Science, Engineering and Technology Vol. 5, No. 2, Online First
www.setjournal.com *https://doi.org/10.54327/set2025/v5.i2.223*

A Survey on Blockchain-driven Music Industry: Trends, Gaps, and Future Directions

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Abstract

The music industry is a vast field that has different stakeholders, such as artists, publishers, promoters, etc., for the creation, distribution, promotion, and monetization of music. Blockchains can help the music industry maintain the legal and ethical aspects of music creation, distribution, and incentivization while also preventing frauds owing to their intrinsic security attributes. We oversee various blockchain-driven music industry systems, where we comprehend 11 functions of blockchain-driven music industry perception and inspect them comprehensively towards music industry- and blockchain-linked attributions. We lumped a precursory sample of 89 resources by selecting the reports for filtering benchmarks looked up from E-libraries by applying a descriptive and persistent narrative synthesis-driven quality analysis methodology to identify trends, gaps, strengths, and weaknesses. Founded on the overview**,** in the blockchain-driven music industry**,** blockchain can pave the path for blockchain-based musical platforms (D1), decentralized music apps (D2), author attribution, monetization, and royalty payments (D3), preventing ticketing frauds (D4), music recommendation (D5), piracy prevention (D6), digital rights management systems (D7), music supply chain automation (D8), metadata optimization and tracking (D9), disintermediation (D10), and licensing (D11). Comprehensive inspection exposes that in the blockchain-driven music industry, 28.2% draw upon digital rights management (D7)**,** 79.4% draw upon traditional blockchain, and 12.9% draw upon PoS/PoW consensus, drawing the hypothesis that there exists a trend toward reducing third-party reliance and improving revenue transparency and rights for artists. Another hypothesis is that there are gaps such as lack of practical implementation, lack of experimental validation under quantum attacks, and lack of focus for music ticketing fraud prevention, music recommendation, music supply chain automation, and metadata optimization and tracking. At last, we announce the capabilities and adversities to the perception of the blockchain-driven music industry and then contribute propositions to impede them along with future directions to cater to the gaps identified.

Keywords *- Music industry, Blockchain, Piracy, Monetization, Music copyright.*

1. Introduction

Music production involves the creation of new music or remixing of already-existing music and forms the core component of the music sector since it is the foundation of the whole music sector [1]. Sampling has been differentiated from copying of music as extracting a music code within ethical codes and has been identified as incorporated within the music creation procedure [2]. Digital audio workstations have been pointed out as playing a central role in hyphenated musicianship for free or low-cost music production [3]. The study in [4] shows how social exchange of music with listeners can improve the production of music by capturing the music dynamics that have provided the opportunity for the artists to work together remotely while sharing their creative ideas

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Received: *15 October 2024*; Revised: *8 April 2025*; Accepted: *23 April 2025*; Published: *5 May 2025*

online. Virtual studio technology has been reviewed as a modern software-based solution that provides a virtual studio consisting of multiple musical instruments that can be implemented in the virtual studio to create music using a virtual platform implemented on one device [5].

Music distribution involves making the music available to appropriate audiences while at the same time providing financial gain and proper attribution to the creators of music [6]. Music licensing ensures that users of music, such as performers, producers, broadcasters, etc., obtain legal permission to use copyrighted work, and it further promotes collaboration by providing a framework for negotiating and granting permissions for using music [7]. Copyright provides exclusive rights to music creators to control how their music is created and distributed, while these rights include rights for reproduction in physical or digital form, distribution, public performance, and production of derivative works [8]. Monetization and royalty payments determine how musicians and other stakeholders earn revenue from their creative works [9]. Piracy in the music industry pertains to the illicit replication and redistribution of copyrighted music without any prior authorization from the copyright holders [10]. According to a study done in Norway and Finland, strong anti-piracy law enforcement has increased legal music sales by 36%; however, with loose law enforcement, this effect has been reduced [11]. In this work, we review how blockchain has been effectively employed to reduce music piracy, enable fair monetization, protect the copyright of music, enable proper attribution, prevent unauthorized modification, etc.

A blockchain is a decentralized ledger system that securely stores transactions over a node network [12]. In traditional blockchain, there lies a direct concatenation of blocks, including a cluster of transactions per block, while every block is associated with the preceding one, harnessing a ciphered hash and constructing a chain [13]. The non-uniform blockchain diverges from the traditional blockchain, in which transactions will not be classed into blocks; however, they are separately associated with numerous preceding transactions [14]. An electronic signature that is executed by harnessing asymmetric cryptography is leveraged to assure the truthfulness of entries by utilizing a confidential key for authoring the entries and an open key to confirm the signed content [15]. Automatically enforced contracts can be harnessed to enforce agreements automatically, excluding the necessity for mediators, and lowering threats of scams and tampering. They are more reinforced by an elevated level of faith due to blockchain's unchangeable characteristics [16].

The objective/aim of this research is to identify distinct functions of the concept of the blockchain-driven music industry and explore the strengths, weaknesses, gaps, and trends and to discuss the propositions to overcome the challenges identified and then present future directions.

Originating from this overview, the blockchain-driven music industry perception can be separated into 11 functions. First, there are blockchain-based musical platforms like the blockchain-driven Internet of musical things [17]. Next, decentralized music apps have been created for implementing diverse tasks like music streaming and selling purposes while paying to the owners [18]. Furthermore, they facilitate author attribution, monetization, and royalty payments with the aid of smart contracts to give credit to the original creators of music each time music is distributed on the platform [19]. Moreover, they can be utilized to prevent ticket frauds, prevent piracy, digital rights management, disintermediation, and licensing to prevent illegal and unethical distribution of music by utilizing blockchain's inherent security features with smart contracts and other techniques like watermarking, fingerprinting, advanced cryptography, artificial intelligence, etc. [20]. Additionally, the perception includes music recommendation and music supply chain automation by means of self-executing contracts to deliver agreements among multiple stakeholders [21]. Finally, the perception also includes metadata optimization and tracking, where music metadata can be stored on the blockchain with the aid of consensus approaches while being tracked by the creators [22].

