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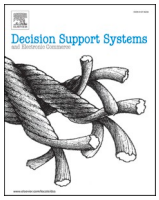

Designing a fair and inclusive digital asset-based name-image-likeness marketplace☆

Arthur Carvalho [a], Liudmila Zavolokina [b,*], Suman Bhunia [c], Gerhard Schwabe [d]

[a] Farmer School of Business, Miami University, Oxford, OH, USA
[b] Faculty of Business and Economics, Department of Information Systems, University of Lausanne, Lausanne, Switzerland
[c] Department of Computer Science and Software Engineering, Miami University, Oxford, OH, USA
[d] Department of Informatics, University of Zurich, Zurich, Switzerland

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ABSTRACT

Regulatory changes have enabled American student-athletes to profit from their name, image, and likeness (NIL). However, only a fraction of the student-athlete population is actually profiting from their NIL, which raises questions concerning fairness and inclusiveness. Motivated by that scenario, we look at technological solutions capable of sharing a limited amount of financial resources fairly and inclusively. Following a design science methodology, we define design requirements for such technological solutions after interviewing student-athletes, which leads us to establish the inclusive-meritocratic fairness criterion. Subsequently, we determine design principles that artifacts aiming at helping student-athletes should satisfy. We find that a solution that satisfies the proposed design principles is to associate student-athletes with digital collectibles represented as non-fungible tokens (NFTs). The core idea behind our artifact is that student-athletes receive royalties in primary markets after NFTs are randomly minted, plus deterministic royalties in secondary markets whenever a transaction involving their collectibles happens. Interviews with student-athletes validate our design. We conclude the paper by discussing how our ideas give rise to a new NIL design theory.

1. Introduction

Changes in the regulatory landscape have enabled approximately 500,000 student-athletes in the United States to profit from their name, image, and likeness (NIL), departing from previous policies requiring those athletes to maintain their amateur status. The policy change has brought to life several opportunities to explore digital assets in the form of collectibles related to student-athletes. For example, the company Mercury has partnered with Kansas University to sell digital collectibles related to members of the Kansas basketball team. In addition, the famous retired football player Tim Tebow has partnered with the NIL-focused company INFLCR to create Campus Legends, a platform focused on leveraging NILs through digital assets. Despite the ongoing frenzy, without proper mechanisms in place, it is unlikely that all the hundreds of thousands of student-athletes will ever profit from NIL deals — be it through the sales of digital assets or not — thus resulting in inclusiveness worries. Moreover, substantial variation in the amount of financial resources received by different student-athletes can exist, which raises fairness concerns.

Following a design science approach, we validated the above conjectures by interviewing student-athletes competing in different sports. The interviewees unanimously agreed that only the most prestigious athletes from the most popular sports will likely profit from NIL deals. Having validated the problem with the most important stakeholders, we investigated technological solutions that satisfy the resulting inclusive-meritocratic fairness criterion. Our search led us to a solution based on digital collectibles as non-fungible tokens (NFTs) that pay royalties to student-athletes whenever a transaction (purchase or exchange) happens in different markets. Specifically, by selling only packs of random collectibles in primary markets, our solution ensures that all student-athletes can receive some NIL-based royalties. These collectibles can subsequently be sold in secondary markets for different prices, and royalties are still paid after each transaction. That allows for, for example, NFTs associated with more popular athletes to be sold at

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* Corresponding author.
E-mail addresses: arthur.carvalho@miamioh.edu (A. Carvalho), liudmila.zavolokina@unil.ch (L. Zavolokina), bhunias@miamioh.edu (S. Bhunia), schwabe@ifi.uzh.ch (G. Schwabe).

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higher prices in secondary markets, thus resulting in higher ex-post royalties. We argue this is not only an inclusive but also a fair solution as it embraces the acclaimed Aristotle's equality principle that says "equals should be treated equally, and unequals unequally, in proportion to relevant similarities and differences." Since our main ideas rely on the existence of a marketplace, we later explain how the above sales mechanism enables NFT markets that are thick, secure, and have low congestion, which are features required by well-functioning marketplaces [1].

After formalizing our solution in terms of design requirements, principles, and features, we developed a prototype implementing our ideas and evaluated our artifact and design through interviews with student-athletes. The obtained qualitative data show that student-athletes indeed expect our solution to achieve higher degrees of inclusiveness and fairness when allocating NIL-based financial resources. To summarize, our main contributions in this paper are twofold: 1) we identify fairness and inclusivity concerns in the distribution of financial resources from NIL rights among student-athletes, and 2) we address those concerns by employing a design science methodology that culminates in a digital-asset-based artifact and a novel design theory.

2. Research background & literature review

Since our work relates to rather distinct concepts and lines of research, we provide some extra background and review the relevant literature in the following subsections.

2.1. Fairness research and definitions

The topic of fairness has received greater attention in recent years from the information systems community, primarily concerning the rise of artificial intelligence and machine learning. For example, Teodorescu et al. [2] explored the need for human augmentation of machine learning models to achieve fairness. As part of their work, the authors reviewed four fairness criteria, namely fairness through unawareness, demographic parity, equalized odds, and equalized opportunity. Such a plurality illustrates the challenges in defining an objective and universal fairness criterion. Computer scientists echo the same thoughts, as quotes from prominent researchers in the work by Krakovsky [3] highlight, e.g., "*What does it mean to say that a system … is fair? Without a concrete definition we see that it doesn't mean a lot*" (by Omer Reingold) and "*Your typical law scholar doesn't have her own mathematical definition of fairness that we can line up and compare with a computer scientist's notion.*" (by Katrina Ligett).

Instead of algorithmic fairness, our work relates more to *distributive justice*. In information systems, distributive justice has been studied in terms of the allocation of computational resources, assignment of priorities, and conflict resolution [4]. Our work takes a more economic perspective of fairness as wealth distribution. We shall use the traditional *cake-cutting* metaphor [5] to explain fairness in our setting and its interplay with inclusiveness. A cake can be seen as a bounded and infinitely divisible resource, such as the amount of NIL-related money available to all student-athletes, recently estimated to be $1.14 billion USD [6]. For our purposes, inclusiveness then means that all student-athletes have access to a share of the pie, whereas fairness relates to the size of the share (or slice) of the pie. That said, Moulin [5] elaborates on different welfarist definitions of fairness. For example, *egalitarian* means all student-athletes get the same share of the pie, whereas *envy-free* means that nobody wants another's share more than their own. Our definition of fairness is motivated by Aristotle's equality principle that says "*equals should be treated equally, and unequals unequally, in proportion to relevant similarities and differences*," [5] or what Krakovsky [3] called *individual fairness*. In particular, we adopt a blend of an egalitarian approach coupled with meritocratic adjustments, which we later define as the *inclusive-meritocratic fairness* criterion.

Our proposed concept of inclusive-meritocratic fairness differs explicitly from established theories of fairness in several significant ways. For example, Rawlsian fairness [7] is built upon the "Difference Principle," which posits that any social or economic inequality is only permissible if it benefits the least-advantaged members of society. In contrast, our proposed inclusive-meritocratic model, based on Aristotelian principles, advocates for a system where everyone is first given an opportunity to participate, fulfilling an "inclusiveness" requirement. Following this initial access, it allows "meritocratic allocation," where market forces and individual merit lead to unequal but justifiable rewards. Thus, while the inclusive-meritocratic framework embraces market-driven inequality as a fair outcome of merit after ensuring initial access, Rawlsian justice strictly limits inequality to scenarios that uplift the most vulnerable, prioritizing their welfare over market-based merit. Compared to algorithmic fairness frameworks, such as the above-mentioned demographic parity or equalized odds, which generally attempt to achieve statistical parity or fairness across predefined demographic groups, inclusive-meritocratic fairness addresses individual-level fairness by incorporating market-driven adjustments as meritocratic factors, allowing differentiated outcomes based on personal achievements and popularity. This approach aligns with Aristotle's principle of proportional equality, recognizing that differences in individual circumstances and abilities justify varying allocations of resources.

