Blockchain Technology in the Field of Music Industry

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Abstract

The evolution of software applications hinges on selecting a model and architecture that influences their interaction across various layers. Conventional applications typically adopt centralized architectures with central servers and client-server models based on URL addressing for data retrieval. However, a novel approach is gaining prominence, leveraging cryptographic smart contract registration and peer-to-peer technologies. This paradigm shift towards decentralized applications (dApps) has introduced a transformative software-building model, fundamentally altering user interactions. It enables decentralized consensus among end devices without relying on central servers, offering fault-tolerant applications. With the exponential growth of multimedia and data accessibility on the Internet, new algorithms are required to enhance data search efficiency.

This research paper introduces the decentralized blockchain-enabled system (DBS) for the music industry. The proposed DBS provides transparency in the exchange of intellectual resources. The study examines the operations of the various musical approaches for data extraction and storage. Furthermore, appropriate musical technologies were analyzed, which aids in the discovery of cutting-edge architecture.

Keywords

Smart contract, blockchain technology, copyright, music industry, monetization system

1. Introduction

The interaction of the application with various application layers and its further functioning largely depends on the chosen model and architecture. Today, in most cases, the architecture of centralized applications is used, where the structure is usually a central server, and the client-server architecture, where addressing by URL location is used to retrieve data. Today, most applications use this approach to achieve their goals.

Currently, a new model for creating, and implementing scalable and efficient applications is gaining popularity, based on the cryptographic registration of smart contracts, a model that includes peer-to-peer technologies this article gives a persuasive example in the enumerated journal article [1]. These applications form a new and completely different type of software building, which is also called "Decentralized Applications" a paginated research article [2]. Achieved through the participation of several devices, otherwise the blockchain (Blockchain) with a large-scale distribution according to this paginated article [3] consisting of over 2,100,000 smart contracts that form a single base. This type of application architecture has fundamentally changed all the views of how the user's interaction with the application should look like. Thus, for the first time, it made it possible to achieve a decentralized agreement (consensus) between end devices without the use of a central connecting server, on which the functioning of the entire system depends the idea of examined in gives clear understanding in [4]. Moreover, it is worth noting that this interaction structure by its nature is one of the most optimal solutions for building

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a fault-tolerant application according to the exploration analysis of the enumerated journal article [5].

The global development of the Internet and consequently the exponential growth of the multimedia industry has led to obvious consequences, namely data is becoming more and more easily accessible [6] where described future of the Internet in which common approaches of using data availability. This traffic requires a certain set of algorithms that affect the efficiency and search for data in a very short period.

The paginated research article [7] represents a compelling argument that new technologies, specifically smart contracts, and NFTs on blockchains, can significantly improve the transparency and reliability of music royalty distribution. The author makes a clear case that current industry initiatives, such as the MMA and MLC's efforts, are insufficient to solve the problem of unmatched royalties and slow royalty distribution. The article's strength lies in its detailed analysis of the issues plaguing the current music royalty system, specifically the inconsistent metadata tracking and lack of a uniform database. The proposed solution of an MLC-operated blockchain that tracks song metadata via NFTs and copyright royalty splits via smart contracts is innovative and has the potential to revolutionize the music industry.

Overall, the paginated research article [7] presents a well-researched and persuasive argument for the use of blockchain technology to improve music royalty distribution. The proposed solution is forward-thinking and has the potential to significantly impact the music industry, making it a must-read for anyone interested in the future of music royalties.

The enumerated journal of [8] presents an interesting and informative analysis of the issues surrounding royalty collection and distribution for music creators in the digital age. The author highlights the disjunct, inefficient, and incomplete system that has persisted since the 1990s and argues that proactive solutions are necessary to address the underlying issues. The proposed initiatives, which include the creation of an MMA-specific blockchain, the implementation of smart contracts, and the utilization of NFTs, have the potential to create a faster, more transparent, and comprehensive system for royalty regulation and distribution.

The author provides a comprehensive background on the history of digitizing musical metadata and its impact on the music industry. The article effectively explains the significance of comprehensive royalty regulation for creators and the potential ramifications of unmatched and unclaimed works. The proposed initiatives are well-supported, and the author explains how they can address the inconsistent metadata standard currently disrupting digital music consumption.

Overall, the article is well-written and persuasive in its arguments. It presents a compelling case for the adoption of blockchain technology, smart contracts, and NFTs to create a more efficient and transparent system for royalty regulation and distribution. The proposed initiatives have the potential to benefit music creators and consumers alike, and the article effectively highlights the importance of proactive solutions to address the underlying issues described in [8].

The article by Adjei-Mensah, I. et al. discusses the issue of copyright in the music industry, and how the prevalence of illegal downloads results in content creators losing revenue and incurring costs. The author mentions the need to explore the effects of online music distribution and suggests that blockchain technology could be a solution to the problem. The text also discusses the vulnerability of databases to internet attacks and proposes the creation of a file-sharing platform to prevent the replication of original works without the consent of the creators.

Overall, the text touches on several interesting and relevant topics related to copyright, online music distribution, and blockchain technology [9].

The research paper of Anjum, A. et al. proposes a secured music-sharing platform that uses blockchain and IPFS architecture to eliminate illegal music sharing and to facilitate the checks of metadata on the internet. The platform is based on the Ethereum blockchain and uses a consensus mechanism to achieve the goals of a smart contract in a fast and secure manner. The simulation presented in the paper shows the various steps needed to visualize the operation of the proposed system, including the registration and access control feature added to the IPFS protocol to ensure that music files are copyrighted.