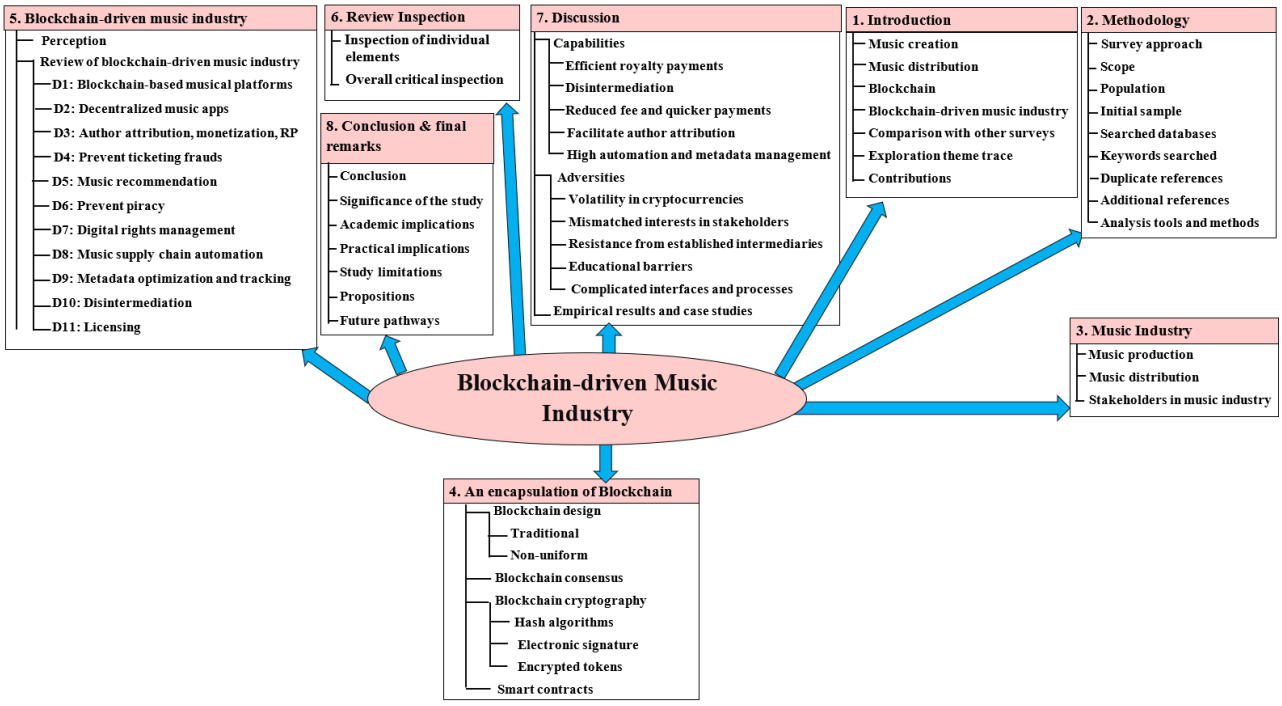


Figure 1. Theme trace of blockchain-driven music industry exploration.

The review paper [23] identifies 3 challenges in the music industry and discusses how blockchain addresses those identified challenges using a decentralized music database. Furthermore, the survey [24] does a preliminary review of how blockchain can be involved in the music industry compared to legacy systems and further suggests ideas to help in integrating the two concepts together. On the other hand, the literature study in [25] studies the pros and cons of blockchain in the music industry from the perspective of non-fungible token digital asset applications and does not review the broad scope. Finally, in [26], challenges are discussed on the utilization of blockchain systems for collective management organizations in music, concluding that there exist only a few studies for the preceding concept. In contrast to these 4 surveys, the novelty of our survey is that our survey focuses on the whole picture of the music industry in broad scope, from music production to distribution, and attempts to review how blockchain is utilized for music fair monetization, media service consolidation, preventing ticketing frauds, preventing music piracy, enabling author attribution, disintermediation, licensing, etc. Thus, the research problem is how can the distinct functions of blockchain-driven music industry systems be identified, and what are the strengths, weaknesses, gaps, and trends within these functions, along with proposed solutions and future directions?

By providing useful information on the blockchain-driven music industry, this research adds to the body of standard literature. In the blockchain-driven music sector, this can guide opportunities for experimenters to determine the standard stirrings and diversities to move forward with future study. Figure 1 communicates the theme trace of this exploration.

Contribution to standard literature includes:

- We listed and briefly questioned music industry concepts (Section 3);
- An encapsulation of the blockchain architecture is announced (Section 4);
- Oversee standard blockchain-driven music industry systems (Section 5);
- Inspect comprehensively on the overseen blockchain-driven music industry systems (Section 6);

- The capabilities and adversities of the blockchain-driven music industry are announced (Section 7);
- Propositions and imminent pathways for a functioning blockchain-driven music industry are announced (Section 8).

2. Methodology

This overview oversees the recent research works into the blockchain-driven music industry propagated as electronic records over a timeline, applying a descriptive and persistent quality assessment along with a narrative synthesis methodology [27]. Specifically, we perform a systematic literature review in order to find solutions to two research questions: “Q1: What are the state-of-the-art blockchain-driven music research works/platforms that have been proposed?” and “Q2: What are the strengths, difficulties, gaps, trends, and future directions in blockchain-driven music industry systems?”. To answer these two questions, we followed a narrative synthesis-driven qualitative systematic literature review with conceptual categorization and percentage-based quality assessment.

In this study, we don’t formulate an initial hypothesis. In contrast, we find solutions to two review questions mentioned above, and we derive two hypotheses based on critical analysis of the review. Our approach aligns well with the approach used in most systematic reviews.

Notably, it appraises a collection of concepts from the music industry and blockchain. Thereupon, all originative intellectual documents and electronic matter publicized in the music industry, blockchain-driven music industry, and blockchain describe the potential outcomes within the limits of this overview. However, the potential outcome citations are challenging to inquire about. Thereupon, applying the appropriate search phrases and filtering benchmarks, we lumped 92 citations from investigative study documents and electronic matter.

We looked up Google Scholar as a service for looking up pedagogical text and systematically reviewed articles using ScienceDirect, ACM E-library, Wiley E-library, MDPI’s directory of research, and IEEE Xplore digital library. The essentially selected search queries were "Music industry" OR "Blockchain-driven music industry" OR "Blockchain-driven music production" OR "Blockchain-driven music sampling and remixing" OR "Blockchain-driven collaborative music production" OR "Blockchain-driven music licensing" OR "Blockchain and virtual music instruments" OR "Blockchain-driven music distribution" OR "Blockchain-driven music copyright" OR "Blockchain-driven author attribution in music" OR "Blockchain-driven music monetization" OR "Blockchain-driven music royalty payments" OR "Blockchain-driven music piracy prevention" OR "Blockchain-driven digital marketplaces" OR "Blockchain-driven streaming platforms" OR "Blockchain-driven disintermediation" OR "Blockchain".

Countless elements for selecting the reports were stated by the filtering benchmarks. First, the specified published work dictates English typing, and subsequently, it dictates incredible bearing on the search strings. Next, to hoist the trustability of the conducted overview, academic journals were considered more authoritative than proceedings documents and draft documents. We didn't embrace originative study documents inside a selected article publisher adhering to the filtering benchmarks; contrarily, we imagined all article publishers evenly. The ultimate filtering benchmark discloses that a selected originative research document asks for public exposure between 1980 and 2024.

The precursory sample was depressed to 89 resources; thereupon, it was discovered that 3 resources were redundancies. We specified ideas and depictions by deploying 42 resources. To bond this overview with existing overviews, we, in the end, combined 4 overviews into the repertoire of references, earning the global measure of resources to 135.

Metadata from the reviewed literature were extracted manually owing to the small size of the study. Moreover, we didn't have to use PRISMA, as the used method does not perform any meta-analysis and does not involve multiple reviewers and inference from multiple studies.

To visualize assembled blockchain-driven music production, we applied the matrix format for overview inspection. We framed conceptions by applying MS Office to indifferently scan overview data clamped to music industry- and blockchain-centered elements [28].

3. Music Industry

In this section, basic concepts of the music industry, such as music production, music distribution, and stakeholders in the music industry, are introduced and reviewed with respect to existing literature.

3.1. Music production

Music production forms the core component in the music field since it is the foundation of the whole music field. It involves the creation of new music or the remixing of already existing music. Researchers argue that it is the emotion of music that does matter and can capture a large number of listeners, and music should be producing a target emotion [29]. Furthermore, some argue that even though artificial intelligence [30] cannot replace human creativity yet, it can be effectively utilized to strengthen the acoustic excellence of the music produced for the purpose of attaining sustainable progress in the music field [31].

3.1.1. Sampling and remixing

Sampling and remixing in music production is the concept of borrowing a sample of music from an existing track and editing it to transform it into a new track. It has been differentiated from copying music as extracting a music code within ethical codes and has been identified as an element of the music creation procedure [32]. However, sampling should be done ethically and carefully, and attribution must be provided to the original creators. On the other hand, remixing, a post-production technique initially introduced for dance music, has defined a new production culture in the music industry and is currently used to identify as media made from pre-existing media [33].

