadorias virtuais. Desta forma, a tecnologia pode ser usada para criar sistemas de propriedade intelectual e monetização e que os fãs tenham acesso a conteúdos exclusivos de forma segura e transparente (CARLSSON-WALL; NEWLAND, 2020; SCHELLINGER; ANTE; BAUERS, 2022).

Neste novo contexto de Web3 nasce também as Organizações Autônomas Descentralizadas (Decentralized Autonomous Organizations - DAOs) que são organizações que utilizam a tecnologia blockchain para operar de forma autônoma e descentralizada, sem a necessidade de intermediários (WANG *et al.*, 2019). As DAOs são governadas por um conjunto de contratos inteligentes, que são programados para gerenciar as operações da organização de forma transparente e sem a necessidade de uma autoridade centralizada (KOTA; GIBBINS; JENNINGS, 2012).

Integrar a tecnologia blockchain nos esportes redefine operações e engajamento dos fãs e prepara o terreno para a adoção das Organizações Autônomas Descentralizadas (DAOs) neste campo. As DAOs são entidades pioneiras na gestão esportiva, caracterizadas por suas estruturas de governança e financeiras descentralizadas, que divergem significativamente dos modelos hierárquicos tradicionais (SANTANA; ALBAREDA, 2022). Essas organizações permitem que os detentores de tokens tomem decisões críticas coletivamente através de processos automatizados de tomada de decisão facilitados por contratos inteligentes, eliminando a necessidade de autoridades centralizadas (SATO, 2021). Um exemplo de aplicação das DAOs no esporte é o projeto Socios.com, que permite que os fãs de futebol possam votar em decisões do clube e ter acesso a recompensas exclusivas (BERKANI *et al.*, 2024).

Além disso, as DAOs podem ser usadas para financiamento coletivo de projetos esportivos, como a criação de times, eventos e competições. Um exemplo é o projeto Buy the Broncos DAO, que tinha o objetivo de comprar o time Denver Broncos da *National Football*

League (NFL) nos Estados Unidos, tornando-se assim o primeiro clube da NFL administrado por seus fãs. Porém com o insucesso da aquisição o projeto foi descontinuado (SIGALOS, 2022).

As DAOs também podem ser utilizadas para gerenciar e distribuir ativos digitais exclusivos, como ingressos, cartões colecionáveis e outras mercadorias virtuais. Um exemplo é o projeto NBA Top Shot, que permite que os fãs comprem, vendam e troquem cartões digitais colecionáveis, que representam momentos icônicos do basquete (PELECHRINIS *et al.*, 2023).

As DAOs apresentam um grande potencial para revolucionar a forma como o esporte é gerenciado, possibilitando uma maior participação dos fãs e uma maior eficiência na gestão de projetos esportivos (CARLSSON-WALL; NEWLAND, 2020). No entanto, ainda são necessárias mais pesquisas e experimentações para explorar todo o potencial das DAOs no esporte.

No contexto do futebol, a DAO pode se relacionar com uma estrutura profissional de gestão e criar um modelo de gestão que permite a participação de investidores por meio de iniciativas tecnológicas, seja a Sociedade Anônima do Futebol (SAF - Lei nº 14.193/2021) no Brasil, Sociedade Anônima Desportiva (SAD - Decreto-Lei n.º 10/2013) em Portugal, a Sociedade de Resposabilidade Limitada (*Società a Responsabilità Limitata - Legge 426/42*) em Itália, a Sociedade Anônima Desportiva (*Sociedades Anónimas Deportivas – SAD - Lei 10/1990*) na Espanha, ou mesmo como na Inglaterra (*Unincorporated Association; Private Company Limited by Guarantee; Private Company Limited by Shares; Public Limited Company*) ou Alemanha (*Gesellschaft mit beschränkter Haftung – GmbH; German Kommanditgesellschaft auf Aktien – KgaA; Aktiengesellschaft – AG*) que não apresentam lei específica para o futebol.

Regulamentada no Brasil com base em outras legislações desportivas mundiais a Lei da SAF (Lei nº 14.193/2021), estabelece que clubes de futebol podem se transformar em sociedades anônimas de capital aberto ou fechado, com o objetivo de captar recursos no mercado financeiro (CASTRO, 2021).

Uma possível aplicação da DAO em qualquer modelo empresarial em uma entidade esportiva seria a utilização da tecnologia blockchain para aprimorar a governança da sociedade, permitindo que os acionistas possam participar mais ativamente das decisões do clube, sem a necessidade de intermediários. As SAF pode se beneficiar da DAO para aprimorar a governança corporativa, aumentar a transparência e reduzir os custos de operação (ZATTI, 2022).

A DAO pode permitir a criação de comunidades autônomas de torcedores, que possam participar ativamente da gestão do clube e contribuir com ideias e recursos, podendo ser vista

como um modelo de governança participativa e colaborativa, que permite a tomada de decisão descentralizada e transparente. Dessa forma, a DAO pode aumentar o engajamento dos torcedores e criar uma cultura de participação e transparência na gestão do clube (SCHELLINGER; ANTE; BAUERS, 2022).

As DAOs podem representar uma oportunidade para a modernização e profissionalização do futebol, mas é importante debater e regulamentar adequadamente essa nova forma de gestão. No entanto, ainda são necessárias mais pesquisas e experimentações para avaliar a viabilidade e os desafios da utilização da DAO em uma organização profissional de futebol, no contexto de qualquer país. No Brasil, a SAF enfrenta desafios como a complexidade regulatória, a resistência cultural e a falta de familiaridade dos torcedores e investidores com a tecnologia blockchain. Ainda assim, a DAO pode representar uma alternativa interessante para aprimorar a gestão e a governança da SAF e criar novas possibilidades de participação e engajamento dos torcedores (BALCERZAK *et al.*, 2022).

Por fim, a tecnologia Web3 também tem um grande potencial no setor de governança e democracia digital. Com a descentralização da internet, é possível criar sistemas mais justos e transparentes de tomada de decisão, onde cada indivíduo tem uma voz igualitária. A Web3 pode ser usada para criar sistemas de votação online seguros e confiáveis, o que pode ajudar a aumentar a participação dos cidadãos nas decisões políticas. Além disso, a Web3 também pode ser usada para criar sistemas de identidade digital, permitindo que os indivíduos controlem seus próprios dados e garantindo uma maior segurança e privacidade das informações.

Embora a literatura tenha destacado o potencial da tecnologia blockchain e as soluções da Web3 como ferramentas de transformação em diversos setores, ainda existem lacunas significativas no entendimento de como essas tecnologias podem ser efetivamente implementadas para promover mudanças estruturais na gestão, governança e economia.

Estudo recente explorou os desafios técnicos da tecnologia blockchain como a escalabilidade, onde o aumento no volume de transações leva a atrasos e limitações de desempenho, também o consumo elevado de energia o que torna a operação insustentável em larga escala. Além disso, questões de segurança como vulnerabilidades em contratos inteligentes e riscos de ataques comprometem o uso dessa tecnologia (ISLAM *et al.*, 2021).

Da mesma forma, a interoperabilidade entre diferentes blockchains e a integração com sistemas existentes são barreiras críticas para a gestão da tecnologia blockchain (MAKRIDAKIS; CHRISTODOULOU, 2019). A falta de padrões globais dificulta a integração de blockchains, enquanto as DAOs, apesar de fornecerem uma estrutura de governança mais transparente e descentralizada, também expõem desafios relacionados à concentração de poder

e à necessidade de mecanismos mais eficazes para a resolução de crises (APPEL; GRENNAN, 2023; SHEVKO; YANOVICH; ZHUKOVA, 2023).

A implementação de tecnologias blockchain em contextos esportivos, como nas iniciativas da LinksDAO e MakerDAO, demonstra o potencial de reconfigurar as relações entre *stakeholders* e promover um novo paradigma de engajamento dos fãs (ELLINGER *et al.*, 2023). No entanto, existe dificuldades em manter a verdadeira descentralização e a necessidade de frameworks legais e regulatórios mais robustos para garantir a viabilidade dessas soluções a longo prazo (BELLAVITIS; FISCH; MOMTAZ, 2022). Essas dificuldades incluem a falta de clareza regulatória e a proteção de dados, especialmente sob regulamentações como o Regulamento Geral sobre a Proteção de Dados (General Data Protection Regulation – GDPR), que podem entrar em conflito com a transparência inerente ao blockchain. Essas incertezas jurídicas criam barreiras significativas para a adoção e exigem uma constante adaptação às mudanças legais (BILAL; SAJID; SINGH, 2022).

Além disso, a literatura indica que os *fan tokens*, enquanto ferramentas promissoras para o engajamento dos fãs e geração de receitas, ainda enfrentam desafios regulatórios e econômicos que podem limitar sua adoção e eficácia (FERREIRA, 2020). A análise dos impactos econômicos dessas tecnologias na economia digital do esporte, como discutido por Vidal-Tomás (2024), é vital para entender como elas podem ser utilizadas não apenas para inovar a gestão dos clubes, mas também para criar novas oportunidades de valor tanto para os clubes quanto para os fãs (DEMIRTAS; ORÇUN, 2022). Assim, este estudo busca preencher essas lacunas, integrando e articulando as diversas perspectivas presentes na literatura, com o objetivo de contribuir para o avanço do conhecimento e para uma compreensão mais aprofundada das potencialidades e desafios da Web3 no contexto esportivo.

Assim diante das lacunas apresentadas na literatura atual que envolve a tecnologia blockchain e os poucos estudos na gestão do esporte, esta pesquisa se propõe a mapear e analisar as publicações existentes, com a intenção de fornecer uma visão abrangente e aprofundada sobre o tema.

1 ESTUDO 1 - A SYSTEMATIC LITERATURE REVIEW OF BLOCKCHAIN TECHNOLOGY AND THE SPORTS INDUSTRY[1]

Blockchain technology heralded as a transformative force since its inception through Bitcoin in 2008, has found substantial applicability across various sectors, notably in the sports industry. This academic paper conducts a thorough literature review, employing the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and the Evidence-Based paradigm in Software Engineering (EBSE), to systematically analyze the integration of blockchain and its impact within the sports sector. In the initial search across seven databases, 1,571 articles were identified. From these, 37 primary studies were selected and analyzed to understand the current applications and potential of blockchain technology in sports. The review process involved a rigorous selection criterion to ensure the inclusion of relevant studies, emphasizing the technology's role in enhancing fan experiences, managing digital assets, and improving sports governance models. The findings underscore blockchain's capacity to revolutionize sports management through digital collectibles, secure transactions, performance optimization, and fan engagement through exclusive digital content. This exploration highlights not only the technical merits of blockchain but also its potential to drive innovation, suggesting a significant paradigm shift in how sports industries operate and engage with their audiences. The study's methodology, grounded in evidence-based research and systematic analysis, reveals blockchain's emerging role as a pivotal technology in sports. This points towards future directions for research and practical applications that could redefine the sports industry's landscape.

Keywords: Blockchain; Disruptive technology; Sports industry; Systematic review; Technology adoption

Introduction

In 2008, Satoshi Nakamoto introduced the concept of blockchain through Bitcoin, which provided a decentralized infrastructure for computing and storage (Nakamoto, 2008). Nevertheless, upon realizing the technology's vastly greater potential, blockchain has attracted significant interest from numerous industries and the academic world in recent years (Gökalp

[1] Vitor Ayres Principe, Giullio César Pereira Salustiano Mallen da Silva, Wecisley Ribeiro Espírito Santo, Juliana Brandão Pinto de Castro, Diego Gama Linhares, Rodrigo Gomes de Souza Vale, Rodolfo de Alkmim Moreira Nunes

et al., 2022). Indeed, blockchain technology is evolving to become the most significant technological advancement since the advent of the Internet (Casino et al., 2021).

Blockchain technology is a multifaceted field that encompasses a range of technical aspects, such as mathematics, cryptography, internet protocols, and computer programming (Sato, 2021). Despite its complexity, blockchain has shown potential in practical applications, capable of addressing specific technical challenges by applying basic principles to understand complex phenomena (Di Ciccio et al., 2019).

This technology has the potential to revolutionize industries beyond its initial associations with cryptocurrency (Antonopoulos, 2017) and non-fungible tokens (NFTs) (Zarifis & Cheng, 2022). Blockchain has evolved to offer management solutions across various global industries. Its applications now extend to decentralized finance (Far et al., 2023), healthcare (Andrew et al., 2023), internet of things (IoT) (Abdelmaboud et al., 2022), supply chain management (Al-Rakhami & Al-Mashari, 2021), energy supply (Bürer et al., 2019), tourism (Arif et al., 2023), and education (Bucea-Manea-Tonis et al., 2021), among others. By leveraging blockchain technology, these sectors are exploring innovative strategies to maintain a competitive edge (Pu & Lam, 2021).

The emergence of blockchain as a disruptive technology can provide advantages to the sports industry (Khaund, 2020). It marks a shift towards a new economy that promises to revolutionize not only the sports industry but also the governance and economic models underlying it (Liu et al., 2021; Wang et al., 2019). This includes enhancing fans' experiences by enabling access to unique content, facilitating interaction with athletes, and granting the opportunity to own exclusive digital assets, such as collectible cards and other virtual goods (Naraine, 2019). Additionally, blockchain technology can help create intellectual property and monetization systems, ensuring that fans have safe and transparent access to exclusive content (Franceschet & Libera, 2023).

The implementation of blockchain technology in the sports industry can result in significant paradigm shifts, changing professional and societal perceptions of the sports industry's future. Given the fundamental importance of sports in human life, the impact of this technology could be substantial. This article adopts a novel approach by examining the innovative applications of blockchain technology within the sports context, thus expanding the research scope in this field. From a practical standpoint, the integration of blockchain technology into the sports industry is expected to become a prominent trend for innovation and development within the sports sector. Thus, this study aims to show the potential uses of blockchain in sports through a systematic literature review (SLR) process. This method facilitates the identification of key

terms and interpretations in the scientific literature over the years, enabling a comprehensive evaluation of the various applications of blockchain in the sports industry.

The main contributions of this paper are as follows: (1) We identify a set of primary studies related to blockchain in the sports industry, serving as a starting point to conduct further research on blockchain applications within a sports context. (2) We provide a comprehensive synthesis through both quantitative (bibliometric analysis) and qualitative (research questions) approaches, reflecting the state-of-the-art in sports applications of blockchain technology. (3) We offer insights based on our project experiences and SLR results.

The remainder of this paper is organized into sections as follows: Section 2 provides the background knowledge of blockchain and discusses related work; Section 3 describes the study methodology; Section 4 presents the results; Section 5 discusses blockchain applications in the sports field, including insights, study limitations, and recommendations; Section 6 concludes the paper.

Background and related work

Blockchain

Blockchain technology, due to its unique characteristics, differs from traditional centralized systems and provides a decentralized computing environment that operates without the need for a central authority (Zhang et al., 2018). Blockchain is a distributed database consisting of records linked together in a chain, where each network node is capable of achieving peer-to-peer communication and is designed to be fault-tolerant (Makridakis & Christodoulou, 2019). This decentralized structure, where multiple nodes collaborate to form a peer-to-peer network (Feng et al., 2020), is what defines blockchain.

Its main characteristics include decentralization, distribution, encryption, security, and immutability (Nakamoto, 2008). The term "blockchain" derives from the chain of interconnected blocks secured by a cryptographic hash function for information exchange. Each block functions as a digital ledger, containing a collection of transaction records. Hence, each network node holds a copy of this digital ledger, and synchronization ensures that each local copy is identical (Bashir, 2020).

The distributed nature of blockchain technology facilitates innovation and efficient reallocation of resources. This environment is highly conducive to creativity, fostering innovative solutions with the potential to revolutionize various industries (Ozcan & Unalan,

2022). Furthermore, blockchain technology can be integrated with other emerging technologies, thereby expanding its applications and capabilities (Deng et al., 2022).

The unique properties of blockchain, including a secure transaction environment, decentralized management, consensus mechanisms, immutability, distributed ledger technology, and transparency of stored data (Sato, 2021), allow its functionality to vary according to the involved parties, such as users, suppliers, and administrators, highlighting its adaptability to different function (Park, 2020).

Being an emerging technology that drives decentralized computing, blockchain has attracted researchers seeking to explore its characteristics. Several studies are also exploring different applications of this technology. In the sports industry scenario, blockchain technology is growing and has the potential to transform and redefine operations involvement and the entire value creation chain (Tripathi et al., 2023). Its integration with the sports industry holds promising potential, highlighting its innovative role in the business model, and opening up new possibilities for fan engagement (Carlsson-Wall & Newland, 2020; Naraine, 2019). With the constant evolution of blockchain technology, other applications of blockchain in sports are emerging, making this SLR essential for understanding its usage and applicability in this industry.

Related work

In selecting primary studies, we identified several articles that conducted research or reviews related to the value proposition of a decentralized network across various domains (Adediran et al., 2024; Deng et al., 2022; Far et al., 2022; Feng et al., 2020; Y. Liu et al., 2023; Ocheja et al., 2022; Xu et al., 2019), including physical exercise, physical activity, sports, active aging (Lopez-Barreiro et al., 2022), and gambling (Guillou-Landreat et al., 2021; Lawn et al., 2020).

Compared to existing studies, our contribution is distinct in three main aspects: timelines, methodology, and scope. While related works have covered relevant studies from both the sports industry and academia, there remains a gap in specific information about the application of blockchain technology within the sports industry. In this review, we conducted a systematic search of primary studies on blockchain within the sports context, where sports are defined as the methodical, individual, or collective practice of a game or any activity that requires physical movement and skill, for recreation or entertainment, maintenance of physical fitness and health, and/or competition, according to the Oxford dictionary (Oxford, 2024).

Regarding the scope of the research, the related work emphasized a specific aspect of the use of blockchain technology only in the context of sports. Through six research questions, we

comprehended how blockchain technology is used in sports. Specifically, we analyzed the general dimensions based on the definition of blockchain extracted from primary studies. Thus, this study offers a comprehensive and multidimensional insight into blockchain technology's role in the sports industry.

Method

This study followed the standard guideline for systematic reviews according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021). We also followed the Evidence-Based paradigm in the Software Engineering (EBSE) (Kitchenham et al., 2007; Kitchenham & Brereton, 2013). A common objective of conducting an SLR is to map the current state of knowledge in a specific field, identify a research inquiry, and contribute to the expansion of existing knowledge (Tranfield et al., 2003).

Motivations of the SLR study

Sports constitute a significant element of human life and play an essential role in society (Lombardo, 2012). With the progressive advancements in technology and its impact on the sports environment, the management of sports has become increasingly complex and challenging (Ratten, 2019). In this scenario, blockchain technology garnered significant attention in recent years, particularly due to the widespread adoption of cryptocurrencies (Antonopoulos, 2017), and created a promising opportunity to enhance sports management, offering improved efficiency, transparency, and engagement among stakeholders in the industry (Carlsson-Wall & Newland, 2020).

This interconnection with the sports world has the potential to revolutionize the way fans interact with content, as well as how teams, players, and leagues manage their digital presence and monetization (Baker et al., 2022; Scharnowski et al., 2023). Major sports leagues, including the National Basketball Association (NBA) and National Football League (NFL), are increasingly investing in blockchain-based solutions. For instance, NBA Top Shot, a platform developed in partnership with Dapper Labs, allows users to trade "moments" – digital collectibles featuring videos of iconic NBA player performances (Young, 2021). Gaining popularity among fans and collectors, the platform had over $230 million spent on it in 2021. Moreover, startups are developing innovative blockchain-based solutions to address challenges faced by sports organizations, suggesting a promising future for blockchain in the world of sports.

The blockchain application can extend across many domains, from ticket management (Nugraha et al., 2021; Regner et al., 2019) to the copyright protection of sporting events (Jun-Ming & Jing, 2021). Blockchain has the potential to democratize global access to sports, enabling worldwide participation and enjoyment of its benefits (Carlsson-Wall & Newland, 2020). Furthermore, blockchain could offer greater transparency in resource management and revenue distribution within sports (Raveh, 2020).

Conducting research in this field can aid in identifying blockchain applications that can offer advantages to sports. Additionally, it can help comprehend the difficulties surrounding the implementation of blockchain in sports, which are crucial to developing effective solutions that meet the needs of sports users and organizations. By identifying blockchain applications in sports, research can also assist sports managers in understanding how technology can enhance processes and boost the efficiency of organizations. Furthermore, it can identify gaps in existing knowledge and suggest areas for further study, contributing to the advancement of scientific research and sports management.

Ultimately, conducting an SLR on blockchain's use in sports can disseminate scientific knowledge on the subject and promote advances in this field. Thus, research can benefit both the scientific community and sports organizations looking for innovative solutions to challenges in the sports world.

Development protocol

This section outlines the SLR research principles, covering record identification in databases (step 1 – research framework), record screening and eligibility assessment (step 2 – primary study selection and quality assessment), and record inclusion for qualitative and quantitative synthesis (step 3 – bibliometric analysis and research questions).

Research framework

To conduct a comprehensive SLR, we searched for relevant articles from multiple sources, including the Institute for Scientific Information (ISI) Web of Science, Scopus, ScienceDirect, PubMed, Embase, Institute of Electrical and Electronics Engineers (IEEE) Xplore, and Dimensions. We selected data sources from the two leading databases for bibliometric analyses, with the Dimensions database emerging as a significant competitor to Web of Science and Scopus databases (Singh et al., 2021). We also selected two of the most representative digital libraries for Software Engineering Research (ScienceDirect and IEEE Xplore) (Kitchenham et

al., 2007), and relevant databases in the sports area (PubMed and Embase). The electronic search was conducted by two independent and experienced evaluators without language or time filters. Any conflict was resolved by a third evaluator. The search terms used in a single Boolean phrase were: Blockchain* AND Sport*.

Selection of primary studies

We established rigorous selection criteria for papers, which were later reviewed by four researchers to finalize the eligibility criteria. The inclusion criteria were:

- Papers proposing blockchain technology applications in the sports industry.

The exclusion criteria were:

- Papers unrelated to the sports industry.
- Papers focusing on gambling or sports betting.
- Papers not employing blockchain technology.
- Superseded versions of studies with more comprehensive updates.
- Inaccessible papers.
- Books, book chapters, theses, preprints, editorials, conference proceedings, and retracted papers.
- Survey, review, and SLR papers, which were categorized separately to outline the state-of-the-art in blockchain within sports. Data from these studies were not extracted or synthesized, as they are considered related work for this study.

Following the initial search, we conducted a forward and backward snowballing process to identify any additional related studies that may have been missed. Backward snowballing involves examining the references of papers, while forward snowballing involves examining the papers that cited the selected studies (Wohlin, 2014). Using the snowball strategy, we identified 41 articles: 32 were from the initial database and nine met all research criteria and were manually included. This process resulted in the inclusion of additional studies, as illustrated in Table 1.

Table 1. Snowballing process paper insertions

Seed paper	Snowballed paper

Vidal-Tomás (2023)	Ersan, Demir & Assaf (2022)
Scharnowski, Scharnowski & Zimmermann (2023)	Mazur & Vega (2023)
Alaminos, Salas & Fernández-Gámez (2024)	Solntsev, Alekseeva & Susov (2022)
Ante, Schellinger & Demir (2023)	Bernstein (2018)

Created by the authors.

Quality assessment

We assessed the quality of selected papers using established systematic review guidelines to determine their inclusion eligibility (Kitchenham & Brereton, 2013; Petersen et al., 2015; Wohlin et al., 2020). Five quality criteria (QC) were developed, each with a possible score of 1 (yes), 0.5 (partially), or 0 (no). The total scores of the five QC were calculated, and the papers were ranked into three categories: good ($4 < \text{score} \leq 5$), fair ($3 \leq \text{score} \leq 4$), and fail ($0 \leq \text{score} < 3$). Papers in the good and fair groups were included, while those in the failure group were excluded. During the quality assessment, we also reviewed the reference lists of the selected studies to identify additional peer-reviewed studies. All 37 papers selected for this review scored above two, indicating fair or good quality. The QC are as follows:

- QC1: Does the study have a clearly defined research purpose?

  To be considered for inclusion, a primary study must have a clear objective related to the use of blockchain technology in sports. A study that fails to meet this criterion will not be included in the subsequent data extraction and synthesis process, as it cannot adequately present blockchain applications without a defined research purpose.
- QC2: Does the study provide a clear definition of the blockchain concept and its application in sports?

  A clear definition is necessary for developing a comprehensive understanding of the use of blockchain technology in the context of sports institutions.
- QC3: Does the study describe its methodology clearly?

  The applied methodology is crucial in determining the relevance of the article to this research.
- QC4: Does the study propose practical solutions and provide a way to evaluate them?

  The feasibility of a study's proposed solutions is important in designing useful, available, and applicable methods.
- QC5: Does the study discuss its limitations?

  Discussion of the current limitations of blockchain governance can reveal the direction of future studies on this research.

Bibliometric analysis

The data extraction process began with the download of selected articles to compose the SLR and the recording of their basic information (e.g., title, year of publication, authors, publication journal, and affiliation) to evaluate the impact of these publications. The impact analysis of the articles in this SLR assesses the impact in the following ways: a) Author impact (Egghe & Rousseau, 2008; Hu et al., 2021); b) Journal ranking methods (Canales, 2020; Vairavan et al., 2020). Google Scholar was used to search for the researcher's h-index. The scientific structure is essential for understanding a specific research field. Therefore, it becomes necessary to analyze the structure of the works and how authors organize themselves in this context (Horta et al., 2018). This bibliometric analysis composition used during a systematic review can be observed in Principe et al. (2022).

Research questions protocol

Our SLR protocol employs the 5W1H approach (i.e., what, why, where, when, who, and how) to formulate research questions (RQ), in accordance with Liu et al. (2023), providing a comprehensive examination of blockchain adoption and application in the sports industry, as detailed in Table 2.

Table 2. Research questions with 5W1H approach.