2.2. Inclusiveness research and definitions

Inclusiveness, as a concept, addresses the extent to which environments, systems, or processes are accessible, welcoming, and beneficial to every individual, undeterred by characteristics like race, gender, physical disabilities, age, or economic status [8]. In the context of information systems, inclusiveness reflects the degree to which information technologies (IT), practices, and policies are designed with consideration and accommodation for the needs, identities, and experiences of a diverse user base [9]. Existing design studies demonstrate the multifaceted nature of inclusiveness in IT, focusing on aspects like equal access, participation, equity, representation, and gender and racial diversity [8].

Inclusiveness research in information systems has historically focused on ensuring equal access and usability of technology for all users, often neglecting how technology can promote inclusiveness within groups or society. With the rise of new disruptive technologies, like artificial intelligence and blockchain, there is a growing need for information systems research to pivot toward understanding how technology can be designed not just for equal access but also as an instrument to foster inclusiveness and equitable opportunities in broader societal and group contexts. That is precisely what we aim to achieve with our design. In what follows, we introduce blockchain technology, as it sits at the core of our proposed design and artifact.

2.3. Blockchain technology

Blockchain is a distributed and decentralized append-only database in which transactions are stored in batches — called blocks — and distributed across a number of computational devices called nodes. It operates without a central authority and uses a consensus mechanism to incentivize agreement among the decentralized nodes. Users of a blockchain-based system interact with nodes using wallets, i.e., software that manages users' cryptographic keys and helps to create blockchain transactions. Cryptocurrencies, such as Bitcoin, are the most prominent and well-known examples of blockchain-based applications.

Since the introduction of Bitcoin, various blockchain models have been developed, including those that allow nodes to store and execute algorithms known as smart contracts. These self-executing digital contracts are stored immutably by distributed and decentralized blockchain nodes, and they serve two primary functions: 1) as a consensus mechanism to ensure the correct execution of an algorithm and 2) as an access

log to record who has executed the algorithm and when. Consequently, smart contracts can automate transactions transparently without the need to rely on a third party. Although our work is agnostic regarding blockchain types, we focus primarily on public blockchains as these networks operate with unrestricted access in the sense that anyone can create, access, and validate transactions, thus providing an open and transparent platform for developing and interacting with applications and digital assets.

2.3.1. Non-fungible tokens

From a technical standpoint, smart contracts have catalyzed the emergence of diverse types of assets, such as tokens. A token is a digital version of an asset representing goods, utilities, or claims [10]. Our proposed solution for leveraging NIL regulatory changes and universally rewarding student-athletes relies on collectibles, such as game cards, built using non-fungible tokens (NFT) technology, i.e., blockchain tokens that are not directly interchangeable as they possess distinct values. The work by Wang et al. [11] studied the impact of NFT design features on different metrics. More specifically, the authors analyzed how competency-related and investment-related design aspects affect the financial performance of an NFT project. Broadly, our work differs from previous research in that we examine the influence of NFT sales mechanisms on the fair and inclusive distribution of limited financial resources.

Blockchain-based token applications have also been proposed in the sports domain, the original motivator of our research work. In particular, those applications have manifested in digital collectibles and fan tokens, transforming engagement and creating new revenue streams [12]. For example, NFTs create digital memorabilia and trading cards, while fan tokens enhance the participatory aspect of sports fandom by enabling supporters to have a say in certain club decisions. Despite the popularity of these applications, the academic literature still lacks in-depth studies in certain key areas [12], including cross-organizational management and collaboration, privacy implications of using blockchain for storing athlete performance and health data, and the associated legal concerns. Our work adds to the literature by proposing a way to use NFTs to reward athletes fairly and inclusively, thus benefiting key stakeholders in the short and long term.

2.3.2. Blockchain-based marketplaces

Our proposed artifact in this paper involves well-crafted NFT marketplaces. The seminal work by Nobelist Alvin Roth [1] suggests three major characteristics marketplaces should have to avoid market failures. First, marketplaces must be thick, meaning that market participants should be able to quickly find a counterparty available to trade. Second, marketplaces must overcome congestion by making transactions fast enough. Finally, marketplaces must be safe to attract participants while preventing transactions outside of the market or engagement in strategic behavior.

It has been recently suggested that blockchain-based marketplaces fail to satisfy all the characteristics suggested by Roth [1]. In particular, Park et al. [13] have suggested that blockchain-based technologies might not be attracting a substantial user base, thus affecting thickness. Moreover, the existence of illegitimate projects might be affecting the security perception of prospective users. Finally, slower transaction times notorious on some blockchain networks might contribute to a congested marketplace. As a secondary contribution of our work, we suggest when designing and evaluating our proposed artifact that the idea of random minting NFTs that pay royalties while allowing their free trade in secondary markets can alleviate all of the aforementioned issues and potentially reduce NFT marketplace failures.

3. Research context

Our research originated with regulatory changes in college sports, an inherent part of many American higher-education institutions. Up until 2021, student-athletes used to be full-time students and amateur players, meaning they should refrain from receiving monetary awards or wages. They could nonetheless receive scholarships to attend universities as compensation for the amateur nature of college athletics. Organizations like the National Collegiate Athletic Association (NCAA) oversee athletic scholarships in the United States. Currently, there are about 500,000 active NCAA student-athletes [14].

That amateur status introduced various challenges. For instance, scholarships given to student-athletes may not cover the whole cost of tuition, fees, and housing [15]. Furthermore, student-athletes may not have the same opportunities as their peer students, such as access to summer internships, due to athletic commitments. Since 98% of NCAA student-athletes do not go on to become professional athletes after college [14], such absence may affect their future job prospects outside of athletics. The NCAA modified its amateurism policies on June 30, 2021, allowing student-athletes to profit from their name, image, and likeness (NIL). That is, NCAA student-athletes may now sign NIL contracts as long as they comply with federal and state laws [16].

Since the implementation of NIL regulations, the financial landscape for student-athletes has expanded significantly, giving rise to a variety of revenue streams. For example, student-athletes can secure income through corporate sponsorships and endorsement deals, where brands seek to leverage the athlete's visibility for marketing purposes. In addition to commercial partners, student-athletes can generate income by creating and sharing content on platforms like YouTube, TikTok, and Instagram, where monetization occurs through ad revenue, sponsorships, and audience engagement. Revenue can also be derived from paid appearances at events such as training camps, speaking engagements, or community outreach initiatives, and from the sale of personal-branded merchandise and collectibles, which is our focus in this paper.

Although widely praised, there have been some reservations about who will truly benefit from the new NIL improvements. In that regard, the legendary American football coach Nick Saban said: "*Everything in high school and college football has always been equal for everyone. It's not going to be that way anymore. Certain positions probably enhance* [the] *opportunity to create value, like* [a] *quarterback*." [17]. While NIL endorsements may be unlikely to become a reality for the majority of NCAA student-athletes, there have already been a few high-profile endorsements, such as the roughly $1 million USD sum obtained by Bryce Young, a previous athlete at the University of Alabama [17].