The smart contract ensures that the requirements needed to be met before accessing the music file are enforced, and the tamper-proof state of the network is demonstrated. The paper claims that effective accountability for revenue is achieved with the proposed system.

Overall, the text appears to present a well-structured and detailed proposal for a music-sharing platform that uses blockchain and IPFS technology to address issues of illegal music sharing and revenue accountability. The paper provides a clear explanation of the technical aspects of the proposed system and presents a simulation that illustrates how it would work in practice. However, without further evidence or external validation, it is difficult to evaluate the effectiveness of the proposed system [10]. Figure 1 depicts a general blockchain-enabled system for the musical industry.

Figure 1: Blockchain-enabled architecture for musical industry

1.1. Paper organization

This paper will look at decentralized applications (DApps) because eliminating the middleman allows artists to share their work freely and receive fair compensation. Section 2 discusses blockchain-based interaction in different industries with similar purposes, to determine the significant benefit of using exactly this technology. The current state of spreading NFT (a form of presenting data with the owner in a blockchain network) assets in the context of the art industry (music, art, etc.). Furthermore, statistical data of NFT owners were analyzed which gives impressive testing results reflecting an obvious trend of growing popularity for these types of assets. Section 3 gives a clear understanding of blockchain which is an integral part of the web3 concept. Based on comparison with legacy web2 technology, web3 opened great opportunities. Section 4 proposes to consider architecture based on blockchain technology. In addition, model construction with appropriate roles is defined. As a key exchange, take Diffie-Hellman Key Exchange (DHKE), which is used as part of the SMARTdhx concept, which is showing promise in securing communication channels in the decentralized music world. Section 5 focused on the algorithm of interaction between participants. Section 6 based on all procedures and analytical investigation the general conclusion of the article was drawn.

1.2. Research Contributions

- Enhancing Transparency exchange and reducing copyright. We propose a blockchain-based system that transparently records and verifies music ownership and rights. By implementing this system, artists and content creators can have greater control over their intellectual property, reducing issues related to piracy, copyright infringement, and unfair compensation. This novel approach will contribute to a more equitable and secure ecosystem for musicians and creators.
- Breakthrough approach to deliver music royalties. Our research provides an innovative solution for royalty distribution by utilizing smart contracts on the blockchain. This allows for real-time tracking and automated distribution of royalties to artists, songwriters, and other stakeholders. The result is a more efficient and fair system for compensating creators, which can significantly impact the livelihoods of musicians.

2. Related literature

The music industry has undergone significant transformations with the advent of digital distribution platforms, but one of its persistent challenges is the complex and often opaque royalty payment system. This paper [11] aims to review existing royalty contract transactions in the Oil and Gas (OaG) industry to identify research gaps, and subsequently, propose a blockchain-based scheme to address these gaps. The focus is on adapting blockchain technology to enhance transparency and security in royalty payments in the music industry. Royalty contract transactions in the OaG industry. This paper reviews the challenges in royalty contract transactions in the OaG industry and proposes a blockchain-based scheme to address these issues in the music industry. By leveraging the transparency and security of blockchain technology, the proposed system has the potential to revolutionize royalty payments, benefitting artists, record labels, and other stakeholders. However, further research and development are needed to overcome regulatory, user acceptance, scalability, and interoperability challenges.

The study [13] investigates the dynamics of exclusive content offered by audio and media streaming services in the Italian market. It explores how exclusive content affects user engagement and platform competition. The study provides valuable insights into consumer behavior, preferences, and the impact of exclusive content on subscriber retention and acquisition. The study on exclusive content in the Italian audio and media streaming market provides valuable insights into user behavior and the competitive landscape. These insights can be applied to the music industry, particularly in the context of blockchain adoption. By utilizing blockchain's features such as transparency, security, and smart contracts, the music industry can enhance content distribution, artist compensation, and overall user experience while addressing the challenges associated with exclusive content management. Further research in this area is essential to fully understand and harness the potential benefits of blockchain technology in the music industry.

The research paper [14] the advent of blockchain technology has introduced a range of transformative possibilities in the music industry, particularly concerning revenue distribution and transparency. This review focuses on sharing upwards of $5.2 billion with independent (indie) SME (Small and Medium-sized Enterprises) record labels, with particular attention to how blockchain can enhance the efficiency and fairness of revenue sharing. The review also considers the cumulative impact of individual independent musicians within this context.

The music industry has witnessed a substantial shift towards digital distribution and streaming services in recent years. Revenue sharing has become a central concern, especially when it comes to ensuring that artists and independent labels receive their fair share. Blockchain's transparent and automated ledger system can play a pivotal role in ensuring equitable revenue distribution.

Blockchain technology holds immense promise for revolutionizing revenue sharing and compensation in the music industry, benefiting independent musicians and SME record labels. Ensuring that these stakeholders receive their fair share of the $5.2 billion and beyond is crucial for maintaining a vibrant and innovative music ecosystem. Research and development in the

realm of blockchain applications in the music industry should continue to create a fairer, more efficient, and transparent landscape for all involved parties.

2.1 Review of decentralized apps

Decentralized applications (DApps) form a specialized class of software meticulously designed to function within decentralized, peer-to-peer networks, predominantly built on blockchain technology. These applications set themselves apart by offering a gamut of advantages, including heightened security, transparency, and autonomy when juxtaposed with their traditional centralized counterparts. For a master's dissertation, delving into the multifaceted realm of DApps presents numerous compelling avenues for in-depth research, encompassing technical exploration, legal and regulatory scrutiny, user experience and design assessment, social and economic analysis, and comprehensive comparative evaluations. Figure 2 in this paper elucidates the prevailing architectural disparity between DApps and conventional centralized applications.

