Non-Fungible Tokens (NFTs): A Systematic Study of Trust Criteria

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Abstract

Despite the rapid growth of NFTs, they face challenges in gaining user trust. This study evaluates key criteria shaping trust in NFTs, validated through a questionnaire survey. A multi-criteria decision-making (MCDM) method, TOPSIS, was used to identify key trust factors. Results show that Authenticity Verification, Transparency, and Reasonable Fees are critical for trust, while factors like Uniqueness and Community Governance are less significant. This paper aims to provide insights for NFT issuers and marketplaces to enhance user confidence and participation by focusing on the most crucial aspects of trust.

Keywords

Non-Fungible Tokens, Trust, Blockchain, Metaverse, TOPSIS, Community Engagement

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1 Introduction

In this evolving digital landscape, *Non-Fungible Tokens* (NFTs) have emerged as integral elements within the blockchain and crypto ecosystems, redefining digital ownership and commerce. According to [10], "NFTs are non-fungible, meaning that their perceived value depends on their characteristics". It is a unique programmable blockchain-based digital asset or element such as digital art, music, or physical assets that publicly prove ownership of digital assets and can be tokenized [33]. NFT marketplaces typically operate on a peer-to-peer basis, where sellers list items at a set price, and buyers submit lower bids. Sellers can accept a bid, wait for a purchase at the listed price, or hold out for a better offer [38].FTs play a key role in metaverse activities, from gaming to art exhibitions, and drive the virtual real estate market [38]. As unique digital assets stored on blockchain networks like Ethereum and utilizing standards such as ERC-721 and ERC-1155 [14], NFTs provide undeniable proof of ownership and traceability for digital objects.

However, the NFT market is characterized by pricing discrepancies, volatility, scams, and 'rug pulls,' reflecting its nascent and speculative nature [15]. Pricing discrepancies often arise from factors like perceived artistic value, creator reputation, and market hype, leading to significant variations in how stakeholders value the same NFT [5, 9, 24]. Conversely, volatility stems from rapid shifts in user demand and market sentiment, often influenced by broader trends in the cryptocurrency market and social media buzz [37].Scams and 'rug pulls' occur when an NFT issuer misrepresents the value or authenticity of an NFT or abruptly abandons a project after collecting funds. According to [15], several challenges in the NFT space remain to be explored - transparency and verifiability of NFTs are the utmost priority to stop the misuse of information and build trust. To the best of our knowledge, no systematic study has yet been conducted that investigates how various criteria influence the trustworthiness of users of NFTs [3, 23]. Conflicting criteria like authenticity, transparency, cost, and community present challenges for NFT users and issuers in decision-making. This study applies the Multi-Criteria Decision Making (MCDM) method to analyze the key factors involved. Through this analysis, we seek to answer the following research questions:

(1) 1. How do consumers evaluate NFTs based on their experiences?
(2) 2. What are the critical criteria that influence NFT buying behavior?
(3) 3. What are the relative weights of these criteria in shaping buying preferences?

2 Literature Review

Trust in NFTs relies heavily on different criteria that cater to the needs of the diverse stakeholders involved in the ecosystem. These stakeholders include issuers, auditors, marketplaces, buyers, and user communities—all playing crucial roles in shaping the perception and credibility of NFTs. Through an extensive review of recent studies, this section identifies and discusses key trust criteria, including authenticity, utility, uniqueness, transparency, security, and marketplace reputation.

2.1 Non-Fungible Token (NFT) Ecosystem

The Non-Fungible Token (NFT) ecosystem comprises various stakeholders essential to the creation, distribution, and consumption

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of NFTs. Understanding this ecosystem is crucial to analyzing factors influencing trust, especially for high-value NFTs that attract significant investment. Key players include:

- **NFT Issuers**, like Yuga Labs (creator of Bored Ape Yacht Club), mint NFTs, defining their characteristics, utility, and rarity, which directly impact user trust [19]. The issuer's reputation and transparency in the minting process play a critical role.
- **Security Auditors** (e.g., CertiK, Hacken) review and validate NFT smart contracts, ensuring code security through rigorous audits for high-value NFTs [21].
- **NFT Marketplaces** such as OpenSea are central NFT platforms that facilitate interactions between buyers and sellers [2]. Trust here depends on platform transparency, security, transaction costs, and user support.
- **NFT Buyers**, ranging from individual collectors to institutional investors, base trust on issuer reputation, marketplace security, and perceived NFT value. High-value NFTs attract buyers concerned with authenticity and scarcity, who rely on the transparency of NFT provenance and marketplace security [34].
- **NFT Communities** on platforms like Telegram, Twitter, and Discord support the ecosystem by discussing, promoting, and critiquing NFTs. Trust within these communities is fostered through peer recommendations and shared experiences [4].

2.2 Key Trust Criteria in NFTs

Recent research explores various dimensions of trust in NFTs, essential for understanding this evolving ecosystem. Key trust criteria include:

(1) **Authenticity**, crucial for trust, especially for issuers, is supported by identity management via NFTs. [7] suggests using digital avatars to enhance identity systems, while [16] highlights NFTs' role in tracking medical device ownership for authenticity.
(2) **Utility** spans NFT industries such as art, gaming, and DeFi. [29] identifies these uses, examining the functional impact of virtual items, particularly in pay-to-win contexts. Interoperability in Web3 is key, with [30] stressing NFT utility for digital ecosystem evolution, further supported by [37] on economic value in gaming and virtual properties.
(3) **Uniqueness and Exclusivity** rarity of NFTs drives consumer demand, quantified by [26] through transaction analysis, while [12] links uniqueness with intense consumer interest, a factor marketers leverage to boost engagement.
(4) **Transparency in NFT Transactions** intrinsic to blockchain, is vital for trust. [9] explores transparency benefits, such as verifying ownership history, but also notes challenges, including privacy concerns and metadata standardization issues.
(5) **Community Governance and User Feedback** are crucial for trust. [15] emphasizes enhancing feedback mechanisms to address ethics and accountability, while [18] and [41] stress the balance of security and inclusivity in metaverse governance.
(6) **Security**, especially in smart contracts, is essential. [20] and [22] discuss vulnerabilities in Ethereum contracts, noting audit importance to prevent fraud. Financial risks like scams and money laundering in Web3 are detailed by [39], while [23] categorizes vulnerability causes and tool effectiveness.

2.2.1 Marketplace Reputation and Security Measures. Marketplace reputation and security impact trust. [1] links reputation and operational efficiency to purchasing behavior, with [19] classifying marketplace security measures. [13] underscores escrow services as effective transaction safeguards.

2.3 Research Gaps and Objectives

Our literature review on NFT trust criteria highlights several research gaps. First, few studies use MCDM methods to thoroughly assess user preferences. While some research has explored individual trust factors [39], a comparative analysis from end users' perspectives is lacking [36]. Additionally, there is no structured data capturing the behavioral aspects of NFT selection. This study addresses these gaps by providing a holistic overview for issuers and users, improving the understanding of trust factors that influence NFT choices in this evolving market.

Our study uniquely contributes by identifying and ranking NFT trust criteria, offering end users a step-by-step assessment of these factors. By focusing on top-ranked variables, users can prioritize key factors that establish trust, enabling more effective evaluations of NFT reliability and value, and ultimately guiding informed decisions in the digital asset market.

3 Methodology

The study gathered in-depth insights into the criteria influencing trust among NFT users. We administered a structured questionnaire to 100 NFT users and received completed responses from 76. Then, we apply the following process to gain insights into the trustworthiness of NFT as presented in Figure 1

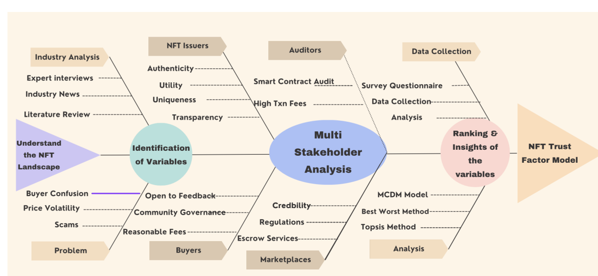

Figure 1: Overview of the study

Fishbone diagram in Figure 1 reflects that research moved on to define the following key components: (i) Identification of variables, (ii) Questionnaire creation from multi-stakeholder perspectives, (iii) Response analysis by TOPSIS, and (iv) Trust criterion ranking.