3.1.2. Music technical advancements

The music sector has experienced a technical advancement shift over the past time. Specifically, advancements in digital audio workstations, software, recording equipment, etc. have made music production easier than before. Specially, digital audio workstations have been pointed out as playing a central role in hyphenated musicianship for free or low-cost music production [34]. In contrast, in the past, musicians had to go to a studio for music creation, and a lot of human resources were required. However, studies show that technological advancements leading to independent music production have made the job of some stakeholders in the music industry, such as record labels, challenging [35].

3.1.3. Collaborative production

Collaborative music production has been identified as coproduction in music, which typically involves a large number of resource persons collaborating to produce a piece of music [36]. Due to the prevalence of social networking sites, file sharing platforms, and the internet, music collaboration has intensively increased compared to the past. The study in [4] shows how social exchange of music with listeners can improve the production of music by capturing music dynamics. This has provided the opportunity for the artists to work together remotely while sharing their creative ideas online. In [37], authors suggest that for remote and real-time music production, a high quality of service having low latency is required for efficient communication, improving the efficiency of music production. Due to the real-time nature of these activities, the quality-of-service parameters like

latency and jitter should be very low while having a high packet delivery ratio [38].

3.1.4. Production using virtual instruments and artificial intelligence

In the past, music production occurred entirely using physical musical instruments played by experts [39]. However, in the modern world, there exist virtual instruments softwarized musical instruments that may be automatically played once proper instructions are given. Thus, virtual studio technology has been reviewed as a modern software-based solution that provides a virtual studio consisting of multiple musical instruments that can be implemented in the virtual studio to create music using a virtual platform implemented on one device [5]. Moreover, music production can be assisted by artificial intelligence to create new music with the supervision of musicians, reducing the overall cost of music production. Work in [40] shows that there exist two types of intelligent music production approaches. One of them interacts and works collaboratively with human engineers to produce music, while the second category is fully autonomous, black-box, uninterpretable music production systems. Furthermore, authors in [41] argue that the symbolic representation and inclusion of composition tasks with editing and mixing activities of artificial intelligence are better at supporting the artist's music creation.

Figure 2 communicates the intelligent music production process.

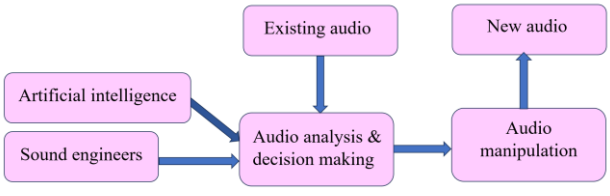


Figure 2. Intelligent music production process.

3.2. Music distribution

Music distribution is as important as music production. It involves making the music available to appropriate audiences while at the same time providing financial gain and proper attribution to the creators of the music. Compared to the past, the internet and social media have defined how music is reached by listeners and how listeners reach music [42]. Work in [43] proposes an artist-led online musical distribution model that considers both traditional value chains in the music field and features of digital music for consumer value production and shows that transformations are required for players in the music field value chain.

Licensing and copyright are essential components from a music distribution perspective. We will discuss them in the sections beneath.

3.2.1. Licensing of music

Licensing allows the music creators to earn revenue during performing, recording, print distribution, etc. Licensing in music is typically done by a regulatory agency with the aid of the government in order to avoid piracy and illegal distribution [44]. Thus, it ensures that users of music, such as performers, producers, broadcasters, etc., obtain legal permission to use copyrighted work. It further promotes collaboration by providing a framework for negotiating and granting permissions for using music in various contexts. However, scholars argue that a 100% license scheme is biased towards reducing collaboration and creativity within song writers [45]. There exist different types of licenses in the music industry, which are briefly discussed below.

- Performance license – A performance license confers the authorization to openly demonstrate musical work as a live performance or music played on the radio or in other public venues. These licenses are handled by a performance rights organization in order to provide transactional efficiency by means of contract negotiation and paying royalties to the copyright owners for publicly performing the music [46].
- Mechanical license – A mechanical license confers permission to recreate and redistribute

copyrighted music in the form of physical or digital recordings such as compact discs, digital downloads, etc. In the United States, the "music modernization act" has defined how this mechanical license is issued, and it has recommended a blanket licensing approach over a compulsory licensing approach [47]. This license protects the person who has obtained it from copyright infringement and grants permission for reproduction and distribution in the form specified in the license [48].

- Synchronization license – A synchronization license provides permission to use a musical work in synchronization with another activity/event, such as a film, TV show, commercial, etc. However, it has been reported that many musical artists have refused to provide a synchronization license, especially for synchronization and releasing in the form of a DVD, and have asked for a large fee for giving a license [49]. YouTube has introduced content ID for user-generated contents that have others' music in them in order to provide revenue automatically to the audio creators using the YouTube partner program [50].
- Sub-publishing license – A sub-publishing license allows a music publisher in one territory to grant rights to another publisher in a different territory to exploit the musical work. An analytical study of multi-territorial licenses in musical works shows that authorities have succeeded in issuing a multi-territorial license; however, there are some concerns regarding intellectual property protection and competition [51].
- Print license – A print license allows the sheet music of copyrighted musical compositions to be reproduced and distributed in printed form. In the past, the print license was a primary source of income for musicians; however, in the modern digital world, this license is less used [52].

3.2.2. Copyright of music

Copyright aims to protect intellectual property by granting creators exclusive rights to their work and preventing unauthorized use and exploitation by other people. Intellectual property safeguarding aims to shield intellectual rights while distributing intellectual work, stating that knowledge should be distributed ethically, giving creators credit [53]. Usually, copyright is held by a musical author even after 70 years of death of the creator according to the law in Europe and the United States [54]. Copyright provides exclusive rights to music creators to control how their music is created and distributed. These exclusive rights include rights for reproduction in physical or digital form, distribution, public performance, and production of derivative works. Research shows that copying and theft have increased due to the digitalization of music and the increased use of social media that facilitate redistribution [55]. The licenses described in the previous section provide a license or permission to use such copyrighted works. A license may not be required for fair use of copyrighted work, such as limited use of a copyrighted musical work such as criticizing, commenting, using for educational purposes, etc., where the whole content of the musical work is not directly utilized. For instance, music teachers and students may review a copyrighted work where they can criticize or appreciate it without being subjected to copyright infringement since such activity belongs to fair use of music [56].

There exist digital rights management technologies and content identification systems in order to protect copyrighted music online and prevent unauthorized distribution and use. For instance, YouTube uses content IDs to automatically detect copyrighted material, which allows copyright holders to get automatic compensation despite being criticized for false positives and accidental matching [57]. It is said that copyright infringement occurs when someone uses copyrighted music without permission, such that the exclusive rights of the copyright holder are violated.

3.2.3. Author attribution

In author attribution, creators of a musical work, such as composers, lyricists, song writers, performers, producers, etc., are acknowledged, and required compensation and recognition are provided. In [58], authors have attempted to create a convolutional neural network to provide author attribution when song lyrics are provided using phoneme-level characteristics that denote verse-based text. In order to prevent copyright infringement, author attribution is essential, according to copyright law. By showing biases and errors in author attribution for music compositions using stylistic traits, work in [59] uses music features like melodies and rhythmic variables for proper author attribution using machine learning [60]. Moreover, author attribution information can be included in the metadata of digital music, music album liner notes, etc.