RQ	5W1H	Research question	Motivation
1	What	What is blockchain technology?	To observe how primary studies define the concept of blockchain.
2	Why	Why is blockchain technology adopted in the sports industry?	To understand the forces to adopt blockchain technology in sports.
3	Where	Where is blockchain technology enforced in sports?	To distinguish the key objects to use the blockchain ecosystem in sports.
4	When	When is blockchain technology applied in the sports environment?	To understand where blockchain fits in the development process of the sports environment.
5	Who	Who is involved in blockchain technology in the sports context?	To identify the different roles and their authorities, capabilities, and responsibilities
6	How	How is blockchain technology designed for sports?	To explore actionable mechanisms for implementing blockchain technology in sports

RQ: Research question and 5W1H: five questions starting with the letter W (What; Why; Where; When; Who) and 1 question starting with the letter H (How). Created by the authors.

In RQ1, our goal is to extract the definition of blockchain from primary studies, which will provide us with insights into the fundamental dimensions of this technology. RQ2 aims to identify critical issues that require appropriate solutions. This research question will enable us to comprehend the strengths and consequences of the mechanisms for using blockchain technology analyzed in RQ6. RQ3 aims to expand the sports ecosystem by identifying key objects for blockchain technology use. By doing so, we will be able to understand how these objects are interconnected and determine when sports can apply blockchain technology for their development, as explored in RQ4. RQ5 focuses on comprehending the different stakeholders involved in the adoption of blockchain technology in sports. Lastly, RQ6 explores the mechanisms and best practices for implementing blockchain technology in the context of sports.

Data extraction and synthesis

We exported the results of our electronic search to the Rayyan web platform for organization, duplicate removal, and to conduct the inclusion and exclusion process through double-blind validation by three reviewers (Ouzzani et al., 2016). For study quality assessment and the snowballing method, we used Zotero® 6.0.19, a user-friendly, open-source software, along with Google® Sheets for continuum double-blind verification.

Results

This section outlines the SLR framework workflow, detailing the study selection, quality assessment, and both quantitative (bibliometric) and qualitative (research questions) analyses.

SLR framework

Our SLR, last updated in March 2024, involved searches across the ISI Web of Science, Scopus, ScienceDirect, PubMed, Embase, IEEE Xplore, and Dimensions electronic databases. The search phrase was developed using the Boolean operator [AND] (between descriptors). Initially, 1,571 articles were identified. After removing duplicates, retracted papers, and those outside the scope, we reviewed the full text of 55 studies. Then, 32 articles underwent the snowballing process to identify additional relevant articles not retrieved by keyword search. We included four studies from the snowballing process and added five known studies not previously identified. After quality analysis, we excluded four studies that failed to meet the criteria, leaving 37 articles for quantitative and qualitative analysis (see Figure 2).

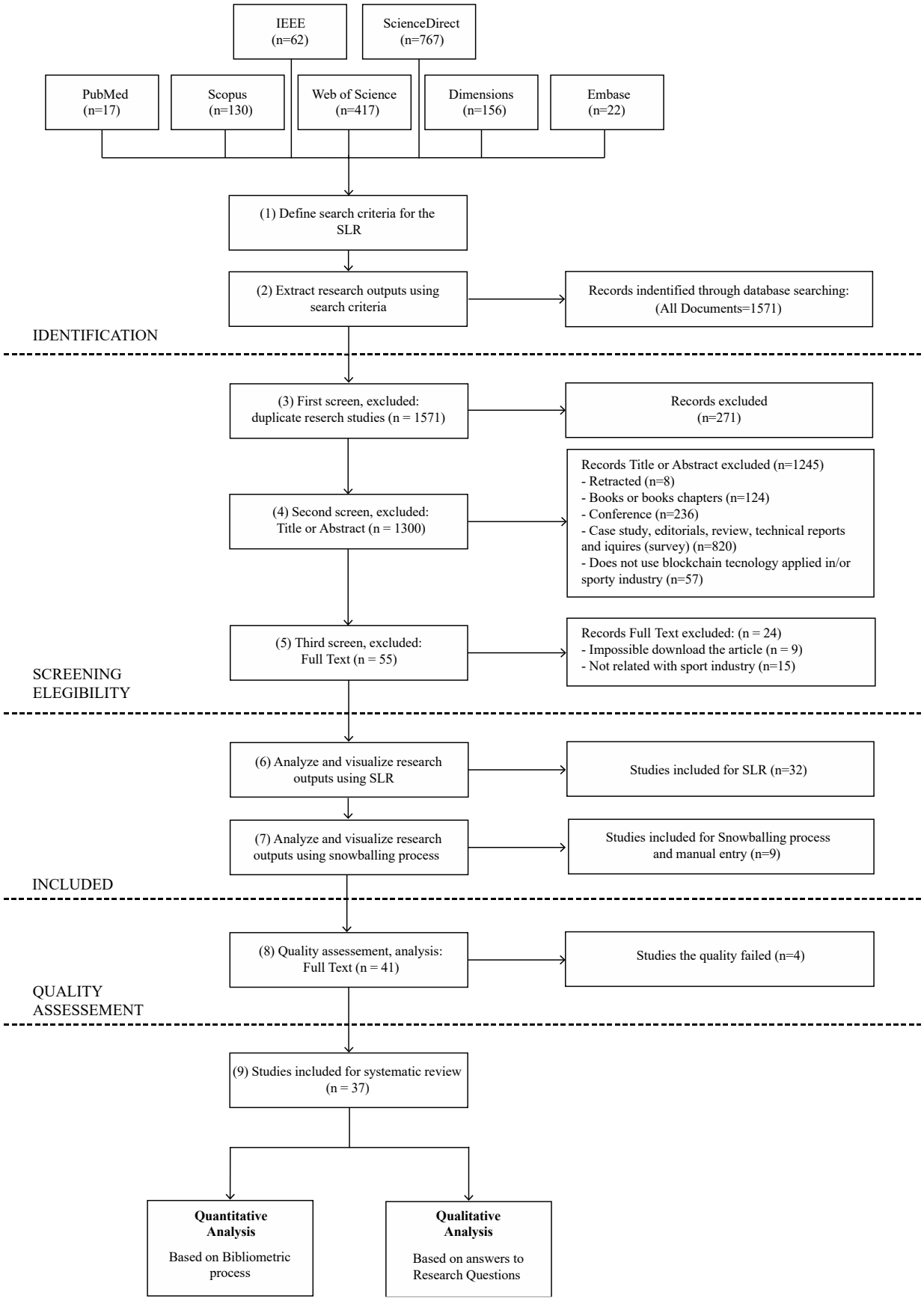

Figure 1. The overview process of the literature review was adapted from Page et al. (2021) and Kitchenham et al. (2007). IEEE: Institute of Electrical and Electronics Engineers and SLR: systematic literature review. Created by authors.

Following the SLR guidelines by Kitchenham & Brereton (2013), Petersen et al. (2015), and Wohlin et al. (2020), the review process may introduce validity threats that could affect the entirety of the study. Consequently, following the selection of studies shown in Section 3 and the framework depicted in Figure 1, we devised strategies aimed at mitigating the influence of these studies based on their quality. The construct validity might be jeopardized by the potential incompleteness of the search strings and the ambiguity of the terms used. Therefore, we intended to include synonyms for "blockchain", such as "web3" and "Distributed Ledger Technology", in our search queries.

However, the ambiguity of these terms led us to define our search terms conservatively, mitigated by strict inclusion and exclusion criteria and detailed screenings of titles, abstracts, and full texts. Publication bias, favoring studies with positive outcomes over those with negative findings, also poses a threat. This bias stems from the higher likelihood of studies reporting significant findings being accepted for publication. To mitigate this, we rigorously evaluated all studies against quality criteria, with four researchers reviewing them to ensure protocol adherence.

Bias during data extraction was addressed by having two researchers independently extract data from assigned studies and validate each other's findings using a predefined quality protocol. Studies scoring below 3, based on five critical questions (Table 3), were considered inadequate and excluded, resulting in 37 selected studies.

Table 3. Study quality assessment results.

Studies	QC1	QC2	QC3	QC4	QC5	Total
Alaminos et al. (2024)	1	0.5	1	1	0.5	4
Ante et al. (2023)	1	1	1	1	1	5
Baker, Pizzo & Su (2022)	1	1	0	1	0	3
Bernstein (2018)	0	1	0	1	0	2
Cao et al. (2021)	1	0.5	1	1	0	3.5
Chen (2024)	1	1	0.5	0	0	2.5
Chen et al. (2022)	1	0.5	1	1	0	3.5
Demir et al. (2022)	1	0.5	1	0.5	0	3
Ersan et al. (2022)	1	0.5	1	0.5	0	3
Foglia et al. (2024)	1	0.5	1	1	1	4.5
Fukuzawa et al. (2023)	1	1	1	1	1	5
Hong & Park (2020)	1	0.5	1	1	0	3.5
Jiang et al. (2023)	1	1	1	1	1	5
Jin et al. (2021)	0	0.5	0	1	0	1.5
Jun et al. (2024)	1	1	1	1	1	5
Karakaya & Akleylek (2021)	1	0.5	1	1	1	4.5

Li & Zhu (2023)	0.5	1	0.5	1	0	3
Li et al. (2021)	1	1	1	1	0	4
Liu et al. (2018)	1	0.5	1	1	0	3.5
Lv et al. (2022)	1	1	1	1	1	5
Ma (2021)	1	1	0.5	1	0	3.5
Mazur & Vega (2023)	1	0.5	0.5	1	0	3
Mohammad et al. (2023)	1	0.5	1	1	0	3.5
Naraine (2019)	1	1	0.5	1	1	4.5
Nugraha et al. (2021)	0.5	1	1	1	0	3,5
Pinto et al. (2022)	1	1	1	1	1	5
Pu et al. (2023)	1	1	1	1	0	4
Sabarigirisan et al. (2021)	1	1	0.5	1	1	4.5
Sang & Wang (2022)	1	1	1	1	0.5	4.5
Scharnowski et al. (2023)	1	0.5	1	1	0	3.5
Shan & Mai (2020)	1	1	1	1	0	4
Sharma (2021)	1	1	1	1	0	4
Singhal et al. (2023)	0	0.5	1	1	0	2.5
Solntsev et al. (2022)	0.5	1	0.5	1	1	4
Song & Tuo (2022)	1	1	1	1	0	4
Vidal-Tomás (2023)	1	0.5	1	0.5	0	3
Wang & Liu (2022)	0.5	1	1	1	0	3,5
Wilson et al. (2022)	1	1	0.5	1	1	4.5
Yang et al. (2023)	1	1	0	1	0	3
Yin et al. (2023)	1	0.5	1	1	0	3.5
Yu (2021)	1	0.5	1	1	1	4.5

QC: quality criteria; QC1: “Does the study have a clearly defined research purpose?”, QC2: “Does the study provide a clear definition of the blockchain concept and its application in sports?”, QC3: “Does the study describe its methodology clearly?”; QC4: “Does the study propose practical solutions and provide a way to evaluate them?” and QC5: “Does the study discuss its limitations?”. Created by authors.

Figure 2 illustrates the relationship between blockchain technology and its main characteristics, its applications in the sports industry, and which stakeholders benefit from its use. The reviewed articles indicate that using blockchain technology within the sports industry stems from the characteristics outlined in Figure 2, making blockchain a potential solution for the observed gaps. Thus, from the included studies, it was possible to observe that various segments with specific needs are already utilizing blockchain technology.

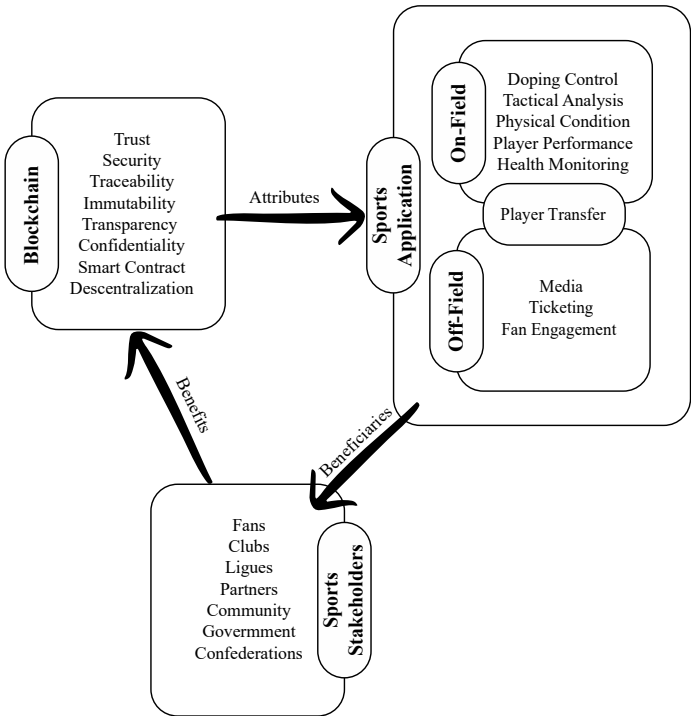

Figure 2. The sports blockchain overview.

The provided image represents a preliminary conceptual sketch of the studies selected in this review, aimed at exploring the potential impact of blockchain technology in the sports industry. The central element is sports applications where blockchain technology is applied holistically, covering a wide range of operations and processes in the industry. The direct connection between blockchain and sports applications suggests a facilitative role for blockchain, acting as an enabler in this context. This relationship highlights the potential of blockchain's inherent features – decentralization, transparency, and security – to enhance sports applications.

Expanding on this idea, the flowchart categorizes activities into 'On-Field' and 'Off-Field' domains, suggesting a separation between activities directly related to sports performance and those that are part of the infrastructure and administration that sustain sports. The inclusion of 'Player Transfer' under the 'Off-Field' domain with a direct link to the 'On-Field' domain specifically alludes to the potential role of blockchain in facilitating player transfers, a process that traditionally involves complex negotiations, contracts, and significant asset exchange. The use of blockchain could introduce new methods of contracting, based on smart contracts, which can automate and legally protect player transfers, thereby improving transaction efficiency and reliability.

The reference to sports stakeholders acknowledges the diverse entities and individuals with interests in this sector. The impact of blockchain adoption is likely to be heterogeneous, affecting different stakeholders in distinct ways. For example, fans may experience greater

integration and engagement with their favorite teams and athletes through blockchain applications that offer increased transparency and interaction. Similarly, regulators and sports organizations may use blockchain as an effective means to track and validate the integrity of results and regulatory compliance. The inclusive nature of the diagram suggests that the scope of blockchain's impact on sports is broad, potentially altering the landscape for all participants, from players to governmental organizations and spectators.

Bibliometric analysis

Impact assessment was based on the annual number of articles published from 2019 to 2024, as shown in Figure 3.

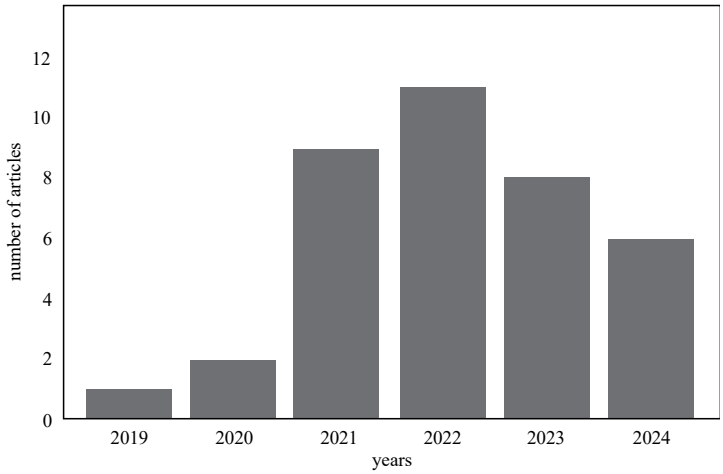

Figure 3. Annual publication volume (2019–2024)

Publications on blockchain in the sports industry have risen. Specifically, nine and 11 papers on this topic were published in 2021 and 2022, respectively. This highlights the growing interest and relevance of this topic in the academic community. Notably, the earliest article selected from our comprehensive search dates to 2019, 11 years after Nakamoto's paper introducing the technology (Nakamoto, 2008).

Twenty-nine different scientific journals published the articles reviewed in this research. IEEE Access (Cao et al., 2021; Liu et al., 2021; Mohammad et al., 2023) and Mobile Information Systems (Song & Tuo, 2022; Wang & Liu, 2022; Yu, 2021) had the highest number of publications, with three articles each. Research in International Business and Finance had two publications each (Ersan et al., 2022; Foglia et al., 2024). Additionally, 29 other journals were identified with only one publication each.

Table 4 provides a comprehensive overview of the most relevant journals extracted from the databases using the search term(s), classified by the number of articles published in these databases. While all journal counts are recorded in a spreadsheet for further analysis, this table highlights the top three journals with the highest number of publications during the study period. The table includes other important metrics such as impact (Journal Citation Reports and H-index) and prestige (SCImago Journal Rank and Eigenfactor Score), along with the number of articles found in the search.

Table 4. The impact of the most relevant journals

Journals	NA	JCR	HI	SJR	ES
IEEE Access	3	3.476	204	Q1 (0.93)	0.002
Mobile Information Systems	3	1.863	42	Q3 (0.66)	<0.001
Research in International Business and Finance	2	6.143	63	Q1 (1.27)	None

NA: Number of articles, JCR: Journal Citation Reports, HI: H-index, SJR: SCImago Journal Rank, ES: Eigenfactor Score, CIT: Total number of journal citations, and None: There are no records for the search criteria you entered. Created by the authors

Regarding impact, especially in terms of the Journal Impact Factor, the journal Research in International Business and Finance performed better, most likely due to the relevance of its publications in the business and finance field since 2018. It is noteworthy that none of the most published journals are in the sports field, suggesting possible disinterest in technology-related topics within this field or reluctance among researchers who commonly publish in this area to submit their work to these journals. Remarkably, the journals Research in International Business and Finance were not found in the Eigenfactor Score database (eigenfactor.org), which ranks only certain ISI-listed journals by category, journal, and publisher.

In the subsequent step, the articles were condensed to determine which researchers had the greatest impact. None of the authors listed in the database had more than one article included in this study, implying that no author stood out in terms of the number of publications. Consequently, we used the criterion to analyze the lead authors of the six papers published in the year 2024. Table 5 presents the researchers ranked by total number of citations and h-index in the Google Scholar database.

Table 5. The 2024 authors' impact

Authors	CIT	HI	Institution
Alaminos, David	363	8	University of Barcelona, Spain
Ante, Lennart	2126	19	Blockchain Research Lab
Foglia, Matteo	640	14	University of Bari, Italy

Fukuzawa, Mathew	8	2	North Carolina State University, USA
Jun, Wang	None	None	Anhui Xinhua University, China
Vidal-Tomás, David	1333	16	University College London, UK

CIT: Number of author citations on Google Scholar; HI: H-Index; USA: United States of America; UK: United Kingdom. Created by the authors.

The analysis of the author's impact in a research area reveals how each researcher seeks to establish their ideas in their field of expertise. Therefore, journal impact analysis favored the selection of high-quality journals and determined study visibility. The six articles published in 2024 highlight expertise in financial and economic research, with Alaminos, Ante, Matteo, and Vidal-Tomás holding PhDs in economics. Fukuzawa, a doctoral student in Operations Research, has fewer citations and a lower h-index. Information on Jun was unavailable in the Google Scholar database.

Discussion

In this section, we present the qualitative stage of the analysis: a discussion of the answers we identified for each of our research questions. After, we describe the limitations of this study and implications for future research.

RQ1: What is blockchain technology?

Approximately 60% (n = 22) of the articles included in this review provide an understanding of what blockchain technology is, while 25% (n = 9) exclusively address the term fan token or non-fungible token (NFT), sometimes without explicitly defining blockchain technology itself. Around 20% of the articles do not have a specific section dedicated to discussing the definition of blockchain, incorporating it within the context of the study's objective. This requires the reader to have some familiarity with the subject to comprehend the analyses proposed by these articles. Additionally, 15% (n = 6) of the studies do not provide a clear definition of this technology.

Within this context, several definitions of blockchain technology have emerged. However, from a technical perspective, blockchain can be defined as a distributed peer-to-peer digital ledger that uses cryptography to ensure its security while recording transactions (Jiang et al., 2023; Nugraha et al., 2021). At the same time, it allows the addition of new data through a commonly agreed consensus mechanism, ensuring that previous data records cannot be altered or deleted (Lv et al., 2022). Thus, it becomes a decentralized and transparent record-keeping

system. However, according to Naraine (2019), this definition of blockchain may be too abstract for professionals in the sports industry if they do not have a background in technology.

At its core, blockchain is a revolutionary technology that enables the creation of a shared database among multiple parts without relying on a central authority. This database consists of a sequence of blocks, with each block containing information about transactions conducted (Hong & Park, 2020; Pinto et al., 2022; Yu, 2021). The key characteristic of blockchain technology is decentralization. Instead of a single point of control, multiple participants in the network possess a copy of the complete database, known as the ledger. These participants, also known as nodes, validate and record transactions, ensuring the integrity and security of the data (Ma, 2021; Song & Tuo, 2022; Wang & Liu, 2022).

In the database analyzed in this study, we can find a definition to explain what blockchain is simply and directly: "A blockchain consists of blocks and chains. Blocks are linked together in chronological order by the hash value of the previous block, which makes the blockchain difficult to change" (Sang & Wang, 2022). Additionally, Chen et al. (2022) make the impactful statement that catalyzes this study: "The blockchain is a game-changer."

RQ1 Insight: What is blockchain technology?
Blockchain technology originated with the creation of Bitcoin, linking it to the decentralization of the financial market. However, due to its inherent features, its application has extended beyond financial sectors to various other fields and segments. The sports industry has leveraged the versatility and innovative potential of this technology for the development and facilitation of processes, both in technical and managerial contexts. Within the sports industry, blockchain can be regarded as a pivotal tool for ensuring data integrity, transparency, and security regarding health and performance metrics, as well as for enhancing fan engagement through the authenticity of collectibles and digital assets.

RQ2: Why is blockchain technology adopted in the sports industry?

According to the definition of sport presented in the Oxford online dictionary, 73% of the studies refer to the adoption of blockchain technology in the context of competitive/professional gaming, only 5.4% use the technology in the context of physical activity, and 21.6% do not mention a specific area of use. Blockchain technology is adopted in the sports industry for its security, decentralization, traceability, and credibility, enhancing data protection, fan

engagement, performance analysis, and integration with other industries, as evidenced by the studies:

- Digital Economy: The use of technology to ensure new sources of income through digital collectibles (Alaminos et al., 2024; Baker et al., 2022; Chen et al., 2022; Demir et al., 2022; Ersan et al., 2022; Foglia et al., 2024; Mazur & Vega, 2023; Naraine, 2019; Scharnowski et al., 2023; Solntsev et al., 2022; Vidal-Tomás, 2023; Wilson et al., 2022; Yang et al., 2023).
- Transfer and Contracts: The use of blockchain for automated and decentralized contract management favoring the process of acquiring or transferring athletes (Fukuzawa et al., 2024; Liu et al., 2021).
- Health Monitoring and Injuries: Blockchain can be used to monitor health by collecting and recording data on the blockchain, allowing tracking of relevant information and ensuring data integrity (Karakaya & Akleylek, 2021; Li & Zhu, 2023; Mohammad et al., 2023; Pinto et al., 2022; Pu et al., 2023; Yu, 2021).
- Performance or Physical Activity: Blockchain can be used for analysis, improvement, and control of the performance of sports teams or physical activity practice (Cao et al., 2021; Hong & Park, 2020; Jun et al., 2024; Sang & Wang, 2022; Shan & Mai, 2020; Song & Tuo, 2022).
- Integration and Innovation: The integration of blockchain with various industries, including the sports industry, is a growing trend. This integration can bring benefits such as innovation, better data management, security, and transparency in different processes (Jiang et al., 2023; Li et al., 2021; Naraine, 2019; Nugraha et al., 2021; Sabarigirisan et al., 2021; Shan & Mai, 2020; Sharma, 2021; Wang & Liu, 2022; Yin et al., 2023).

RQ2 Insight: Why is blockchain technology adopted in the sports industry?
Adopting blockchain technology in the sports industry offers multiple benefits, such as generating new revenue streams via fan tokens, combating data manipulation and forgery, crowd management at competition venues, and facilitating secure decision-making processes based on data analysis. This multifaceted approach addresses current challenges and fosters sustainable innovation within the sports industry.

RQ3: Where is blockchain technology enforced in sports?

Blockchain technology is applied across various sports sectors, including digital collectibles, contract management, athlete transfers, access control and digital tickets, performance monitoring, health and injury management, and fan engagement, among many others. As the technology continues to evolve, new applications and use cases are being explored, mainly to increase transparency, security, and efficiency in different aspects of the sports industry.

Within the context of the studies included in this review and for didactic purposes, we will divide them into three facets: (1) those studies that focused on investigating the use of blockchain technology in the field, meaning applicability with a focus on the activity itself; (2) off the field, with characteristics more related to sports management; (3) the intersection between these two areas, where an application has interference both off and on the field almost equally, as shown in Table 6.

Table 6. RQ3: Where is blockchain technology enforced in sports?

Sports Field	Primary studies		
On-Field	Cao et al. (2021) Jun et al. (2024) Mohammad et al. (2023) Song & Tuo (2022)	Hong & Park (2020) Karakaya & Akleylek (2021) Pu et al. (2023) Yin et al. (2023)	Jiang et al. (2023) Ma (2020) Sang & Wang (2022) Yu (2021)
Off-Field	Alaminos et al. (2024) Demir et al. (2022) Liu et al. (2021) Naraine (2019) Scharnowski et al. (2023) Wang & Liu (2022)	Baker et al. (2022) Ersan et al. (2022) Lv et al. (2022) Nugraha et al. (2021) Solntsev et al. (2022) Wilson et al. (2022)	Chen et al. (2022) Foglia et al. (2024) Mazur & Vega (2023) Sabarigirisan et al. (2021) Vidal-Tomás (2023) Yang et al. (2023)
Both	Ante et al. (2024) Li et al. (2021) Sharma (2021)	Fukuzawa et al. (2024) Pinto et al. (2022)	Li & Zhu (2023) Shan & Mai (2020)

Created by the authors

The studies reviewed show a higher but balanced focus on blockchain technology applications focusing on sports management, with 32% (n=12) addressing on-field perspective and 49% (n=18) examining off-field aspects. This indicates a homogeneous application of blockchain technology across the sports industry.