The abovementioned situation raises concerns about inclusiveness surrounding prospects for obtaining and signing NIL deals. Simultaneously, the size of some of these agreements prompts questions about fairness and whether student-athletes receive adequate or excessive compensation. Our proposed artifact in this paper leverages digital assets to alleviate those concerns. It is noteworthy that the idea of profiting from student-athletes' NIL through digital assets is receiving considerable attention within the sports industry, although most companies are still in the startup phase at the time of writing. Besides the Campus Legends platform, which we mentioned in Section 1, Open Locker, Draftly, and NFTU are also notable startups trying to succeed in this area. While Open Locker allows student-athletes to receive royalties from sales of digital collectibles associated with them, Draftly targets organizers and communities representing several athletes by providing NFT-related management and content-creation tools. NFTU's operation is the closest to what we propose in this paper. In particular, that platform sells random packs of collectibles in primary markets and allows student-athletes to receive royalties from sales in secondary markets. However, unlike our proposed solution, randomness is not meant to boost inclusiveness. Instead, it creates a tiered system comprised of "Common," "Premium," "Rare," and "Ultra Rare" collectibles. Overall, our solution differs from and contributes to the above industry practices by explicitly investigating a sale mechanism that can boost inclusiveness while ensuring fairness regarding the allocation of NIL financial resources.

4. Research methodology

We address the problems of fairness and inclusiveness when allocating NIL financial resources by following a design science methodology [18], a standard IS method that guides the design of IT artifacts to address real-world problems such as ours. In particular, besides developing and evaluating practice-oriented artifacts, we also contribute to the information systems body of knowledge by proposing grounded design requirements, principles, and features. Our research process consists of a design cycle structured according to the guidelines by Peffer et al. [19], which consists of six phases, namely 1) problem identification and motivation; 2) identification of solution objectives; 3) artifact design and development; 4) artifact demonstration; 5) artifact evaluation; and 6) communication.

We started by identifying and validating problems with NIL financial resource allocation after conducting semi-structured interviews with key stakeholders, namely 12 student-athletes from four academic institutions in the United States. We deliberately focused on diversity in terms of gender and sport type during the interviewee selection process. The primary focus of the interviews was on gaining insights into the student-athletes' perspectives on the new NIL regulations and who might benefit from them. The interviews were recorded, transcribed, and coded using MAXQDA software. We analyzed the obtained qualitative data by first assigning codes to short passages as part of our open coding process. We subsequently organized and connected the initial codes by creating categories during the axial coding phase. Finally, we combined categories during the selective coding phase to develop a more structured and integrated understanding of the data. The responses we received helped validate our initial understanding of the challenges associated with NILs and inform our research approach within the design science methodology.

In the second phase, we defined solution objectives "*from the problem definition and knowledge of what is possible and feasible*" [19]. Specifically, based on the insights from the interviews with key stakeholders, we defined *design requirements* related to fairness and inclusiveness that any solution should satisfy. Moreover, we contemplated a natural design requirement in that solutions to the allocation of NIL financial resources must not only be fair and inclusive but also sound. Given our focus on market-based solutions, soundness translates into three new design requirements (thickness, no congestion, and safety), which collectively define necessary conditions for a well-functioning marketplace [1].

In the third phase of the process, we designed and developed a concrete artifact that satisfies the design requirements. To do so, we relied on the relevant literature on inclusiveness and fairness to derive two *design principles* defining the generic capabilities of an artifact. These design principles were made concrete through two *design features*, i.e., technical aspects that are solution-specific. The final result was a blockchain-based artifact that satisfies all design principles and incorporates the design features.

In the fourth and fifth phases of our design cycle, we demonstrated and evaluated our artifact to assess how well the proposed ideas support a solution to the identified challenges. Besides including "*a comparison of the artifact's functionality with the solution objectives*" [19], we also evaluated our ideas by interviewing the same 12 student-athletes we interviewed before and gathering their feedback on the proposed solution. We concluded our design cycle by communicating our findings in this academic paper.

5. Solution design & development

The process of deriving our proposed solution to the problem of allocating NIL financial resources fairly and inclusively involves defining *design requirements*, *design principles*, and *design features*. For our purposes, design requirements are broad criteria that any artifact must satisfy to address the underlying problem class. Design principles, in turn, are the overarching functionalities of an artifact through which the design requirements are fulfilled. Finally, design features delineate the technical aspects of one specific solution. Fig. 1 shows the proposed design requirements, principles, and features and their connections. Next, we explain how we derived the design science components.

5.1. Design requirements

The first phase in the design science research methodology is to both "*define the specific research problem and justify the value of a solution*" [19]. To achieve these goals, we conducted semi-structured interviews with 12 student-athletes who participated in a range of sports at the highest level (Division I) within four distinct academic institutions in the United States. The qualitative data we obtained corroborates previous findings that information saturation is often reached with 12 interviews [20]. Table 1 provides anonymized information about the interviewees.

During the first phase of the interviews, our primary goal was to elicit student-athletes' perspectives regarding the newly introduced NIL regulations. That endeavor involved exploring topics such as the likely beneficiaries of these regulations and how universities can assist in obtaining NIL endorsements. From a methodological standpoint, the responses we gathered served two interconnected purposes: 1) to validate our initial understanding of the possible inclusiveness and fairness issues surrounding NILs; and 2) to systematically structure our thoughts within the design science research methodology. The collected information also helped with the second phase in the design science research methodology, which is to "*infer the objectives of a solution from the problem definition and knowledge of what is possible and feasible*" [19].

We start by highlighting the unanimous agreement among the interviewees that student-athletes should have the opportunity to monetize their name, image, and likeness. Moreover, when discussing who will most likely secure NIL deals, a consensus was reached that only a select few are going to reap the rewards. Specifically, interviewees suggested that prominent athletes in high-revenue sports or those with substantial social media followings are more likely to secure NIL endorsements. For instance, Interviewee #10 said:

> *"I guess the sports that make the most revenue normally. So, I feel like athletes, who are in bigger name sports that have like a large following and attention from the media [are more prone to get NIL deals]."*

Responses similar to the above naturally raise concerns regarding certain student-athletes' limited access to NIL financial resources. In other words, there may be minimal financial opportunities. Consequently, this brings us to the first design requirement for a solution to assist student-athletes in securing NIL opportunities.

> ***Design Requirement #1 (Inclusiveness)**: NIL projects should provide all student-athletes with access to opportunities and resources.*

The above requirement proposes that every student-athlete should be afforded the opportunity to benefit from the regulatory changes regarding NIL. In other words, any solution aiming to assist student-athletes in capitalizing on NIL prospects should be offered to all, such as educational events about exploring social media and building personal brands, networking opportunities, and participation in technological solutions. Using the previously introduced cake-cutting metaphor, solutions should be inclusive not only because everybody gets a small piece of the cake, but also because everybody has good access to the table with the cake. Interestingly and, perhaps, surprisingly, the majority of interviewees expressed favorable opinions regarding certain student-athletes obtaining greater financial resources compared to others. For instance, Interviewee #1 articulated the following viewpoint:

> *"There are guys making lots of money from what I understand who, honestly, are one hop away from being a professional . . . so I feel it [NIL endorsement] is warranted because of the revenue they [star student-athletes] create."*