3.1 Scope

NFTs share core attributes like structure, storage, and primary uses across platforms such as Ethereum, Polygon, and Solana. This study

Table 1: Criteria affecting the successful adoption of the NFTs

No	Criteria	Significance
1	Authenticity Verification [7, 16]	Ensure the genuineness and originality of NFTs, preventing counterfeits and ensuring creators' rights
2	Transparency [9]	Access to information related to NFT smart contract, ownership records, and transactions
3	Reasonable Minting Fees and Transaction Costs [25]	Fairness and competitiveness of the costs associated with creating and transacting NFTs
4	Brand Recognition and NFT Price Performance [1, 5]	Brand Recognition emphasizes the visibility and reputation of the NFT issuer's brand. NFT Price Performance highlights the NFT's historical and expected price trajectory.
5	Certification of Security Measures Adopted [20, 22]	Measures the extent and effectiveness of security protocols in place to protect NFT users' assets and data
6	Marketplace Provided Regulation and Security [9, 19]	Rules, regulations, and security measures implemented by the marketplace to safeguard transactions
7	Community Feedback and Grievance Management [15]	Responsiveness of the marketplace to community input, feedback, and complaints, facilitating an engaged and supported user base
8	Utility [29, 37]	Additional functionalities offered by the NFTs, beyond ownership, e.g., access to services,content, or decision-making
9	Marketplace Provided Escrow Services [13]	Reliability and effectiveness of the escrow services by the marketplace, ensuring secure and fair transactions
10	Exclusivity of NFT [26]	Measures the degree of unique, rare, or limited-edition NFTs, contributing to their value and desirability
11	Community Governance (DAOs, Voting Systems, etc.)[18]	Mechanisms in place for community involvement in the marketplace's governance, decision-making, and operations

focuses on EVM-compatible NFTs, primarily on Ethereum and Polygon, due to their market share and infrastructure. Blockchain-based trust differs from traditional cloud systems, as it depends on protocols and consensus mechanisms (e.g., Ethereum and Polygon use PoS, while Solana combines PoH with PoS). Despite these differences, NFTs' core characteristics and user interactions remain consistent, making our insights broadly applicable.

This study emphasizes high-value NFTs, where trust, authenticity, and security are crucial, particularly in art and collectibles. While NFTs also serve lower-value applications like in-game microtransactions, this research focuses on high-value assets with pronounced trust dynamics, providing an in-depth analysis of trust criteria in the NFT ecosystem.

3.2 Identification of Variables

Based on an in-depth literature review, industrial evidence, practices, and recent reports, we consider the eleven criteria listed below in Table 1 contributing to a comprehensive understanding of trust criteria in the NFT acquiring process.

3.3 Data Collection and Analysis

We developed a questionnaire using a 5-point Likert scale to quantify perceptions and attitudes towards trust criterion. There are two parts to the questionnaire - (i) asking Demographic characteristics (Q1 to Q7) of the respondents like participants' age, gender, geographic location, and experience with NFTs. (ii) NFTs trust characteristics (Q8 to Q18): comprised questions aimed at understanding the perspectives of trust criteria for the respondents. For instance, we asked the following question: "How confident are you about the importance of NFT authenticity (including criteria like the origin of the NFT and the reliability of the issuer) in establishing trust within the NFT marketplace?" aligning with the Authenticity criteria, one among the eleven trust criteria.

The questionnaire was distributed online to NFT enthusiasts familiar with NFT marketplaces. Anonymity was ensured to encourage honest responses, and participation was voluntary to highlight the value of their input on trust. After data cleaning, 76 complete and valid responses were retained.

3.4 MCDM Methods

TOPSIS method was utilized to discern the underlying relationships between different trust criteria and quantify each criterion's importance. The analysis aimed to quantify the level of agreement or importance of each NFT trust criterion and to reveal how these criteria interact and contribute to the overall trustworthiness of NFT marketplaces as perceived by users.