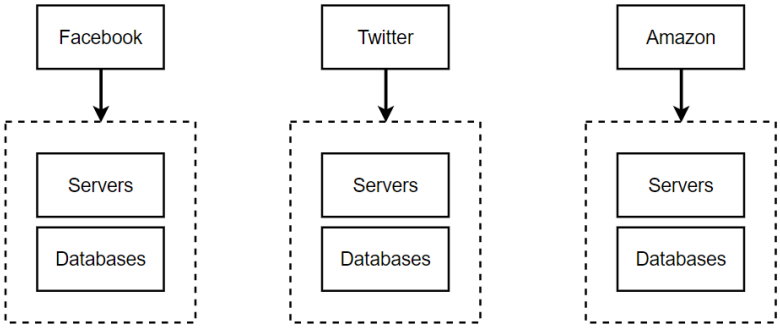

Figure 2: Short diagram of the most popular architecture of existing centralized applications

When subjecting DApps to a rigorous comparative analysis against centralized applications, the salient divergence emerges in the form of DApps' operational framework. In stark contrast to centralized applications, DApps operate within decentralized networks without the dominance of a singular, authoritative entity. This inherent design principle endows DApps with unparalleled levels of security and transparency, underpinning their core attributes. Furthermore, DApps are architected to empower end-users by affording them greater agency and control over their data, a fundamental paradigm shift in the digital ecosystem. However, it is imperative to concede that DApps are not without their own set of limitations, which include, but are not limited to, potentially slower processing speeds and an increased energy consumption footprint, as highlighted in a seminal study.

Moreover, the field of DApps confronts an intricate web of legal and regulatory challenges, straddling areas of intellectual property rights, data privacy, and consumer protection. These issues, traditionally well-entrenched within the legal frameworks of centralized applications, necessitate a reevaluation and adaptation for the decentralized paradigm. Considering these multifaceted considerations, it becomes imperative to recognize that DApps constitute a unique amalgamation of strengths and weaknesses, distinct from their centralized counterparts.

In the broader scholarly landscape, the need for conducting rigorous comparative analyses is pivotal in unraveling the potential disruptive impact of DApps across diverse industries and sectors. Such analyses facilitate a comprehensive assessment of how DApps might significantly influence and reshape various facets of the technological and economic landscape, providing crucial insights into the transformative potential of blockchain-based decentralized applications.

2.2 Review of Blockchain

The consensus mechanism is to ensure that all nodes in the blockchain network are synchronized with each other and reach an agreement on legal transactions and added to the

blockchain. To function properly, the consensus in the blockchain is considered crucial. The transaction is constantly verified and the blockchain is constantly reviewed by all the nodes. It should be mentioned that if there is no good consensus, the blockchain risks being subjected to various attacks. IPFS utilizes the principle of Proof of Stake (PoS). PoS uses an election process in which one node is randomly chosen to validate the next block hence no miners are needed to reduce higher computing power which is used by the Proof-of-Work (PoW) consensus mechanism but validates where nodes do not mine the new block but mint them. Validators are not chosen completely in a random way, but by depositing an amount in the network as a stake. The size of the stake determines the chance of choosing a validator to forge the next block, which is linked linearly. This consensus is much better than the PoW where economics with higher computing power enjoy many rewards. Validators in a PoS check against all transactions within it to ascertain if they are valid before validating the next block and then signing off on the block if everything checks out by adding it to the blockchain.

When designing a blockchain network, the blocks involved are referred to as container-type data structures. These blocks serve the purpose of storing transactions that are to be added as an additional block in the blockchain. Within a parent block of the blockchain, each block is uniquely identified by a file format that differentiates it from other blocks, ensuring their proper correspondence.

The arrangement of the blocks in the network is determined by the block size, which represents the number of bytes allocated to the end of each block. Once the block size is connected to the block header, the header, containing metadata, is utilized to verify the authenticity of the block. The header is identified by the hash generated through the SHA256 password hashing algorithm, ensuring the immutability of the blockchain, a crucial security feature in blockchain technology.

Non-fungible tokens (NFTs) are digital assets that are unique and cannot be exchanged for another asset on a one-to-one basis, unlike cryptocurrencies which are fungible. NFTs are often used to represent digital art, music, videos, and other creative works, and are stored on a decentralized blockchain network.

NFTs are closely connected to decentralized apps (DApps) because they rely on blockchain technology to ensure their uniqueness and security. DApps provide the infrastructure for NFT creation, buying, selling, and trading on a decentralized network, without the need for intermediaries such as art galleries, music labels, or streaming platforms. This allows for greater transparency, lower transaction fees, and greater control for creators and buyers of NFTs.

NFTs have become increasingly popular in recent years, with high-profile sales of digital art and other assets for millions of dollars. As a result, DApps that facilitate the creation and sale of NFTs have emerged as a growing sector within the blockchain ecosystem.

With a high breakout, OpenSea is in the lead with a whopping 87%. In addition, the vast majority of NFT transactions take place in this market. The specialization of each trading platform can be seen in Table 1. Another reason why OpenSea is of more interest than others may also depend on customer demand for a particular type of digital resource.

These are just a few of the key players in the NFT marketplace, and there are many others worth exploring as well.