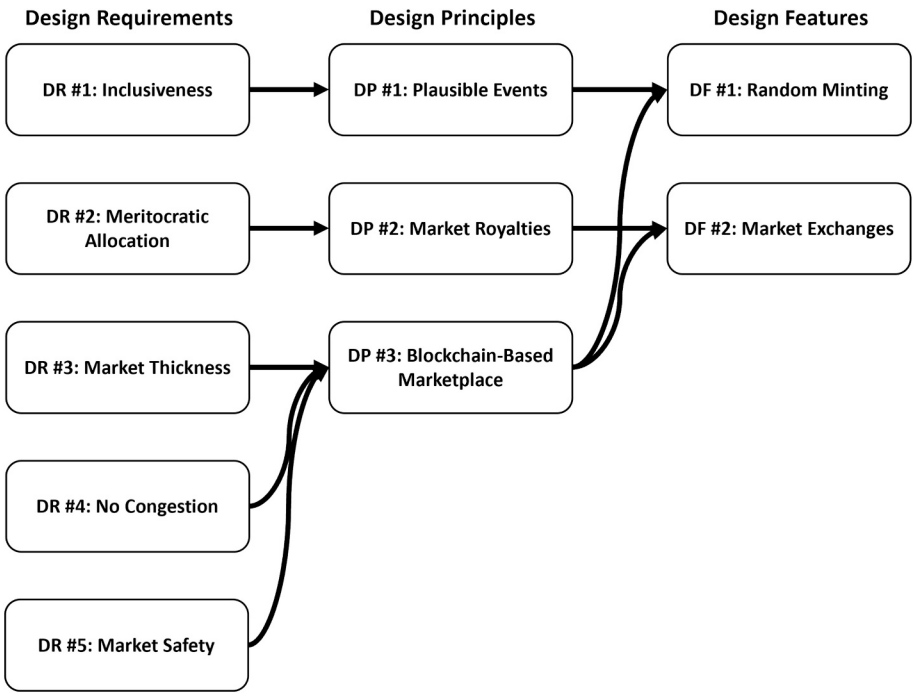


Fig. 1. Design requirements (DR), principles (DP), and features (DF).

Table 1
Information about the interviewees in our first study.

Interviewee #	Sport	Gender
#1	Golf	Male
#2	Golf	Male
#3	Track and field	Male
#4	Track and field	Male
#5	Soccer	Female
#6	Soccer	Female
#7	Track and field	Female
#8	Soccer	Female
#9	Track and field	Female
#10	Track and field	Male
#11	Track and field cross country	Female
#12	Swimming	Female

Overall, the interviewees' answers recognize that student-athletes have varying circumstances and abilities, and therefore, treating everyone exactly the same may not lead to an ideal allocation of financial resources. That is, their responses promote the idea that solutions must consider relevant differences and adjust access to NIL resources accordingly. That leads us to formulate the second design requirement:

> ***Design Requirement #2 (Meritocratic Allocation)****: Relevant differences among student-athletes should be a driving factor when allocating NIL financial resources.*

We note that the above requirement succinctly captures the acclaimed equality principle by Aristotle that says "*equals should be treated equally, and unequals unequally, in proportion to relevant similarities and differences*" [1]. Moreover, we are now in a position to combine the first two design requirements to create a new overarching definition of fairness, which we call *inclusive-meritocratic fairness*.

> ***Definition (Inclusive-Meritocratic Fairness)****: All student-athletes should have access to NIL financial resources (pie), and the final, long-term allocation (pie share) is determined based on individual merits.*

Inclusiveness and meritocratic allocation are necessary but, on their own, not sufficient conditions to achieve fairness. As such, a fair allocation of NIL resources must satisfy both design requirements #1 and #2. Finally, any NIL project must be sound by following standard practices and theoretical underpinnings. There are three conditions that well-functioning marketplaces should satisfy [1]. Given our focus on market-based solutions, those conditions naturally become the following design requirements in our work.

> ***Design Requirement #3 (Market Thickness)****: Participants in market-based NIL projects should be able to find trading partners quickly.*
> ***Design Requirement #4 (No Congestion)****: Market-based NIL projects must overcome congestion by having fast transactions.*
> ***Design Requirement #5 (Market Safety)****: Market-based NIL initiatives must be safe for the student-athletes.*

It is noteworthy that we analyze safety from the perspective of fraud targeting student-athletes due to the emergence of issues related to third-party involvement in NIL payments. Notably, the introduction of NIL regulatory changes has given rise to intriguing phenomena such as the formation of collectives comprising supporters who operate independently of universities and athletic departments [21]. Concerns have been raised regarding these third-party entities' transparency, particularly in how revenue shares from events and donation campaigns are distributed among student-athletes, e.g., a recent survey of 80 athletic directors revealed that 77% of them believed an unregulated NIL market would lead to a surge in sports-related scandals [22]. Design Requirement #5 is meant to alleviate such issues.

5.2. Design principles

In what follows, we define design principles a solution (artifact) should obey to overcome the existing challenges brought by the fairness and market-focused design requirements, which is part of the third phase of the design science research methodology. This phase involves the actual design of the underlying artifact. In formulating our design principles, we follow the schema by Gregor et al. [23]. Although artifacts implementing design principles could be any solution that can help student-athletes obtain NIL financial resources — e.g., educational campaigns helping them understand how to produce relevant content

and build a following on social media and how to sell merchandise having their personal brands — our focus in this paper is on the narrower space of market-based technological solutions.

Our first design principle in Table 2 tackles the design requirement of inclusiveness. It introduces the idea of collectibles, i.e., items that are valued and sought after by collectors for their rarity, uniqueness, or connection to a particular interest or theme, such as a student-athlete. In short, the first principle suggests market-based randomized sales of collectibles that pay royalties, where every student-athlete has a non-zero chance of profiting from their NIL. From a market perspective, such randomization can stimulate engagement due to the possibility effect, a psychological phenomenon that drives choices under uncertainty when there is a chance, however small, to gain something of great perceived value [24].

The non-zero probabilistic nature of the first design principle's mechanism states that all student-athletes should have at least a chance to access NIL financial resources. But the second design requirement (meritocratic allocation) implies that popular student-athletes, be it due to being top performers and or having a considerable number of social media followers, should be rewarded more than their peers in the long term. We draw from concepts in fair division and distributive justice (see Subsection 2.1) to propose the design principle in Table 3 that tackles the meritocratic-allocation requirement.

While the first design principle has a more egalitarian approach under the distributive justice lenses, the second design principle embodies meritocratic justice. Defining a meritocratic system in the context of college sports can be challenging, as sports differ in performance metrics and degrees of popularity. Moreover, individual athletes possess qualities beyond performance that may influence their popularity. As such, instead of attempting to quantify a clear-cut allocation of financial resources ex ante, the second design principle proposes ex-post, exogenous, market-driven adjustments to an initial allocation of resources. Specifically, by means of market forces (the law of supply and demand), our second design principle allows student-athletes who have (not) equal status in normatively relevant aspects to be treated (un)equally regarding the allocation of NIL financial resources, all of that by means of sales of collectibles in secondary markets. Hence, one can argue that Aristotle's maxim "*equals should be treated equally, and unequals unequally, in proportion to relevant similarities and differences*" serves as a kernel theory for the second design principle. From a market perspective, when individuals have heterogeneous preferences, the secondary market reallocates assets based on individuals' willingness to pay for specific collectibles. If the market is considered competitive and transaction costs are minimal, trading in the secondary market leads to an efficient allocation of collectibles, regardless of their initial distribution [25].

When combined, the first two design principles satisfy our definition of inclusive-meritocratic fairness. Design Requirements #3, #4, and #5 ground our work by narrowing the space of potential solutions for sharing NIL financial resources to those involving marketplaces. The third design principle in Table 4 suggests that blockchain technology should serve as the foundational infrastructure to achieve a well-functioning marketplace. As we elaborate later in Section 6, the transparency of modern public blockchains aligned with the power of smart contracts can effectively help create well-functioning marketplaces for NIL collectibles. Naturally, the work by Roth [1] serves as the kernel theory underpinning the third design principle.

Table 2
Design principle #1 (Plausible events).

Components of the design principle schema [23].	
Aim, implementer, and user	For NIL project implementers to create an inclusive distribution of NIL financial resources (aim) for student-athletes (users).
Context	NIL-based allocation of financial resources among student-athletes.
Mechanism	Student-athletes earn royalties from sales of random collectible packs in primary markets, each with a non-zero chance of having specific items.
Rationale	A greater than zero probability of obtaining NIL financial resources fosters inclusiveness among student-athletes.

Table 3
Design principle #2 (Market royalties).