3.5 TOPSIS

The TOPSIS method is the widely used MCDM method as it consists of simple computational steps and is easy to explain. This method ranks the alternatives according to the distance between the positive and negative ideal solutions. Data normalization is the first important step in the TOPSIS method. Normalization aims to bring the data according to the criteria to the same length scale, filtering out differences in magnitude between the dimensions. Numerous data normalization methods are used in the literature [8]. Three of them are used in the present study: TOPSIS with Min-Max weight, TOPISIS with Shanon Entropy, and TOPSIS with Gaussian Weights [32]. The TOPSIS method consists of the following steps [27]:

Step 1: Formulate a decision matrix ($X = (x_{ij})_{m\times n}$). And determine the normalized decision matrix $r = (r_{ij})_{m\times n}$, where $r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}}$ (under Euclidean normalization), $r_{ij} = \frac{x_{ij}-x_j^{min}}{x_j^{max}-x_j^{min}}$ (under Max-min approach) and $r_{ij} = \frac{x_{ij}}{x_j^{max}}$ (under Max-linear). Using the weights (w_j), the weighted normalization matrix is calculated as $v = r.diag(w)$, where $diag(w)$ is a diagonal matrix whose diagonal elements are the weights (w_j). We refer to Section S1 in the appendix for the details of weight generation.

Step 2: Next, we determine the Ideal (A^+) and Anti-ideal (A^-) solutions using the following formulas:

$$A^+ = \left\{ \left(\max_i \ v_{ij} | j \in J_1 \right), \left(\min_i \ v_{ij} | j \in J_2 \right) | i = 1, 2, \cdots m \right\}$$
$$= \left\{ {v_1}^+, {v_1}^+, \cdots, {v_j}^+, \cdots, {v_m}^+ \right\}$$
$$A^- = \left\{ \left(\min_i \ v_{ij} | j \in J_1 \right), \left(\max_i \ v_{ij} | j \in J_2 \right) | i = 1, 2, \cdots m \right\}$$
$$= \left\{ {v_1}^+, {v_1}^-, \cdots, {v_j}^-, ..., {v_m}^- \right\}$$

where J_1 and J_2 are the benefit and loss criterion, respectively. Therefore, the ideal solution is considered the best performance, and the anti-ideal solution is considered the worst.

Step 3: The Euclidean distance of each indicator from A^+ and

A^- are calculated as follows: $D_i^+ = \sqrt{\sum_{j=i}^{n} \left(v_{ij} - v_j^+\right)^2}$, $D_i^- = \sqrt{\sum_{j=i}^{n} \left(v_{ij} - v_j^-\right)^2}$, $\forall i = 1, 2, \cdots n$. Using those distance measures, the relative closeness measures ($C_i^* \in (0, 1)$) is computed for each alternative, where $C_i^* = \frac{S_i^-}{S_i^- + S_i^+}$, $i = 1, 2, \cdots m$. By arranging closeness (C_i^*) measures, the alternatives are ranked from best to worst.

4 Results

Before implementing the MCDM methods, we conduct a pre-analysis to explore the characteristics of demographics. Results are presented in Figure 2.

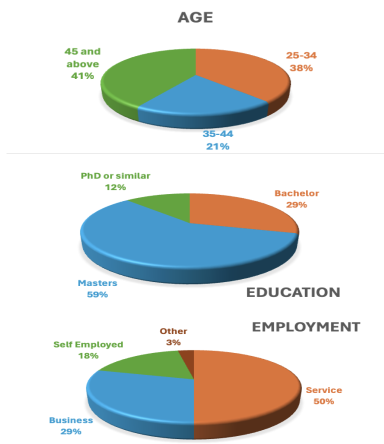

Figure 2: Demographics of respondents

The above data presents the demographics of the respondents. Our survey targeted individuals with solid qualifications and expertise in NFT and blockchain fields. Most respondents held Master's degrees, with a few holding Ph.D. degrees, and they primarily work in this domain. Their age typically falls in the 45 and above range. This composition suggests that our analysis is more likely to yield insightful and rational outcomes due to the participants' solid knowledge base and relevant experience. Next, we present the overview of the responses for the rest of the questions as in Figure 3.