RQ3 Insight: Where is blockchain technology enforced in sports?
The implementation of blockchain technology has been observed in optimizing trajectories and target tracking in videos, smart contracts for data management,

protecting the integrity of anti-doping control processes and broadcasting rights for sporting events, negotiating fan tokens and digital assets, and managing athlete skills and performance in real time. Therefore, its adoption in sports is not confined to functionality or management; these practical applications demonstrate its versatility and ability to meet emerging needs in challenging contexts. Thus, blockchain emerges not merely as a facilitator of secure transactions and data management but as a vector for innovation, engagement, and integrity across the entire sports industry.

RQ4: When is blockchain technology applied in the sports environment

As noted, the applicability of blockchain technology in the sports industry is diverse. Studies show significant homogeneity regarding the application of the technology. It is worth remembering that the first paper to introduce the concept of blockchain through Bitcoin was in 2008 (Nakamoto, 2008), meaning we are discussing a technology that rapidly gained prominence and also made significant strides in the sports industry.

In this environment, the use of technology is consistently applied during training sessions and matches, focusing on its effectiveness in physical tests related to athlete health monitoring (Karakaya & Akleylek, 2021; Yu, 2021), injury monitoring (Li & Zhu, 2023), improvement of athletic performance (Hong & Park, 2020), monitoring of physical data for high school students (Sang & Wang, 2022), or basketball players (Song & Tuo, 2022). An analysis of the use of technology for doping control, highlighting the most efficient data-sharing processes to ensure athlete privacy preservation, traceability, and integrity (Pinto et al., 2022), was also observed as an application of blockchain technology in the context of sports.

Other studies explore applications that are not limited to specific moments, such as training or games but are more connected to the sports management process and different applications aimed at understanding the dynamics of technology use in the sports industry. We can highlight actions related to fans during sporting events, in the context of COVID-19 control or access control measures (Nugraha et al., 2021; Sabarigirisan et al., 2021) and in the digital realm, where several authors have explored the application of blockchain from the perspective of fan tokens and their various uses, ranging from fan engagement (Demir et al., 2022) to the appreciation of digital assets (Solntsev et al., 2022; Vidal-Tomás, 2023) based on team victories in championships (Ante et al., 2024) and their financial relationship (Ersan et al., 2022; Foglia et al., 2024; Mazur & Vega, 2023) as an attractive form of resources.

From the perspective of technology's applicability in the context of sports, we can highlight the use of smart contracts for athlete transfers (Liu et al., 2021), due to blockchain's main characteristics of security, immutability, transparency, and auditability, which offer possibilities to optimize processes and create new forms of trust and collaboration. As a result, we may soon see the use of this technology applied to the NFL draft, as this conceptual idea was explored by (Fukuzawa et al., 2024).

RQ4 Insight: When is blockchain technology applied in the sports environment?
Its application becomes established from the moment there is a recognized need for security, clarity, and engagement in the processes to be undertaken. As these are fundamental characteristics of blockchain technology, its use is becoming increasingly prevalent in this industry, driving innovation, and connecting sectors that might not have been envisioned to operate together. In a hyper-connected world, it is challenging to view the sports industry without associating it with the necessary and existing technological advancements, and at this juncture, the use of blockchain, both technically and commercially, is part of this process.

RQ5: Who is involved in blockchain technology in the sports context?

From the analysis of these studies, we can identify various actors in this scenario, including government, sports entities, clubs, athletes, fans, sports organizations, leagues, and companies, among others, who are working and innovating in the use of blockchain technology in sports. This can be confirmed by some citations, such as: "Players, spectators, technical team, and club doctors are involved, with blockchain technology ensuring the integrity of the data" (Karakaya & Akleylek, 2021); "The system has three unique roles: coach, team doctor, and athlete, each with its functional modules" (Li & Zhu, 2023); "Who is involved: sports clubs, the fans, blockchain developers, and platforms like 'Socios' that facilitate the engagement between these entities" (Alaminos et al., 2024); or "Sports industry enterprises, government, and regulatory bodies involved in blockchain technology in the sports context" (Li et al., 2021).

RQ5 Insight: Who is involved in blockchain technology in the sports context?
The unique involvement of emotion, presence, and significance of a wide range of stakeholders, from sports organizations to digital platforms and regulatory bodies, presents a challenge in this industry. Thus, it is observable that athletes, spectators, and

technical and medical team members of clubs interact directly with the technology, benefiting from the data integrity ensured by it. Besides these, online sales platforms, investors, and fans also reap benefits from the applicability of blockchain. However, it is crucial not to overlook the developers working in this industry, both in the creation and maintenance of applications and in teaching their use to other professionals, highlighting the intersection between sports, technology, and investment.

RQ6: How is blockchain technology designed for sports?

It is not possible to provide a recipe or manual on how blockchain technology is or can be designed for the sports industry. Each institution has its own reality and distinct problems to solve depending on its level of managerial maturity. As blockchain technology continues to advance, it is believed that numerous other studies on this topic and its applicability in sports will emerge in the coming years. Thus, we are still dealing with an emerging technology that requires more time for in-depth exploration of its uses and applications.

However, we can frame blockchain technology as a shift in focus from algorithms and computer science to management and operationalization. Furthermore, it guides how this new system differs from the current paradigm and gains acceptance in the sports industry. Blockchain can be conceptualized in sports organizations not only as a new technology that can bring about changes but as a paradigm that, due to its decentralized and transparent nature, sets it apart from other studies and applications in sports that are focused on centralization as a key factor in this industry.

RQ6 Insight: How is blockchain technology designed for sports?
Blockchain technology is tailored for the sports sector through various forms of usability, in addition to its integration with other technologies. The amalgamation of these factors and the versatility of this technology are crucial for sports management, especially using smart contracts and encryption that ensure trustworthy governance processes. This capacity has the potential to revolutionize management and operational practices in the sports sector through decentralization, security, and the immutability of data.

Study limitations and future research directions

The limitations of the study stem from the lack of clear indications about the applicability of blockchain technology in the sports industry, as this is a relatively new area and there is a scarcity of articles in exercise and sports science journals. Most articles are published in technology-focused journals, and in the case of this review, we found many articles with a financial bias, mainly focusing on fan tokens. Due to this fact and the speed of technological advances, the breadth of this theme relies on many works presented at conferences and scientific congresses, but many without peer review, which was an exclusion process adopted for this review. It is also worth noting that among the selected databases, five articles were identified that, at first glance based on their titles, would be part of this review but were excluded due to failures in peer review of the journals. In this way, it is recommended to produce more articles that are submitted to journals utilizing peer review and that address the topic of using this technology in the sports industry from the perspective of professionals already immersed in this field. Thus, it will be possible to understand how to expand the contribution of blockchain technology with new applications and contribution strategies within the sector beyond the technical bias of its development, but rather as its application that can modify and facilitate sports actions.

Based on the findings regarding blockchain technology in the commercialization of fan tokens, it is also recommended to produce new studies that address the topic beyond the financial aspect, but rather analyze the possibility of this technology's application on its influence on fan engagement and participation in activities proposed by clubs and sports organizations, considering the potential for fans to have a greater sense of belonging to a group with common interests.

Conclusion

This study aimed to show the potential uses of blockchain technology in the sports industry. The importance of using this technology is increasingly recognized both in the industry and academia. Different stakeholders and blockchain applications were found in the selected studies. We collected 1,571 articles and selected 37 of them as primary studies for this comprehensive review. The primary studies reveal that the current main objectives of employing blockchain technology in sports are closely related to sports management, mainly with applications involving the use of fan tokens. Several studies fall within the domain of theoretical experimentation, as this is an emerging field where theories are being tested for subsequent applications. Based on the extracted data, we observe various areas where the technology is being applied that are expected to transform the industry in the coming years. As

blockchain technology is still in its early stages, especially in the sports context, we acknowledge that this is an ongoing topic, with increasing interest from the scientific community. Therefore, it is important to include a refinement of the lifecycle of different objects within this technology, studying the mapping between stakeholders and their decision rights, responsibilities, and incentives, as well as analyzing legal regulations and ethical responsibilities. In the future, we intend to better understand the use of blockchain technology in sports, guided by the perspective of governance.

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2 ESTUDO 2 – BLOCKCHAIN AND SPORTS INDUSTRY: A SYSTEMATIC LITERATURE REVIEW OF FAN TOKENS AND THEIR IMPLICATIONS[2]

Blockchain and Sports Industry: A systematic literature review of Fan Tokens and their Implications

ABSTRACT

Background: Fan tokens emerge as a significant innovation that enables a new form of interaction between clubs and their followers and introduces an alternative economic model for sports entities. **Purpose:** The review discusses the technical characteristics of fan tokens and their role in enhancing fan participation in minor club decisions, reinforcing the sense of belonging and community. **Methods:** The research encompassed a systematic literature review, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and Evidence-Based Systematic Mapping in Software Engineering (EBSE). Thus, it presented a quantitative and qualitative analysis of the applications of fan tokens in the sports industry. **Results:** Despite engagement and monetization opportunities, **t**he results highlight significant challenges, such as price volatility and appropriate regulation to ensure safe and effective adoption. The discussion also includes the ethical and social implications of using fan tokens, emphasizing the need for strategies that prioritize inclusion and fairness for fan engagement. **Conclusion:** Finally, the study proposes future research directions that consider continuous technological development and changes in fan expectations, aiming to optimize the use of fan tokens to benefit the stakeholders involved.

Keywords: Sport Management; Blockchain; Fan Engagement; Fan Tokens; Digital Assets; Tokens

Antecedentes: Los tokens de fans surgen como una innovación significativa que permite una nueva forma de interacción entre los clubes y sus seguidores e introduce un modelo económico alternativo para las entidades deportivas. **Propósito:** La revisión discute las características técnicas de los tokens de fans y su papel en mejorar la participación de los aficionados en decisiones menores del club, reforzando el sentido de pertenencia y comunidad. **Métodos:** La investigación abarcó una revisión sistemática de la literatura, siguiendo las pautas de los

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Elementos de Informe Preferidos para Revisiones Sistemáticas y Meta-Análisis (PRISMA), y presentó un análisis cuantitativo y cualitativo de las aplicaciones de los tokens de fans en la industria deportiva. **Resultados:** Los resultados destacan que existen desafíos significativos como la volatilidad de los precios y la necesidad de una regulación adecuada para garantizar una adopción segura y efectiva a pesar de las oportunidades de participación y monetización. La discusión también incluye las implicaciones éticas y sociales del uso de tokens de fans, enfatizando la necesidad de estrategias que prioricen la inclusión y la equidad para la participación de los aficionados. **Conclusión:** Finalmente, el estudio propone futuras direcciones de investigación que consideren el desarrollo tecnológico continuo y los cambios en las expectativas de los aficionados, con el objetivo de optimizar el uso de los tokens de fans para beneficiar a las partes interesadas involucradas.

Palabras clave: Gestión Deportiva; Blockchain; Compromiso de los Aficionados; Tokens de Aficionados; Activos Digitales; Tokens.

INTRODUCTION

The intersection of technology and sports, innovation, demographic shifts among fans, and the evolution of global sports sectors have catalyzed notable transformations in how sports entities interact with their fan base (Frevel, Beiderbeck, & Schmidt, 2022). In the past, fan engagement was directly linked to maximizing game attendance, viewership of sports broadcasts, and team merchandise sales (Funk & James, 2001). However, the emergence of digital platforms has ushered in a new era of community building. Fans now actively participate, share opinions, and influence club decisions (Filo, Lock, & Karg, 2015).

At the center of this revolution are fan tokens, which utilize blockchain technology to provide a secure and transparent digital collectible to engage fans in an innovative and meaningful way. These tokens strengthen the connection between sports entities and their supporters and open new avenues for monetization and community engagement, reshaping the commercial landscape in sports (Manoli, Dixon, & Antonopoulos, 2024).

The tokens represent a new class of digital assets that offer fans an active voice in the operations of sports entities. These tokens let fans vote on minor decisions like training locations, halftime music selections, or merchandise designs. They can participate in exclusive events, creating a sense of inclusion and belonging (Ante, Saggu, Schellinger, & Wazinski, 2024). This new form of engagement is crucial for strengthening the bonds between clubs and their fans, transforming them from mere spectators into active participants in the culture of the sports entity and more involved in its management (Zarifis & Cheng, 2022).

Blockchain technology forms the foundation upon which fan tokens are built, bringing robustness, security, and transparency. Blockchain enables decentralized transactions and records each transaction on a distributed ledger, ensuring data security, transparency, and fairness in fan token operations. This technology is crucial for mitigating fraud and ensuring user trust, allowing fans to engage knowing that their contributions are secure and verifiable (Al-Saqaf & Seidler, 2017; Ata et al., 2023).

While fan tokens offer many opportunities for innovation in fan engagement, they also present various challenges. Price volatility, driven by market speculation, can deter less adventurous fans and put the investment of the more enthusiastic ones at risk. Furthermore, the absence of precise regulation for crypto-assets can create an environment of uncertainty for sports entities and fans, hindering the full realization of the potential offered by fan tokens (Assaf, Demir, & Ersan, 2024). Appropriate regulation is, therefore, crucial for the future use of fan tokens in sports. Hence, developing a regulatory framework that protects consumers without stifling innovation is essential. This regulation should address the economic aspects of fan tokens and their social and ethical implications, ensuring that fan engagement is fair and inclusive (Foglia, Maci, & Pacelli, 2024).

Therefore, defining a transparent approach to using fan tokens in sports is essential. The primary objective of this systematic review is to comprehensively explore the role of fan tokens in the sports industry, particularly how these blockchain-based assets are reshaping fan engagement, governance, and revenue generation for sports organizations. Specifically, this study aims to (1) analyze the adoption and utilization patterns of fan tokens by sports entities, (2) evaluate the economic and regulatory challenges associated with these digital assets, and (3) investigate the ethical and social implications of integrating fan tokens into the broader sports ecosystem. By addressing these aspects, this research seeks to provide a clearer understanding of the potential and limitations of fan tokens as tools for innovation in sports management.

This study strictly adhered to the standard guidelines for systematic reviews, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021) and the Evidence-Based Systematic Mapping in Software Engineering (EBSE) (Kitchenham et al., 2007; Petersen, Vakkalanka, & Kuzniarz, 2015). The key contributions of this article are threefold, each designed to support and complement the study's objectives: (a) identifying and curating a set of primary studies related to fan tokens in the sports industry, providing a foundational database for future research; (b) conducting a comprehensive synthesis, both quantitative (bibliometric analysis) and qualitative (thematic

analysis), to reflect the current state of the art in fan token research; and (c) offering practical insights based on systematic review findings, which can guide future applications and address the specific challenges highlighted in the study objectives.

The remainder of this article is organized as follows: Section 2 provides an in-depth exploration of fan tokens and reviews relevant literature; Section 3 details the study methodology; Section 4 presents and discusses the results, focusing on fan token applications in the sports field and providing key insights; Section 5 addresses the study's limitations and offers recommendations for future research; and Section 6 concludes the article.

THEORETICAL BACKGROUND

Fan Engagement

Fan engagement in the context of sports currently transcends mere attendance at games or the consumption of licensed products. It encompasses a range of strategies and practices to strengthen the emotional and psychological connection between fans and their favorite clubs or athletes. Based on passion and loyalty, this connection is seen as a fundamental pillar of sports marketing (Huettermann, Uhrich, & Koenigstorfer, 2022). Additionally, brand equity significantly enhances this connection, directly influencing fan satisfaction and loyalty (Miranda, Filho, Silva, & Pedroso, 2024), has demonstrated that the success of a team and the emotional bond fans have with their club can significantly impact their overall satisfaction, which fosters deeper engagement.

In recent years, the intersection of digital innovation in sports has led to an evolution in consumer behavior, redefining the fan engagement process and transforming sports management (Pandita & Vapiwala, 2023). One of the facilitators of this digital revolution is blockchain technology. This decentralized and secure digital ledger system has manifested itself in various application areas in the sports industry (Berkani, Moumen, Benharzallah, Yahiaoui, & Bounceur, 2024; Glebova & Mihal'ová, 2023; Stegmann, Matyas, & Ströbel, 2023), prompting clubs to rethink their engagement approaches. Currently, it is not just about providing a fan experience during the sporting event but creating an ecosystem of interaction that engages the fan at all times and through all available channels (Huth & Kurscheidt, 2022).

Academic literature examines fan engagement as a multidimensional phenomenon encompassing various forms of interaction between the fan and the club, including participation, identification, and contribution activities (Byon & Phua, 2021). Through these

interactions, clubs seek to expand their fan base and promote a sense of community and belonging.

Fan engagement strategies vary significantly from sport to sport and club to club, reflecting differences in their histories, cultures, and commercial objectives. These strategies can range from simple initiatives, such as fan meetings and autograph sessions, to more sophisticated efforts, such as loyalty programs, exclusive social media content, and immersive augmented or virtual reality experiences (Cranmer, Han, Van Gisbergen, & Jung, 2021; Pìlatti, Pereira, Cantorani, Lara, & Renaux, 2024).

A fundamental aspect of fan engagement is personalizing the fan experience. In the digital era, clubs have access to unprecedented data about their fans, enabling the creation of highly customized offers and content. This personalization enhances the fan experience and increases the effectiveness of marketing campaigns and brand loyalty (Xu, Li, Scott, & Wang, 2023).

Another critical point in fan engagement is constructing a compelling narrative around the club and its players. Stories that resonate emotionally with fans can significantly strengthen their identification with the club and encourage active participation in the fan community. Social media's ability to rapidly spread content enables the construction and spread of viral narratives (Scholz, 2020).

Furthermore, fan engagement is broader than the online environment. Clubs are increasingly recognizing the importance of engaging fans in activities outside of the digital realm, such as community events, social responsibility initiatives, and fan involvement programs in club decisions. These activities help strengthen fans' emotional connection with the club and promote a sense of pride and belonging (Huettermann et al., 2022).

Fan engagement also directly impacts clubs' financial results. An engaged and loyal fan base is likelier to consume licensed products, purchase tickets, subscribe, and participate in loyalty programs. Additionally, high levels of engagement can attract sponsors and commercial partners, increasing the club's revenue (Dima, 2015).

In the digital era, social media has emerged as one of the most effective channels for fan engagement. It allows clubs to communicate directly with their fans, share exclusive content, and promote two-way interaction (Huth & Kurscheidt, 2022). In addition to social media, clubs are exploring a variety of digital technologies to enhance fan engagement. Customized mobile applications provide fans access to news, statistics, exclusive video content, and interactive features such as club-related games and quizzes (Byon & Phua, 2021),

significantly enhancing sports institutions' marketing and publication efforts (Fathoni, Adi, Mu'arifin, Yunus, & Cholifah, 2024).

Gamification is another growing trend in fan engagement, utilizing game design elements to encourage fan participation in online activities. Contests, challenges, and reward systems can significantly increase engagement by motivating fans to interact with club content creatively and enjoyably (Cranmer et al., 2021). Moreover, the use of digital platforms also plays a crucial role in direct revenue generation through the sale of online products and services, further enhancing the economic sustainability of sports clubs (Fathoni et al., 2024). Virtual experiences represent a significant advancement, allowing fans to experience the game innovatively. From viewing matches in virtual reality to participating in virtual events in the metaverse, these technologies are opening up new horizons for interaction between clubs and fans (Scholz, 2020).

Personalization is a crucial aspect of fan engagement, with clubs using fan data to provide more relevant and personalized experiences. Advanced analytics and artificial intelligence allow segmentation of the fan base and delivery of content tailored to their individual preferences, increasing the effectiveness of marketing campaigns and overall engagement (Xu et al., 2023).

Fan tokens and cryptocurrencies are emerging as a new form of engagement, allowing fans to participate in club decisions, access exclusive content, and earn rewards. This innovative approach transforms how fans interact with clubs, offering a new dimension of engagement and participation (Dima, 2015).

Fan Token Overview

Fan tokens have emerged as a disruptive innovation in the sports ecosystem, blending fan passion with emerging opportunities using blockchain technology (Demir, Ersan, & Popesko, 2022; Glebova & Mihal'ová, 2023). These digital assets, operating at the intersection of sports and finance, enable a new form of interaction between clubs and their fan base, offering a demonstration of financial support and active participation in the club's life (Ante, Schellinger, & Demir, 2024).

Academic literature and the cryptocurrency industry generally recognize fan tokens as fungible utility tokens developed on blockchain platforms, making each token of a specific type identical and interchangeable (Ante, Wazinski, & Saggu, 2023; Demir et al., 2022). These tokens empower holders with voting rights on certain organizational matters, access to

exclusive rewards, and interactive experiences with the issuing organization, enhancing fan engagement and participation (Ante et al., 2024a).

However, the domain of fan tokens is dynamically evolving, leading to an unconventional perspective where fan tokens overlap with non-fungible tokens (NFTs) (Zarifis & Cheng, 2022). This approach leverages the unique ownership characteristics of NFTs to foster community engagement and brand promotion, diverging from traditional fungible advantages (Martha, Warnars, Prabowo, Meyliana, & Hidayanto, 2023). This approach opens up various pathways for monetization and enhances fan interaction (Glebova & Mihal'ová, 2023).

These tokens function as a bridge between fan passion and technological innovation, consolidating a new paradigm of engagement and interaction within the sports and entertainment ecosystem (Ante et al., 2024b; Demir et al., 2022; Glebova & Mihal'ová, 2023; Scharnowski, Scharnowski, & Zimmermann, 2023) The tokens represent the fan's loyalty and engagement with the club, allowing them to participate in decisions through voting, access exclusive merchandise, and even experience unique moments, such as meeting players or visiting the club's facilities exclusively (Glebova & Mihal'ová, 2023). This new form of digital engagement represents a significant evolution in how fans interact with their favorite teams, making them active participants in the sports community (Ante et al., 2024a).

In addition to participation and engagement, researchers also highlight fan tokens as an effective way to generate additional income for clubs, expand their marketing strategies, and strengthen relationships with sponsors. This new revenue stream is essential in dealing with financial challenges and gives sports clubs more flexibility in their operations (Foglia et al., 2024; Zarifis & Cheng, 2022).

Through blockchain technology, fan tokens ensure transparency and security in transactions, providing fans with a reliable means of investment and participation (Scharnowski et al., 2023). This technology facilitates the secure acquisition and exchange of tokens and records all interactions on an immutable blockchain, offering an additional layer of trust and authenticity to fan activities.

It is important to note that, in addition to opportunities, there are risks and challenges associated with adopting fan tokens, such as market volatility and the need for proper regulation to protect both consumers and the integrity of sports. These challenges require a cautious approach and a robust regulatory framework to ensure that the benefits of fan tokens are maximized without harming fans or sports overall (Zarifis & Cheng, 2022).

Elite football clubs worldwide have rapidly adopted fan tokens, recognizing the opportunity to strengthen ties with their global fan base while opening a new source of revenue. The Socios.com platform has been at the forefront of this innovation, collaborating with some of the biggest clubs in the world to launch their fan tokens (Demir et al., 2022; Vidal-Tomás, 2023).

However, this adoption has criticism and challenges. Some argue that this innovation may lead to excessive commercialization of the fan experience, putting access to specific exclusive experiences and participation behind a paywall. This concern raises essential questions about inclusion and democratization of fan engagement (Scharnowski et al., 2023).

However, fan tokens also present a new dimension to sports marketing, allowing clubs to engage their fans innovatively and collect valuable data about preferences and behaviors. This insight can, in turn, inform more effective marketing strategies and product development tailored to meet fans' needs and desires (Ante et al., 2023; Glebova & Mihal'ová, 2023). This transformation benefits clubs with increased revenue and enhances the fan experience, making it more interactive and satisfying (Manoli et al., 2024).

Therefore, the issuance of fan tokens is typically associated with an Initial Coin Offering (ICO), where tokens are sold to fans and investors, akin to the launch of a new cryptocurrency. This process generates immediate revenue for the club and establishes a base of token holders with a vested interest in the club's success (Demir et al., 2022; Glebova & Mihal'ová, 2023). These tokens also represent an opportunity for globalization for clubs, enabling them to reach fans in international markets more effectively (Scharnowski et al., 2023).

This technology within the sports ecosystem offers innovative ways to enhance the fan experience, increase transparency in operations, and create revenue streams for stakeholders (Glebova & Mihal'ová, 2023). It provides safer and more efficient transactions, simplifies ticket and merchandise sales processes, and adds transparency in contract management, promoting fair and equitable treatment (Zarifis & Cheng, 2022).

The creation and widespread dissemination of fan tokens offer a new level of fan engagement, allowing them to own unique digital assets linked to their favorite teams and players (Zarifis & Cheng, 2022). Additionally, it helps reshape monetization opportunities for sports brands, communities, organizations, teams, and leagues, as they can sell these assets to fans at a premium. Blockchain-based voting systems can create a more democratized and inclusive sports industry and greater fan involvement in decision-making processes (Ante et al., 2024a).

The challenges and limitations must be carefully considered to unlock these technologies' full potential in the sports industry. These include regulatory issues, security concerns, and potential resistance from traditional sports organizations and stakeholders, who may view blockchain technologies as threatening their existing business models (Foglia et al., 2024; Wilson, Karg, & Ghaderi, 2022). Although there are significant challenges, this technology offers exciting opportunities to transform the sports industry in various ways, leading to greater efficiency, transparency, and fan engagement.