Components of the design principle schema [23].	
Aim, implementer, and user	For NIL project implementers to create a meritocratic allocation of NIL financial resources (aim) for student-athletes (users).
Context	NIL-based allocation of financial resources among student-athletes.
Mechanism	Student-athletes receive royalties from deterministic sales of collectibles in secondary markets.
Rationale	The interviews with key stakeholders suggest that Aristotle's equality principle adequately captures how NIL financial allocation should be done. This principle is fulfilled through market forces.

Table 4
Design principle #3 (Blockchain-based marketplace).

Components of the design principle schema [23].	
Aim, implementer, and user	For NIL project implementers to create a successful marketplace (aim) for collectors (users).
Context	NIL-based allocation of financial resources among student-athletes.
Mechanism	Blockchain technology should form the backbone of market-based NIL initiatives.
Rationale	Under certain conditions, blockchain-based marketplaces can satisfy Roth's requirements [1] for successful markets.

5.3. Design features

After establishing a suitable set of design requirements and principles necessary for a solution to help student-athletes secure NIL deals fairly and in a sound manner, we next outline specific *design features* that encompass crucial technical aspects of our proposed artifact, completing the third phase of the design science research methodology. Our suggested solution centers around digital collectibles, which are individually associated with each student-athlete, thereby reflecting their NIL. Additionally, we ensure that a portion of the proceeds from any transaction involving a student-athlete's collectible is automatically allocated to the respective student-athlete. From an implementation perspective, this concept can be likened to NFTs that offer royalty payments whenever a transaction occurs. Fig. 2 depicts the interactive dynamics between key stakeholders, namely collectors (fans) and student-athletes, within our solution.

User interactions start with fans initiating transactions through an NFT platform (marketplace). In the background, the platform establishes a connection with a smart contract stored on a public blockchain network. That smart contract is responsible for creating (minting) NFTs associated with student-athletes, thus representing their NIL. The transactions initiated by the fans can be of two types, *purchase* or *exchange*.

A *purchase* transaction occurs when a fan transfers a predetermined amount of money to the smart contract in exchange for a number of collectibles. The smart contract then allocates ownership of randomly created collectibles (NFTs) to the fan who created the transaction. At this point, a portion of the earnings (for instance, 30%), which is predefined when NFTs are created, is distributed among all the student-athletes related to the NFTs. The design feature below captures the aforementioned process:

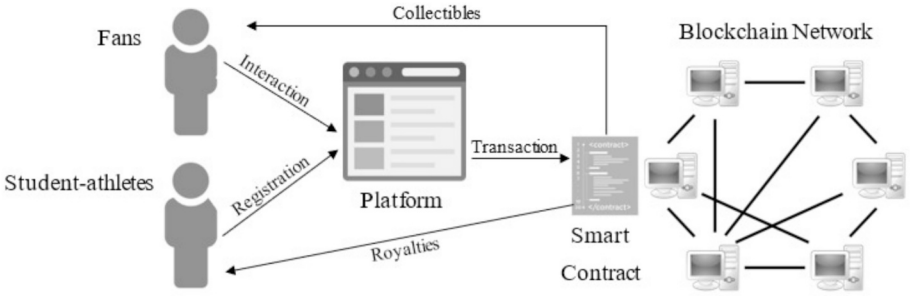


Fig. 2. High-level description of the proposed solution.

***Design Feature #1 (Random Minting)**: NFTs that pay royalties to student-athletes are randomly minted in primary markets.*

By relying on the random creation of NFTs that pay royalties, our solution generates opportunities to reward all student-athletes, thus implementing the first design principle and fulfilling the inclusiveness requirement. Considering the inherent stochasticity of the purchase process, it is possible for fans to acquire duplicate collectibles. To address this point, the *exchange* operation facilitates the sale or trade of collectibles between fans, where two fans can exchange cards for cards, cards for monetary compensation, or a combination of cards for cards and money. When there is monetary compensation, a predetermined and hardcoded portion of the monetary value is distributed as royalties among all the student-athletes associated with the collectibles involved in the exchange. The following design feature encapsulates the above discussion:

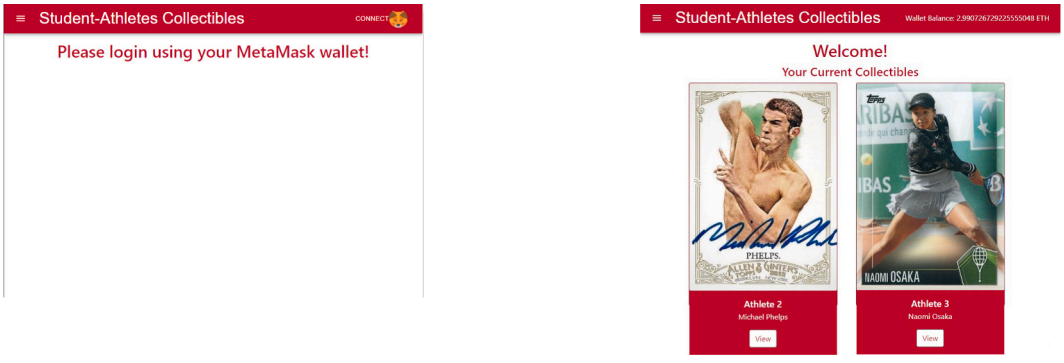
***Design Feature #2 (Market Exchanges)**: Minted NFTs that pay royalties to student-athletes can be traded in secondary markets.*

We argue that deterministic sales in secondary markets implement the second design principle, thus fulfilling the meritocratic allocation design requirement. That is because collectibles representing popular student-athletes should naturally experience a higher demand and, hence, a higher volume of transactions. As such, in the long term, the most popular student-athletes should receive higher compensation in royalties.

5.4. Prototype

The fourth phase of the design science research methodology involves the demonstration of the proposed artifact [19]. In line with this, we have developed a *decentralized application* (DApp) functioning as an NFT platform, along with corresponding smart contracts, to effectively implement our ideas. DApps belong to a software category that relies on decentralized networks as their back-end systems. In our prototype, the DApp is a web-based application that leverages the Ethereum network, which operates on a public blockchain model capable of executing smart contracts. Therefore, in addition to facilitating financial transactions involving the native cryptocurrency *Ether*, Ethereum users can also initiate transactions that interact with smart contracts. The communication between our DApp and the deployed smart contracts is facilitated through the utilization of a *blockchain wallet*. Specifically, our DApp relies on wallets whenever a user initiates a purchase or exchange transaction. For instance, when a fan intends to perform a transaction, the wallet prompts them to verify and digitally sign the transaction before it is posted to the blockchain network. Fig. 3 illustrates the welcome screen of our proposed DApp (NFT platform). Upon accessing the DApp, users are asked to establish a connection between their wallets and the application (refer to Fig. 3a). Subsequently, the DApp collects the user's blockchain address, uses it to query the deployed smart contracts, and retrieves information about the collectibles associated with the user's address (Fig. 3b).

Upon a user's purchase of a collectible, their blockchain wallet is responsible for determining the precise amount of Ether to be transferred to the smart contract. The wallet prompts the user to confirm and digitally sign the transaction, ensuring its authenticity. Subsequently, the DApp invokes a function within the smart contracts, which is designed to randomly mint a predetermined quantity of collectibles from a pre-existing list. Notably, this particular function also automatically distributes a predefined fraction of the payment as royalties to the student-athletes associated with the randomly created collectibles. Note that the proposed solution is agnostic to the specific number of collectibles minted at a time. With a fixed purchase price for each pack, minting fewer collectibles at once results in higher royalties per collectible for the associated student-athletes due to the concentrated value distribution. Conversely, minting a larger number of collectibles simultaneously dilutes the royalty payments, reducing the earnings per student-athlete. Additionally, higher mint volumes decrease the rarity of each card, which diminishes their perceived value and potential resale



(a) Before connecting the wallet. (b) After connecting the wallet.