Figure 3 demonstrates that most respondents strongly agree that authenticity verification is a key criterion, whereas utility is not. Next, We provide the final ranking in Table 2 and refer to Table S1.1 in the appendix for the closeness index for TOPSIS. The higher the value, the more critical that specific feature is to the respondents.

We found *Authenticity Verification*, *Transparency*, and *Reasonable Minting Fees and Transaction Costs* are critical for user trust, cost-effectiveness, and disclosure of NFT issuance and its metadata. We used TOPSIS with three different normalization techniques, Max-TOPSIS, Euclidean-TOPSIS, and Max-Min-TOPSIS to ensure comprehensive analysis and validate the robustness of our framework. Using these three distinct methods, we aimed to confirm that our framework yields consistent results independent of the normalization technique applied, thus reinforcing the reliability

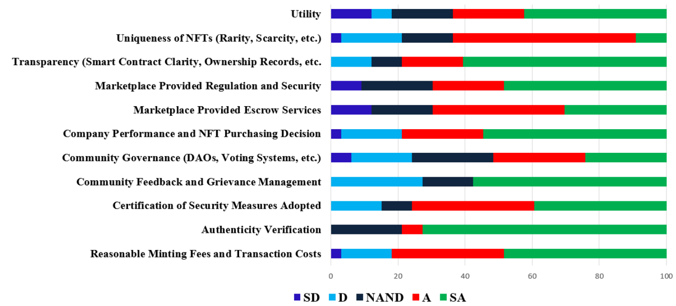

Figure 3: Percentage of response for Q8-Q18 (SD- strongly disagreed, D- disagreed, NAND- Not agreed and not disagreed, A- agreed, SA- strongly agreed)

Table 2: Trust criteria ranking by TOPSIS Methods

Rank	TOPSIS-Euclidean	TOPSIS-max-min	TOPSIS-max
1	Authenticity Verification	Authenticity Verification	Authenticity Verification
2	Transparency	Transparency	Transparency
3	Reasonable Minting Fees and Transaction Costs	Reasonable Minting Fees and Transaction Costs	Reasonable Minting Fees and Transaction Costs
4	Utility	Utility	Brand Recognition and NFT Price Performance
5	Marketplace Provided Escrow Services	Marketplace Provided Escrow Services	Certification of Security Measures Adopted
6	Certification of Security Measures Adopted	Certification of Security Measures Adopted	Utility
7	Brand Recognition and NFT Price Performance	Brand Recognition and NFT Price Performance	Marketplace Provided Escrow Services
8	Marketplace Provided Regulation and Security	Community Feedback and Grievance Management	Marketplace Provided Regulation and Security
9	Community Feedback and Grievance Management	Marketplace Provided Regulation and Security	Community Feedback and Grievance Management
10	Exclusivity of NFT	Exclusivity of NFT	Exclusivity of NFT
11	Community Governance	Community Governance	Community Governance

and scalability of our proposed model. Table 2 reflects that the final rank remains consistent. As noted by [8, 11], the outcome of TOPSIS methods remains unaltered with the normalization technique; the results also reflect this. The Min-max normalization technique ensures that all criteria are on the same scale. This method provides no criterion dominates due to scale differences, promoting fairness in comparison [8]. Whereas, Gaussian normalization (or standard score normalization) transforms the scores of criteria so that the distribution of scores has a mean of 0 and a standard deviation of 1. This method is beneficial when criteria scores are normally distributed, making the TOPSIS analysis more robust to outliers or skewed data [11].

The three criteria in all three normalization techniques are confined into the set *Authenticity Verification*, *Transparency*, and *Reasonable Minting Fees and Transaction Cost*. However, a small variation is observed for the bottom three criteria, namely *Exclusivity of NFT*, *Community Governance*, and *Community Feedback and Grievance Management*. Note that we compare the results of two different MCDM methods. However, the results remain consistent [6]. The Spearman rank correlation coefficient between the three methods also supports the outcome (Please see Table S1.2).