3.2.4. Monetization and royalty payments

Monetization and royalty payments determine how musicians and other stakeholders earn revenue from their creative works.

Monetization can occur in numerous ways. First, there are streaming platforms where the musical content is streamed. The artists will be paid relied upon the quantity of streams the song receives, despite the fact that payment per stream is comparatively low. In YouTube, exploitative monetization has become a problem that uses the monetization feature of it for self-advantage by individuals and channels, which is harmful to the platform users [61]. Spotify, being a commercial music streaming service, has both a freemium advertisement-based mode and a premium subscription-based mode, providing monetization for the creators and the platform, despite it has been criticized for unfair payment by some artists [62].

Secondly, there are digital music selling platforms where users need to buy the musical contents and download them. On these platforms also, the artists receive a percentage amount of the sale. Examples of such platforms are iTunes, Bandcamp, and Amazon music. For instance, Bandcamp music is known to be economically congruent and act more as a cultural alternative while providing self-managing and self-auditing features [63].

The traditional approach to musical monetization is the physical sale of music compact discs, printed content, etc. For instance, Christian music has been marketed as resembling CDs through record stores, providing revenues of more than 500 million dollars per year [64]. Finally, musical work can generate money by performing at live concerts, festivals, etc.

Royalty payments are a specific type of payment made to copyright holders for the exploitation of the copyrighted works. As specified in the licensing section, when licenses such as performance licenses, mechanical licenses, synchronization licenses, print licenses, etc. are issued, corresponding royalty payments must be paid to the copyright holders. Researchers argue that there exists an inequity in the royalty payments of music streaming platforms that pay royalties based on the number of streams and recommend a subscriber-share model that distributes royalties by considering the user subscription fee [65].

3.2.5. Piracy

Piracy in the music industry pertains to the illicit replication and redistribution of copyrighted music without any prior consent from the copyright holders. However, in the presence of legal music distribution channels like iTunes, research shows that there has been a decline in online music piracy over physical sales of music [66]. Piracy is high due to the modern digital era, where music files can be easily copied and distributed on file-sharing networks, streaming sites, etc. It causes ethical concerns regarding intellectual property protection and has legal implications regarding copyright infringement. It has been found that piracy is somewhat favorable to popular artists and less favorable to less popular artists since it has been found that the cost of illegal downloads

increases with recording scarcity [67]. Anti-piracy measures and digital rights management systems have been introduced to combat against piracy. According to a study done in Norway and Finland, strong anti-piracy law enforcement has increased legal music sales by 36%; however, with loose law enforcement, this effect has been reduced [11].

3.2.6. Live Music

In live music, a group of musicians play musical instruments and sing for an audience. Traditionally, the musicians need to stay in the same place. However, the new paradigm of the 5G-based internet of musical things is a new concept where musicians play live over a communication network thanks to ultra-low latency and high reliability [68]. Thus, in this paradigm, routing schemes that consider the mobility of the network and capture link lifetime are more appropriate to satisfy the quality-of-service requirements [69].

3.3. Stakeholders in music industry

In the music industry, many stakeholders are involved in the creation and distribution of music. Figure 3 communicates the traditional music production process involving diverse stakeholders.

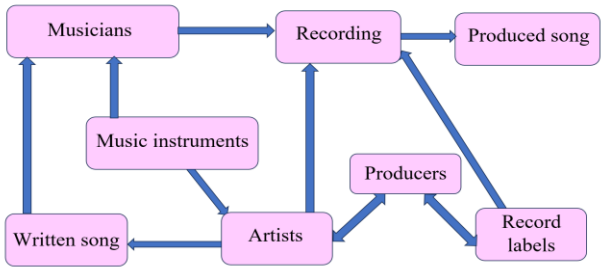


Figure 3. Traditional music production process.

3.3.1. Artists

Artists are the individuals who create and perform the music. Music composers create the musical elements of a song, including melodies and harmonies. It has been found that music composers can embody emotions in the melodies, despite the fact that listeners sometimes report unintentional emotions present in music [70]. Lyricists are artists who write the lyrics of a song, capturing the story behind the song and embedding emotions. In the modern world, song lyrics can also be written by artificial intelligence, like in AI-Lyricist, which produces lyrics when vocabulary and MIDI files are supplied [71]. Performers are either singers who sing the song or musical instrument players who provide the music for the song. It has been found that music performers have faced psychological challenges during their early careers that can be reduced by the support of peers and good teachers while being worsened by abusive teachers [72].

3.3.2. Producers, publishers, and promoters

Producers are people who oversee the recording process by arranging studios, engineering, and mixing sound tracks to carefully shape them to improve the quality of sound. According to a study, a producer is responsible for the artistic direction of music and should have good communication and interpersonal skills [73]. Next, publishers are responsible for handling the administrative aspect of music copyrights by securing licenses and collecting royalties. They may also help in synchronizing music with other works, such as TV shows, films, etc. The music production economy has seen a shift from getting income from sales to licensing and copyrighting during the recent past [74]. Finally, promoters organize and market live performances and events by working with artists to arrange concerts and tours, etc. Music promoters have a significant role in promoting rock/pop concerts, and their role is considered flexible and adaptable and should have multiple facets in the promotion process for success [75].

3.3.3. Digital marketplaces and streaming platforms

Digital marketplaces and streaming platforms distribute and monetize music online. A digital marketplace is responsible for selling music online,

where users buy music online and creators receive a percentage of the compensation. Compared to a traditional marketplace, a digital marketplace has numerous changes in the players in the music industry value chain [76]. Streaming platforms, on the other hand, stream music online, where the creators get compensation for streaming. On these platforms, ways of people seeing things are affected by algorithmic individuation and the classes required by advertisers [77]. Data can be gathered in these networks by a centralized authority, where authorities may make critical decisions regarding music distribution after examining the data [78]. Data gathered could be user preferences, playlists, number of views, duration, and other metadata [79].

3.3.4. Record labels

Record labels are companies whose main task is to record music, sign, and develop artists by providing artists with resources such as recording facilities, marketing budgets, etc. However, the role of record labels is less defined in the modern industry compared to the past due to the development of the internet and file-sharing software [80]. It should be noted that there is a trend for independent records over traditional record labels in the modern music industry, according to a meta-analysis of literature [81].

3.3.5. Distribution companies

Distribution companies are responsible for handling the physical and digital distribution of musical works. Specifically, they work with artists and record labels to distribute music to retailers, digital marketplaces, streaming platforms, etc. In traditional distribution, distributors accept unpurchased merchandise from retailers, where less-selling albums are less profitable, while in digital distribution, this trend does not exist [82].

Table 1 communicates standard literature on the music industry. In Table 1, we categorize literature based on music industry aspects such as music production, sampling, etc., and state the methodology used in each framework along with performance.

Table 1. Summary of standard literature on the music industry.

Music industry aspect	**Standard literature**	**Methodology**	**Performance/Results**
Music production	Emotional effect [29]	Formalize music emotional effects	Argue that music should be producing a target emotion
	AI [31]	Deep learning for music production	Improve quality of music
Sampling	Sampling continuum [32]	Provide viewpoints differentiating sampling from copying	Discussion on sampling presented
Remixing	Rhetoric of remix [33]	Qualitatively analyze remixing & provide new interpretation	No performance analysis
Technical advancements	Music making [34]	Digital audio workstations	Free or low-cost music production
Collaborative production	Creating time [4]	Social exchange of music with listeners	Improve the production of music
	Remote, interactive recording [37]	Show the requirement for low latency communication	Show that tools and file sharing facilitate to interact productively
Virtual instruments	Virtual studio technology [5]	Virtual studio consisting of multiple musical instruments	Consider VST development and application
Artificial intelligence	Intelligent music production [40]	Human mix collaboration and black box autonomous system	Potentials of IMP are considered
	AI production [41]	Identify usage patterns and challenges	Symbolic representation and inclusion of composition tasks with editing and mixing support artists
Music distribution	Music that moves [42]	Examine how music reach people	Internet and social media have defined how music is reached

Table 1 continued

Table 1 (continued). Summary of standard literature on the music industry.