Fig. 3. Screenshots of the welcome screen.

price in secondary markets, thereby reducing long-term royalties for those athletes. As such, in practice, it may be preferable to mint a smaller number of collectibles. In our prototype, that number is three.

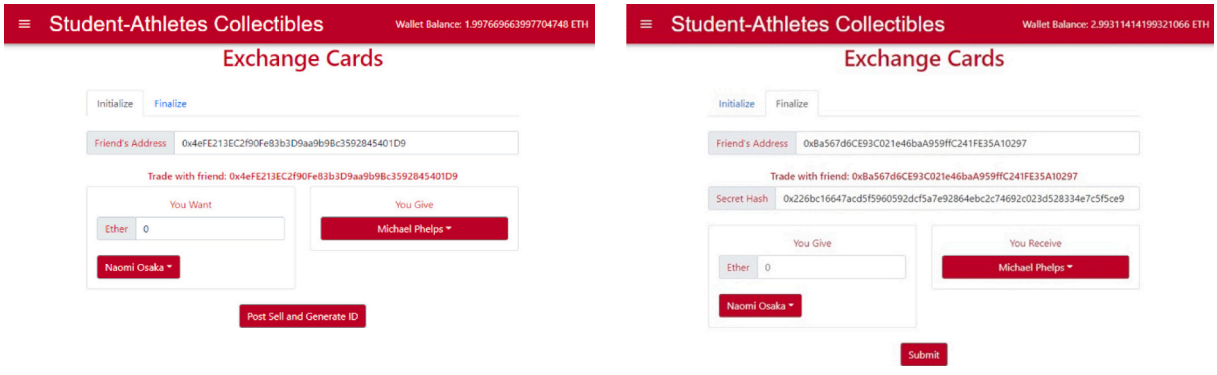
Besides the purchase functionality, our DApp provides robust support for the exchange of collectibles. As mentioned earlier, users have the option to exchange their collectibles for monetary compensation (effectively, a sale), other cards, or a combination of collectibles and money. Fig. 4 illustrates the exchange process. It starts with one user informing the address of their trading partner, along with the collectibles being offered and the desired amount of money and/or collectibles (Fig. 4a). Next, a unique transaction identifier is generated to facilitate the completion of the exchange by the trading partner. The trading partner then confirms the transaction identifier, the requested collectibles, and the offered amount of money and/or collectibles, as illustrated in Fig. 4b. Similar to the purchase transaction, when monetary compensation is involved in the exchange, a fraction of the money is automatically distributed to the student-athletes featured on the exchanged collectibles.

6. Design evaluation

The fifth phase in the design science research methodology involves evaluating the effectiveness of the proposed ideas and artifacts in addressing the identified challenges. For example, evaluation may include reflections involving "a comparison of the artifact's functionality with the solution objectives" [19]. In this regard, we contend that our solution successfully fulfills the five design requirements outlined in Section 5.1. Firstly, Design Principle #1, encompassing randomization and royalties in primary market transactions, ensures that all student-athletes have the opportunity to receive financial rewards based on NIL-related collectibles, aligning with the design requirement of inclusiveness. Additionally, Design Principle #2, involving royalties from secondary market transactions, enables student-athletes to profit from the demand for their collectibles, thus satisfying the meritocratic allocation design requirement by rewarding student-athletes differently. Our design choices specifically address the concern that less popular athletes might be overlooked in a purely market-driven NIL environment. In particular, the system actively promotes the distribution of royalties to a wider range of student-athletes in the primary market. This mechanism acts as an equalizer, providing initial financial opportunities to those who, for example, may not have a significant social media following or play in high-revenue sports. For popular athletes, the secondary market provides ample opportunity for greater earnings as their collectibles will likely be traded more frequently and at higher values, ensuring that their popularity is appropriately rewarded without undermining the initial inclusiveness for others. This two-pronged approach ensures that both less popular and popular athletes can benefit from the NIL system in a fair and inclusive manner.

Our studied solution for bringing fairness to the distribution of NIL-based financial resources relies on market-based ideas. As mentioned in Subsection 2.3.2, the seminal work by Roth [1] suggested three conditions for successful marketplaces, namely *thickness*, *no congestion*, and *safety*. Those conditions are natural design requirements in our setting, which we satisfy by having blockchain technology as the underlying technological foundation. Starting with *thickness*, we note that the introduction of random minting of collectibles in primary markets is akin to specialized automated market makers [26] in the sense that buyers always have an entity ready to sell collectibles. Naturally, this alleviates the need for matching buyers and sellers for a transaction to occur, thus reducing the impact the number of market participants has on market liquidity, at least in primary markets. Second, the argument that blockchain-based marketplaces suffer from *congestion* issues — as determined by transaction processing times — is becoming less relevant as the technology evolves. For example, at the time of writing, Ethereum — the blockchain network used by our artifact — is undergoing an update that will enable it to handle around 100,000 transactions per second, which is orders of magnitude more than its current capabilities. Moreover, our solution is generic enough that it can be readily deployed to different Ethereum virtual machine-based networks, such as Avalanche, which can currently handle about 4500 transactions per second. Such capacity from different blockchain networks can easily handle the current daily demand of well-established NFT platforms. In terms of computational complexity, the randomization algorithm is linear, i.e., O(n), where n is the number of distinct collectibles. Consequently, both the computational workload and the associated transaction fees (e.g., gas costs) for executing this algorithm in a blockchain environment scale linearly with the number of collectibles. As such, we do not see congestion as a hard limitation concerning the deployment of our solution. Finally, we note that using smart contracts ensures the automation of royalty payments, mitigating the risk of student-athletes not receiving the rewards they were promised. Additionally, the transparency of blockchain networks facilitates traceable and near-real-time money transfers. Thus, our proposed solution serves as a crucial step toward addressing *safety* concerns as blockchain technology helps reduce risks in NIL transactions.

Following the terminology by Hevner et al. [18], besides the above *informed argument* evaluation method, we also assess our design and artifact by performing *descriptive* evaluations. In particular, after identifying and validating the challenges associated with profiting from NIL through the initial set of interviews with student-athletes (see Subsection 5.1), the subsequent set of interviews aimed to validate our solution to address those challenges. To initiate this process, we sought feedback on the effectiveness of our artifact/ideas in achieving the goal of rewarding all student-athletes, i.e., promoting inclusiveness. *All*



(a) Exchange initialization. (b) Exchange finalization.

Fig. 4. Screenshots of the exchange transaction.

participants in the interviews expressed their belief that the proposed solution possesses the capability to allocate financial resources to every student-athlete. For example, Interviewee #2 said:

> *"It [the solution] has the potential to benefit everybody, not just, you know, the star athletes. So, I like it."*

Interviewee #11 underscored the inclusive nature of the solution in terms of different sports by expressing the following sentiment:

> *"Because it is distributed throughout the whole campus and all sports are involved, I do think that people will be interested in the idea, and potentially all athletes could contribute or gain some financial resources from it."*

In addition to the direct financial rewards associated with transactions, the interviewees highlighted additional positive outcomes from adopting the proposed solution. For example, Interviewee #6 emphasized that leveraging collectibles as NFTs can help student-athletes develop and strengthen their personal brands:

> *"They [fans] have an athlete on there [a random pack] that they didn't know who it was, but then they might look into them and kind of know who the athlete is and literally put a face to the name, and help them [student-athletes] build their brand a little bit too."*

Based on the highly positive responses from the interviewees, we have obtained strong qualitative evidence supporting the claim that sales of random packs of collectibles that pay royalties in primary markets promote inclusiveness. Similarly, interviewees expressed a positive sentiment regarding the meritocratic-allocation aspect of our solution. For instance, Interviewee #6 provided feedback about whether popular student-athletes would be negatively affected by the randomization feature:

> *"If, you know, one of these famous athletes' cards went out. Say the original pack was bought for a lower price than what the actual value of the card was worth, because it was just in this random pack. But then, once it gets traded [in a secondary market] I'm sure there will be plenty of [royalty] money to make up the difference."*

Collectively, the responses from the interviewees reinforced our evaluation that the direct sales/exchange of collectibles that pay royalties in secondary markets foster a meritocratic distribution of financial resources. In addition to soliciting feedback on inclusiveness and fairness, we also discussed other non-technical considerations, which we aim to investigate thoroughly in future design cycles. For example, one aspect that emerged as a potential barrier to adoption, as pointed out by Interviewee #5, is the novelty of the technology:

> *"I don't think a lot of people know about cryptocurrency and NFTs and name-image-likeness. So, I think just advertising it [the solution] in a way where it is easy for all to comprehend would be super effective."*

The work by Mishra et al. [27] suggests that technological, organizational, and environmental factors influence blockchain adoption, including the perceived ease of use and technological trust. For example, without a strong foundation of trust, users may be hesitant to engage with blockchain-based applications, particularly for those involving sensitive data or valuable assets. Moreover, a user-friendly interface and a clear understanding of system features are paramount in the context of blockchain, which can be technically complex. Our focus in this work did not revolve around enhancing trust and usability; rather, it centered on assessing the viability and impact of the proposed ideas. As such, we believe there is significant room for future work to explore trust-building strategies, user interface improvements, and usability testing to ensure broader accessibility and adoption among diverse user groups.

Another important concern that emerged during the interviews is the establishment and long-term viability of a community, specifically addressing the incentives for fans to engage in the purchase of collectibles. Interviewee #11 articulated this concern through the following question:

> *"I mean [the solution] obviously works perfectly for athletes whose faces are on the cards, but a quick question: what do people who purchase the cards get from that?"*

Our collectible-based solution presents a range of possibilities for creating unique fan engagement experiences. For instance, fans possessing specific cards could have the opportunity to take photographs with student-athletes following a game. Additionally, fans who collect all the cards may be recognized during a game, granted access to premium seating, or offered discounts on merchandise and food. These new experiences can potentially incentivize fans to actively engage in the ecosystem. However, the successful implementation of these experiences relies on the participation of multiple stakeholders. For example, universities' athletics divisions should be responsible for tying some tangible benefits to the ownership of collectibles. Additionally, they should take responsibility for verifying the authenticity of student-athletes, thus preventing fraudulent impersonation. While our primary focus is on the student-athlete perspective and the exploration of new avenues for the fair and inclusive distribution of NIL resources, we acknowledge that a comprehensive examination of the aforementioned issues deserves further investigation in future studies and/or when deploying our ideas in practice.

7. Discussion: The rise of an NIL design theory

After studying the feasibility of our design and artifact in a study with major stakeholders, we conclude our work by summarizing and formalizing our findings in terms of a *design theory*. But first, we define clearly the boundaries of the design, i.e., the circumstances under which we expect our artifact to produce a more inclusive and fair distribution of financial resources. When reflecting upon our two studies, we observe that the existence of *players* as stakeholders is a *necessary*, although not sufficient, condition for our artifact to achieve its goals. Specifically, players are self-interested agents whose specialized skills are used when directly or indirectly cooperating and/or competing with/against other players. Different players are rewarded differently based on a series of factors, such as skills, previous performance and achievements, style, personality and charisma, fan base and support, and media exposure. Given the complexity of the resulting rewarding function, inequalities in the distribution of limited financial resources among players naturally arise. Another necessary condition for our artifact to achieve its goals is the existence of a *fan base* driving demand for collectibles so that players can reap the financial benefits.

Having established the boundary conditions of our design, we turn to the seminal work by Gregor and Jones [28] to define the full specification of a *design theory* in terms of eight components. The first component, *purpose and scope*, determines "*what the system is for*." As such, the purpose and scope of a design theory are intrinsically related to the design requirements, as they relate to a whole class of artifacts, as opposed to a single instance. That said, the purpose and scope of our design theory is to *develop market-based information systems to help share limited financial resources among a pool of players in a fair and inclusive manner*.

The second component, *constructs*, relates to "*representations of the entities of interest in the theory. These entities could be physical phenomena or abstract theoretical terms*" [28]. That is, constructs are the most basic level (unit) of a design theory [29]. Our solution to sharing financial resources according to our inclusive-meritocratic fairness criterion relies on a marketplace. Thus, the key constructs in our design requirements (*inclusiveness*, *fairness*, *market thickness*, *no congestion*, and *market safety*) naturally become constructs in our design theory. Moreover, since our solution involves rewarding players based on sales of collectibles, we note that *collectible* is also a basic unit in our design theory.

The third component of a design theory, *principle of form and function*, defines an abstract blueprint of the proposed artifact. That includes both

the general shape/form and function of the artifact. In our work, after defining the purpose and scope of our design through design requirements, we subsequently provide a blueprint of a solution that satisfies those requirements via design principles and design features. Collectively, the design principles and features constitute actionable guidelines delineating both the form and function of an instantiated artifact.

The fourth design theory component, artifact mutability, acknowledges the mutable nature of information systems artifacts by specifying potential changes that affect an artifact's form/shape and functionality. We note that two aspects of our proposed design can be modified based on one's needs: the probabilities in primary markets and the amount of royalties players receive. Regarding the former, in practice, one may define the probabilities differently based on different fairness or inclusiveness definitions as well as idiosyncrasies that may arise when deploying the artifact. Through changes in the underlying smart contracts, our artifact can be easily mutated to handle the above cases in a transparent way. For example, a star student-athlete may negotiate a fixed, low minting probability to increase the scarcity and, consequently, perceived value of their collectible. This scarcity can boost resale prices in secondary markets, potentially leading to greater royalty earnings. It also illustrates the flexibility and adaptability of the artifact in real-world deployments. Similar changes can also prevent some strategic and undesirable behavior, such as when fans receive side payments outside the blockchain system for the trade of collectibles in secondary markets, thus avoiding paying royalties to student-athletes. For example, a seller might list an NFT for free on-chain and settle the real sale off-chain, thereby skirting the royalty logic and depriving student-athletes of their due share. To fix that, the NFT representing a player can be coded to enforce a non-zero, token-specific floor price that every secondary-market transfer must satisfy. In practice, this means that buyers and sellers cannot complete transfer transactions without paying a certain royalty amount, which nullifies some of the economic incentive for off-chain side-payments. Another possible artifact mutation is to implement a wash-trade filter that automatically rejects transfers between identical blockchain addresses or addresses detected within a k-hop circular sequence. By blocking these self-referential or tightly looped transactions, the contract thwarts wash-trading schemes in which a trader simulates fake demand to inflate a collectible's apparent market value.

The fifth component of a design theory relates to truth statements written as *testable propositions* of the general form "*if a system or method that follows certain principles is instantiated then it will work, or it will be better in some way than other systems or methods*" [28]. In light of that definition, two key testable propositions involving our constructs emerge as part of our design theory. Following the definitions by van Aken [30], these testable propositions are *heuristic* propositions of the form "*if you want to achieve Y in situation Z, then something like action X will help.*" In our work, we validated with key stakeholders that we can achieve a meritocratic and inclusive distribution of limited financial resources among players by paying royalties after random sales of collectibles in primary markets and deterministic transactions in secondary markets. Moreover, by means of informed arguments, we explained how that dual operation implemented through blockchain-based marketplaces can enhance thickness, congestion, and safety. The validity of these two knowledge claims aligns with what Larsen et al. [31] define as "criterion characteristic validity," since the claims result from comparing features of our proposed design with those of an abstract reference entity, namely, the current NIL-based revenue sharing practices and conventional (non-blockchain) marketplaces.