MATERIALS AND METHODS

A systematic literature review (SLR) was conducted to achieve the study's objectives, enabling mapping and assessing the current state of knowledge on fan tokens from the sports management perspective, thus expanding existing knowledge on fan engagement (Tranfield, Denyer, & Smart, 2003). The choice of SLR was motivated by the primary aim of examining the extent and function of fan tokens from the viewpoint of sports fan engagement. The methodological basis of this review article follows the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021), as well as guidelines for systematic literature review and Evidence-Based Systematic Mapping in Software Engineering (EBSE) (Kitchenham & Brereton, 2013; Kitchenham et al., 2007; Petersen et al., 2015). This combination of guidelines ensures a comprehensive analysis of both quantitative and qualitative research, leading to a more robust data synthesis.

Motivations of the SLR Study

Sports is one of the most established phenomena worldwide, involving billions of people. Consequently, it plays a fundamental role in society (Lombardo, 2012), thanks to its multidimensionality, which contributes to the community's well-being in various ways, from educational and recreational to political and fiscal aspects. With technological advancements, the impact on sports management has become increasingly challenging (Ratten, 2019).

In this scenario, the rise of NFTs comes into play, where they can become standalone brand assets, influencing marketing funnel stages from pre-purchase awareness to post-purchase loyalty, suggesting that NFTs enable brands to create highly engaging brand communities by blending ownership of products both online and offline, potentially creating a solid bond between the brand and consumers (Colicev, 2023). This technological advancement provides new management approaches that offer greater efficiency, transparency, and stakeholder engagement (Carlsson-Wall & Newland, 2020). This connection can revolutionize

fan interactions with content and how teams, players, and leagues manage monetization and their digital presence (Baker, Pizzo, & Su, 2022; Scharnowski et al., 2023). Major sports leagues, including the NBA and NFL, are investing in blockchain technology-based solutions, such as NBA Top Shot, a platform developed in partnership with Dapper Labs, allowing trading of digital collectibles or "moments" from the NBA, such as videos of iconic plays (Young, 2021).

Conducting research in this field can help identify various use applications for fan tokens with transformative potential for sports enthusiasts. Additionally, it can assist in understanding the challenges regarding implementing this technology, which may be crucial for developing practical solutions that meet user needs. Moreover, it is possible to identify gaps in existing knowledge and suggest areas for further studies, contributing to advancing scientific research in sports management.

Research Strategy

To gather pertinent literature for this systematic review, a search strategy reflecting the scope and objectives of the research was formulated. Search strings were defined in two main domains: "fan token" and "sport." For the "fan token" domain, variations of keywords such as "fan token," "NFT," "non-fungible token," and "non fungible token" were included. In the "sport" domain, the term "sport" (or "sports" in plural) was included. The search algorithm was constructed by intertwining these two domains with an AND operator, resulting in the following search string: sport* AND (("fan token") OR ("NFT") OR ("non-fungible token") OR ("non fungible token")). To ensure comprehensive exploration, relevant articles were sought from multiple data sources, including the Institute for Scientific Information (ISI) Web of Science, Scopus, ScienceDirect, Institute of Electrical and Electronics Engineers (IEEE) Xplore, Dimensions, and Springer Link. Also, we included other articles through manual searches on Google Scholar to encompass a broader range of literature.

Specific inclusion and exclusion criteria guided the selection of studies for this systematic literature review to ensure the relevance and quality of the research considered. Only peer-reviewed research articles in English were included, as this language dominates the academic discourse and provides access to a broader range of scholarly work. Additionally, the availability of the full text was a prerequisite, allowing for a thorough examination of each study's methodology and findings. The review focused exclusively on studies directly related to the use of fan tokens in the sports industry, excluding any work that only mentioned fan tokens superficially or addressed them outside the scope of sports. These stringent criteria were

essential in narrowing down the literature to studies that specifically addressed the research questions and contributed valuable insights into the application of fan tokens in enhancing fan engagement and the management of sports entities. Two independent and experienced researchers conducted the electronic search without language or time filters. Third, research resolved any conflicts.

After the initial search, we conducted a forward and backward snowballing process to identify any additional related studies not found in the initial search. Backward snowballing involves examining the references of articles, while forward snowballing involves examining articles that cited the selected studies (Wohlin, 2014). Using the snowballing strategy, a total of 32 potential studies were found, with 16 already in the initial research database, 2 were book chapters, 1 was a conference paper that we did not consider in this review, and 10 studies did not adhere to the study scope after full reading; thus, three studies were found within the scope according to all the research criteria and were included.

This method involves using the reference lists of the initially selected "seed" papers to discover new studies ("snowballed" papers) that were not captured in the initial search but are relevant to the research topic. For instance, the paper Singhal, Gupta, Bhushan, & Choudhuri (2023) led to the inclusion of Zarifis & Cheng (2022), while Chen (2024) pointed to Zaucha & Agur (2024). Notably Ersan, Demir, & Assaf (2022), it was initially cited Mazur & Vega (2023) in their pre-print version from 2022, updated in the final published version. This process was instrumental in broadening the scope of the review and ensuring that all relevant literature was considered.

Quality assessment

The studies were evaluated to ensure their quality based on established guidelines for systematic reviews. Therefore, we assessed the quality and finalized the eligibility for inclusion of the studies (Kitchenham & Brereton, 2013; Petersen et al., 2015; Wohlin, Mendes, Felizardo, & Kalinowski, 2020). Thus, five quality criteria (QC) were developed, each with a possible score of 1 (yes), 0.5 (partially), or 0 (no). The total scores of the five QCs were calculated, and articles were classified into three categories: good ($4 < \text{score} \leq 5$), fair ($3 \leq \text{score} \leq 4$), and poor ($0 \leq \text{score} < 3$). Articles in the excellent and fair categories were included, while those in the poor category were excluded. All articles selected for this review had scores above three, indicating fair or sound quality. Therefore, all selected articles were included in this review study, with no exclusion based on the quality criteria of the studies. The QCs analyzed were:

- QC1: Does the study have a clearly defined research objective?

To be considered for inclusion, a primary study must have a clear objective related to fan tokens. A study that does not meet this criterion will not be included in the subsequent data extraction and synthesis process, as it can only adequately present fan token applications with a defined research objective.

- QC2: Does the study clearly define a fan token and its application in sports?
  A clear definition is necessary as it can help develop a comprehensive understanding of fan tokens in sports.
- QC3: Does the study clearly describe its methodology?
  The applied methodology is crucial for determining the article's relevance to this research.
- QC4: Does the study propose practical applications for the use of fan tokens?
  The proposed solutions from a study and their feasibility are essential for designing practical, available, and applicable methods.
- QC5: Does the study discuss its limitations?
  The discussion about the current limitations of the applicability and use of fan tokens can reveal the direction of future studies on this research topic.

Bibliometric Analysis

The data extraction process began with the download of selected articles to compose the SRL, with their basic information recorded (e.g., title, year of publication, authors, publishing journal, and affiliation) to assess the impact of these publications, enabling the understanding of a specific research field from its scientific structure. It becomes necessary to analyze the structure of the works and how authors organize themselves in this context.(Horta, Ströele, Braga, David, & Campos, 2018). This bibliometric analysis composition used during a systematic review can also be observed in articles such as Principe et al. (2022). Google Scholar was used to centralize the search for the researcher's h-index. Thus, the analysis of the articles' impact in this SRL followed the following format:

a) Analysis of authors' impact (Egghe & Rousseau, 2008; Hu, Yang, Zu, & Huang, 2021)
b) Classification of journals (Canales, 2020; Vairavan, Prayle, & Davies, 2020)

Research Question Protocol (RQ)

The research questions (RQ) in our RSL protocol are framed using the 5W1H approach (i.e., what, why, where, when, who, and how). (Liu, Lu, Zhu, Paik, & Staples, 2023) carried out this same idea; however, we added one more question for this research: How Much, thus resulting in 5W2H as a premise. This comprehensive analysis enables a better understanding of the use and application of fan tokens in the sports industry, as shown in Table 1.

Table I.

Research questions with 5W2H approach.

RQ	5W2H	Research question	Motivation
1	What	What is a fan token?	To observe how primary studies define the concept of fan token.
2	Why	Why is the fan token adopted in the sports industry?	To understand the forces to adopt fan tokens in sports.
3	Where	Where is the fan token distributed in the sports context?	To identify how fan tokens are distributed to fans.
4	When	When is the use of fan token valid?	To distinguish the key objectives to use fan tokens in the sports industry.
5	Who	Who is involved in the development of fan tokens in the sports context?	To identify who the stakeholders are in the development of fan tokens in sports.
6	How	How is the fan token applied in the sports industry?	To determine how a fan token is used in the sports industry.
7	How Much	How much can fan tokens transform sports clubs' finances and operations?	To understand in monetary and operational terms what the behavior of a fan token is like.

RQ: Research Question and 5W2H: five questions starting with the letter W (What; Why; Where; When; Who) and two questions beginning with the letter H (How; How Much). Source: Created by the authors.

In RQ1, our objective is to extract the definition of fan tokens from primary studies, which will provide insights into the fundamental dimensions of using this digital asset. RQ2 aims to identify essential issues related to the use of these tokens. This research question will allow us to understand the distribution of these fan tokens to fans in RQ3 and when their use is valid in RQ4. RQ5 focuses on understanding the stakeholders involved in developing fan tokens in sports. RQ6 aims to expand knowledge about the sports ecosystem by identifying documented uses and applications of fan tokens. By doing so, we can understand how fan tokens are interconnected and determine when it makes sense to use them as an engagement strategy, up to understanding the variation in their cost and the challenges in an operational way in RQ7.

Data Analysis, Synthesis, and Reporting

During the final phase, we extracted data from each study that met the inclusion criteria, followed by analysis relevant to the research questions. The fundamental attributes of the

studies were carefully extracted and examined to answer the research questions. To address the initial research question, we analyzed each article's proposal and provided a taxonomy of the presented use cases.

While an answer to the research question may be found in the initial analysis, a more comprehensive synthesis of the studies is needed to extract the details of fan token usage and utilization. Addressing the third, fourth, and fifth research questions, barriers, challenges, and stakeholders associated with fan tokens in the sports industry can be identified, as per information in the analyzed articles. We also discuss how these limitations and strategies have been adopted. The insights obtained in this systematic review are detailed in Section 4.

To manage the results of our electronic search, we initially exported them to the Rayyan web platform to organize the articles, excluding duplicates. We then conducted the entire process of inclusion and exclusion through double-anonymized validation using three reviewers (Ouzzani, Hammady, Fedorowicz, & Elmagarmid, 2016). For study quality and the snowballing method, we utilized Zotero® 6.0.19, an open-source desktop software that is free, easily accessible, and user-friendly for researchers, in addition to Google® Sheets for ongoing double-anonymized verification.

RESULTS

This section will present the workflow with the review framework and each step employed for study selection, assessment of study quality, and analysis, both quantitative (bibliometric) and qualitative (research questions).

SLR framework

Six electronic databases, ISI Web of Science, Scopus, ScienceDirect, IEEE Xplore, Dimensions, and Springer Link, were used to review the literature systematically. The search phrase was developed using the Boolean operators [AND] and [OR] (among the descriptors). Initially, 2,253 studies were identified, but after removing all inconsistencies (duplicates, retractions, and out-of-scope), 38 studies were used for full-text reading. After this stage, 20 articles remained, and we began the snowball process to identify other articles that could not be determined using the keywords. In this way, we included 3 studies and manually added 2 more studies that we found on Google Scholar and did not appear in the snowball process. Therefore, the 25 studies included in this review met the established criteria regarding methodological quality, and none were excluded. In this way, the 25 articles remained for quantitative and qualitative analysis (see Figure 2), last updated in May 2024.

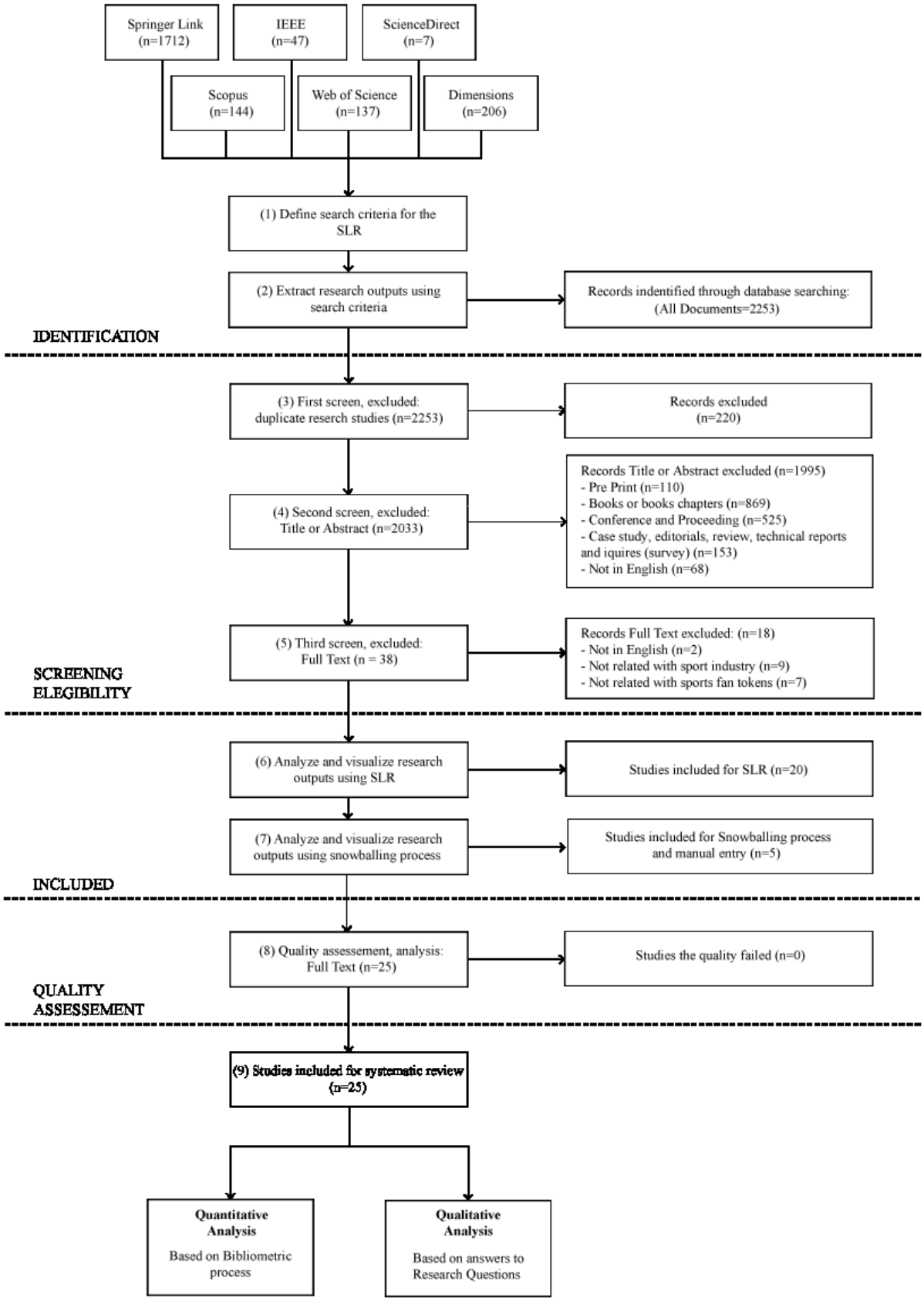

Figure 1. The overview process of the literature review was adapted from Page et al. (2021) and Kitchenham et al. (2007). IEEE: Institute of Electrical and Electronics Engineers and SLR: systematic literature review. Legend: Source: Created by authors.

According to the guidelines established by Kitchenham & Brereton (2013), Petersen et al. (2015) and Wohlin et al. (2020), for a systematic literature review (SLR), the review process can introduce threats to the validity of the studies found. Consequently, following the study selection shown in Section 3 and the framework represented in Figure 1, we developed strategies to mitigate the influence of these studies based on their quality. The validity of this construct can be compromised by the possible incompleteness of the search words and the ambiguity of the terms used.

However, this ambiguity was mitigated by applying strict inclusion and exclusion criteria and conducting thorough screenings of titles, abstracts, and full texts during the study selection process. Publication bias, favoring studies with positive outcomes over those with negative findings, also poses a threat. This bias arises from the higher likelihood of studies reporting significant findings being accepted for publication. To counterbalance this effect, all included studies were meticulously evaluated against quality criteria by four researchers who reviewed these studies to ensure adherence to the predefined protocol.

Bias in the data extraction phase occurs when two researchers extract the assigned studies and validate each other's results. A predefined quality protocol was used to facilitate the extraction, considering the researchers' different experiences and knowledge reserves. Thus, studies that scored less than 3 were deemed inadequate and failed the quality criterion based on five questions needing identification (Table 2). In this way, all 24 selected studies met the methodological quality criteria.

Table II.

The methodological quality of the included studies.

Authors	Questions					Total
	1	2	3	4	5	
Alaminos et al. (2024) [51]	1	.5	1	1	1	4.5
Ante et al. (2024) [5]	1	1	1	1	1	5
Ante et al. (2024) [26]	1	1	1	.5	.5	4
Assaf et al. (2024) [9]	1	1	1	1	.5	4.5
Baker et al. (2022) [38]	1	.5	1	.5	0	3
Chen (2024) [52]	1	1	1	.5	0	3.5
Demir et al. (2022) [25]	1	1	1	1	1	5
Demir and Ramazan (2022) [53]	1	.5	1	.5	0	3
Ersan et al. (2022) [54]	1	.5	1	.5	1	4
Foglia et al. (2024) [10]	1	1	1	1	1	5
Glebova and Mihal'ová (2023) [16]	1	1	1	.5	.5	4

Lopez-Gonzales and Griffiths (2023) [55]	1	.5	1	.5	0	3
Lopez-Gonzalez and Petrotta (2023) [56]	1	1	1	.5	0	3.5
Manoli et al. (2024) [4]	1	0	1	.5	.5	3
Mazur and Vega (2023) [41]	1	1	1	.5	0	3.5
Read et al. (2023) [57]	1	1	1	.5	0	3.5
Saggu et al. (2024) [58]	1	.5	1	.5	0	3
Scharnowski et al. (2023) [29]	1	.5	1	1	0	3.5
Singhal et al. (2023) [59]	1	1	1	.5	0	3.5
Solntsev et al. (2022) [60]	1	.5	1	1	1	4.5
Stegmann (2023) [17]	1	1	1	1	1	5
Vidal-Tomás (2023) [30]	1	1	1	.5	0	3.5
Wilson et al. (2022) [31]	1	1	1	0	1	4
Zarifis and Cheng (2022) [6]	1	1	1	.5	.5	4
Zaucha and Angur (2022) [61]	1	.5	1	0	.5	3

Source: Created by authors.

Bibliometric analysis

The impact was initially assessed for the bibliometric analysis based on the number of articles published per year (2022, 2023, and 2024). Figure 2 illustrates the number of articles published each year. Therefore, it can be observed that the subject related to fan tokens in sports is in its initial stage but shows an increase in the number of articles each year.

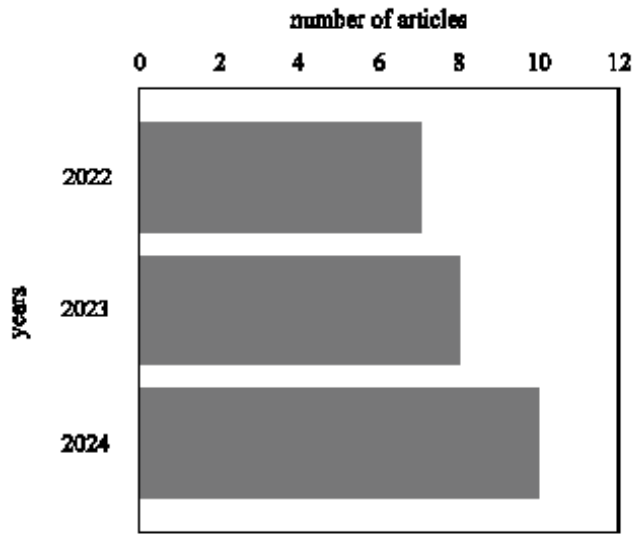

Figure 2. Number of articles published each year available. Legend: Source: Created by authors.

Specifically, publications on fan tokens began in 2022 with seven studies, while in 2022, this number increased to eight, and in 2024, it increased to ten studies. This highlights the interest and relevance of this topic in the academic community, as the market also introduces other uses for this digital asset. Notably, despite conducting a comprehensive search on fan tokens in the sports industry, the first selected article is dated 2022. Fourteen years after Nakamoto's article introducing blockchain technology (Nakamoto, 2008), publications on using this technology for sports benefits, in this case, through the lens of fan tokens, began. Therefore, it is emphasized that the theme of fan tokens in the sports industry presents much potential that can be explored in the coming years.

In this research, 22 scientific journals were identified, and the articles used for this review were published. The journal Research in International Business and Finance, Ersan et al. (2022), Foglia et al. (2024), and Saggu, Ante, & Demir (2024) had the highest number of studies included in this review with three papers, followed by the International Journal of Sports Marketing and Sponsorship, Chen (2024) and Stegmann et al. (2023) with two. Additionally, another 20 journals were identified, each with only one publication.

The impact of the journals with the most publications in the database was assessed using several key metrics across the 22 identified journals. Two journals demonstrated superior performance, particularly notable for publishing more than one article. According to the Scimago Journal & Country Rank (SJR), the Research in International Business and Finance ranked in the first European quartile with a score of 1.29. It also boasts an H-Index of 73, a Journal Impact Factor (JIF) of 6.5, and a Journal Citation Indicator (JCI) of 2.05. In contrast, the International Journal of Sports Marketing and Sponsorship has an SJR of 0.6, an H-Index of 33, a JIF of 2.2, and a JCI of 0.6. The analysis captured each journal's performance in terms of impact and prestige. However, it is essential to note that for some of these journals, more data is needed regarding the Eigenfactor Score (eigenfactor.org), which is specific to ISI-ranked journals, thereby limiting the comparison across all metrics.

In the subsequent stage, the articles were condensed to determine which researchers had the most impact. For this analysis, two authors, Dr. Lennart Ante and Dr. Hibai Lopez-Gonzalez, were compared, as both have two articles included in this study's database. Dr. Lopez-Gonzalez, a professor at the Faculty of Information and Audiovisual Media at the University of Barcelona, holds a PhD in Public Communication. His research interests include the pathological behaviors of individuals engaged in gambling and sports betting. His notable works in this review include "Gambling-like Features in Fan Tokens" and "Gambling-like Digital Assets and Gambling Severity: A Correlational Study with U.S. Sports Bettors

Consuming Cryptocurrencies, NFTs, and Fan Tokens," which explore the gambling-like characteristics of fan tokens. Dr. Lopez-Gonzalez has 2,343 citations and an H-Index of 24 on Google Scholar, underscoring his significant influence in his field.

Dr. Lennart Ante, CEO and Co-Founder of the Blockchain Research Lab in Germany, a non-profit organization dedicated to independent science and research on blockchain technology, holds a PhD in Economics. His contributions to this study include "Voting Participation and Engagement in Blockchain-based Fan Tokens" and "The Impact of Football Games and Sporting Performance on Intra-day Fan Token Returns." Additionally, he co-authored the study "Anticipatory Gains and Event-driven Losses in Blockchain-based Fan Tokens: Evidence from the FIFA World Cup" with Saggu. Dr. Ante has 2,255 citations and an H-Index of 19 on Google Scholar, reflecting his significant impact on blockchain technology and its application to sports.

Analyzing these two researchers' citation counts and H-index highlights their substantial contributions and influence within their respective areas of expertise, emphasizing their relevance to the ongoing discourse in fan token and blockchain research.

Research questions

In this section, we present the qualitative stage of the analysis. A discussion of the responses identified in the studies for each of our research questions is provided. All responses are organized below in the order and as the questions were presented.

RQ1: What is a fan token?

A fan token is a digital asset that has enabled sports fans to take various actions with their teams, using blockchain technology to ensure efficiency and trust. Beyond promoting more significant interaction between sports clubs and their fans, fan tokens represent an innovative frontier in the digital financial market. They are part of the growing trend of asset tokenization, offering a new form of digital and economic engagement in sports and entertainment (Ante et al., 2024a; Manoli et al., 2024; Zaucha & Agur, 2024). According to Ante et al. (2024a): " Fan tokens, a class of crypto asset that grants holders access to voting on club decisions and other perks, serve as a mechanism for stimulating democratized decision-making and fan engagement in the sports and esports sectors."

These tokens are developed using blockchain technology, ensuring transaction transparency and security. Consequently, each token is unique and associated with a specific sports entity. They allow fans to participate in voting that influences minor decisions, such as

the choice of music at games or uniform designs, and also provide access to exclusive content and experiences (Vidal-Tomás, 2023; Zarifis & Cheng, 2022).

Fan tokens are considered a form of "utility token." Still, beyond the aspect of engagement, they also emerge as a new, innovative source of revenue for sports entities, introducing a business model that capitalizes on the passion and loyalty of fans. Thus, the money raised from token sales can be reinvested to improve facilities, hire new players, or enhance various initiatives (Scharnowski et al., 2023). Despite these advantages, fan tokens have risks. Market volatility can lead to significant financial losses, and the absence of comprehensive regulation may leave room for fraudulent activities and market manipulation (Foglia et al., 2024; Mazur & Vega, 2023).

These tokens are revolutionizing fan engagement and bringing new challenges and opportunities at the intersection of sports, technology, and finance. They represent a clear example of how the boundaries between entertainment, consumer engagement, and financial investment are increasingly intertwined in the digital age (Foglia et al., 2024; Manoli et al., 2024; Scharnowski et al., 2023; Zarifis & Cheng, 2022).

RQ1 Insight: What is fan token?
A fan token is a type of cryptographic digital asset, based on blockchain technology, that allows fans to actively participate in some decisions and in the daily life of their teams, through the right to vote on various issues. Fan tokens also serve as a means of engagement and loyalty for the community, creating a channel of interaction between fans and sports entities. Economically, fan tokens represent a new source of revenue for the issuing organizations, with the token's value often linked to the performance and popularity of the corresponding sports entity in the market.

RQ2: Why are fan tokens adopted in the sports industry?