While the criteria of NFT *uniqueness* and *community governance* were uniformly identified as the least influential (rank 10 and 11), the analysis revealed a divergence in the rankings for the 9th position across different evaluation methods. TOPSIS methods identified

Community Feedback and Grievance Management as pivotal. Considering the predominance of methodological preference, *Community Feedback and Grievance Management* were selected as the definitive 9th-ranked criteria. Noticeably, the final rank also aligned with the descriptive statistics presented in Table 3.

Table 3: Mean, standard deviation (S.D.), Kurtosis, and Minimum (Min.) value of the responses against each criterion

Criterion	Mean	S.D.	Kurtosis	Min.
Authenticity Verification	4.5152	0.8210	-0.3099	3
Utility	3.7576	1.3714	-0.4390	1
Exclusivity of NFT	3.4848	0.9885	-0.1598	1
Community Feedback and Grievance Management	3.8788	1.3429	-1.7212	2
Transparency	4.2727	1.0523	0.1719	2
Community Governance	3.4545	1.2083	-0.8714	1
Certification of Security Measures Adopted	4.0000	1.0445	-0.4435	2
Marketplace Provided Regulation and Security	4.0000	1.2309	0.8045	1
Marketplace Provided Escrow Services	3.7576	1.2317	0.6582	1
Reasonable Minting Fees and Transaction Costs	4.0909	1.1642	0.5134	1
Brand Recognition and NFT Price Performance	4.0909	1.2398	-0.0288	1

The highest mean value, lower standard deviation, and negative kurtosis imply lighter tails and a flatter distribution against the "Authenticity Verification" response. On the contrary, the lowest mean value, relatively high standard deviation, and highest negative kurtosis imply that *Community Governance* should be ranked at the lower end.

5 Discussion

In traditional market dynamics, consumer decisions are heavily influenced by critical criteria such as the product's authenticity, the transparency of information provided by the issuers, and the cost-effectiveness of the product offering [35]. Authenticity ensures that the product is genuine and of high quality, and transparency allows consumers to make informed decisions by understanding the product's features and benefits clearly [17]. Although the criterion to represent authenticity varies based on the categories, quality, brands [28, 40], still few explore what the key criteria affect the trustworthiness of NFTs. This study proposed a systematic framework by applying MCDM methods to guide NFT users.

5.1 Transitioning to NFT Trust Factor Model

In NFT marketplaces, decision-making hinges on authenticity, ensuring each asset is unique and verifiable. Given NFTs' digital nature, rigorous verification and transparent information are essential for trust [31]. Key factors include transaction transparency and cost-effectiveness, as [40] found transparency boosts authenticity perceptions. Together, authenticity verification, transparency, and cost-effectiveness build trust and drive participation in NFT marketplaces. Our study's criteria are grouped as follows:

(1) **Trustworthiness**: Criteria like "Authenticity Verification" and "Transparency" rank highest, reflecting a consensus that authenticity and transparency are fundamental for users' trust in NFTs and marketplaces.
(2) **Cost**: This includes financial factors such as "Minting Fees and Transaction Costs," covering expenses like gas costs, platform fees (including royalties and DAO contributions), and creator earnings—critical factors influencing user choices.
(3) **Functional Value**: Focusing on the NFT's intrinsic appeal, this category includes "Utility" and "Uniqueness," capturing the characteristics that make NFTs desirable and contribute to their market success.
(4) **Security**: Criteria here, such as "Certification of Security Measures" and "Marketplace Escrow Services," underscore security's importance. While essential, security is seen as secondary to authenticity and transparency, suggesting users prioritize verifiable authenticity first.
(5) **Community and Governance**: Elements like "Community Feedback" and "Governance" are considered secondary, reflecting that while community involvement aids long-term engagement, it is less immediate than trustworthiness and security.

5.2 Business Implication

The results provide NFT users with a valuable tool for navigating the digital asset market. Emphasizing "Authenticity Verification" and "Transparency" addresses key concerns like fakes, rug pulls, and pump-and-dump schemes, enabling users to avoid unverified projects and protect their investments.