The sixth component of a design theory, justificatory knowledge, regards the use of a kernel theory that "*gives a basis and explanation for the design*" [28]. We justify our design by drawing primarily from the distributive justice and market literature. Regarding the former, the collected qualitative data showed that the acclaimed maxim by Aristotle, "equals should be treated equally, and unequals unequally, in proportion to relevant similarities and differences," prescriptively describes the NIL-based allocation of financial resources. Second, the seminal work by Roth [1] guided our solution development since our design space is restricted to market-based solutions.

Although the last two theory components are optional, we nonetheless include them in our design theory as "*the credibility of the work is likely to be enhanced … by* [the] *provision of an instantiation as a working example*" [28]. The seventh component, principles of implementation, "*concerns the mean by which the design is brought into being*" [28]. As we discussed in Subsection 5.3, using NFTs backed up by smart contracts and blockchain technology can effectively instantiate an artifact that satisfies the fairness and market-related design requirements. In particular, NFTs represent the collectibles associated with players, smart contracts are responsible for the code logic, including minting NFTs and the randomization in primary markets, and a public blockchain is the underlying technology that enables NFTs and smart contracts, besides storing ownership data in a transparent fashion. The eighth and final theory component is an expository instantiation of an artifact. Gregor and Jones [28] state that "*a prototype system can often be used to illustrate how a system functions, with better communicative power than a natural language description.*" That was indeed the case in our work, where the open-source NFT platform we developed (Subsection 5.4) effectively served the purpose of theory representation and exposition. In particular, the prototype helped us illustrate how our artifact functions in practice, allowing key stakeholders to evaluate it qualitatively (Section 6).

8. Conclusion

We note that our design theory is highly prescriptive in nature; it can guide researchers and practitioners when designing fair and inclusive NIL projects while being abstract and flexible enough to capture different application needs. Moreover, our work touches on all the phenomena of interest for design research, as determined by Gregor and Jones [28]: 1) we instantiate a concrete artifact; 2) we create a theoretical and, thus, abstract description of the artifact; and 3) the previous points are guided by human understanding of the artifact, done by means of evaluations and requirement elicitation. In terms of future work, it is worthwhile to contemplate potential applications of our design beyond traditional sports. The fundamental principles of inclusive-meritocratic fairness that we propose are highly generalizable, as the challenge of equitably distributing revenue and recognition is not unique to NIL. Exploring other domains would allow us to refine our solution and make further contextual knowledge claims [31], as we believe our model offers a robust blueprint for other creator-centric economies where individual rights and royalties are critical, such as music, art, and digital content. For example, in the music industry, our solution could be adapted to support a collective of emerging, independent artists. Instead of athlete collectibles, a platform could issue NFTs representing a micro-share of streaming royalties, exclusive B-side tracks, or digital liner notes. The primary market would function as a discovery engine, where fans could purchase randomized packs of these assets. This mechanism would provide all participating artists with crucial initial funding and exposure, fulfilling the inclusiveness requirement. Subsequently, the secondary market would allow fans to trade these assets, with the value of an artist's tokens naturally increasing as their popularity grows. Similarly, in the art world, our design could empower a collective of digital artists, e.g., a gallery or platform could launch a curated collection where each NFT is initially sold in a randomized loot box format [32] at a uniform price. This approach would guarantee every artist in the collective a sale and an entry point into the market. As collectors begin to trade the individual pieces in the secondary market, the artists who garner the most acclaim would see the value of their work and their subsequent royalties increase.

Whereas our qualitative evaluation through stakeholder interviews

provided valuable insights into the fairness and inclusiveness of our proposed solution, we acknowledge that future work could benefit from complementary quantitative validation approaches. For example, controlled experimental simulations could be designed to measure behavioral responses to different fairness criteria and randomization mechanisms, thus enabling a more rigorous assessment of user engagement as well as deriving causal knowledge claims [31]. Additionally, willingness-to-pay studies could offer a quantifiable perspective on how fans value different NFTs, thereby enriching our understanding of demand-side incentives. These methods would serve to triangulate findings from our qualitative evaluation and support the refinement and validation of our artifact.

While our proposed artifact promotes fairness and inclusiveness in NIL monetization via NFTs, it is essential to recognize associated ethical and regulatory challenges. Privacy concerns may arise from the storage and sharing of athlete data on public blockchains, which are inherently transparent and immutable. To mitigate such risks, our design avoids recording sensitive personal or biometric data on-chain and instead uses minimal identifiers linked to verified athlete identities. Additionally, speculative risks tied to the NFT market, such as price volatility or artificial scarcity, can expose student-athletes to reputational or financial harm. To minimize these risks, the proposed system focuses on royalty-based compensation, rather than asset speculation, and incorporates mechanisms (e.g., randomized minting) that discourage manipulative trading behavior. Lastly, concerns about exploitation are addressed through automated, transparent royalty distribution, ensuring athletes receive fair and traceable compensation. Future work could explore formal mechanisms for athlete consent and data governance on blockchain platforms, as well as longitudinal studies on the financial and reputational impacts of NFT participation. In addition, developing design adaptations that account for emerging NIL regulations across jurisdictions is critical to ensure compliance and scalability. Given the exciting future research directions above, we believe our work marks a meaningful step toward more just and participatory NIL platforms.

CRediT authorship contribution statement

Arthur Carvalho: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Liudmila Zavolokina:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Data curation, Conceptualization. **Suman Bhunia:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Formal analysis, Conceptualization. **Gerhard Schwabe:** Writing – review & editing, Validation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Arthur Carvalho is an Associate Professor of Information Systems & Analytics at Farmer School of Business, Miami University. Dr. Carvalho's research focuses on theory-driven applications of blockchain technology, the wisdom of crowds, and artificial intelligence. His research has been published in academic journals such as Decision Support Systems, Decision Analysis, International Journal of Information Management, Journal of Cleaner Production, among many others.

Liudmila Zavolokina is an Assistant Professor of Information Systems and Digital Innovation at the University of Lausanne, Switzerland. She earned her Ph.D. in Informatics at the University of Zurich, where she was postdoctoral researcher at the Digital Society Initiative. Her research is design-oriented and focuses on emerging technologies such as blockchain, AI, and digital platforms, for creating public value, digital resilience, and trust.

Suman Bhunia is an Assistant Professor in the Computer Science and Software Engineering Department at Miami University of Ohio. He earned his Ph.D. in Computer Science and Engineering from the University of Nevada, Reno (UNR). Specializing in security and vulnerabilities in wireless communications, Dr. Bhunia has also contributed to various research domains, including neighbor discovery in free space optical (FSO) communication, cross-layer routing, and location management for unmanned aerial systems (UAS), as well as ensuring the quality of voice traffic over wireless networks. He has published numerous peer-reviewed articles in esteemed journals such as IEEE Transactions on Vehicular Technology, ACM Transactions on Cyber-Physical Systems, IEEE Transactions on Dependable and Secure Computing, and IEEE Transactions on Mobile Computing. In addition to his academic pursuits, Dr. Bhunia has played a pivotal role in establishing and guiding the Miami University Cybersecurity Club, assuming the role of advisor since its inception.

Gerhard Schwabe has been a Full Professor at the University of Zurich since 2002. His research interests focus on the intersection of collaborative technologies and information management. He has published in major IS conferences, IS journals, and computer science conferences (like CHI, CSCW, and ICSE). Currently, his research interests focus on Blockchain Applications, Generative AI applications, Human AI collaboration, human drone collaboration, and government as a platform. He is currently a senior editor of ISJ and JIT.