The sports industry uses fan tokens because they offer a new way to engage fans. They represent an innovative tool for managing and monetizing fan interaction, strengthening loyalty and connection (Ante et al., 2024a).

The adoption of fan tokens in the sports industry has been driven by economic and technological factors that transform how clubs interact with their fans (Vidal-Tomás, 2023). The tokens represent a new form of revenue for the clubs and provide a new way of engaging

with fans, allowing for minor interaction, participation in smaller club decisions, and access to exclusive content (Singhal et al., 2023).

On the other hand, fan tokens are also seen as speculative assets whose prices can fluctuate significantly based on team performance, player popularity, and other market variables. This volatile nature introduces an element of risk for investors, potentially affecting the perception and financial stability of the clubs involved (Scharnowski et al., 2023).

Therefore, there is a growing awareness of the similarities between fan tokens and gambling (Lopez-Gonzalez & Griffiths, 2023; Lopez-Gonzalez & Petrotta, 2023), such as gamification and the possibility of trading on cryptocurrency exchanges, which can turn these tokens into collectibles whose value fluctuates over time (Lopez-Gonzalez & Griffiths, 2023). This perspective is complemented when game outcomes impact token returns, highlighting the strong connection between sports performance and the appreciation of these digital assets (Ante et al., 2024b).

While fan tokens offer new opportunities for clubs to generate revenue and increase fan engagement, they also introduce challenges related to market volatility and the need for robust regulations to protect fans and maintain the integrity of the sports market (Foglia et al., 2024; Mazur & Vega, 2023). These aspects underscore the complexity and multifaceted nature of fan tokens within the context of the sports industry.

RQ2 Insight: Why are fan tokens adopted in the sports industry?
Fan tokens are transforming the interaction between sports clubs and their fans by enabling participation in decisions and access to exclusive content, strengthening the emotional bond and increasing engagement. These digital tokens also open up new revenue streams by tapping into fans' enthusiasm. However, the volatile nature of these assets, which fluctuates based on sports performance and market speculation, presents significant risks. Additionally, their gambling-like characteristics necessitate clear regulations to protect consumers and maintain market integrity. Therefore, while fan tokens offer unique opportunities, they also require careful management and adequate regulation to mitigate potential risks.

RQ3: Where is the fan token distributed in the sports context?

Fan tokens are primarily distributed through specialized platforms collaborating directly with sports entities (Lopez-Gonzalez & Griffiths, 2023). The leading platform offering these

tokens in the context of sports is Socios.com, developed by the company Chiliz and pioneering in this sector (Ante et al., 2024a; Vidal-Tomás, 2023). Fan tokens enable holders to participate in decisions related to the club, such as jersey design and other promotional activities, thus offering a new way of interaction between fans and sports entities(Alaminos, Salas, & Fernández-Gámez, 2024). In addition to Socios, other platforms such as Binance have also started offering fan tokens, expanding access to and trading these digital assets (Demir & Ramazan, 2022; Scharnowski et al., 2023).

These tokens are acquired through an Initial Token Offering (FTO), similar to an Initial Coin Offering (ICO), where tokens are made available to the public. After the initial offering, the tokens can be traded on the secondary market on various cryptocurrency platforms. This offering process and subsequent trading establish the token price based on market supply and demand (Assaf et al., 2024).

Additionally, new tokens are distributed to fans periodically. This distribution is related to market dynamics and may occur during promotional activities and/or significant events, such as major games. However, this distribution is strategically planned to maintain fan engagement and increase the token holder base (Scharnowski et al., 2023). These tokens are also used as a marketing tool, providing fans with a way to participate more actively in club activities while also generating a source of revenue (Ante et al., 2024b).

Therefore, fan tokens in sports are primarily distributed through strategic partnerships between fan engagement platforms and sports clubs. Initial sales and secondary markets facilitate acquiring and trading these digital assets. Integrating these tokens into the financial market highlights the growing merger between digital finance and sports entertainment, presenting opportunities and challenges for investors and fans (Ante et al., 2024b; Assaf et al., 2024; Scharnowski et al., 2023).

RQ3 Insight: Where is the fan token distributed in the sports context?
The distribution of fan tokens in the sports context is primarily carried out through specialized platforms that collaborate directly with sports entities to launch the tokens. The tokens are strategically distributed in alignment with significant events, enhancing fan engagement and using these tokens as a powerful marketing tool. This approach helps to strengthen the bond between the parties and expand revenue opportunities. The merging of digital finance with sports entertainment brings new opportunities, but also

challenges and the need for regulations due to the complexity of this new facet of the sports economy.

RQ4: When is the use of the fan token valid?

Fan tokens are valid as long as they are in circulation and supported by the platform and the club offering them (Lopez-Gonzalez & Griffiths, 2023; Solntsev, Alekseeva, & Susov, 2022; Vidal-Tomás, 2023). These tokens are used primarily to increase fan engagement and open new revenue sources for clubs. They are also used to vote on club decisions during specific periods when voting is open for token holders to participate (Ante et al., 2024a).

Fan tokens, as blockchain-based digital assets, give holders special rights. This form of digital interaction enables increased loyalty and fan engagement. It allows for a new form of monetization, aligning with the expectations of younger generations and the growing digitization of sports entertainment (Manoli et al., 2024; Singhal et al., 2023; Solntsev et al., 2022). They also introduce gamification features into the fan experience, typically offering a rewards system and competitions that incentivize and lead to more significant interaction. These aspects transform fan activity into a more interactive and rewarding experience, promoting a "serious leisure" model in fan culture (Manoli et al., 2024; Stegmann et al., 2023).

Furthermore, fan tokens can be traded as financial assets, enabling gains depending on market demand (Saggu et al., 2024), thus creating an economic dimension that benefits both token owners and sports entities in terms of increased liquidity and potential market value growth (Scharnowski et al., 2023; Solntsev et al., 2022; Zaucha & Agur, 2024). However, trading these tokens also involves risks, including the introduction of gambling-like features (Lopez-Gonzalez & Griffiths, 2023), which can lead to problematic gambling-related behaviors (Foglia et al., 2024; Lopez-Gonzalez & Griffiths, 2023). The strategic use of fan tokens also highlights the importance of data as capital and the ethical implications associated with digital assets. Clubs should implement these technologies ethically and responsibly, ensuring that they positively contribute to the fan experience without compromising the core values of sports (Read & Smith, 2023; Zarifis & Cheng, 2022).

The use of fan tokens is valid when it strengthens the relationship between fans and clubs, offering mutual benefits that transcend mere commercialization, and when it is implemented ethically and regulated. This approach can benefit the sports industry on various levels, from increasing revenues to creating a richer and more engaging fan experience (Ante

et al., 2024b; Lopez-Gonzalez & Griffiths, 2023; Manoli et al., 2024; Read & Smith, 2023; Stegmann et al., 2023; Zarifis & Cheng, 2022).

RQ4 Insight: When is the use of the fan token valid?
Fan tokens validate themselves as a mechanism for engagement and monetization in the sports industry, enabling fans to actively participate in some decisions and obtain tangible benefits that strengthen their bond with their team. They not only offer a chance for financial appreciation in secondary markets but also enhance the sense of community and identity among fans. However, given their inherent volatility, it is imperative that there be careful regulation to protect the interests of fans and the integrity of sports. The valid uses of fan tokens, as identified in academic articles, include: • Voting on non-critical club decisions. • Access to exclusive or signed merchandise. • Opportunities to experience unique events and obtain tickets. • Holding tokens as collectible items of sentimental value. • Demonstrating support and belonging to the club. • Trading as financial assets with potential for value appreciation.

RQ5: Who is involved in developing fan tokens in the sports context?

Various stakeholders are involved in developing fan tokens within the sports context, ranging from sports clubs and their management teams to technology companies, investors, fans, and regulatory bodies (Lopez-Gonzalez & Griffiths, 2023; Vidal-Tomás, 2023; Wilson et al., 2022). The primary entities driving the development and distribution of fan tokens include sports clubs and specialized technology companies, such as Chiliz's Socios Collectibles. These organizations collaborate to create digital assets that offer fans unique privileges, enhancing their engagement and connection with their favorite teams. This collaboration leverages the clubs' brand loyalty. It utilizes the technical expertise of firms like Chiliz to innovate and secure these digital assets, providing a new layer of interaction and value for fans (Ante et al., 2024a; Demir et al., 2022; Ersan et al., 2022).

Investors and fans constitute a crucial group of stakeholders (Wilson et al., 2022). While some fans purchase fan tokens to support their favorite clubs and enjoy the associated benefits,

others see them as speculative investments, hoping to profit from fluctuations in token prices (Scharnowski et al., 2023; Vidal-Tomás, 2023). This dual role of fan tokens, both a fan engagement tool and a speculative asset, highlights the diverse motivations driving their purchase and use. The cryptocurrency market's volatility (Mazur & Vega, 2023), where fan tokens are traded, adds another layer of complexity, affecting both the clubs' ability to generate stable revenue from the tokens and the risk exposure of fans and investors (Ersan et al., 2022; Solntsev et al., 2022).

To deepen the discussion on the involvement of various stakeholders, it is essential to recognize the growing role of blockchain and fintech technologies in the sports industry (Wilson et al., 2022). Blockchain technology provides a secure and transparent foundation for creating fan tokens, enabling fans to participate more actively in club decisions (Ante et al., 2024b). Furthermore, NFTs emerge as a new form of collectible sports memorabilia, allowing digital ownership of iconic moments, game-worn uniforms, and other items that offer new revenue streams for athletes and sports organizations (Glebova & Mihal'ová, 2023; Singhal et al., 2023).

Integrating fan tokens and blockchain technologies in the sports industry reshapes how brands engage with their fans, creating opportunities for branding, monetization, and community building (Demir & Ramazan, 2022; Vidal-Tomás, 2023). The use of NFTs allows sports brands to launch products that act as standalone components of the brand, expanding brand awareness and engaging previously inaccessible audiences, such as Generation Z. These digital products not only serve as new sources of revenue but also as tools to enhance fan engagement during challenging times, such as the COVID-19 pandemic, where physical attendance at stadiums was limited (Chen, 2024; Ersan et al., 2022).

However, sports brands' adoption of fan tokens and NFTs also presents significant challenges, including issues of valuation, alignment between brands and consumers, integration of physical products with digital assets, cryptocurrency market volatility, regulatory matters, and the need for effective communication strategies. These barriers need to be addressed to maximize the potential of these technologies (Foglia et al., 2024; Scharnowski et al., 2023).

RQ5 Insight: Who is involved in the development of fan tokens in the sports context?
The rise of fan tokens in sports illustrates a revolution in the interaction between clubs and their fans, marking the beginning of an era where digitalization transforms

engagement into a two-way street with exclusive opportunities and shared experiences. Tokens go beyond simple monetization, touching the core of what it means to be a true fan by offering a share in the action and an active voice in club decisions, thus redefining the notions of loyalty and belonging. Brand communities become the new "virtual stadiums" where the passion for sports finds free expression, enhanced by the authenticity and proximity these spaces provide. However, this uncharted path brings with it regulatory challenges and market volatilities that test the resilience and adaptability of clubs in their quest for innovation. Ultimately, fan tokens are not just an emerging tool in sports marketing; they are an invitation to reimagine the dynamics between sports brands and their fans, promising an ascent to engagement that transcends the boundaries of the physical and digital, shaping the future of loyalty.

RQ6: How is the fan token applied in the sports industry?

Fan tokens are introducing an innovative interaction layer between clubs and their followers. Based on blockchain technology, these tokens allow fans to participate in club decisions, access exclusive content, and experience unique events (Ante et al., 2024a; Lopez-Gonzalez & Petrotta, 2023; Vidal-Tomás, 2023). They are used to increase fan engagement with trivial club decisions (Lopez-Gonzalez & Griffiths, 2023) ranging from choosing merchandise designs to selecting locations for friendly matches, providing fans with a sense of belonging and tangible influence over some club decisions (Ante et al., 2024a; Demir et al., 2022). Renowned football clubs like Juventus, Barcelona, and Paris Saint-Germain have been pioneers in adopting fan tokens, signaling the start of a trend that extends to other sports (Manoli et al., 2024). These tokens represent a new source of revenue and a method to expand fan bases globally, establishing a stronger bond between clubs and their followers (Demir et al., 2022; Zarifis & Cheng, 2022). Unlike traditional shares, fan tokens do not confer ownership rights but offer exclusive benefits that reinforce the loyalty of their holders (Manoli et al., 2024).

The digitalization facilitated by fan tokens aligns with the trends of sports consumption on digital platforms, meeting modern fans' expectations for more immersive and personalized interactions (Manoli et al., 2024; Singhal et al., 2023). This move towards broader digitalization is a natural response to the growing demand for digitally accessible sports content and meaningful social media interactions. Through this digitalization, clubs can reach a global audience, expanding their reach far beyond geographical barriers and creating an international community of supporters. Additionally, the initial offerings of these tokens open a significant

financial opportunity for clubs to capitalize on the loyalty and engagement of their fans (Foglia et al., 2024).

Despite its positive potential, the expansion of fan tokens is not free from criticism. Clubs face challenges when implementing these initiatives, including concerns about the excessive commercialization of sports, the exclusion of fans who cannot or do not want to acquire tokens, and the volatility in the value of the tokens (Mazur & Vega, 2023; Scharnowski et al., 2023). Therefore, clubs must adopt strategies to mitigate these concerns, ensuring that fan tokens complement rather than replace traditional forms of fan engagement (Manoli et al., 2024).

In this way, clubs must seek a balance between innovation and inclusion, not to tote a significant portion of their fan base. The careful integration of fan tokens into the clubs' engagement strategies can help maintain the authenticity of the fan-club relationship while exploring new digital opportunities (Manoli et al., 2024; Vidal-Tomás, 2023). However, for this innovation to be sustainable in the long term, clubs must carefully navigate the associated challenges, ensuring that the benefits for fans outweigh the potential disadvantages (Scharnowski et al., 2023). The future of fan tokens and their widespread adoption in the sports industry remain uncertain, but the potential for a new era of engagement is undeniable (Baker et al., 2022; Manoli et al., 2024).

This innovative NFT marketing and community engagement approach highlights non-fungible tokens' vast and largely untapped potential as standalone brand assets (Zarifis & Cheng, 2022). By linking a brand's NFT strategies with the marketing funnel stages, from brand awareness to post-purchase loyalty, NFTs offer a new dimension to branding, digital marketing, and consumer engagement (Manoli et al., 2024). They allow brands to venture beyond traditional marketing methods, exploring the intersection between technological innovation and emotional connection with consumers (Zarifis & Cheng, 2022).

RQ6 Insight: How is the fan token applied in the sports industry?
The function of a fan token is to facilitate interaction between clubs and supporters through an innovative platform that allows for direct engagement and participation in decisions, deepening fans' sense of belonging. It also serves as a vector for potential new revenue streams, although this aspect should be approached with caution to maintain the integrity of sports and authentic relationships with followers. Through fan tokens, clubs expand their fan bases, overcoming geographical barriers and fostering a

united community driven by passion for the sport. Aligned with digitization, these tokens encourage innovation, creatively introducing clubs into the digital landscape and appealing to a younger audience. However, the implementation of fan tokens brings significant challenges, including concerns about exclusivity and volatility, necessitating a careful balance between commercialization, fan inclusion, and maintaining an authentic and valuable experience for supporters.

RQ7: How much can fan tokens transform sports clubs' finances and operations?

Fan tokens, emerging from the interaction between blockchain technology and the world of sports, represent a significant innovation with broad implications for clubs, fans, and the sports ecosystem. These digital assets, anchored in blockchain technology, offer a new avenue for fan engagement and open up possibilities for revenue generation and the democratization of fan participation in minor club decisions (Ante et al., 2024a; Ante et al., 2024b; Glebova & Mihal'ová, 2023; Scharnowski et al., 2023). Fan tokens are beginning to stand out as a phenomenon of increasing interest within the sports context, promoting a deeper connection between clubs and their global followers (Ersan et al., 2022; Glebova & Mihal'ová, 2023).

The introduction of fan tokens to the market, as detailed by Ersan et al. (2022), has brought to light the complex dynamics between these new assets and the actions of sports clubs. Through the methodology of Time-Varying Parameter Vector Autoregression (TVP-VAR), it was observed that despite fan tokens being considered independent assets from club actions, they demonstrate a remarkable ability to transmit shocks within the market, underscoring their growing influence (Vidal-Tomás, 2023). Furthermore, although subject to external influences such as game results and cryptocurrency market activities, the variation in fan token prices highlights their volatility and the potential risk for unsuspecting investors (Lopez-Gonzalez & Griffiths, 2023).

On the other hand, it's important to emphasize the broader impact of blockchain and fintech technologies on professional sports (Demir & Ramazan, 2022; Solntsev et al., 2022; Vidal-Tomás, 2023). They point out that beyond fan tokens, the tokenization of tickets and merchandise opens new frontiers for innovation in sports, promising operational efficiency and new forms of fan engagement (Glebova & Mihal'ová, 2023). While fan tokens can serve as a new engagement tool, they also bring challenges related to price volatility and ethical issues

that require appropriate regulation and consumer protection measures (Ante et al., 2024b; Read & Smith, 2023).

Furthermore, research on the dynamics of fan token prices during and after football matches illustrates the direct impact of sporting performance on the returns of these digital assets. Studies show abnormal variations in fan token returns correlated with match outcomes (Ersan et al., 2022). This phenomenon underscores the importance of considering external factors and sporting performance when analyzing investments in fan tokens (Demir & Ramazan, 2022; Lopez-Gonzalez & Griffiths, 2023).

However, the emergence of fan tokens is challenging. Issues related to regulation, ethics (Read & Smith, 2023), and price volatility (Mazur & Vega, 2023) are recurrent in academic discussions, reflecting the need for a clear regulatory framework and investor protection measures. For example, research by Scharnowski et al. (2023) highlights the high volatility of fan tokens as a potential risk for investors, pointing to the need for more outstanding education and transparency in the market.

Furthermore, the analysis of the connectivity between fan tokens and other classes of crypto assets, as observed in works by Foglia et al. (2024), reveals an emerging financial ecosystem in which fan tokens play an increasingly central role. Although still in its early stages, this ecosystem suggests a future in which fan tokens could offer a new form of fan engagement and a robust tool for club financial management.

Finally, applying the theory of technological determinism to the study of fan tokens and blockchain technology in sports offers a theoretical framework for understanding the transformative influence of these technologies on the sports ecosystem. This framework suggests that technological innovations, such as fan tokens, not only reshape interactions between clubs and fans but also have the potential to redefine the business model and operations of sports clubs, paving the way for a future where blockchain technology plays a central role in the sports industry.

RQ7 Insight: How much can fan tokens transform sports clubs' finances and operations??
Fan tokens are opening new frontiers in the sports industry, transforming how fans interact with their favorite clubs. This innovation not only strengthens the connection between clubs and followers by allowing their participation in club decisions but also unveils an emerging business model promising to revolutionize revenue generation.

Each ticket, every piece of merchandise, and even exclusive moments can be tokenized, ensuring authenticity, and creating a rewards economy directly linked to fan engagement. As we move forward, it is crucial to address the challenges of volatility and regulation with a clear vision, protecting investors and ensuring the integrity of this ecosystem. Fan tokens are not just a technological step forward; they are the gateway to a more inclusive, engaging, and financially sustainable sports ecosystem, redefining the value of fan loyalty in a digital era.

Study limitations and future research directions

This study's main limitation lies in its dependence on the quality and scope of existing studies. Due to the emerging nature of fan tokens, the available literature still needs to be expanded and predominantly focused on technological and market aspects, potentially not fully reflecting these assets' social and ethical impacts. Additionally, the price volatility of fan tokens and the lack of precise regulation introduce a layer of uncertainty that may have influenced the analysis results and limited the ability to generalize findings to different contexts or geographical regions.

Despite these challenges, the future of fan tokens in the sports industry appears promising, with vast potential for innovation and redefining brand and fan engagement strategies. As blockchain technology evolves, these digital tools transform sports marketing and set new standards for interactions among clubs, sports-supporting brands, and consumers. Considering the limitations, future research should focus on expanding the body of studies on fan tokens in sports with empirical investigations exploring their long-term impacts on fan behaviors and loyalty. Studies could also analyze the effectiveness of fan tokens in improving fan experience and the financial sustainability of clubs, as well as developing strategies to mitigate risks associated with these digital assets. Developing and implementing a comprehensive regulatory framework that addresses identified challenges, such as market speculation and the ethical implications of token use, is essential. Future studies should also address the interactions of fan tokens with issues of inclusion and accessibility, ensuring that fan engagement promotes fair and equitable participation, free from economic and social barriers.

CONCLUSION

Fan tokens represent a significant innovation in engagement between sports entities and their fans, offering an additional layer of interaction and participation thanks to blockchain

technology. This study has detailed the transformative role of fan tokens in fan engagement within the sports ecosystem, highlighting it as an innovative fusion of technology and sports. Using blockchain technology to develop fan tokens has provided a secure and transparent platform, allowing for more direct and meaningful interaction between clubs and fans. Through specialized platforms, fan tokens are traded to the interested fan base, allowing them to participate in their team's decisions, even minor ones, attend exclusive events, and access specialized content, strengthening the bond between fans and clubs and fostering a sense of community. This advancement represents not only a new class of digital assets but also a new engagement strategy that empowers fans to have an active voice in the operations of their favorite teams, redefining the relationship between sports entities and their followers.

The analysis conducted in the study has shown that fan tokens not only strengthen community ties and increase fans' sense of belonging and loyalty but also provide essential security, robustness, and transparency through blockchain technology, which are crucial for mitigating fraud risks and promoting greater trust and fairness in fan token operations. Such characteristics are vital for the success and acceptance of this technology in the mainstream market. However, the study also acknowledges the challenges faced, such as the market volatility of crypto-assets and the need for clear and compelling regulations. Despite these challenges, fan tokens stand out as a remarkable example of digital innovation in sports, offering valuable insights for academics, sports managers, and fans on how technology can enrich fan experiences and strengthen the internal operations of sports entities. With the continued development of blockchain technology and a regulatory approach, fan tokens have the potential to set a new standard in fan interactions and loyalty in an increasingly digital era, leveraging an already organized and passionate community for the sports institution in the real world.

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All authors confirm no conflicts of interest with any public or private financial institution regarding the manuscript's content.

AUTHOR'S CONTRIBUTION

Conceptualization: VAP, GCPSMS, RGSV, RAMN; Methodology: VAP, GCPSMS, RGSV, RAMN; Formal analysis: VAP, GCPSMS, RGSV, RAMN; Investigation: VAP, GCPSMS, RGSV, RAMN; Writing: VAP, RGSV, RAMN; Visualization: VAP, GCPSMS, RGSV, RAMN; Supervision: VAP, RGSV, RAMN.

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3 ESTUDO 3 – AVALIANDO O IMPACTO E AS PERSPECTIVAS FUTURAS DOS FAN TOKENS NA ECONOMIA DIGITAL DOS ESPORTES: UMA ANÁLISE CORRELACIONAL[3]

Resumo

O presente estudo teve o objetivo de explorar as interações entre variáveis financeiras e de mercado de 20 *fan tokens* do esporte, para fornecer uma compreensão das dinâmicas de mercado que influenciam a avaliação e a percepção de valor dos ativos digitais. Utilizando dados coletados do site CoinGecko, este trabalho adotou uma metodologia quantitativa para analisar a dinâmica de mercado desses tokens, incorporando variáveis como preço (P), capitalização de mercado (CM) e fornecimento circulante (FC). Os resultados das correlações da CM com P (rho=0,54) e P30 (rho=0,46) sugerem que aumentos na capitalização de mercado estão associados a aumentos nos preços atuais e futuros. A avaliação totalmente diluída (FDV) apresentou correlações com P30 (rho=0,701) e com CM (rho= 0,802) e indicam que as expectativas futuras estão alinhadas com as avaliações de mercado. A M/FDV teve correlação negativa com P30 (rho=-0,742) e FDV (rho=-0,771), sugerindo que à medida que a M/FDV diminui, existe tendência para o aumento nos preços futuros, o que pode indicar uma percepção de subvalorização do ativo. A correlação de DIFF com P30 (rho=0,586) e M/FDV (rho=-0,901) pode trazer também a percepção de subvalorização e uma expectativa de correção positiva nos preços. Além disso, a análise destacou o papel dos *fan tokens* como novas formas de receita para os clubes, ao mesmo tempo em que introduzem complexidades financeiras e regulatórias. O estudo concluiu que, apesar dos desafios, os *fan tokens* representam uma evolução no conceito de *fandom*, com potencial para transformar o engajamento dos fãs em uma experiência mais ativa e valorizada.

Palavras-chave: *Fan Tokens*. Dinâmicas de mercado. Engajamento dos fãs. Valorização digital. NFT. Blockchain.

Abstract

The present study aimed to explore the interactions between financial and market variables of 20 sports fan tokens, to provide an understanding of the market dynamics that influence the valuation and perception of value of digital assets. Using data collected from the CoinGecko website, this work adopted a quantitative methodology to analyze the market dynamics of these tokens, incorporating variables such as price (P), market capitalization (MC), and circulating supply (CS). The results of the correlations of MC with P (rho=0.54) and P30 (rho=0.46) suggest that increases in market capitalization are associated with increases in current and future prices. The fully diluted valuation (FDV) showed correlations with P30 (rho=0.701) and with MC (rho= 0.802), indicating that future expectations are aligned with market valuations. The M/FDV had a negative correlation with P30 (rho=-0.742) and FDV (rho=-0.771), suggesting that as M/FDV decreases, there is a tendency for an increase in future prices, which may indicate a perception of undervaluation of the asset. The correlation of DIFF with P30 (rho=0.586) and M/FDV (rho=-0.901) may also bring the perception of undervaluation and an expectation of positive price correction. Furthermore, the analysis highlighted the role of fan tokens as new forms of revenue for clubs, while introducing financial and regulatory complexities. The study concluded that, despite the challenges, fan tokens represent an

[3] Principe, V.A., Santo, W.R.E., Duarte, R.M., Vale, R.G. de S., e Nunes, R. de A.M. (2024). Avaliando o impacto e as perspectivas futuras dos Fan Tokens na economia digital dos esportes. Uma análise correlacional. Lecturas: Educación Física y Deportes, 29(312), 26-40. https://doi.org/10.46642/efd.v29i312.7487

evolution in the concept of fandom, with the potential to transform fan engagement into a more active and valued experience.