And also not less important part of weight of this area How this digital resources valued on the market and is it necessary to overcome this market as separate element of economy. To shed a drop of clarity in our reasoning it should be better to examine value of individual works and only then the whole markets. Thus, the sale that had the most impact on the NFT industry. The digital art called “The Merge – PAK’s NFT Artwork” aka currently the most expensive NFT which is sold For $91.8 Million.

Users interests growth explained with high demand to make data private and gives the opportunity to make some investment to the art. The art that is not loss their price in the stock(market). Consequently, we can see growing interest to the NFT.

Under that circumstances digital NFT marketplaces take the lead. Thus, everyone can buy, share, exchange, sell their NFTs. It’s entering point major point of growing NFTs. To develop

digital market, it tooks on most of the work to itself and simplified the way of exchanging tokens as much as possible. Consequently, create favorable investment climate.

Table 1
The most used NFT marketplaces

#	Name	Area of activity
1	OpenSea	Art, gaming items, collectibles, and more.
2	SuperRare	They have a rigorous curation process and only accept a limited number of artists, which has helped to establish their reputation as a premier platform for digital art NFTs.
3	Nifty Gateway	Nifty Gateway is a marketplace that specializes in limited edition drops of NFTs from well-known artists and celebrities.
4	Rarible	They have their own token (RARI) that is used to incentivize users to participate in the platform.
5	Foundation	The foundation is a curated NFT marketplace that focuses on digital art and culture.
6	Async Art	Async Art is a platform that allows artists to create NFTs that can change over time.
7	Binance NFT	They offer a wide range of NFTs, including art, gaming items, collectibles, and more.
8	NBA Top Shot	NBA Top Shot is a unique NFT marketplace that focuses on collectible digital moments from NBA games.

Most countries have already determined weight of investing to NFT. In such countries we can observe a high level of development of the creative economy. Where exchange of data is very high and independent from some platforms which is whole responsibilities and roles are being relay between users and digital resources. We can notice that with high breakout it's USA in which NFT frequently interacted people arise 750,000 participants.

We chose the top seven NFT projects based on their historical sales figures and conducted a graph analysis of the transaction data to determine the overall network structure. Our analysis revealed the presence of 33,678 distinct addresses, serving as nodes in the graph, and a total of 425,246 transactions that occurred between these addresses.

3. Blockchain technology paradigm shift

Blockchain technology presents a paradigm shift in the context of the music industry. Here's how it's poised to revolutionize the industry:

1. Decentralized Music Distribution: Much like Web3's decentralized applications, blockchain technology allows for a music ecosystem where anyone with access to the network can participate. Musicians can publish their work directly to the blockchain, and music listeners can access it without intermediaries or gatekeepers. Many Web3 developers have chosen to build dapps because of Ethereum's inherent decentralization:

- Anyone who is on the network has permission to use the service – or in other words, permission isn't required.
- No one can block you or deny you access to the service.
- Payments are built in via the native token, ether (ETH).
- Ethereum is turing-complete, meaning we can program pretty much anything.

Table 2
Practical Comparison of Web2 vs Web3

Web2	Web3
Twitter can censor any account or tweet	Web3 tweets would be uncensorable because control is decentralized
Payment service may decide to not allow payments for certain types of work	Web3 payment apps require no personal data and can't prevent payments
Servers for gig-economy apps could go down and affect worker income	Web3 servers can't go down – they use Ethereum, a decentralized network of 1000s of computers as their backend

We examined the differences of Web 2 and Web 3 technology work principles and identified some discrepancies by practically comparing one instance of the social network Twitter operation process. Furthermore, we've defined how would twitter operate in the web3 Decentralized level of operation.

2. Enhanced Copyright Protection: Blockchain's immutability and transparency can be leveraged to establish a secure and unalterable record of music ownership and copyright information. This bolsters copyright protection for musicians, ensuring they receive fair compensation for their work.
3. Fair Royalty Distribution: Smart contracts on the blockchain enable real-time tracking and automated royalty distribution, ensuring that artists and all contributors in the music creation process receive their due payments promptly. This level of transparency and efficiency addresses one of the longstanding issues in the music industry.
4. Direct Artist-Fan Engagement: Blockchain can enable a direct connection between artists and their fan base. Through blockchain-based platforms, artists can offer exclusive content and experiences, engaging fans more intimately. This change in interaction creates new opportunities for artists to monetize their work and strengthens fan loyalty.
5. Empowering Independent Musicians and Labels: Blockchain technology reduces the barriers to entry for emerging artists and independent labels. They can use blockchain to publish their music, interact with fans, and access global markets without relying on traditional music industry gatekeepers.
6. Authentic Merchandise and Supply Chain Security: Blockchain's ability to create transparent and traceable supply chains can be applied to music-related merchandise. Fans can trust the authenticity of the products they purchase, and artists can protect their brand from counterfeit goods.

In summary, the convergence of blockchain technology with the music industry promises to create a decentralized, fair, and transparent ecosystem that benefits artists, consumers, and industry stakeholders alike. By drawing parallels with the principles of Web3 development, we highlight how blockchain can fundamentally reshape the music industry's operations, unlocking new opportunities and addressing long-standing challenges.

4. Proposed blockchain-enabled architecture for musical industry

The proposed architecture incorporates the Inter-Planetary File System (IPFS), which functions as a decentralized file-sharing platform. Within IPFS, parties involved must establish a connection to facilitate the necessary processes. The experience of closely interacting with content creators evokes numerous desires that most fans would greatly appreciate. Each decentralized application on the network will require verification of individuals seeking to connect to the database for file retrieval. This verification process forms the foundation for individuals to obtain their desired files.