Understanding trust criteria is essential for growth and participation for NFT issuers and the broader ecosystem. The study highlights the need for *1. Authenticity verification*, *2. Transparency in operations*, and *3. Reasonable minting fees and transaction costs*. Issuers are encouraged to invest in strong authentication and transparent processes to reinforce legitimacy, while affordable transaction fees support adoption and trust. Users should prioritize platforms that uphold these trust criteria for secure investments.

The analysis showed that complex trust criteria like authenticity and transparency, when objectively validated, ranked as most important. Although feedback and governance are valuable, their significance is relatively secondary to foundational trust elements. Criteria like uniqueness and community governance contribute to the NFT market's resilience but should be supported by authenticity and transparency to foster a healthier ecosystem.

6 Conclusion and Future Research

This study addresses a crucial gap by examining specific trust mechanisms within NFT marketplaces, a key sector in the Web 3.0 landscape. Using MCDM methods, we assess eleven criteria that highlight priority areas for fostering trust and engagement in NFT platforms. This structured approach, integrating TOPSIS methods, is one of the first to evaluate NFT acceptance, bridging financial and strategic dimensions.

Our findings show that 'Authenticity Verification,' 'Transparency,' and 'Reasonable Minting Fees and Transaction Costs' are pivotal for security, clarity, and economic fairness in the NFT ecosystem. Emphasizing these criteria allows platforms to create a more trustworthy and inclusive trading environment, aligning with principles of traditional consumer behavior. These insights offer valuable guidance for NFT platform developers and marketers focused on enhancing user engagement and trust.

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Online appendix for "Non-Fungible Tokens (NFTs): A Systematic Study of Trust Criteria"

S1 Weight determination of TOPSIS

Methods like the Delphi method and Shannon entropy are commonly used to determine criterion weights, a crucial step [8]. In this study, we applied Shannon entropy to calculate weights based on uncertainty in the decision matrix criteria [27]:

Step 1: We start with the decision matrix, $X = \left(x_{ij}\right)_{m\times n}$ with $m = 76$ alternatives formula $A_1, A_2, \cdots, A_m$; and $n = 11$ number of criteria. Consequently, the following decision matrix was constructed:

$$X = \left(x_{ij}\right)_{m\times n} \tag{S1.1}$$

Step 2: The entropy value e_j can thus measure the amount of decision information contained in the normalized matrix and queued in each criterion is given by $E_j = -\frac{1}{ln(m)} \sum_{i=0}^{m} p_{i,j} log(p_{i,j})$,

where $p_{i,j} = \frac{x_{i,j}}{\sum_{i=0}^{n} x_{i,j}} \quad \forall\{i, j\} \in \{1, .., m\} \times \{1, .., n\}$.

Step 3: Weights (w_j) for each criterion are determined based on the degree of divergence (d_j), and the following relations are used: (i) $d_j = 1 - E_j$ and (ii) $w_j = \frac{d_j}{\sum_{j=0}^{n} d_j} \quad \forall j \in \{1, .., n\}$.

Table S1.1: Closeness index for TOPSIS under three normalized techniques

Criterion	TOPSIS Euclidean	TOPSIS Max-Min	TOPSIS Max
Authenticity Verification	0.856	0.807	0.799
Transparency	0.644	0.665	0.636
Reasonable Minting Fees and Transaction Costs	0.6	0.598	0.587
Brand Recognition and NFT Price Performance	0.495	0.516	0.551
Certification of Security Measures Adopted	0.498	0.528	0.547
Marketplace Provided Regulation and Security	0.43	0.455	0.496
Community Feedback and Grievance Management	0.414	0.465	0.481
Utility	0.578	0.571	0.538
Marketplace Provided Escrow Services	0.548	0.564	0.526
Exclusivity of NFT	0.4	0.396	0.459
Community Governance	0.291	0.34	0.368

Table S1.2: Spearman rank correlation coefficient

	TOPSIS-Max-Min	TOPSIS-max
Shanon	0.9909	0.91818
Min-Max		0.9091