Music industry aspect	Standard literature	Methodology	Performance/Results
Music distribution	On-line music distribution [43]	Artist led online musical distribution model	Transformations are required for players
Licensing	Licensing system [45]	Analyze licensing schemes	100% license scheme is biased towards reducing collaboration creativity
	Performance license [46]	License handled by a performance right organization	Provide transactional efficiency by means of contract negotiation
	Mechanical license [47]	Blanket licensing approach	Open questions for mechanical licensing discussed
	Synchronization license [50]	Content ID in YouTube partner program	Provide revenue automatically to the audio creators
	Sub-publishing license [51]	Analyze multi-territorial license in musical works	Succeeded in issuing a multi-territorial license
Music copyright	Intellectual property [54]	Analyze rhetoric and institutional practices	Rhetoric of author rights carried by third parties
	Music and copyright [55]	Music copyright is analyzed	Copying and theft have increased due to social media
	Fair use [56]	Show how music can be fairly used in the classroom	Discuss fair use and alternatives to copyright infringement
	Next generation YouTube [57]	Content ID to automatically detect copyrighted material	Copyright holders get automatic compensation
Author attribution	Song authorship attribution [58]	Convolutional neural network to provide author attribution	Compare the proposed one with existing test classifications
	Attribution studies [59]	Music features for author attribution using machine learning	Identify factors inherent for composers leading for decision making
Monetization and royalty payments	Exploitative monetization [61]	Analysis of YouTube data	Provide evidence and insight for exploitative monetization
	Spotify [62]	Investigate perceptions of streaming services	Suggestions for future in streaming services provided
	SoundCloud and Bandcamp [63]	Examine audio distribution platforms	Bandcamp music is known to be economically congruent
	Selling CDs [64]	Analyze mainstreaming of Christian music videos	Revenues more than 500 million dollars per year
	Royalty payment [65]	Analyze weaknesses in streaming-driven royalty payments	Recommend a subscriber-share model
Music piracy	iTunes [66]	Analyze impact of online music piracy	Decline of online music piracy of physical sales
	Music piracy [67]	A model of music piracy	Cost of illegal downloads increase with recording scarcity
	Piracy and music sales [11]	Difference-in-differences technique to investigate on illegal file sharing	Increased the legal music sales by 36%
Music artists	Composer music expression [70]	Listeners providing judgment on emotional qualities of music composed by artists	Music composers can embody emotions
	AI-Lyricist [71]	Produces lyrics when the vocabulary and MIDI files are supplied	Superior performance for a dataset containing music-lyrics
	Performers psychological challenges [72]	By conducting interviews	Performers have faced psychological challenges during their early career
Music producers	Role of producers [73]	Analysis of verbal data from musicians and sound engineers	Producer should have good communication and interpersonal skills

Table 1 continued

Table 1 (continued). Summary of standard literature on the music industry.

Music industry aspect	Standard literature	Methodology	Performance/Results
Music promoters	Concert promoters [75]	Compare and contrast historical research	Promoters have a significant role in promoting rock/pop concerts
Digital marketplace	Online music distribution [76]	Model to learn about market transformations	Digital marketplace has numerous changes in the players
	Algorithmic individuation [77]	Closely inspect online music streaming services	Ways of people seeing things are affected by algorithmic individuation
Record labels	Trend in RL [80]	Examine music industry and record labels	Role of record labels are less defined in the modern industry
	Independent RL [81]	A meta-analysis of literature on record labels	Trend for independent records
Distribution companies	Digital age distribution [82]	Compare traditional distribution and analyze music distribution in the digital age	In traditional distribution, less selling albums are less profitable

4. An Encapsulation of Blockchain

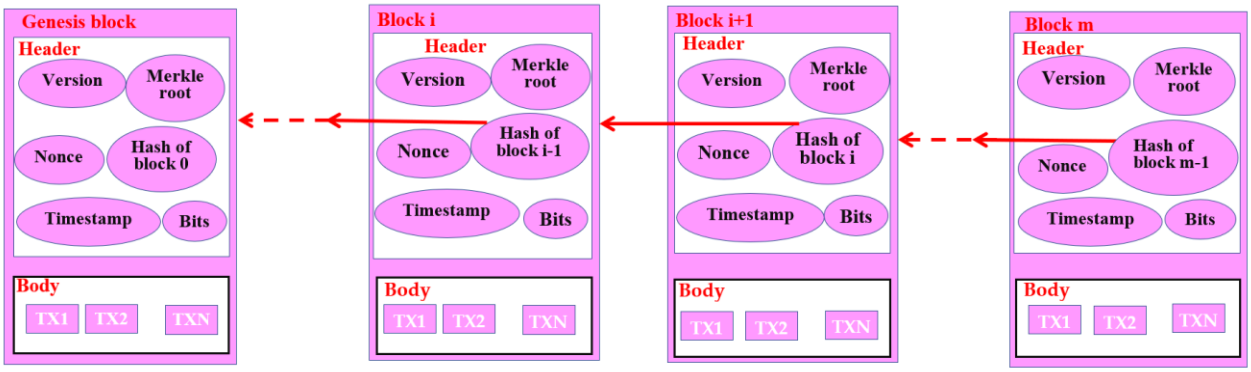
Blockchain is a decentralized/deconcentrated ledger system that securely stores transactions over a node network [83]. The entries are unchangeable, yielding it not feasible to modify or erase them without the consent of the partners, further making the blockchain trustful [84]. Moreover, blockchains have been applied in mesh networks to improve their efficiency, as mesh networks are characterized by a lack of a central point of failure and higher fault tolerance [131]. Even though blockchain is suitable to store small-sized data, it struggles with the storage of large data such as videos, images, music, etc. Thus, off-chain storage mechanisms like Inter-Planetary File System (IPFS), which is a decentralized file storage system that uses content-addressed data blocks to store and share files across a distributed network that allows users to retrieve files based on their content hash, can be utilized [132].