Keywords: Fan Tokens. Market dynamics. Fan engagement. Digital valuation. NFT. Blockchain.

Introdução

Os novos ativos digitais, como tokens de torcedores (*fan tokens*) e tokens não fungíveis (NFTs), ganharam destaque em uma onda de atenção da mídia, gerando mais de US$ 44 bilhões em transações em 2021 (Baker et al., 2022), e revolucionando a forma como as organizações esportivas interagem com sua base de torcedores (Ante et al., 2023). Assim, o NFT é um ativo digital que não possui valor fixo e não pode ser substituído pois possui propriedades únicas (Behera et al., 2023).

Os *fan tokens* são uma espécie de criptomoeda que permitem que os fãs tenham uma voz ativa nas decisões menores de suas instituições, promovendo uma conexão mais profunda (Scharnowski et al., 2023). A integração da tecnologia blockchain, devido sua transparência (Wang & Liao, 2022), facilitou o desenvolvimento de *fan tokens,* remodelando a forma de envolvimento dos fãs ao oferecer itens colecionáveis digitais únicos e verificáveis (Chen & Omote, 2022), que podem ser comprados, vendidos e negociados em mercados virtuais (Singhal et al., 2023).

Estes tokens representam uma abordagem inovadora para aumentar o envolvimento e o apoio dos fãs (Hüttermann, 2021) que são objetivos fundamentais para as organizações desportivas profissionais (Baker et al., 2022), e são normalmente emitidos por equipes esportivas para seus fãs, proporcionando-lhes utilidade e oportunidades de engajamento (Demirtas & Orçun, 2022; Scharnowski et al., 2023). Essa inovação vai além do tradicional merchandising, oferecendo uma nova dimensão de lealdade e pertencimento, onde os fãs não são mais meros espectadores, mas participantes ativos na jornada e evolução (Carlsson-Wall & Newland, 2020; Hüttermann, 2021).

Estes ativos digitais foram aproveitados como um meio de aumentar a capacitação, o envolvimento dos fãs e criar novas fontes de receitas para as organizações esportivas (Solntsev et al., 2022), demonstrando o seu potencial como fonte financeira e ferramenta de marketing digital (Demirtas & Orçun, 2022). Esta nova vanguarda tecnológica não apenas aproxima os fãs de suas paixões, mas também oferece uma forma tangível e interativa de participação e engajamento, transformando a natureza passiva do suporte em uma experiência ativa e imersiva (Ante et al., 2023).

Paralelamente, os NFTs no esporte abrem um mundo de possibilidades para o *fandom* (Schmidt, 2024), permitindo a aquisição de momentos icônicos e artes exclusivas (Chen & Omote, 2022). Esses ativos digitais únicos não só servem como uma nova forma de colecionismo esportivo, mas também como uma expressão de apoio e paixão, com o potencial de valorização ao longo do tempo. A propriedade de um NFT é uma declaração de conexão íntima com um momento ou personalidade esportiva, oferecendo aos fãs uma maneira de possuir uma parte da história que eles tanto admiram (Carlsson-Wall & Newland, 2020).

No entanto, o uso de NFTs e *fan tokens* não passou isento de críticas. Eles foram examinados quanto ao seu potencial para mercantilizar o *fandom* e foram associados a características semelhantes às do jogo, levantando preocupações sobre seu impacto no comportamento dos fãs (Lopez-Gonzalez & Griffiths, 2023).Dessa forma, as implicações éticas da conversão de dados de torcedores em capital por meio de estratégias digitais, incluindo tokens de torcedores, levantam preocupações sobre a confiança dos torcedores (Regner et al., 2019).

Apesar dessas preocupações, os *fan tokens* foram identificados como uma potencial plataforma de envolvimento, promovendo uma participação dos fãs nos processos de tomada de decisão dentro das organizações desportivas (Stegmann et al., 2023). Portanto, a

intersecção dos *fan tokens* com os mercados de criptomoedas e as potenciais dependências entre eles têm sido objeto de investigação (Vidal-Tomás, 2023).

À medida que olhamos para o futuro, é presumível que os *fan tokens* e NFTs continuarão a influenciar e moldar a forma como o *fandom* é vivenciado no mundo dos esportes (Schmidt, 2024). Essas tecnologias prometem uma era de maior interação, participação e personalização na experiência dos fãs, oferecendo novas maneiras de celebrar e apoiar suas paixões. Confrontando os desafios e maximizando as oportunidades que surgem com essas inovações, podemos antecipar um futuro em que o *fandom* esportivo seja mais vibrante e inclusivo (Scharnowski et al., 2023).

Nesse sentido, enquanto navegamos nesta era de transformação digital no esporte, os *fan tokens* e NFTs representam não apenas uma mudança na forma como os fãs se engajam com seus ídolos, equipes e instituições, mas também uma evolução no próprio conceito de *fandom* (Carlsson-Wall & Newland, 2020). Eles oferecem uma ponte entre a paixão pelo esporte e as possibilidades ilimitadas da tecnologia, prometendo um futuro em que a conexão entre fãs, instituições, equipes e atletas seja mais dinâmica, profunda e gratificante (Hüttermann, 2021).

Sendo assim, o presente estudo teve o objetivo de explorar as interações entre variáveis financeiras e de mercado de 20 *fan tokens* organizadas e disponibilizadas pelo site CoinGenko (2024), para fornecer uma compreensão das dinâmicas de mercado que influenciam a avaliação e a percepção de valor dos ativos digitais.

Métodos

Para composição desde estudo, foram analisados *fan tokens* esportivos listados e categorizados pelo site CoinGenko (2024), disponível em: https://www.coingecko.com/pt/categories/fan-token.

Desta forma, o critério de inclusão adotado foi a utilização do ranqueamento criado pelo próprio site para selecionar a quantidade de 20 *fan tokens* que iriam compor a amostra desta

pesquisa. O ranqueamento do site tem como base no preço atual do ativo digital no momento da coleta de dados. Vale salientar que esta coleta foi realizada no dia 18 de fevereiro de 2024 às 10:38 minutos e o preço em dólar dos *fan tokens* está relacionado a este momento, o que quer dizer que existe uma flutuação do preço destes ativos.

Amostra

Para a composição da amostra foram selecionados 20 *fan tokens*, utilizando as posições apresentadas pelo site CoinGenko (2024). Essa amostra inclui *fan tokens* de 15 clubes de futebol espalhados pelo mundo, duas federações de futebol, dois projetos de lutas e um time de eSports. Os clubes de futebol geralmente lançam tokens de torcedor por meio da empresa denominada de socios.com, desenvolvida pela Chiliz (CHZ). É o primeiro e mais popular centro para os fãs comprarem direitos de voto tokenizados em seus times favoritos. As variáveis analisadas nesses estudos foram aquelas disponibilizadas digitalmente no site. Na Tabela 1 pode-se observaras variáveis utilizadas e suas descrições.

Tabela 1
Descrição das variáveis de estudo.

Variáveis	Descrição
Preço (P)	Valor em dólar do ativo digital no momento ad coleta dos dados.
Preço e 30 dias (P30)	Valor em dólar do ativo digital nos últimos 30 dias que antecedem o dia da coleta dos dados.
Fornecimento Circulante (FC)	A quantidade de ativos digitais que circulam no mercado e são negociáveis.
Fornecimento Total (FT)	A quantidade de moedas que já foram criadas, menos as moedas que foram queimadas (removidas de circulação). Fornecimento total = fornecimento em cadeia - tokens queimados

Diferença do Fornecimento (DIFF)	Diferença entre o fornecimento total e o fornecimento circulante. Diferença do Fornecimento = Fornecimento total – fornecimento circulante
Capitalização do Mercado (CM)	Valor de mercado total de um fornecimento circulante de uma criptomoeda. Capitalização de mercado = Preço Atual x Fornecimento Circulante
Avaliação Totalmente Diluída (FDV)	É a teórica capitalização de mercado de uma moeda, se toda a sua oferta estiver em circulação, baseado no preço atual de mercado. O valor do FDV é teórico, já que aumentar o fornecimento em circulação de uma moeda pode impactar no preço de mercado. FDV = Preço atual x Fornecimento total
Proporção de capitalização do mercado (M/FDV)	A proporção de capitalização do mercado compara-se à capitalização de mercado quando atingido o suprimento máximo. Quanto mais próxima de 1, mais próxima estará a atual capitalização de mercado de sua apreciação totalmente diluída.

*Fonte: Elaboração dos autores com base no site CoinGenko (2024). *A coleta de dados foi realizada no dia 18 de fevereiro de 2024 às 10:38 minutos e o preço está relacionado a este momento.*

Tratamento de dados

Para a coleta de dados, foi utilizado o computador portátil (*notebook*) Vostro 14 da marca DELL®. Uma vez sendo realizada a coleta, os dados foram tabulados no sistema computacional Microsoft Office Excel® 2003. Todos os dados foram modelados e analisados a partir do *software* IBM SPSS Statistic® 25.

A estatística descritiva foi utilizada para caracterizar a amostra quanto as variáveis, sendo apresentada como média, desvio padrão e valores mínimos e máximos. Para verificar se a forma de distribuição dos dados é semelhante a uma distribuição normal, foi utilizado o teste de Shapiro-Wilk nas variáveis P, P30, CM, FDV, M/FDV, FC, FT e DIFF. Os resultados do teste de Shapiro-Wilk indicaram o uso do teste de correlação de Spearman para analisar as possíveis associações entre as variáveis deste estudo. A correlação parcial foi usada para

testar as associações tendo como variável de controle o preço do dólar em função de sua importância sobre a variação dos ativos. Dessa forma, o estudo considerou o nível de $p < 0{,}05$ para a significância estatística.

Resultados e discussões

Os *fan tokens* esportivos são ativos digitais que representam uma forma de propriedade ou engajamento em esporte específico ou ecossistema. Esses tokens são construídos sobre a tecnologia Blockchain e podem fornecer aos fãs do esporte acesso aos conteúdos exclusivos, recompensas e direitos de voto dentro da comunidade (Baker et al., 2022). Os tokens podem ser comprados em bolsas de criptomoedas, e seu valor pode flutuar baseado na oferta e demanda (Behera et al., 2023; Singhal et al., 2023). O propósito dos *fan tokens* é aprofundar a conexão entre os fãs, e criar uma comunidade mais engajada e leal (Carlsson-Wall & Newland, 2020).

Ao possuir *fan tokens*, os fãs podem ter a oportunidade de participar de diversas experiências (Hüttermann, 2021). A introdução desses ativos também proporciona uma nova fonte de receita, pois as instituições podem vender esses tokens aos fãs e ganhar uma parte das taxas de transação nas bolsas de criptomoedas onde os tokens são negociados (Behera et al., 2023; Solntsev et al., 2022). O ecossistema de tokens de fãs também pode fornecer dados valiosos e insights sobre o comportamento e preferências dos fãs (Hüttermann, 2021), o que pode ajudar os clubes a entenderem melhor sua base de fãs e melhorarem suas estratégias de engajamento (Ante et al., 2023).

Portanto, compreender o comportamento deste ativo digital começa a ser importante à medida que estes tokens agregam potencial para remodelar a indústria esportiva. Desta forma, na Tabela 2, podem ser observados os resultados descritivos de forma simples do segmento de atuação dos 20 ativos digitais utilizados neste estudo.

Tabela 2
Estatística descritiva por segmento de fan token

Segmento	Valor (US$)	Valor Máximo(US$)	Valor Mínimo(US$)
Futebol*	2,43	47,45	1,68
Lutas*	0,46	0,01	0,00
eSports**	5,23	5,23	1,18

*Fonte: Elaboração dos autores. * Valores médios; ** Valor absoluto.*

Assim, observou-se que os *fan tokens* que melhor performam, de acordo com a plataforma CoinGenko (2024), são sua maioria do segmento de Futebol. Curiosamente, apenas um projeto de *fan token* do segmento de futebol não foi disponibilizado pela plataforma socios.com, sendo este o projeto do Santos Futebol Clube criado pela Binance. Assim, 15 projetos de futebol são de clubes e dois de seleções nacionais, sendo Argentina e Portugal, respectivamente. Sobre os demais segmentos, a amostra apresenta um token de eSports e dois tokens de lutas, sendo o token de Karatê que apresentou o melhor valor em dólar no momento que houve a coleta de dados.

Todos os projetos têm seus tokens utilizando a blockchain da Ethereum como plataforma para lançamento de seus projetos, e essa escolha é atribuída a uma combinação de fatores (Wang & Liao, 2022). Porém, podemos destacar que a Ethereum estabeleceu o padrão com a introdução do protocolo ERC-721, pavimentando o caminho para o desenvolvimento de NFTs, o que a destacou como líder nesse espaço inovador (Gunay & Kaskaloglu, 2022).

Desta forma, uma das formas para compreender o comportamento desse mercado de *fan tokens* é entender as variáveis disponibilizadas e utilizadas por diversos segmentos do universo tecnológico da blockchain que foram coletadas através do site CoinGenko (2024). Portanto, na Tabela 3, podemos fazer uma análise descritiva das variáveis utilizadas nesse estudo.

Tabela 3
Estatística descritiva das variáveis

Variáveis	Média ± Desvio Padrão (DP)	Min-Máx	$\boldsymbol{Valor\ p\ (SW)}$
P	2,37± 1,49	0,01 – 6,17	0,165

P30	12,19 ± 15,49	-12,60 – 53,50	0,018
CM	17.284.318,10 ± 10.509.197,54	5226991,00 - 43.921.739,00	0,037
FDV	78.994.385,80 ± 129.399.714,91	8794996,00 - 598.340.596,00	<0,001
M/FDV	0,39 ± 0,23	0,07 – 0,97	0,100
FC	410.358.787,10 ± 1.803.989.256,59	3322355,00 - 8.074.650.673,00	<0,001
FT	5.519.739.250 ± 2.459.2103.875	5000000 - 110.000.000.000	<0,001
DIFF	5.109.380.462 ± 22.788.116.371	161338 - 101.925.349.327	<0,001

*Fonte: Elaboração dos autores. Legenda: P – Preço em dólar; P30 – Preço em 30 dias em dólar; CM – Capitalização do mercado; FDV – Avaliação Totalmente Diluída; M/FDV – Proporção de capitalização do mercado; FC – Fornecimento Circulante; FT – Fornecimento Total; DIFF - Diferença do Fornecimento.*Valor p<0,05 para normalidade (SW: Teste de Shapiro-Wilk).*

A análise da Tabela 2 pode demostrar uma ideia sobre o comportamento das variáveis financeiras e do mercado associado aos *fan tokens.* Primeiramente, o preço médio (P) dos ativos mostra uma média de 2,37 dólares com um desvio padrão (DP) alto, indicando uma volatilidade considerável no curto prazo, embora o valor de p associado a essa variável seja de 0,165, sugerindo que essa variação de preço apresentou uma distribuição normal. Isso significa que, embora os preços dos ativos variem consideravelmente no curto prazo (indicado pelo alto desvio padrão), essa variação não é considerada estatisticamente relevante com base nos resultados do teste estatístico realizado. Desta forma, a variação nos preços pode não refletir uma verdadeira diferença, mas pode ser simplesmente devido à aleatoriedade nos dados. Por outro lado, a variação do preço em 30 dias (P30) apresenta uma média de 12,19 dólares com um DP ainda mais elevado, e um valor com significância estatística (p = 0,018), o que sugere que as flutuações de preços nesse período são relevantes e possivelmente influenciadas por fatores externos ou eventos de mercado.

Quanto à capitalização de mercado (CM) e à avaliação totalmente diluída (FDV), observa-se que ambos os valores apresentam grandes variações, com a capitalização de mercado tendo uma média de aproximadamente $17,28 milhões e a FDV uma média significativamente maior, em torno de $78,99 milhões, refletindo uma expectativa potencial de valorização

futura dos ativos. Com uma evidente diferença significativa, essa variável possivelmente aponta para expectativas de mercado otimistas em relação ao potencial de crescimento a longo prazo desses ativos.

Finalmente, a proporção de capitalização de mercado sobre a avaliação totalmente diluída (M/FDV) tem uma média de 0,39 com um valor de p de 0,100. Isso sugere que, embora exista uma variação na proporção do valor de mercado em relação ao seu potencial diluído total, essa variação não é suficientemente forte para ser considerada relevante do ponto de vista estatístico, sugerindo que as diferenças observadas podem ter ocorrido devido ao acaso ou a outras variáveis não consideradas, em vez de refletirem uma verdadeira relação entre as variáveis analisadas.

Essa análise fornece uma visão abrangente do comportamento dessas variáveis financeiras, indicando volatilidade de curto prazo, expectativas de valorização a longo prazo e uma análise mista sobre a proporção entre a capitalização de mercado e a avaliação totalmente diluída.

Tabela 4
Correlação de Spearman

Variáveis	P	P30	CM	FDV	M/FDV	FC	DIFF
CM	0,54*	0,46*					
FDV	0,477*	0,701*	0,802*				
M/FDV	-0,084	-0,742*	-0,299	-0,771*			
FC	-0,421	-0,155	0,334	0,186	0,015		
FT	-0,155	0,418	0,358	0,661*	-0,773*	0,529*	
DIFF	-0,050	0,586*	0,359	0,741*	-0,901*	0,326	0,943*

*Fonte: Elaboração dos autores. Legenda: P – Preço em dólar; P30 – Preço em 30 dias em dólar; CM – Capitalização do mercado; FDV – Avaliação Totalmente Diluída; M/FDV – Proporção de capitalização do mercado; FC – Fornecimento Circulante; FT – Fornecimento Total; DIFF - Diferença do Fornecimento.*Correlação(rho) significativa para $p<0,05$.*

A tabela 4 oferece um olhar detalhado sobre as relações entre diversas variáveis financeiras e de mercado, utilizando o coeficiente de correlação (rho) para mostrar a magnitude e a direção dessas relações. Entre as variáveis analisadas, destacam-se algumas correlações

significativas: a capitalização de mercado (CM) mostra uma correlação positiva moderada com o preço (P) e com P30, indicando que aumentos na capitalização de mercado estão associados a aumentos nos preços atuais e futuros em 30 dias. Além disso, a avaliação totalmente diluída (FDV) tem uma forte correlação positiva com P30 e uma correlação muito forte com CM, sugerindo que as expectativas futuras (FDV) estão alinhadas com as avaliações de mercado atuais e futuras. Esta correlação também reflete a expectativa de que ativos com avaliações totalmente diluídas mais altas tendem a ter uma capitalização de mercado maior, o que pode ser interpretado como um sinal de otimismo dos investidores em relação ao potencial de crescimento desses ativos.

No ponto de vista da proporção de capitalização de mercado sobre a avaliação totalmente diluída (M/FDV) apresenta uma correlação negativa e significativa com P30 e FDV, sugere que, à medida que a proporção M/FDV diminui (indicando uma avaliação de mercado relativamente menor em comparação com a avaliação totalmente diluída), há tendência de aumento nos preços futuros (P30) e uma maior avaliação totalmente diluída. Isso pode indicar uma percepção de subvalorização por parte dos fãs que compram os tokens (que podemos denominar de investidores), e que esperam uma correção positiva nos preços. Por outro lado, as correlações que não foram significativas indicam que, para esses pares de variáveis, não há evidências suficientes para afirmar uma relação direta sob o nível de confiança considerado. Desta forma, pode intercorrer perdas financeiras para fãs ao investirem em *fan tokens*, enquanto os *traders* podem potencialmente superar o mercado ao realizarem investimentos neste setor(Vidal-Tomás, 2023).

Essas observações fornecem insights sobre como diferentes aspectos financeiros e de mercado estão interconectados, destacando as expectativas de crescimento, a volatilidade dos preços e como a percepção de valor pode afetar o comportamento do mercado.

Tabela 5

Correlação parcial em relação a variável do preço em dólar

Variáveis	P30	CM	FDV	M/FDV	FC	DIFF
CM	0,330					
FDV	0,506*	0,902*				
M/FDV	-0,506*	-0,341	-0,484*			
FC	0,463*	0,858*	0,970*	-0,326		
FT	0,463*	0,857*	0,970*	-0,327	1,000*	
DIFF	0,463*	0,857*	0,970*	-0,327	1,000*	1,000*

*Fonte: Elaboração dos autores. Legenda: P – Preço em dólar; P30 – Preço em 30 dias em dólar; CM – Capitalização do mercado; FDV – Avaliação Totalmente Diluída; M/FDV – Proporção de capitalização do mercado; FC – Fornecimento Circulante; FT – Fornecimento Total; DIFF - Diferença do Fornecimento. *Correlação (r) parcial significativa para $p<0,05$.*

A correlação parcial, apresentada na Tabela 5, tem como variável de controle o preço (P) e fornece uma perspectiva detalhada sobre como diferentes fatores estão associados entre si. Este tipo de análise é crucial para entender as dinâmicas de mercado subjacentes que influenciam os preços, isolando o efeito de variáveis específicas.

Desta forma, a correlação parcial entre a FDV e o P30 é positiva (r= 0,506), assim como a correlação entre FDV e a CM, que é alta (r= 0,902). Isso indica que, mesmo controlando o efeito das outras variáveis, a FDV tem uma relação direta e muito forte com o preço e a capitalização de mercado, sugerindo que as FDV estão intimamente ligadas ao valor de mercado dos ativos e têm um impacto direto nos preços.

É interessante notar também a correlação negativa entre a proporção de capitalização de mercado sobre M/FDV e P30 (r= -0,506), assim como sua correlação negativa com FDV (r= -0,484). Isso sugere que uma menor proporção M/FDV está associada a uma expectativa de aumento no preço futuro, reforçando a ideia de que os investidores podem ver esses ativos como subvalorizados e com potencial de crescimento de preço. Porém Mazur & Veja (2022), relatam que um *fan token* pode gerar um retorno extremamente alto no primeiro dia, e esse retorno se pode se tornar maior se o clube de futebol for grande e tiver um bom desempenho histórico, se os fãs estiverem domiciliados num país mais rico e se o preço de listagem for baixo.

Por último, as correlações significativas entre o FC e várias outras variáveis, como P30 (r= 0,463), CM (r= 0,858) e FDV (r= 0,970), enfatizam a importância do fornecimento circulante na determinação do preço dos ativos, sua capitalização de mercado e suas avaliações futuras esperadas. Isso reflete a percepção do mercado sobre a liquidez e a disponibilidade do ativo, que pode influenciar diretamente seu preço e valorização. Essa análise destaca a complexidade das relações entre diferentes variáveis financeiras e o preço dos ativos. Os tokens são altamente voláteis, apresentam risco de queda substancial e se assemelham mais às criptomoedas conforme também apresentado por Scharnowski et al. (2023).

As limitações deste estudo estão na estrutura da análise realizada e nas informações disponíveis, onde a seleção da amostra de 20 *fan tokens*, embora diversificada e representativa de diversos segmentos esportivos, pode limitar a generalização dos resultados para um universo mais amplo. A escolha de tokens listados no site CoinGenko (2024), baseando-se em critérios específicos de ranqueamento e preço no momento da coleta, introduz uma limitação temporal, uma vez que a volatilidade dos preços dos ativos digitais pode afetar a relevância dos resultados ao longo do tempo. Outro aspecto importante que merece destaque é que o foco do estudo está nas variáveis financeiras e de mercado, sem explorar profundamente os aspectos sociais, culturais e psicológicos, que também influenciam a percepção e o valor dos *fan tokens* e assim podem omitir fatores importantes que contribuem para a dinâmica complexa entre os fãs, instituições e o mercado de ativos digitais. Da mesma forma, a rápida evolução tecnológica e as mudanças no ambiente regulatório são fatores que podem influenciar o futuro dos *fan tokens*, representando uma limitação intrínseca ao momento atual da pesquisa.

Conclusões

Este artigo explorou o emergente ecossistema *fan tokens* esportivos e evidenciou o impacto financeiro desses ativos digitais, delineando um cenário onde tais inovações não apenas ampliam a relação com os fãs, mas também abrem novas forma de receita para os clubes e investidores. As análises destacam a dualidade desses ativos enquanto promovem uma conexão entre os fãs e introduzem complexidades financeiras e regulatórias que requerem atenção.

As correlações encontradas entre a avaliação totalmente diluída (FDV), capitalização de mercado (CM) e o preço (P) dos tokens indicam uma percepção de valorização e otimismo do mercado. A relação inversa entre a CM/FDV e o preço em 30 dias (P30) aponta para uma expectativa de crescimento dos *fan tokens*, sugerindo que os investidores podem vê-los como subvalorizados.

Contudo, o sucesso dessas iniciativas depende da capacidade dos envolvidos em navegar pelas complexidades deste novo mercado digital. Portanto, garantir que essas ferramentas sejam inclusivas e acessíveis a todos os fãs, independentemente de sua familiaridade com a tecnologia blockchain, torna-se fundamental. Embora o crescimento dos tokens ainda esteja emergindo e o valor subjacente das criptomoedas vinculadas tenha sido altamente volátil, espera-se que os tokens continuem a representar e se expandir como uma força inovadora em muitas organizações esportivas, e continuem a apostar.

Recomenda-se que futuras pesquisas investiguem o impacto dos ativos digitais na lealdade dos fãs, explorando como essas tecnologias podem influenciar o comportamento em longo prazo nos efeitos econômicos no mercado esportivo, especialmente em instituições de menor expressão, e como elas podem se beneficiar dessa inovação. Da mesma forma, até que ponto os *fan tokens* realmente aumentam a identificação, o compromisso e o envolvimento dos fãs permanece uma questão em aberto, também levantada por Scharnowski et al (2023). Por fim, novos estudos poderiam focar em aspectos éticos, de sustentabilidade, regulatórios e de

segurança, desenvolvendo diretrizes para a proteção de consumidores e integridade do mercado de ativos digitais no esporte.