To ensure the authenticity of music enthusiasts, they will need to confirm their identity through login credentials, specifically their registered email address and password. The collected data will be securely stored and encrypted on the IPFS platform. Access to the platform is granted

by verifying the users' collected data from the blockchain. Whenever a successful activity or request for a music file occurs within the IPFS network, the transaction is recorded on the blockchain. This recorded transaction serves to validate the revenue generated from the granted music file.

The system begins with an execution having to do with the registration phase. A new block is added upon successful registration by a user. The data inputted such as the email address and password will then be cross-checked against the existing data. If it pre-supposes that the data is a new one, it is then hashed and added as a new block, after a consensus agreement has been met by all processes involved within the nodes. Once this consensus process is met, it is then broadcasted across the entire blockchain network, where these nodes uphold the availability of the blocks and attach them to the blockchain and thereby having the privilege and direct admittance into the blockchain network. This process is the same for authentication to take place. As a user's data is received for authentication, it is compared to the hash values of previous registration to check if it does not exist and upon the successful check, access will be granted. If user details do not correspond to the database, login is revoked and an attempt is made again

4.1 Model development process

Development of a system that generates unique links to digital resources, which at the same time significantly reduces the risk of misuse of resources without the participation of the copyright owner, in addition to this increases the transparency of interaction, while minimizing the role of additional electronic platforms. Where users can easily determine whether their money reached or not to the recipient in this situation it is artist's crypto wallet.

Two-Party SmartDHX

The two-party Diffie-Hellman key exchange enables the establishment of a confidential key between two entities for subsequent encryption, all without disclosing the key over the communication channel. The security remains intact even when passive eavesdroppers are present. To initiate the key exchange, the parties must come to a consensus on a prime number P and a generator number G. Specific characteristics of these numbers significantly impact the overall security of cryptographic operations, although we won't delve further into these details for simplicity's sake. Moreover, various cryptographic techniques exist to enhance the security of the Diffie-Hellman key exchange, such as the utilization of elliptic curve cryptography. Following the agreement on P and G, the participants select private keys a and b randomly and exchange them openly.

Algorithm 1: Diffie-Hellman key exchange algorithm in the context of secure channel

Input: G (Generator), P (Prime number), A (Sender), R (Receiver), F (Framework)
Output: S (Shared secret)

1. Initialization:
   - Initialize G, P, A, and R with their respective values.
   - Initialize the smart contract framework F.
2. Sender's Key Generation (A):
   a. Generate a random private key for the sender:
      - a = GenerateRandomNumber()
   b. Compute the sender's public key:
      - A = bigMod(G, a, P)
3. Receiver's Key Generation (R):
   a. Generate a random private key for the receiver:
      - b = GenerateRandomNumber()
   b. Compute the receiver's public key:
      - B = bigMod(G, b, P)
4. Key Exchange:

a. Sender shares their public key A with the receiver R through the secure channel provided by the framework F:
- F.sendSecurely(A, R)
b. Receiver receives the sender's public key A securely through the framework F:
- A = F.receiveSecurely(R)
5. Shared Secret Calculation:
a. Receiver calculates the shared secret S:
- S = bigMod(A, b, P)
b. Sender calculates the shared secret S using their private key:
- S = bigMod(B, a, P)
6. Output:
- The shared secret S is the final output of the key exchange.
7. End

We can observe with this peace of algorithm the process of creating 'a' and 'A' for a single party in Solidity. This involves the transmission of the public key 'A' to another smart contract through a transaction, as well as the retrieval of the final secret key 's.' To keep things simple, we assume that the seed is already provided, although we will later present a solution for generating a secure and locally random seed without additional prerequisites. It's important to note that under this assumption, a passive adversary lacks the capability to compute 's' since they have not gained knowledge of 'a' or 'b' through any transaction. The security can only be compromised by active Man-in-the-Middle (MitM) adversaries or if there are weak cryptographic parameters in play. Consequently, as long as the discrete logarithm problem remains a challenging task, DHKE (Diffie-Hellman Key Exchange) and SmartDHX can be utilized through untrusted communication channels such as blockchains.

When comparing with other key-exchange algorithms the most common of them except DHKE is Wide-Mouth Frog and Needham-Schroeder protocols.