4.1. Design

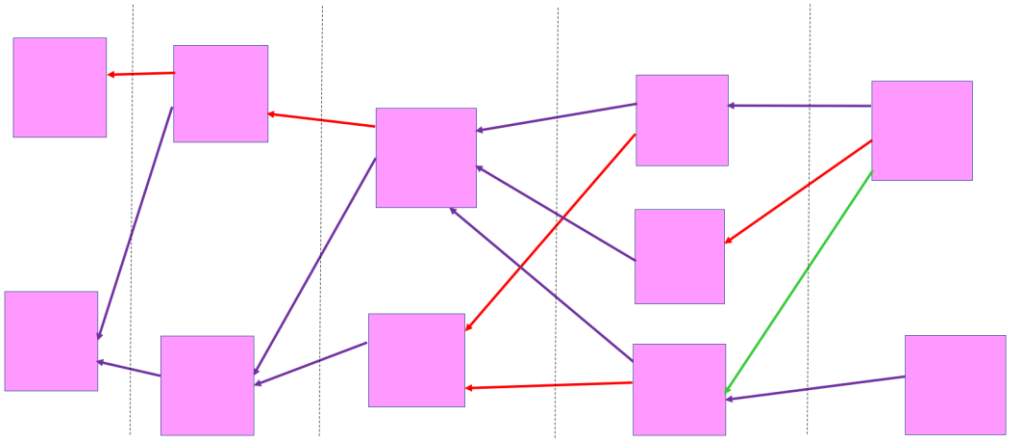
In traditional blockchain, there lies a direct concatenation of blocks, including a cluster of transactions per block, while every block is associated with the preceding one, harnessing a ciphered hash and constructing a chain [85]. The non-uniform blockchain diverges from the traditional blockchain, in which transactions will not be classed into blocks; however, they are separately associated with numerous preceding transactions [86]. This construction yields them expandable and yields elevated efficiency as entries are operated parallelly. There lie also mixed systems that mix attributes of traditional and non-uniform blockchains [87]. Figure 4 communicates these blockchain designs.

4.2. Consensus

The technique by which blockchains come into a common accord pertaining to the credibility of the entries with the aim of preserving their reliability is identified as consensus [88]. In classical consensus methods, miners contend to resolve a convoluted problem, and the initial one to resolve it obtains the privilege to insert the following block [89]. Diverse consensus strategies encompass rooted in the amount of coins retained and capacity to stake, the retention of elevated fame and dominion, the capacity to assign disk storage, etc. [90].



(a)



(b)

Figure 4. Blockchain designs (a) Traditional (b) Non-uniform (Meshcash).

4.3. Cryptography

Cryptographic techniques are operated to retain the defense and unchangeable character of entries, which are different from data fusion [91]. In hash algorithms, provided data generates a constant-size string array, which is harnessed to assure data reliability and spawn distinctive markers for blocks [92]. An electronic signature, which is executed by harnessing asymmetric cryptography, is harnessed to assure the truthfulness of entries by harnessing a confidential key for authoring the entries and an open key to confirm the signed content [93]. Encrypted tokens are harnessed to indicate the resources, possession, and possession shift in decentralized applications [94].

4.4. Smart contracts

In automatically-enforced contracts, treaty phrases are straightly composed inside the script that can be enforced on their own once preset stipulations are encountered [95]. Hence, they can be harnessed to enforce agreements automatically, excluding the necessity for mediators, lowering threats of scams and tampering, and being reinforced by an elevated level of faith due to blockchain's unchangeable characteristics [96]. Ricardian contracts are a special contract that can be used to implement legal agreements among the parties involved in the transactions, and they typically contain the terms and conditions that can be automatically verified. They are particularly useful in decentralized finance [133].

5. Blockchain-driven Music Industry

This section is the core section of this research, and it is dedicated to reviewing the existing blockchain-driven music industry frameworks. First, we present the perception by categorizing it into 11 functions and then thoroughly review each work belonging to those functions later.

5.1. Perception

Originating from this overview, the blockchain-driven music industry perception can be separated into the ensuing 11 functions.

- Blockchain-based musical platforms (D1)
- Decentralized music apps (D2)
- Author attribution, monetization, and royalty payments (D3)
- Preventing ticketing frauds (D4)
- Music recommendation (D5)
- Piracy prevention (D6)
- Digital rights management systems (D7)
- Music supply chain automation (D8)
- Metadata optimization and tracking (D9)
- Disintermediation (D10)
- Licensing (D11)

Figure 5 visualizes the perception of the blockchain-driven music industry. Let's understand each function one by one. As shown in Figure 5(a), in a typical blockchain-driven music industry platform (D1), a creator encrypts the content and stores it in IPFS, while the access control can be implemented using blockchain-based smart contracts. In a decentralized music app (D2), as shown in Figure 5(b), there necessarily exists a decentralized music application that can interact with blockchain and smart contracts. In the graphical illustration shown in Figure 5(c), it depicts a typical example of a blockchain-centered royalty payment scheme (D3), where music owners upload music, ensuring ownership while also avoiding plagiarism, and where the users/listeners can buy the song to provide payments to the authors. Figure 5(d) illustrates a ticketing fraud prevention scheme (D4) where the back end is responsible for administering secret management using issued credentials, while event tickets are utilized as NFTs corresponding to an event ticket in the blockchain. In music recommendation (D5) shown in Figure 5(e), the artists share the music, and the listeners obtain the music from the IPFS based on music recommendations provided by the blockchain-based smart contracts. Figure 5(f) shows an example of how music piracy prevention (D6) can be implemented by using authorization and managing copyright on the blockchain without intermediaries with the aid of a wallet and IPFS, where data can be renewed by versioning. Figure 5(g) shows how a copyright blockchain can be utilized not only to protect copyright (D7-digital rights management), but also to coordinate the desires of music creators, operators, and consumers. Figure 5(h) shows an example of music supply chain automation (D8) that uses the semantic form of smart contracts, a form generator, and a knowledge base to facilitate automatic code generation by allowing the new internet-based artists to present themselves and compete with famous artists. Next, Figure 5(i) shows how metadata optimization and tracking (D9) are implemented by involving music consumers and producers in a blockchain- and smart contract-based decentralized marketplace to manage metadata. Figure 5(j) shows how IPFS can be used to store the music files by encrypting them while selling the decryption keys and file hashes to listeners' smart contracts, preventing intermediation (D10) and further facilitating the collection of a treasury from sales and a scheme for artists to pay for people to share their music. Finally, in Figure 5(k), it shows how artists can create an encrypted license for music and store it in the blockchain, where the music listeners can obtain a self-decryptable license to implement licensing (D11).