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4 ESTUDO 4 – DECENTRALIZING SPORT MANAGEMENT: A CONCEPTUAL MODEL FOR UTILIZING DECENTRALIZED AUTONOMOUS ORGANIZATIONS IN SPORTS CLUBS[4]

This study examines the innovative application of Decentralized Autonomous Organizations (DAOs) within the sports management sector, leveraging blockchain technology to enable more transparent and inclusive governance. This paper explores how DAOs can disrupt traditional governance structures through the democratic participation of fans and stakeholders. It emphasizes the potential of DAOs to facilitate collaborative governance in line with the four modes of governance framework: chief, clan, custodian, and consortium. By dissecting decentralized governance models, the paper discusses how DAOs can transform traditional structures, enabling more democratic fan participation in sport club decisions. The research highlights such innovations' economic, social, and environmental benefits with real-world examples of DAO implementations in sports organizations. Additionally, the study proposes a conceptual model for integrating DAOs into sports clubs, optimizing resource management, enhancing fan engagement, and aligning club operations with the Environmental, Social, and Governance (ESG) criteria. This conceptual model is a foundation for future research and practical applications in the sports management field.

Keywords: Blockchain; Decentralized Autonomous Organizations; Decentralized Governance; Sport Management; DAO.

1. Introduction

The intersection of technology, governance, and sustainability reshapes the foundational principles of management and organization in the evolving sports industry landscape (Carlsson-Wall & Newland, 2020). With the emergence of blockchain as a disruptive technology, the FinTech industry finds itself ideally positioned to revolutionize the intersection of sports and business (Khaund, 2020), particularly in the way of Decentralized Autonomous Organizations (DAOs). This blockchain-based innovation heralds a paradigm

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shift towards a decentralized economy, promising to revolutionize the traditional sports industry and its underlying governance and economic models (Wang et al., 2019).

Blockchain technology was formally introduced in 2008 with the publication of the Bitcoin whitepaper (Nakamoto, 2008) that decentralized digital ledgers, revolutionizing data storage by ensuring secure, immutable, and transparent record-keeping. As a protocol, blockchains employ a network of computers to authenticate and validate transactions, organizing them into interconnected blocks. Each block is intricately linked to its predecessor, forming an unbroken data chain (Guru et al., 2023). This technology facilitates collective awareness of system status and maintains a digital ledger autonomously and free from intermediary control (Wang et al., 2019). Within blockchains, decentralized autonomous organizations (DAOs) can thrive, being capable of asset management and community governance through agreed-upon protocols, voting mechanisms, and smart contracts (Sato, 2021). According to the DeepDAO (2024) website, the total number of these types of organizations is 2,415 that have a collective treasury of US$ 33.7 billion with 8.3% of them valued at over US$ 1 million, 4.1% at over US$ 10 million, and 1.4% at least at US$ 100 million. This evidences the transformative potential of DAOs in multiple fields, exploring their role in fostering a new era of decentralized governance, enhanced sustainability, and inclusive growth.

The concept of decentralization, pivotal in contemporary economic and organizational structures discourse (Natividad, 2022), has been recognized as a critical factor in promoting sustainable development and inclusive growth in the sports sphere (Millington et al., 2022). This decentralized approach emerges as a catalyst for innovation and sustainability in sports, driving a new paradigm in sports management (Abdelmaboud et al., 2022). For instance, the Sacramento Kings, an NBA team, was one of the first institutions to accept Bitcoin at their arena in 2014 (Rizzo, 2014). In 2019, the Dallas Mavericks followed suit (Rader, 2021) and the Miami Dolphins (NFL) began accepting Litecoin for ticket sales (Evans, 2019). In soccer, SL Benfica and Watford FC accept Bitcoin for tickets and official merchandise sales (Dixon, 2019; Forsdick, 2019) as a way to engage the preferences of their tech-savvy fanbase.

DAOs are a prime example of this disruption, offering new governance and organizational frameworks (Saurabh et al., 2023). Their inherent decentralization can help reduce conflicts and divergences between the interests of club managers, members, or fans. In sports clubs, where trust and alignment of objectives are critical (Doherty et al., 2014), adopting a DAO structure could ensure that management decisions are more transparent and closely reflect the desires and expectations of fans, thereby reducing conflicts and improving governance effectiveness (Morrison et al., 2020). They can offer a model for decentralized governance, challenging traditional hierarchical structures in sports organizations (Carlsson-Wall & Newland, 2020). These digital organizations operate autonomously with smart contracts encoding operational and management rules on the blockchain, thus fostering a more democratic and collaborative decision-making process (Potts et al., 2023).

Within sports management, such organizations are exemplified by initiatives such as 'BuyTheBroncos,' which allows fans to oversee a team. Furthermore, the integration of DAOs in sports is aligned with the growing emphasis on Environmental, Social, and Governance (ESG) criteria where social and ecological value creation is increasingly linked to business strategies (Asif et al., 2023). This shift is evident in the sports industry adopting more sustainable practices and the advancement of technology in developing solutions with positive environmental impacts (Tangen, 2021). The modular, recursive, and interconnected nature of DAOs aligns with these ESG criteria, leveraging local knowledge and resources for more environmentally sustainable and efficient governance systems (Saurabh et al., 2023).

Following these arguments and considering the DAO's role in sports management, this study aims to provide a framework to explore the potential applications of DAOs in

sports clubs. Through an SC-DAO framework (Sports Club Decentralized Autonomous Organizations) designed to be implemented in sports clubs, we will delve into the conceptualization across four modes (i.e., chief, clan, custodian, and consortium) and three collaborative governance dynamics (i.e., decentralized decision, transparency, and community empowerment) to explain the dynamics of DAO formation in the sports field.

This study will theoretically contribute to conceptualizing the role of decentralized organizations in managing sports clubs through blockchain technology. By using two theoretical lenses of governance, collaborative and four-mode framework, we can challenge traditional governance structures to operate decentralized to enable open participation, direct interactions, and community-driven decision-making. By staying informed and exploring blockchain solutions, sports clubs can position themselves to adapt to future trends and capitalize on emerging opportunities in areas such as fan engagement, content distribution, and digital rights management.

2. Theoretical base

2.1 Conceptualization of the blockchain technology

Blockchain is a distributed database system that stores transaction data and other information, enabling sharing among network members (Sato, 2021). Also known as a digital ledger or a systematic database (a decentralized and distributed ledger) that records data with cryptographic proof, it transparently, securely, accessibly, and reliably records transactions with incorruptible capabilities, logging economic transactions and anything of value (Akhtar, 2023).

This decentralized transaction and data management technology was initially developed for Bitcoin (Berg et al., 2020). It operates on a network of interconnected nodes, forming a peer-to-peer network, promoting decentralized governance, and democratizing control without needing a central entity to validate transactions (Feng et al., 2020). Data records are stored in blocks, creating a chain structure with previous blocks once identified by a hash. Hash encryption ensures data security and verifies that the data is reliable. This prevents malpractices such as tampering, forgery, and fraud as it ensures the authenticity of the data blocks (Sato, 2021). Blockchain does not require a central governing structure as a distributed data structure as it is maintained by all network members (Liu et al., 2020), thus supporting a transparent and trustworthy transaction environment (Singh et al., 2022).

Blockchain's distributed nature also facilitates innovation and efficient resource reallocation, fostering an environment conducive to technological innovation and creating innovative solutions that can transform multiple industrial sectors (Ozcan & Unalan, 2022). For instance, in the healthcare sector, blockchain technology has revolutionized the management and security of electronic health records, enabling tamper-proof, traceable, and non-repudiation-based mechanisms for patient data. Similarly, logistics and supply chain management have significantly enhanced transparency and efficiency, facilitating real-time tracking of products from their origin to delivery (Tripathi et al., 2023).

Moreover, blockchain technology is integrated with emerging technologies such as big data and artificial intelligence, expanding its applications and capabilities (Deng et al., 2022). Its unique properties such as its environment for transactions, decentralized management, consensus mechanisms, security, immutability, distributed ledger technology (DLT), and transparency (Sato, 2021) generate community empowerment applications. These properties highlight the foundational aspects of this technology that enable its use in a wide range of applications (see Table 1).

Table 1 - Properties of blockchain

Property	Description
Environment for Transactions	Blockchains provide a specialized environment for the execution of transactions and smart contracts, distinguishing them from other technologies that solely verify data authenticity.
Decentralized Management	Blockchain aims for a governance model that does not rely on centralized third-party organizations, enabling autonomous operation among participants.
Consensus Mechanisms	Through mechanisms such as Proof of Work (PoW), Proof of Stake (PoS), and others, blockchain networks ensure data integrity and agreement among disparate and untrusting parties without central oversight.
Security	Using cryptographic hash functions and digital signatures ensures the security and integrity of transactions within the blockchain.
Immutability	Once data is recorded on a blockchain it becomes nearly impossible to alter it without detection, providing a secure and immutable ledger.
Distributed Ledger Technology	Blockchain's distributed nature allows data to be stored across multiple locations, enhancing security and resilience against attacks or failures.
Transparency	The transparent nature of blockchain allows all participants to view transactions and data, enhancing trust and accountability in the system.

Source: Adapted from Sato (2021a).

These tables highlight each aspect's unique properties, advantages, and disadvantages. Understanding the nuances of each characteristic is essential for grasping the potential benefits and challenges of implementing blockchain solutions in real-world scenarios (Matsuo & Sakimura, 2021).

In a decentralized setup, transaction validation is distributed across multiple participants, mitigating the impact of any individual operator. This aligns with Table 1, which demonstrates the unique properties of blockchain such as its decentralized management and consensus mechanisms that provide security and immutability (Tripathi et al., 2023). Participants in this ecosystem may operate anonymously, relying on game theoretical incentives to establish trust (Matsuo & Sakimura, 2021). The integrity of the blockchain is maintained through a collective consensus mechanism wherein all parties ensure the accuracy of the ledger's current state (Matsuo & Sakimura, 2021; Tripathi *et al.*, 2023).

2.2. Governance: collaborative and four-mode frameworks

Effective corporate governance seeks to protect the interests of all key stakeholders such as shareholders, board members, employees, consumers, suppliers, communities, and government authorities (Jamali et al., 2008), but fundamental problems still persist within this system. Governance mechanisms have failed to mitigate corporate bankruptcies and often allowed companies to manipulate stock prices and employ accounting practices to boost short-term profits (Clarke, 2009).

The core issues surrounding governance mechanisms extend beyond mere operational difficulties or practices and relate to the governance model, prevailing strategy, and direction of corporate governance methods (Emerson & Nabatchi, 2015; Goldsby & Hanisch, 2022). Some primary concerns include inadequate oversight, conflicts of interest, lack of

transparency, accountability issues, ethical breaches, board policies on corporate social responsibility, data protection, and executive remuneration (Luna et al., 2014). Such problems have compromised corporate governance mechanisms and their ability to achieve a company's economic and social objectives, necessitating reforming these processes to address these challenges (Jamali et al., 2008).

In recent decades, collaborative governance has replaced adversarial, conflict-oriented, and managerial policy formulation and implementation (Ansell & Gash, 2008). It is a management approach emphasizing cooperation among multiple groups to make decisions and solve common issues, particularly in contexts involving stakeholders or shared resources (Ansell & Gash, 2008; Emerson *et al.*, 2012). Previous studies have noted that collaborative governance structures can significantly impact the efficiency and effectiveness of inter-organizational cooperation, showing that the organizational structure can facilitate knowledge-sharing and transfer processes, thereby stimulating inter-organizational cooperation (Ribeiro & Nagano, 2023). The organizational justice theory also highlights the importance of fair processes and benefits in driving inter-organizational cooperation to improve efficiency and success (Liu et al., 2023). Other studies have highlighted the advantages of network structures in fostering trust and shared goals among participants, emphasizing their suitability for addressing complex societal challenges (Lotan Marcus, 2018; Paulsson et al., 2018). As a result, collaborative governance has been useful for organizations because it promotes trust, shared goals, and innovation by integrating diverse perspectives, resulting in more effective and sustainable solutions (Emerson & Nabatchi, 2015; Liu et al., 2023).

With its inherently decentralized nature, blockchain technology significantly facilitates the active participation of communities and stakeholders in decision-making processes (Glebova & Mihaľová, 2023). This is primarily due to blockchain's ability to create transparent and immutable records of transactions and decisions. Such capability ensures that all interested parties can view and verify information without an intermediary, promoting greater inclusion and enabling broader and more informed participation (Matsuo & Sakimura, 2021; Tripathi et al., 2023). This transparency and accessibility help strengthen trust among stakeholders and encourage in-depth engagement in collective decisions, which is essential for effective collaborative governance (Ansell & Gash, 2008). Emerson et al. (2012) outline three interacting components that drive the dynamics of collaboration in their integrative framework of collaborative governance theory (CGT): (1) engagement with principles, (2) shared motivation, and (3) capacity for joint action (see Figure 1). Each component synergistically boosts collaborative actions. Thus, engagement with principles is a process of discovery, definition, deliberation, and determination that leads to collaborations to construct a shared theory of change (Emerson & Nabatchi, 2015).

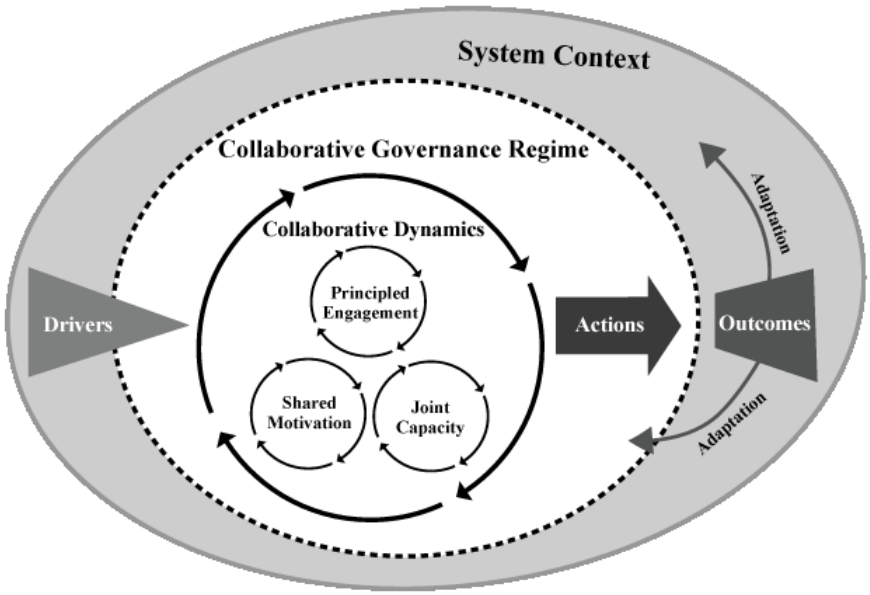

Figure 1 - The integrative framework for collaborative governance

Source: Adapted from Emerson and Nabatchi (2015).

Furthermore, the decentralization promoted by blockchain aligns perfectly with the principles of engagement, shared motivation, and capacity for joint action, which are fundamental in collaborative governance (Akhtar, 2023; Emerson et al., 2012). By distributing decision-making power, blockchain reduces the concentration of authority and fosters an environment where multiple participants can cooperate and coordinate their actions effectively (Deng *et al.*, 2022; Emerson & Nabatchi, 2015). This arrangement broadens participation and motivates those involved by providing a sense of ownership and responsibility over the processes and outcomes. Such a structure is vital for sustaining long-term collaborative efforts, enabling communities to participate and actively influence policies and practices within their respective contexts and needs (Adediran et al., 2024; Lombardi et al., 2021).

Figure 1 also highlights the systemic context in which collaborative governance operates, encompassing political, economic, and social conditions that influence collaboration (Emerson & Nabatchi, 2015). This context is permeated by "drivers" (e.g., an influential individual, a leader, a central group, an external mediator) that catalyze the formation of the governance regime such as the perception of significant uncertainties and the need for interdependence (Ansell & Gash, 2008). The resulting actions lead to concrete outcomes that promote continuous learning and adaptation within the regime, allowing it to evolve in response to external and internal changes (Rapp, 2020). Therefore, it sustains a constant improvement and innovation cycle in collaborative governance.

Similarly, disruptive technologies have capabilities that can overcome highlighted problems as they revolutionize traditional methods and designs, significantly impacting the use of goods and services to achieve organizational objectives (Akhtar, 2023). These technologies can manage large amounts of digital data quickly and efficiently, thereby resolving transparency and data manipulation issues. As a result, this reliance on open network structures and multi-platform setups has increased, paving the way for further innovations (Luna et al., 2014).

As we transition from discussing these fundamental technological underpinnings of blockchain, it becomes imperative to explore how these innovative capabilities can be

leveraged to address the shortcomings of traditional governance models. For this, we will explore the collaborative governance approach as the main theoretical basis and the four modes of governance framework (FMG), which offer a structured pathway to understanding the diverse approaches to governance within blockchain networks (Figure 2). This model categorizes governance into four distinct modes (Chief, Clan, Custodian, and Consortium), each offering unique strategies for managing coordination and control (Goldsby & Hanisch, 2022). By applying these modes, blockchain can transform governance structures, making them more transparent, decentralized, and responsive to stakeholder needs.

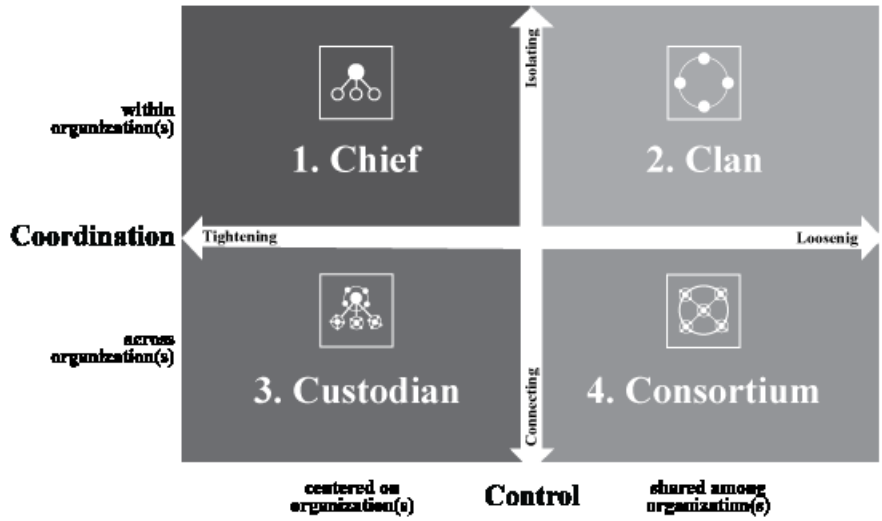

Figure 2 - Four modes of governance for blockchains

Source: Adapted from Goldsby and Hanisch (2022).

This FMG framework encapsulates diverse management strategies within blockchain networks. The “Chief” mode centralizes control within a single entity, making it ideal for environments requiring swift decision-making and centralized security. The “Clan” mode supports decentralized governance within an organization, enhancing internal collaboration and innovation. The “Custodian” mode features centralized oversight by a primary organization that coordinates multiple entities, ensuring stability and compliance. And, the “Consortium” mode offers the highest level of decentralization with multiple organizations sharing control and responsibilities, promoting transparent and equitable decision-making, which makes it suited for projects seeking open and inclusive governance (Goldsby & Hanisch, 2022).

Integrating these governance modes within blockchain frameworks significantly impacts the collaborative governance theory (CGT) by emphasizing participatory and inclusive structures. The “Consortium” and “Clan” modes align with collaborative governance principles of engagement, shared motivation, and joint action. These modes foster a governance environment where stakeholders are encouraged to collaborate transparently and equitably, thus building trust and empowering communities (Emerson & Nabatchi, 2015; Goldsby & Hanisch, 2022). In this way, blockchain can contribute to a governance model that is collaboratively decentralized, offering innovative approaches to defining relationships, reducing corporate risks and inefficiencies, and managing conflicts, all while ensuring data security and integrity across a distributed network (Singh et al., 2022).

This governance model enhances security and promotes community empowerment by encouraging active participation in the decision-making process (Feng et al., 2020). Community empowerment is a concept of economic development that emphasizes society's

values to build a new paradigm that is people-centered, participatory, and sustainable (Adediran et al., 2024; Lombardi et al., 2021). Integrating its principles with blockchain technology holds significant promise in fostering inclusive and sustainable development, enabling communities to actively participate in and benefit from technological advancements and economic opportunities (Makridakis & Christodoulou, 2019). Moreover, it facilitates intentional interaction with evolving governance structures (principled engagement) by fostering unique and shared relationships (shared motivation) and by enhancing the ability to collaborate effectively (joint capacity).

To comprehensively expand, CGT addresses the individual's perception of effectiveness and involvement (Emerson & Nabatchi, 2015) in blockchain initiatives within the sports industry. At the same time, the FMG recognizes that different cultural values influence participant behavior in these initiatives (Goldsby & Hanisch, 2022). These theoretical premises allow us to evaluate the collaborative experience in adopting blockchain projects across different contextual settings. Integrating these theories will help explain the contextual and organizational differences in governance approaches by discussing how these differences may arise and the underlying impacts they may generate.

3. Emerging trends of blockchain applications in the sports context

In the sports management industry, blockchain technology emerges as a transformative force, redefining engagement, operations, and value creation (Potts et al., 2023; Tripathi et al., 2023). Its role in business model innovation and efficiency evaluation opens a new avenue for fan engagement, digital collectibles, transparent operations, and secure ticketing systems (Carlsson-Wall & Newland, 2020; Naraine, 2019; Potts et al., 2023). In addition, its potential applications in the sports management industry are diverse and impactful, suggesting a correlation between the use of blockchain technology and the financial performance of investment sports projects (Ata et al., 2023). Zhang (2022) highlights the incorporation of smart contracts and radio frequency identification (RFID) for multi-sport event ticketing as a potential blockchain application within the industry. Likewise, this technology emphasizes blockchain's capacity to facilitate new revenue sources and improve data management in this field (Naraine, 2019).

As an illustration, blockchain technology in the sports sector extends to sports health data collection systems (Yu, 2021), multi-sport event ticketing accounting information systems (Nugraha et al., 2021), and the dissemination of big data (Wang & Liu, 2022). Another important application is monitoring the player's physical condition and tactical analysis for blockchain and the Internet of Things (IoT) (Sang & Wang, 2022; Song & Tuo, 2022), training data (Mulyati et al., 2020), and doping control applications (Pinto et al., 2022).

From the fan's perspective, integrating tokens and NFTs into the sports industry has reshaped the fan engagement market by offering unique digital collectibles that can be bought, sold, and traded on blockchain marketplaces (Singhal et al., 2023). Fan tokens, or NFTs, are typically issued by sports teams to their fans, providing them utility and engagement opportunities (Ersan et al., 2022; Scharnowski et al., 2023). These tokens represent an innovative approach to increasing fan engagement and support, key objectives for professional sports organizations (Baker *et al.*, 2022). They have also been used to create value regarding soccer clubs' financial and marketing capabilities, demonstrating their potential as an economic source and digital marketing tool (Demirtas & Orçun, 2022). However, these innovations have not been without criticism. They have been scrutinized for their potential to commodify fandom and associated it with gambling-like features, raising concerns about their impact on fan behavior (Lopez-Gonzalez & Griffiths, 2023). Despite these concerns, the issuance of fan tokens and NFTs has opened new sources of revenue for

sports organizations, playing an increasingly important role in the industry (Solntsev et al., 2022).

Integrating blockchain technology into sports redefines operations and fan engagement and sets the stage for adopting Decentralized Autonomous Organizations (DAOs) within this field. DAOs are pioneering entities in sports management characterized by their decentralized governance and financial structures that diverge significantly from traditional hierarchical models (Santana & Albareda, 2022). These organizations enable token holders to collectively make critical decisions through automated decision-making processes facilitated by smart contracts, eliminating the need for centralized authorities (Carlsson-Wall & Newland, 2020; Sato, 2021).

As DAOs apply CGT, they provide a model where collaboration and autonomy are essential in sports (Emerson & Nabatchi, 2015). This decentralized model facilitates direct interaction between athletes, teams, sponsors, and fans, all actively participating in organizational decisions via blockchain technology. This direct involvement contributes to a more dynamic and adaptive governance system, meeting the diverse needs of stakeholders in the sports context and redefining sports management through a more inclusive and transparent approach (Shi, 2023). Based on FMG framework, DAOs can provide for a more flexible and adaptable management approach (Goldsby & Hanisch, 2022). For example, the 'Arena' mode, which emphasizes negotiation among equals, can be seen in DAOs managing sports competitions where various teams and interests must be balanced. This system facilitates negotiation and collaboration in a competitive environment, maintaining integrity and fairness in competitions while promoting governance that engages all participants equitably (Santana & Albareda, 2022). Following the CGT, it is possible that collaborative engagement can help overcome these barriers by promoting broader acceptance of decentralized practices (Emerson et al., 2012). Furthermore, sports DAOs can adapt their governance structures to meet local and global needs better, effectively balancing tradition and innovation (Goldsby & Hanisch, 2022) and aligning with the FMG framework.

Looking forward, DAOs have the potential to revolutionize sports governance by introducing greater transparency and efficiency and by reducing costs associated with traditional management (Morrison et al., 2020). The integration of CGT and the FMG framework could provide a robust model for global sports management, adapting to rapid changes in the sector and better meeting stakeholder expectations (Emerson & Nabatchi, 2015; Goldsby & Hanisch, 2022). This evolution could facilitate more democratic and participatory management, redefining fan and participant engagement in sports. DAOs facilitate more inclusive and transparent governance, opening new avenues for economic and social value creation within sports organizations (Carlsson-Wall & Newland, 2020; Sato, 2021). Through tokenization and innovative financing strategies, DAOs can offer personalized reward and incentive models for players and coaches, enhancing engagement and loyalty (Cao et al., 2021; Chen et al., 2022). Moreover, generating revenue through unique methods such as selling NFTs representing iconic game moments or voting rights on significant club decisions presents a substantial opportunity for sports clubs to diversify their revenue streams and strengthen connections with their global fan base (Ante et al., 2024). Some examples of DAOs in the sports industry can be observed in Table 2.