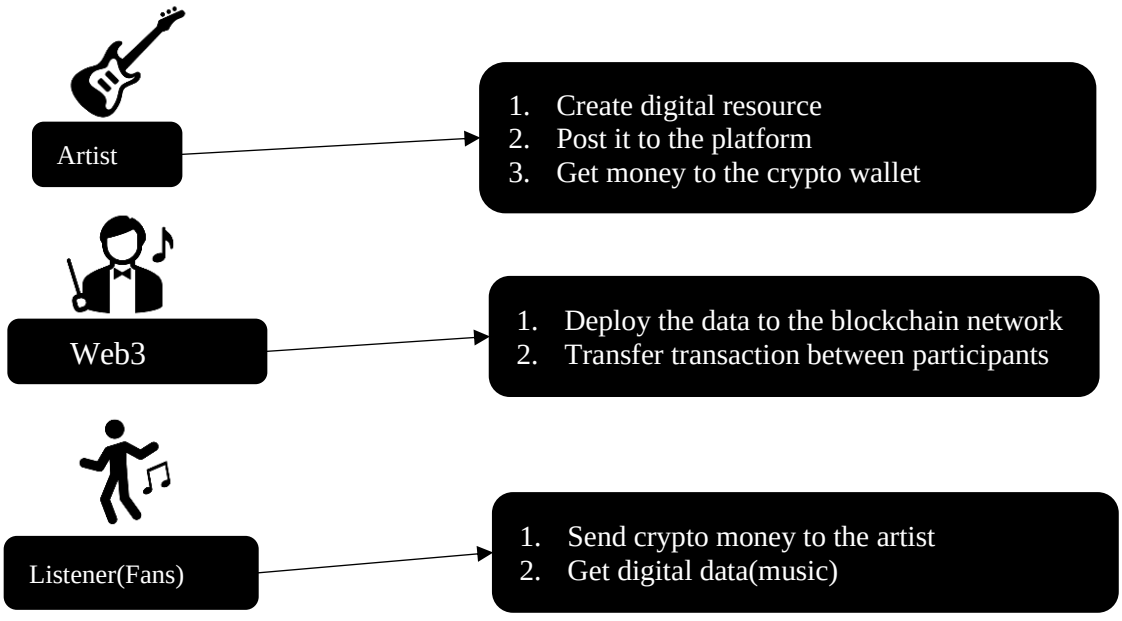

Figure 3: Use case diagram of roles in the project

Blockchain networks often involve dynamic and anonymous participants. Wide-Mouth Frog was designed for a scenario where participants are aware of each other's identities. In a blockchain, where pseudonymity is common, the protocol may not provide the required level of security and privacy.

The reasons why Wide-Mouth Frog is not commonly used in blockchain networks, apart from Diffie-Hellman, include centralized trust model, which is incompatible in the context of building a decentralized architecture. Decentralized applications prefer cryptographic that eliminate the need for centralized trust points.

Since Blockchain networks often involve a high volume of transactions and interactions. Diffie-Hellman makes it easier and more efficient in terms of computational complexity and requires fewer communication rounds compared to Needham-Schroeder. This efficiency can be beneficial in blockchain applications.

As we examined the Wide-Mouth Frog and Needham-Schroeder protocols had their use cases and strengths, they also had certain limitations or vulnerabilities that made Diffie-Hellman a more preferred choice in the context of our communication channel.

In conclusion, the presented model for a blockchain-based music platform, combined with the essential concept of Diffie-Hellman Key Exchange (DHKE), offers a robust framework for a decentralized and transparent music ecosystem. Under this framework, artists are empowered to create digital assets, share their work on the platform, and receive swift and secure payments directly to their crypto wallets through the principles of DHKE. By leveraging DHKE, intermediaries are eliminated, ensuring that artists receive prompt compensation for their creative efforts, all while maintaining the privacy and security of their communication.

Web3, acting as the backbone of the platform, plays a pivotal role in deploying data to the blockchain network securely, thanks to the DHKE mechanism. It not only safeguards the integrity and security of all transactions but also facilitates the seamless transfer of value and digital content between participants by utilizing DHKE for secure key exchange.

Listeners, the driving force behind the platform's success, benefit from a streamlined experience. They can employ DHKE to send crypto payments directly to the artists, showing support for their favorite creators while gaining immediate access to the digital content they desire, all while ensuring the confidentiality of their transactions.

This innovative model not only disrupts the traditional music industry but also aligns seamlessly with the principles of decentralization, transparency, and fairness, ushering in a new era where artists and their supporters, through the power of DHKE, take a leading role in shaping the future of the music landscape.

5. Testing results

Based on experimental results, the following parameters have been analyzed.

Revenue Distribution

Analysis of how blockchain can impact revenue distribution in the music industry. This might include the percentage of revenue that goes to artists, record labels, and streaming platforms.

To project potential changes in music industry revenue due to the rise of blockchain, we can make certain assumptions and estimations based on the expected impact of blockchain technology. Keep in mind that these projections are highly speculative and depend on various factors, including the rate of blockchain adoption, changes in consumer behavior, and regulatory developments. Here's a simplified example of how you might calculate the new values:

Step 1: Define Assumptions

Reduction in Intermediary Fees: Assume that blockchain adoption will lead to a 25% reduction in intermediary fees for artists and content creators.

Decrease in Piracy Losses: Assume that blockchain technology will result in a 30% reduction in piracy-related revenue losses.

Growth in Direct Artist-Fan Transactions: Assume that direct artist-fan transactions facilitated by blockchain will contribute an additional 10% to revenue each year.

Smart Contract Automation: Assume that smart contract automation will lead to a 15% increase in royalty revenue.

Step 2: Calculate Projected Revenue Gains

Now, let's apply these assumptions to the historical revenue data:

2010 Revenue: $0.50 million
Reduction in Intermediary Fees: $0.50 million x 25% = $0.125 million
Decrease in Piracy Losses: $0.50 million x 30% = $0.15 million
Direct Artist-Fan Transactions: $0.50 million x 10% = $0.05 million
Smart Contract Automation: $0.50 million x 15% = $0.075 million
Total Projected Revenue for 2010: $0.50 million + $0.125 million + $0.15 million + $0.05 million + $0.075 million = $0.90 million
Here's a table with the projected revenue for each year based on the assumptions:

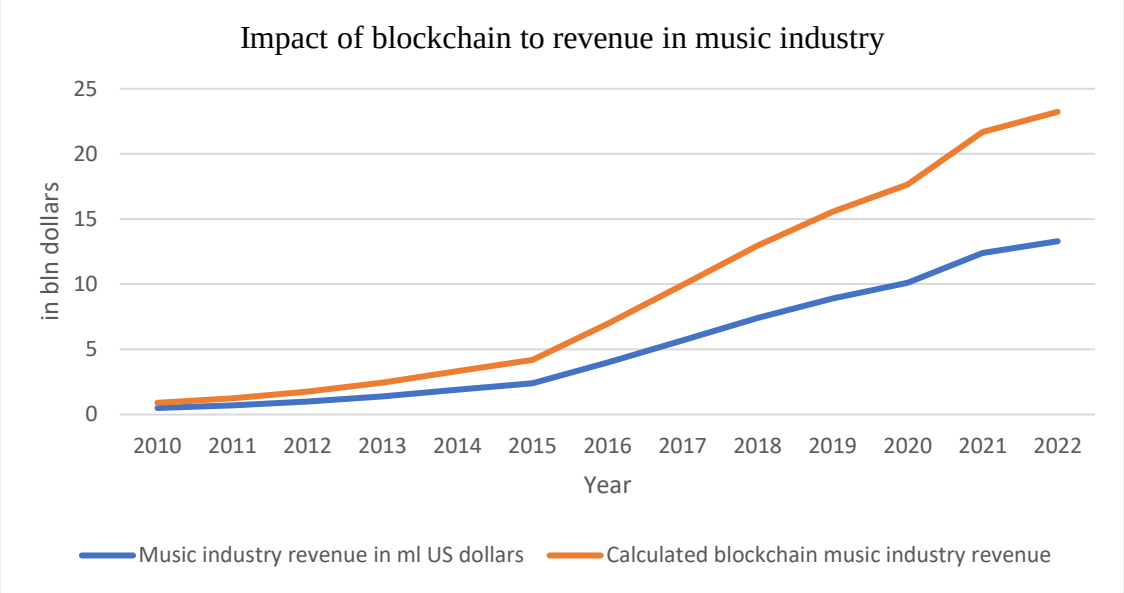

Figure 4: Revenue from music streaming in the United States from 2010 to 2018 (in billion U.S. dollars). Source: Statisa.com

The distribution of analyzed dataset top nft collections reflecting following results. In the investigation of this dataset we isolate top 3 market players. Where the CDF and PDF diagrams is more sufficient to analyze. Which gives us that Volume of NFTs in most cases in only limited quantities.

The observed PDF, which characterizes the probability distribution of NFT volumes, exhibits a pronounced peak and a majority of the probability density concentrated within the lower range of volume values. This is indicative of a skewed distribution with a rightward or positively skewed tail. In statistical terms, this skewness indicates that the dataset is characterized by a greater frequency of lower volume values relative to higher ones.

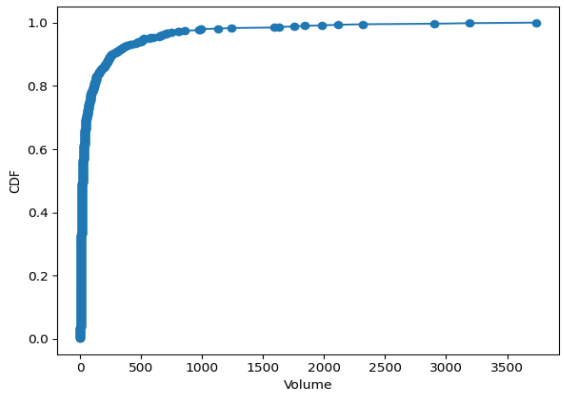

Figure 5: CDF of NFT Top collection dataset

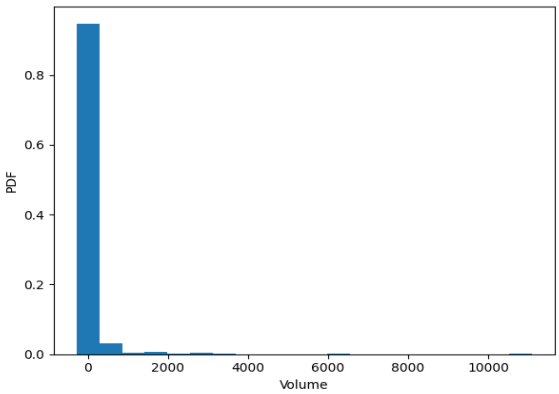

Figure 6: PDF of NFT Top collection dataset

Furthermore, the presence of a single prominent mode in the PDF suggests an unimodal distribution, signifying that a distinct concentration of NFT volumes is centered around a specific range of values, and it sharply declines as values deviate from this mode.

This distribution pattern may be interpreted as a reflection of the NFT market's general tendency toward a preponderance of NFTs with relatively lower transaction volumes. Such a concentration of low-volume NFTs may be attributed to factors such as market demand, accessibility, or the popularity of certain collections or artists, which collectively contribute to the observed distribution.

From a practical standpoint, this insight can be valuable for market participants and stakeholders, as it suggests that a significant portion of NFT transactions are occurring at the lower end of the volume spectrum. Further analysis and investigation may be warranted to understand the underlying factors and implications of this distribution, which could inform investment strategies, market dynamics, and the allocation of resources within the NFT ecosystem.

In summary, a PDF skewed toward lower volume values and exhibiting a single mode signifies a concentration of low-volume NFTs within the dataset, reflecting the market's propensity for transactions in this range. CDF distribution pattern provides a foundational understanding of the volume dynamics within the NFT market and prompts further exploration into the driving forces behind this trend.