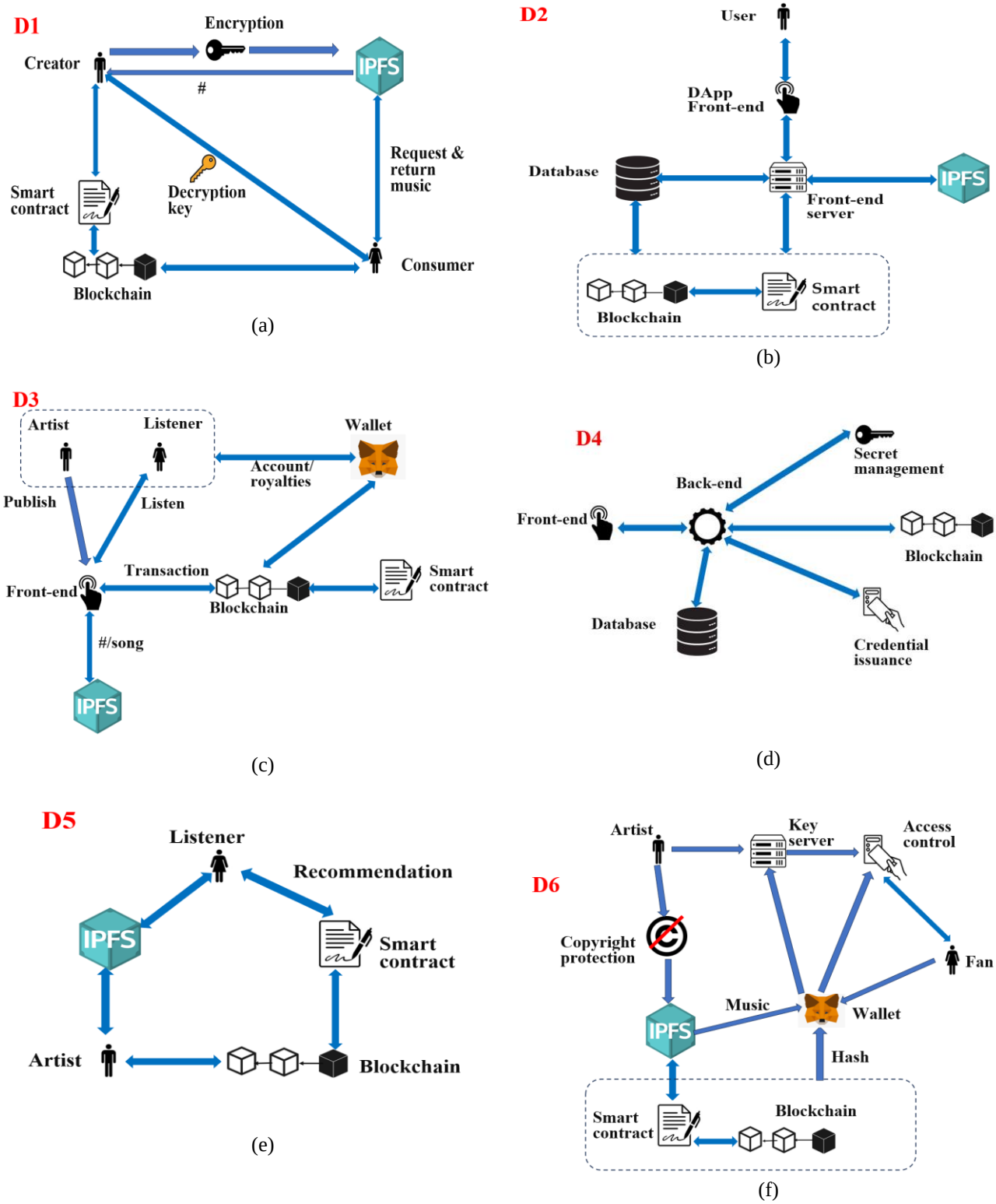
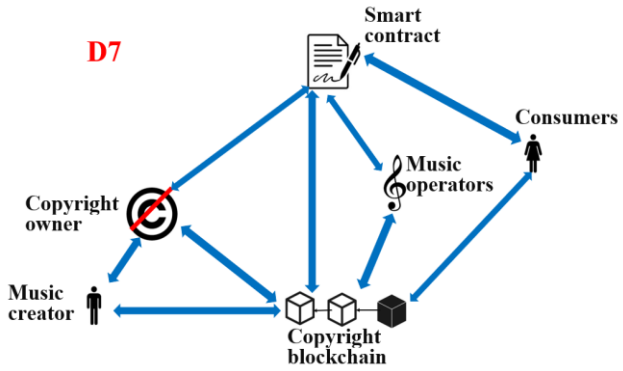
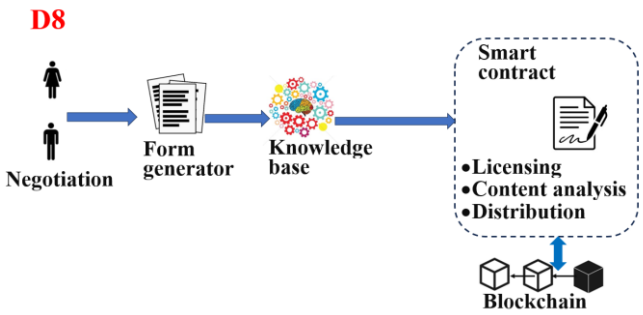


Figure 5. Perception of blockchain-driven music industry (a)D1 (b)D2 (c)D3 (d)D4 (e)D5 (f)D6.



(g)



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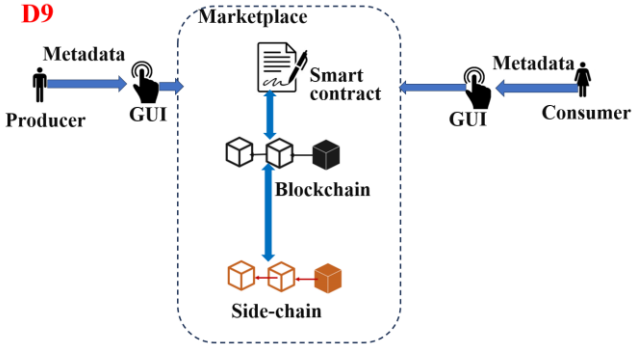
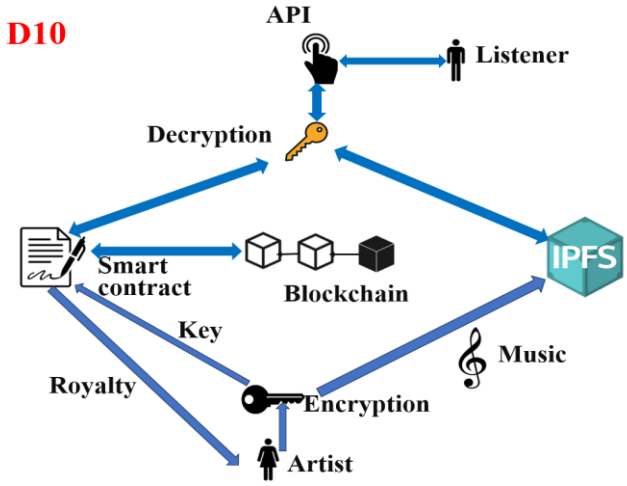
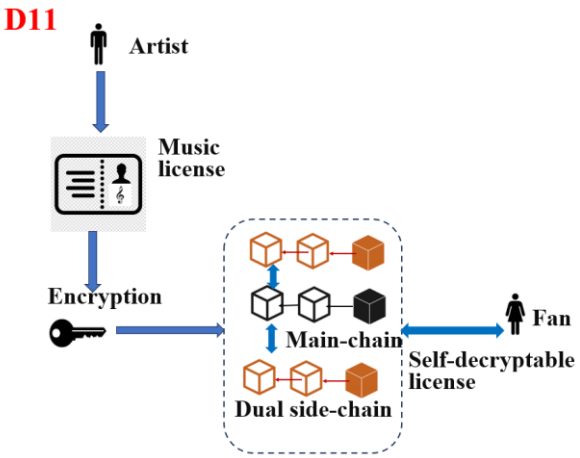


(i)



(j)



(k)

Figure 5 (continued). Perception of blockchain-driven music industry (g)D7 (h)D8 (i)D9 (j)D10 (k)D11.

5.2. Review of blockchain-driven music industry

5.2.1. Blockchain-based musical platforms

The Internet of Musical Things (IoMT) is a decentralized framework having communication techniques serving musical objectives with characteristic decentralization, authentication, etc. in IoT. Blockchain-based Internet of musical things is a new concept by applying blockchain in IoMT to improve the features of copyright management and royalty payments in music and privacy protection features in IoMT [17]. In another study, the Ethereum blockchain with proof-of-stake consensus was recommended to create a decentralized musical platform where artists can invest, reward mechanisms for fans, and feedback mechanisms driven by the advantages of scalability, security, and energy efficiency [97]. A decentralized music sharing platform is implemented with the aid of the Ethereum blockchain using time-efficient proof-of-authority consensus, where IPFS is utilized to store the massive musical content, along with access control implemented using smart contracts [98].