Table 2 - Examples of DAOs in the sports field

DAO	Sports Type	The Challenge	Mission	Stage
LinksDAO (linksdao.io)	Golf	Democratizing access to golf.	Enable members to collectively operate a golf course.	Active

SailGP DAO (sailgp.com)	Sailing	Getting fans involved in strategic decisions.	Co-ownership and democratic management of a sailing team.	Active
KrauseHouse (krausehouse.club)	Basketball	Democratizing NBA team ownership.	Enable members to participate in team decisions.	Active
WAGMI United (wagmiunited.com)	Soccer	Enhancing fan engagement and governance.	Integrate Web3 technologies to enhance fan participation.	Active
BlackPool (blackpool.finance)	eSports	Navigating and optimizing the NFT market in digital sports.	Invest in and manage teams and players in blockchain-based soccer games.	Active

Source: Quoted from the DAO website or whitepaper.

Table 2 presents various real-world examples of DAOs related to sports detailing the specific sport they are associated with, the main challenge they address, their mission, and their current stage of development. This format helps illustrate the diversity and potential of DAOs within the sports management arena, including physical and virtual sports. Based on its collective action strategy, DAOs can introduce structural innovations in practices, values, and self-governance mechanisms, reducing the need for intermediaries (Santana & Albareda, 2022).

4. A new conceptual framework: Sports DAOs

Integrating blockchain technology within sports clubs heralds transformative changes, fostering decentralized and collaborative governance models emphasizing transparency and community involvement in decision-making. This evolution in governance is supported by the principles outlined in FMG (Goldsby & Hanisch, 2022) and CGT (Ansell & Gash, 2008; Emerson & Nabatchi, 2015), providing a robust framework for understanding how decentralized networks can enhance operational and governance structures within the sports sector.

In this way, we can highlight the principal benefits from a technological point of view and the perspective of those people involved with the sports organization. FMG and CGT are traversable and present at different moments when we use blockchain technology, as seen in the figure below. Figure 3 explores a visual representation that captures blockchain technology's integration within a DAO's framework in the sports sector. The image details how this revolutionary technology transforms traditional operations and restructures organizational governance, replacing hierarchical models with a more democratic and collaborative approach. This visual framing serves as a microcosm to understand how emerging technologies are being utilized to foster more active and equitable participation among stakeholders (Glebova & Mihaľová, 2023), reflecting the principles of CGT and the FMG in a practical and contemporary context (Emerson & Nabatchi, 2015; Goldsby & Hanisch, 2022).

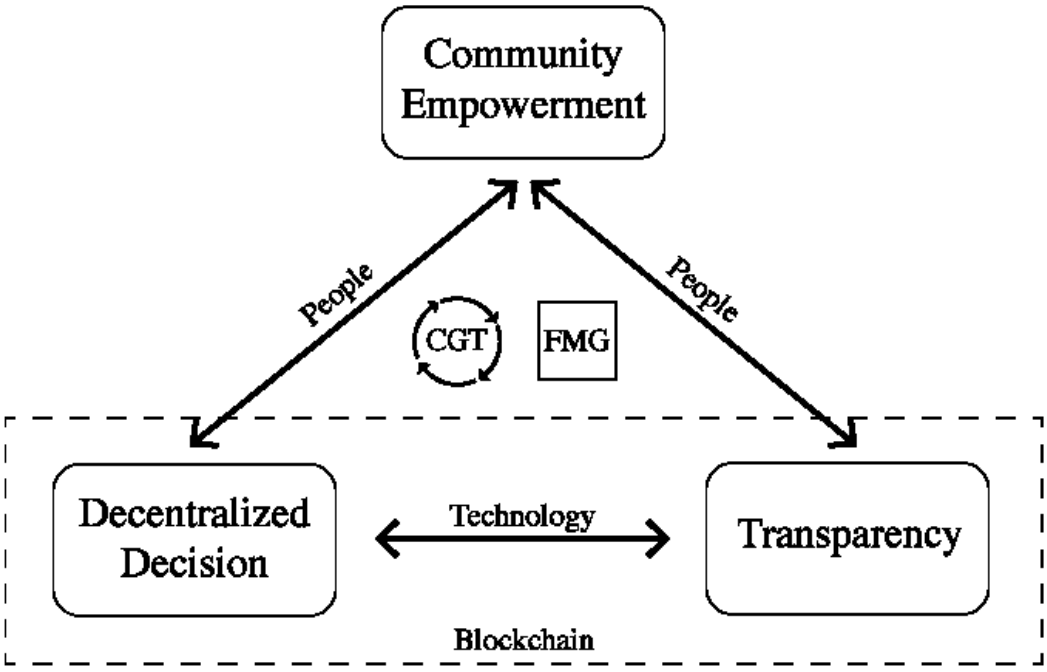

Figure 3 - The Sports DAOs benefits

Source: Authors' creation

The technology arrow represents blockchain's central role in automating and executing smart contracts within a DAO (Sato, 2021). This technology ensures the transparency and security of transactions and empowers all participants (athletes, coaches, sponsors, and fans) to contribute to organizational decisions directly (Glebova & Mihaľová, 2023). Through this innovation, the DAO embraces decentralized governance, characteristic of the Consortium mode of the FMG where a cooperative agreement among various stakeholders replaces traditional command and control structures, allowing for an equitable distribution of power and a management approach that is more resilient and adaptable to the rapid changes in the sports sector (Goldsby & Hanisch, 2022).

The people arrows illustrate the interactive dynamics among the members of the DAO where everyone has an equal voice in the decision-making process. This arrangement highlights the application of the Clan mode of the FMG, emphasizing the importance of shared values and community norms in the decision-making process (Goldsby & Hanisch, 2022). Within this system, collaboration is key to achieving common goals, promoting an environment where governance is exercised with transparency and shared responsibility. Moreover, this structure fosters a sense of belonging and engagement among participants, ensuring that each contribution is valued and that decisions reflect the collective interests of the sports community, aligning organizational goals with the aspirations of its members (Ansell & Gash, 2008; Emerson & Nabatchi, 2015).

Blockchain's effect on sports management significantly alters traditional operational models by leveraging network dynamics whose nodes (representing multiple stakeholders such as players, management or fans) are interconnected (Carlsson-Wall & Newland, 2020). Consequently, sports clubs are envisaged to operate as departments functioning as hubs that are interconnected internally and disseminating information. They are concurrently linked with fan sponsors who may form clusters. This approach enhances communication and strategic alignment across the organization and introduces higher resilience and adaptability to sports club governance (Goldsby & Hanisch, 2022).

The decentralized blockchain systems, characterized by information transparency and traceability, have the potential to positively impact business ethics, corporate governance, and social sustainability (Sato, 2021). Blockchain's multifaceted potential for enhancing sustainability spans economic, environmental, and social dimensions. For sports clubs, it charts a course toward economic sustainability through augmented traceability, heightened visibility, and a decentralized operational structure. Simultaneously, it contributes to environmental and social sustainability by advancing resource efficiency, instilling accountability, fostering trust, and thwarting fraudulent activities (Munir et al., 2022).

Smart contracts, constituting a pivotal facet of blockchain technology, are designed to optimize processes within sports clubs even further. Their automation capabilities in resource allocation, measurement of environmental impact, and overall responsibility are anticipated to instigate continuous improvements. Implementing fan tokens through blockchain is an indispensable tool for fan engagement. These tokens confer exclusive experiences, collectibles, and voting rights, fortifying the emotional connection between sports clubs and their supporters (Bas et al., 2024; Scharnowski et al., 2023). Furthermore, the optimization afforded by blockchain extends to resource allocation within clubs, efficiently managing equipment, transportation, and stadium facilities while adhering to environmentally responsible practices. The technology facilitates precise quantification of the negative environmental externalities associated with sports activities, marking a pivotal step towards mitigating their impact (Lacity, 2022; Solntsev et al., 2022). In the social front, the transformative potential of blockchain on fan engagement is clear. Fan tokens offer avenues for fans to partake in exclusive experiences, acquire collectibles, and exercise voting rights, augmenting fan loyalty and fostering robust communities (Baker et al., 2022; Zarifis & Cheng, 2022). Beyond fan engagement, blockchain technology holds the potential to engender social inclusion through transparent and decentralized governance structures, thereby enhancing decision-making processes within sports clubs. Using blockchain for online voting also enhances democratic participation in sports club governance while reducing costs (Jafar et al., 2021; Widayanti et al., 2021).

As privileged organizations, sports clubs are ideal candidates for integrating blockchain-based voting systems. The shared aspiration among fans to achieve victory serves as common ground for social consensus (Moustakas & Robrade, 2023). However, carefully considering disparities in smartphone ownership and potential security issues is imperative to avoid unintentionally exacerbating social inequalities. Nevertheless, the unique ability of sports to foster social cohesion and consensus among fans positions them as potential catalysts for successful blockchain-based systems (Raw et al., 2022). Conversely, the Anthropology of politics argues that voting is a collective decision. Voters are not isolated entities, but social agents who align their votes with the decisions of the group to which they are effectively linked (Lima et al., 2020). Consequently, our argument posits that a sports DAO can strategically leverage the affective bonds of fans transformed into stakeholders to foster consensus-based decisions through blockchain voting. Based on these points discussed, the organizational structure for implementing a Sports Club DAO (SC-DAO) is presented in Figure 4 below.

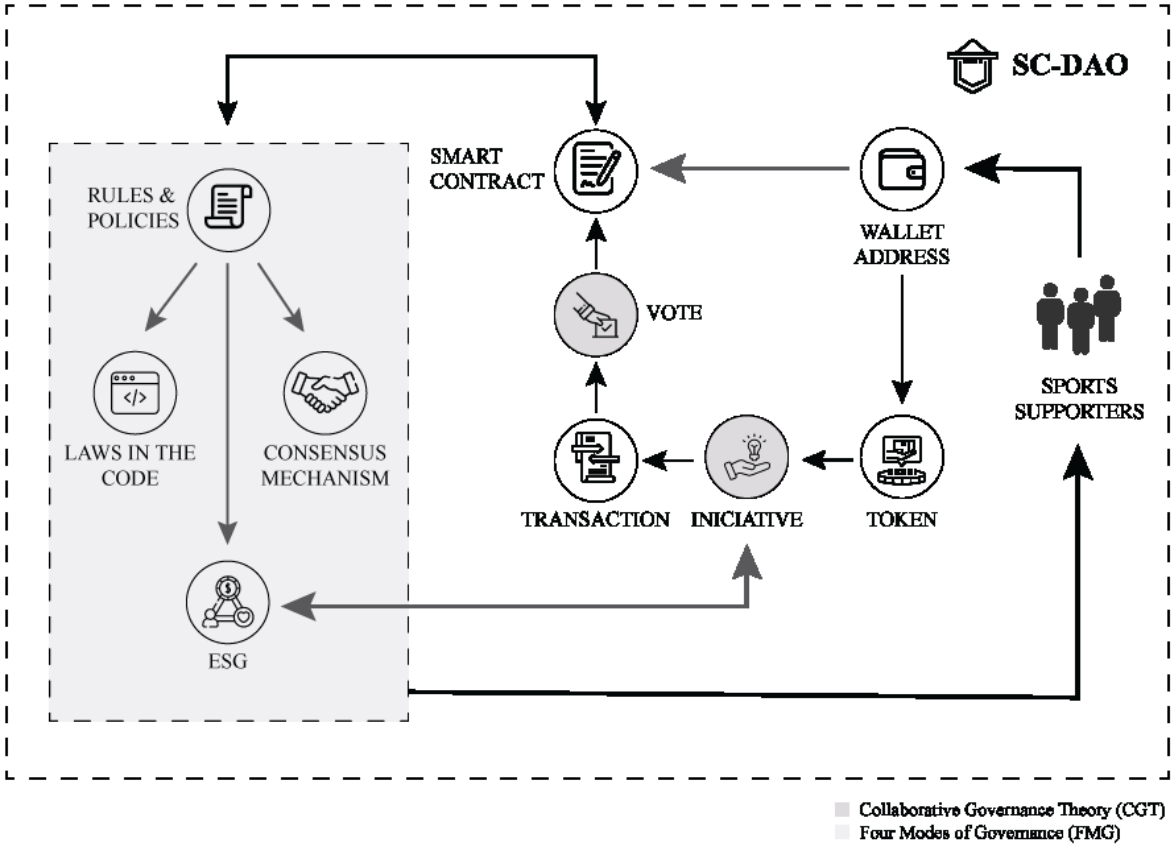

Figure 4 - Organizational structure of the Sports Club DAO

Source: Authors' creation

The structure of SC-DAOs begins with individuals interested in supporting a sports initiative, often sports enthusiasts looking to invest in the sector. These individuals create a virtual wallet enabling the acquisition of tokens for access to the SC-DAO. The token and the wallet will be recorded in a smart contract, allowing the initiation of proposals, voting, and other initiatives created by fellow members. The code regulates and monitors this mechanism through majority consensus voting to ensure transparency and governance. The structural details regarding token types and initiative creation will depend on each project developed for an SC-DAO. Thus, we can design structured applications for sports clubs of different disciplines based on this organizational structure.

The SC-DAO's decentralized nature aligns with CGT principles by fostering engagement, shared motivation, and joint action among all stakeholders. The model promotes transparency and equitable decision-making processes, supporting CGT principles. Additionally, the FMG framework is corroborated by the structure's capacity to adapt and respond to various governance needs through modes such as Clan and Consortium, emphasizing collaboration and shared governance, ensuring that management decisions are transparent and inclusive (Emerson et al., 2012; Goldsby & Hanisch, 2022).

Integrating DAOs into sports club management via blockchain technology offers a promising pathway to redefine sports governance. This model democratizes governance, ensures operational transparency, fosters fan loyalty, and promotes a more engaged and empowered sports community (Carlsson-Wall & Newland, 2020; Sato, 2021). By embracing these innovative approaches, sports clubs can navigate the complexities of modern sports

management and harness the potential of blockchain to create a more inclusive and dynamic sporting environment.

5. Conclusions and further reflections

In sports governance and community engagement, the SC-DAO structure emerges as a transformative force, integrating elements of ESG (Environmental, Social, and Governance) considerations, fostering a sense of community, and incentivizing active participation. The journey within the SC-DAO begins with passionate individuals, primarily sports enthusiasts seeking to invest in and support sports initiatives. These stakeholders create a virtual wallet for acquiring tokens that grant them access to the SC-DAO's innovative platform. The smart contract records the tokens and wallet details, laying the foundation for a governance system where the community's collective will drive proposals, voting, and other initiatives.

Within this groundbreaking structure, the integration of ESG principles becomes crucial. SC-DAOs have the potential to reshape sports initiatives with a focus on sustainability, social responsibility, and ethical governance. As stakeholders actively participate in the decision-making process, the SC-DAO serves as a vehicle for aligning sports clubs with environmentally conscious practices, promoting social inclusivity, and instilling ethical governance standards.

A sense of community is a cornerstone of the SC-DAO as the model thrives on the collective voice of sports enthusiasts. By providing a transparent and democratic platform, the SC-DAO nurtures a profound sense of involvement and ownership among the fanbase. This communal spirit transcends mere fandom, fostering a shared commitment to the success and sustainability of the sports clubs involved. Incentivization within the SC-DAO is dynamic, leveraging token-based rewards to recognize and appreciate loyal supporters. This tokenomics system enhances fan engagement and ensures a reciprocal relationship where the community's commitment is acknowledged and rewarded.

One of the main contributions of this study is the conceptual framework developed from the theories of collaborative governance and four modes of governance applied in conjunction with blockchain technology. This approach significantly enhances community empowerment around sports organizations by creating an SC-DAO structure for managing sports clubs. This model represents a potential innovation in the sports field, contributing to a more involved and empowered community.

In summary, integrating blockchain technology, decentralized governance, and community-driven decision-making within sports clubs, as exemplified by the SC-DAO structure, represents a paradigm shift in the industry. Beyond technological advancements, the SC-DAO promises to align sports initiatives with ESG principles, nurture a profound sense of community, and foster active fan participation through incentivization. As sports clubs evolve into community-driven entities, the SC-DAO stands at the forefront of revolutionizing the sports industry, creating a future where fans are integral partners in the journey of their favorite teams.

6. Limitations, further studies, and implications for sports management

Transitioning from a traditional club to a DAO involves navigating complex legal frameworks, especially in regions where decentralized governance faces regulatory challenges. Despite blockchain's potential, notable constraints exist such as the need for centralized oversight in areas requiring specific expertise, especially in coaching or management. The risk of unqualified token holders influencing critical decisions poses a

significant challenge, suggesting the need for a balanced approach that combines democratic participation with professional governance.

Another limitation is the possibility of analyzing DAOs based on different theoretical frameworks, expanding how these organizations are understood and evaluated. There is a trend and a need for empirical studies in this area (Carlsson-Wall & Newland, 2020; Potts et al., 2023) as it is crucial to ground theories with concrete data and practical observations. Future research could explore the interplay between the social dynamics of DAO governance and the strategic elements of sports, examining how the collaborative dynamics within sports management mirror those in-game scenarios. This exploration could reveal how DAOs as modular structures can enhance team management and performance, suggesting a symbiotic relationship between decentralized governance and the operational tactics of sports teams. Moreover, how DAOs are discussed can be viewed from multiple perspectives by health, economics, management, and other social sciences scholars, leading to diverse interpretations of their role in the sports management industry.

A significant limitation is that analyzing the impact and effectiveness of this technology requires a long-term perspective. This temporal analysis is essential to understanding how blockchain and DAO implementations evolve and sustain over time, while considering the sports context, the dynamic nature of sports management, and rapid technological advancements. This longitudinal approach will help assess the true value and implications of decentralized governance models in sports.

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CONCLUSÃO

Esta tese de doutorado teve como principal objetivo explorar como a Web3, especialmente com o uso da tecnologia blockchain, pode auxiliar os modelos de negócios no setor esportivo, com foco nas DAOs. Os objetivos específicos incluíram identificar tendências e inovações da Web3 no esporte, também de analisar desafios e os impactos econômicos dos *fan tokens*, assim como de investigar o uso de DAOs na gestão esportiva.

Os estudos realizados revelaram várias tendências promissoras na aplicação da Web3 no esporte. A tecnologia blockchain, através da Web3, mostrou-se eficaz na criação de um ambiente mais transparente e participativo, facilitando a interação direta entre fãs e clubes. As DAOs emergiram como uma ferramenta potencial para a democratização da gestão esportiva, promovendo decisões mais colaborativas e transparência na administração de recursos. Essa abordagem pode transformar a governança esportiva, permitindo uma participação mais ativa dos stakeholders, incluindo fãs, jogadores e patrocinadores.

As DAOs oferecem uma estrutura onde a comunidade tem voz ativa na gestão e operação dos clubes esportivos, aumentando o empoderamento e o engajamento dos fãs. Essa participação coletiva não apenas fortalece a relação entre as entidades esportivas e seus apoiadores, mas também promove uma cultura de responsabilidade e transparência. A análise do impacto das DAOs sugere que elas podem levar a um modelo de gestão mais inclusivo e eficiente, onde as decisões são tomadas com base na colaboração e no consenso, refletindo os interesses da comunidade quando se usa a tecnologia blockchain aplicado diretamente na gestão de clubes esportivos.

Porém, outra forma de utilização da tecnologia é o desenvolvimento de softwares que garantam a transparência e a integridade das operações de governança, desde a gestão financeira até a administração de contratos e votações. Essa aplicação tecnológica assegura que todas as transações e decisões sejam registradas de forma imutável e auditável, promovendo um alto nível de confiança e responsabilidade dentro das instituições esportivas. Com isso, é possível não apenas melhorar a eficiência operacional, mas também fortalecer a confiança entre todos os envolvidos no processo, desde os administradores até os torcedores.

Os *fan tokens*, destacaram-se como uma porta de entrada significativa para o mundo da Web3, introduzindo novas formas de engajamento e receita para clubes e organizações esportivas. No entanto, a volatilidade associada a esses ativos aponta para a necessidade de uma gestão cuidadosa e de estratégias regulatórias robustas para mitigar riscos financeiros.

Apesar dessas vantagens potenciais, a implementação da Web3 no setor esportivo enfrenta desafios consideráveis. A adoção generalizada da tecnologia requer uma mudança cultural e um entendimento mais profundo das suas implicações por parte dos *stakeholders*. Além disso, a rápida evolução tecnológica e as mudanças no ambiente regulatório representam obstáculos que precisam ser superados para garantir uma integração bem-sucedida da Web3 no esporte.

Desta forma, as tecnologias da Web3 oferecem oportunidades promissoras para transformar a gestão esportiva, tornando-a mais inclusiva, transparente e eficiente. No entanto, a concretização desse potencial depende de uma abordagem colaborativa entre clubes, fãs, desenvolvedores de tecnologia e reguladores para superar os desafios e maximizar os benefícios dessas inovações. A implementação bem-sucedida das DAOs e a integração da Web3 no esporte têm o potencial de redefinir a governança esportiva, promovendo uma nova era de participação comunitária e colaboração no setor.

LIMITAÇÕES

A amostra de estudos revisados pode não representar toda a diversidade de pesquisas e casos de uso da tecnologia blockchain e aplicações da Web3 e no esporte, especialmente devido ao rápido avanço dessas tecnologias e à natureza dinâmica do setor. Além disso, a análise empírica realizada apresenta uma limitação significativa, pois não foi aprofundada em um caso real de uma Organizações Autônomas Descentralizadas (DAOs) no contexto esportivo, o que é essencial para avaliar a viabilidade dessas organizações na gestão esportiva.

A implementação das DAOs no setor esportivo enfrenta diversas limitações que precisam ser cuidadosamente consideradas. Primeiramente, a complexidade técnica envolvida na criação e gestão de contratos inteligentes exige conhecimentos especializados em programação e blockchain, habilidades que podem não estar amplamente disponíveis em todas as organizações esportivas. Outro desafio crítico é a governança descentralizada, onde a tomada de decisões em uma DAO é realizada coletivamente pelos membros, o que pode resultar em processos de decisão mais lentos e, em alguns casos, gerar conflitos internos. A coordenação e o consenso entre um grande número de participantes podem ser difíceis de alcançar, especialmente em situações que requerem respostas rápidas e eficientes.

A escalabilidade se apresenta como outra uma limitação significativa. À medida que mais membros se juntam à DAO e o número de transações aumenta, a capacidade da rede blockchain de processar essas transações de maneira rápida e eficiente pode ser comprometida,

impactando negativamente a operação da DAO. A regulamentação é outra área de preocupação substancial. Pois, a maioria dos sistemas jurídicos ainda carece de um quadro regulatório claro para DAOs, o que cria incertezas legais em torno de questões como responsabilidade, conformidade e tributação, que precisam ser resolvidas para garantir que as DAOs possam operar dentro da legalidade.

Além disso, a adoção de DAOs no esporte exige uma mudança cultural significativa. Os stakeholders precisam estar dispostos a adotar e confiar em um sistema descentralizado, o que pode ser árduo em um setor tradicionalmente centralizado. Por fim, a volatilidade associada às criptomoedas, frequentemente utilizadas como meio de governança e recompensa em DAOs, pode afetar a estabilidade financeira das organizações que adotam esse modelo. A flutuação nos valores das criptomoedas pode impactar negativamente o planejamento financeiro e a sustentabilidade a longo prazo das DAOs no esporte.

PESQUISAS FUTURAS

As limitações apresentadas, destacam a necessidade de futuras pesquisas se aprofundarem em estudos de caso práticos de DAOs reais aplicadas à gestão esportiva, para entender melhor como essas organizações podem superar os desafios técnicos, regulatórios e culturais, e se estabelecer como uma solução viável e sustentável para a governança no setor esportivo. Portanto, para superar essas limitações, pesquisas futuras podem se concentrar em estudos longitudinais que monitorem a evolução e o impacto das tecnologias no ambiente da Web3 no esporte ao longo do tempo. Isso proporcionará uma compreensão mais profunda das dinâmicas de longo prazo e da sustentabilidade dessas inovações, especialmente para enfrentar a complexidade técnica e a necessidade de infraestruturas robustas e seguras. Investigar mais profundamente a interação entre fãs e organizações esportivas através de *fan tokens* e DAOs pode revelar como essas interações afetam a lealdade dos fãs e o engajamento de longo prazo, ajudando a mitigar os desafios de adoção e engajamento identificados.

Além disso, é essencial a criação de diretrizes regulatórias específicas para o uso de tecnologias blockchain no esporte, como frameworks para a tokenização e gestão descentralizada, incluindo políticas de proteção ao consumidor e prevenção de fraudes. Essas diretrizes poderiam abordar as incertezas legais e de conformidade, criando um ambiente mais seguro e previsível para a adoção dessas tecnologias. A ampliação da análise do impacto econômico e social das tecnologias Web3 no esporte também é crucial. Investigar como essas inovações afetam a economia local e a inclusão social permitirá entender melhor as implicações

mais amplas e ajudar a superar as limitações econômicas e culturais que podem restringir seu uso e eficácia.

Focar em questões de segurança e privacidade associadas ao uso de blockchain no esporte é vital para superar as vulnerabilidades tecnológicas e construir confiança. Desenvolver estudos de caso práticos de clubes, ligas e organizações esportivas que implementaram essas tecnologias fornecerá percepções valiosas sobre a aplicação prática dessas inovações. Esses estudos podem trazer as melhores práticas, mas também permitirão que outras entidades esportivas aprendam com os desafios enfrentados por pioneiros, evitando problemas semelhantes.

Ao abordar essas limitações as áreas sugeridas, as futuras pesquisas podem focar no potencial inexplorado da Web3 e da tecnologia blockchain no esporte, mas também pavimentarão o caminho para uma adoção mais segura, eficiente e inclusiva dessas inovações em um setor em rápida evolução.

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