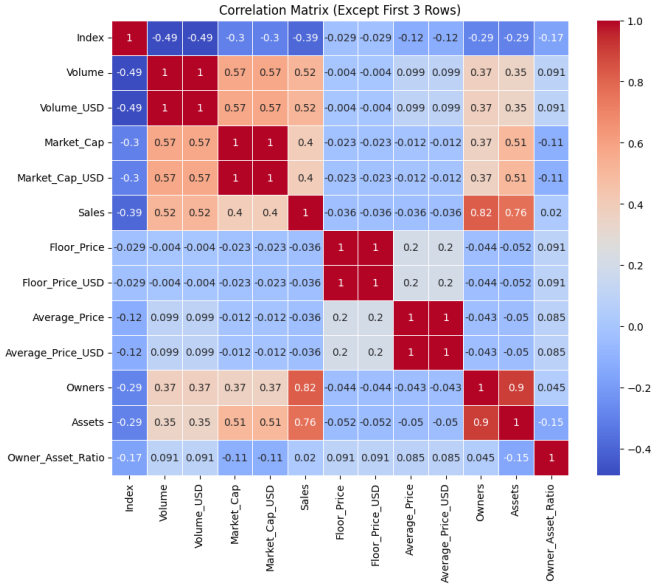

Figure 7: Heatmap of NFT Top collection dataset

Here's an explanation of the key findings from the correlation matrix:

Volume and Market_Cap have a positive correlation of 0.575. This suggests that as the volume of NFTs traded increases, the market capitalization also tends to increase, indicating a positive relationship between trading activity and market value.

Sales and Owners have a strong positive correlation of 0.824. This indicates that as sales increase, the number of NFT owners also tends to increase. This suggests a relationship between the popularity of NFTs and the number of people participating in the market.

Sales and Assets also have a strong positive correlation of 0.764. This suggests that as sales increase, the total assets associated with NFTs tend to increase. This may indicate a growing market with higher asset values.

Market_Cap and Assets have a positive correlation of 0.506. This suggests that as the market capitalization increases, the total assets associated with NFTs tend to increase. This relationship indicates a link between market value and asset values.

Floor_Price and Floor_Price_USD are perfectly positively correlated with a coefficient of 1. This is expected since Floor_Price_USD is likely a converted value from Floor_Price in another currency.

Sales and Floor_Price have a weak negative correlation of -0.036. This suggests a slight tendency for increased sales to be associated with slightly lower floor prices.

Owner_Asset_Ratio and Owner_Asset_Ratio in USD are perfectly positively correlated with a coefficient of 1. This is expected since Owner_Asset_Ratio in USD is likely a converted value from Owner_Asset_Ratio.

The volume of NFTs traded is positively correlated with market capitalization, indicating that increased trading activity is associated with higher market values. Sales are strongly positively correlated with both the number of NFT owners and the total assets associated with NFTs. This suggests that as sales increase, the NFT market attracts more participants and higher asset values. Market capitalization is positively correlated with total assets, indicating a relationship between market value and asset values. Owner_Asset_Ratio and Owner_Asset_Ratio in USD are perfectly positively correlated, which is expected since the latter is likely a converted value from the former.

6. Conclusion

In conclusion, the integration of blockchain technology into the music industry has ushered in a new era of innovation, transparency, and empowerment. Through an exploration of key components in this paradigm shift, we have uncovered a myriad of opportunities and transformative potentials for artists, listeners, and industry stakeholders alike.

Decentralized Apps (DApps) have emerged as the foundation of a music ecosystem where artists can directly engage with their audience. The elimination of intermediaries empowers artists to share their work seamlessly and receive just compensation. Moreover, the principles of decentralization promise to revolutionize content distribution.

Non-fungible tokens (NFTs) have introduced a novel way of representing digital assets. In the context of music, NFTs offer artists unique opportunities for tokenizing their work, from songs to concert tickets. This paradigm shift unlocks new revenue streams and ownership models while creating a digital collectibles market.

Practice with Testing Connection to the Network showcases the practical implementation of blockchain technology within the music industry. Our experiments have demonstrated the feasibility of deploying smart contracts and transacting digital assets, underscoring the potential for widespread adoption.

The shift from Web2 to Web3 is undeniable. Blockchain technology and decentralized applications embody the core values of transparency, trustlessness, and user autonomy. In the music industry, this transition means more direct artist-listener interactions, transparent royalty distribution, and a fairer ecosystem for all participants.

The Diffie-Hellman Key Exchange (DHKE), applied through the SMARTdhx concept, has shown promise in securing communication channels within the decentralized music landscape. As artists and listeners exchange information and value, ensuring the confidentiality and integrity of these interactions becomes paramount.

In essence, the adoption of blockchain technology in the music industry reflects not only a technological transformation but a profound shift in the way artists and listeners perceive, create, and consume music. The decentralized, transparent, and fair nature of this ecosystem has the potential to redefine the music landscape, placing the power back in the hands of the creators and their supporters.

As we stand at the cusp of this exciting evolution, it is clear that further research, innovation, and industry collaboration are necessary to fully realize the promise of blockchain technology in the music realm. With the foundation of DApps, NFTs, and secure communication channels, the music industry is poised for a renaissance where creativity flourishes, artists are equitably

compensated, and music lovers gain unprecedented access to their favorite tunes. The future of music is decentralized, and the possibilities are limitless.

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