5.2.2. Decentralized music apps

A decentralized music streaming application is built where the listener and the artist can interact on the blockchain using a web browser and a front-end created using Web3.js [18]. In [99], a decentralized application is created on the polygon blockchain to serve the purposes of copyright management and royalty payments, where tokenization is utilized to denote the ownership of shares in the copyright of a song to implement share initialization and fee implementation using a smart contract. In [100], a DApp is developed for music listeners to buy various music from artists using Non-Fungible Tokens (NFTs) and resell them if required, while the artists will also receive payment in the form of NFT, and the web application is developed as a two-tier architecture where the users interact with smart contracts deployed on the Ethereum blockchain. A framework known as "DeMusic" is a blockchain-based DApp for artists to distribute music to listeners without intermediaries, where royalties are paid to the creator and tokens are used as tangible value that can be sold to the community [101].

5.2.3. Author attribution, monetization, and royalty payments

In [18], smart contracts running on the Ethereum blockchain are utilized to implement a pay-per-play model that has a fixed price for the artist and other benefactors using the native currency per play, while streaming is implemented as a free service with the option for the listeners to tip the artists. DMS is a decentralized music streaming scheme proposed to incentivize music creators to independently decide their royalty payments in order to get paid correctly using smart contracts running on the private Ethereum blockchain [19]. In order to tackle copyright discrepancies in music data and to adhere to the "music modernization act", work in [102] proposes blockchain to achieve transparent data standards while using smart contracts for automatic royalty distributions with non-fungible tokens to connect them with blockchain. Research in [103] analyzes existing blockchain-based royalty payment schemes using use cases and then proposes an optimized version for paying royalties to music creators. Alternatively, in another blockchain-centered royalty payment scheme, DApps are created for music owners to upload music, ensuring ownership while also avoiding plagiarism, where the users can buy the song to provide payments to the authors while also providing the option to donate [104]. In research [105], music creators are given the deserved credit for their original contribution by providing royalty, where blockchain and IPFS are utilized to transfer the royalty to the music creators while the hash and corresponding fingerprint are leveraged to inspect for copyright.

5.2.4. Prevent ticketing frauds

"NFTicketing" is a framework that provides a blockchain-driven event ticketing system with the

objective of giving event organizations, such as musical organizations, control over ticketing and preventing ticket fraud [106].

5.2.5. Music recommendation

Researchers have implemented a two-schema-driven music recommendation system by using the contributions of 3 parties in the music industry and the adjustable agreement design of smart contracts in a blockchain-based music platform where the artists share the copyrighted music [21].

5.2.6. Piracy prevention

A music file piracy prevention framework to fight against illegal distribution of copyrighted music where music owners can upload legitimate music with the approval of the community and viewers can pay and download the music where incentive-paying transactions are managed by smart contracts running on permissionless blockchain has been effective [20]. "Bmcprotector" is a music copyright protection scheme where they can authorize and manage copyright on the blockchain without intermediaries, where music piracy issues are handled by using encryption and watermarking techniques along with a versioning method to renew data in smart contracts [107]. In [108], the authors present a scheme known as DRM along with a digital currency known as an asset assertion token implemented on a permissioned blockchain to track and monitor digital music, where the information owner is capable of controlling music flow after sharing by using a cross-platform reader. A piracy prevention framework known as global music assurance utilizes token distribution among content creators, distributors, and listeners using blockchain to safely disseminate and track music content, where the owner may control the information flow after releasing the music item [109]. For safe and legal streaming of music files, a blockchain-driven music wallet has been put forward, where users' audio files are converted into blocks with the aid of other algorithms to keep in the secure wallet [110]. In order to counter attack de-synchronization attacks found in traditional watermarking techniques, "RobustCPS" is an Ethereum blockchain-driven scheme where the audio content is segmented and then singular value decomposition is applied to retrieve the fingerprint, and when identical fingerprints do not exist, the audio is stored for copyright protection [111].

5.2.7. Digital rights management systems

A blockchain-based music digital rights management system has been put forward to record the digital rights metadata on the public blockchain, validate those metadata using consensus approaches in a permissioned blockchain, and subsequently pay the royalty payments automatically leveraging stablecoin using smart contracts [112]. A decentralized copyright management system using smart contracts and the Ethereum blockchain not only protects the copyrights of music holders but also attempts to coordinate the desires of music producers and users [113]. In [114], music assets are organized into blocks and distributed among the participating nodes, protecting the integrity of music and minimizing the sole point of collapse where musicians can approve and manage music copyright and receive royalty payments also. Advanced quantum homomorphic cryptography in the Hyperledger fabric blockchain has been utilized to protect the intellectual property rights of music creators where music files exist as NFTs to activate smart contracts, along with filtering algorithms to recommend techniques for copyright protection [115]. In research [116], the Ethereum blockchain operating smart contracts is proposed to store music and provide automatic payments to the creators, which is an internet database scheme that utilizes Block Explorer to inspect music information. A music composition deep neural network is utilized along with music generation rules for the creation of music, and such music's copyright is protected by confirming, using, and protecting rights using blockchain [117]. A combined scheme for digital music transaction management and copyright protection has been realized using blockchain; however, it argues that the intervention of authorities

is required to improve the credibility of music [118]. Similarly, a melody composition model using artificial intelligence combined with a digital music copyright protection scheme using an improved practical Byzantine fault tolerance consensus approach has resulted in a 0% error rate when there are sufficient users in the system [119]. A digital music rights protection framework using public blockchain to store personal and time information, music content, and authentication details using cryptography has been realized, preventing intermediation, along with a feature extraction algorithm to resist malicious user actions [120]. Similarly, another digital music copyright protection system attempts to use user authentication to strengthen access control where such users are only allowed to burrow music content, while an algorithm for digital audio watermarking further improves the security of the blockchain-based system [121]. Alternatively, in order to overcome the issues in traditional blockchain, work in [122] proposes to use a scalable blockchain for digital rights management of music where authorized listeners can use online content and digital watermarking deployed to reclaim copyright ownership in case the music contents are leaked.

5.2.8. Music supply chain automation

A system that uses the semantic form of smart contracts to facilitate automatic code generation in order to make the existing music industry supply chain more flexible by allowing the new internet-based artists to present themselves and compete with famous artists has been investigated in [123].

5.2.9. Metadata optimization and tracking

Work in [22] evaluates the performance of 3 blockchain-centered metadata tracking frameworks in terms of latency and storage and then proposes an optimum blockchain-driven metadata tracking scheme to develop trust among the content providers. Blockchain along with metadata repositories have been utilized to yield a decentralized solution for metadata, overcoming the weaknesses of existing digital archives for curating digital services and resulting in a more sustainable scheme [124].

5.2.10. Disintermediation

Opus is a decentralized music distribution framework that uses IPFS to store the music files by encrypting them while selling the decryption keys and file hashes to listeners' smart contracts, preventing intermediation and further facilitating the collection of a treasury from sales and a scheme for artists to pay for people to share their music [125].

5.2.11. Licensing

Researchers have proposed a method called practical tokenized drafting that has principles for implementing Ricardian contracts and uses tokenized music licenses using blockchain for music licensing, satisfying the requirements of music industry stakeholders [126]. Alternatively, there is a concept of creating "smart propertized digital contents" to encrypt the digital content and utilizing a public blockchain to distribute the license of these smart contents in a distributed manner, eliminating platform monopolies where the license can include time/device/reselling limitations [127]. Similarly, another research piece proposes blockchain to be used with license generation in order to reinforce the security of prevalent copyright protection frameworks [128].

6. Review Inspection

In this section, we first inspect the reviewed frameworks related to the blockchain-based music industry by summarizing and categorizing them into the concepts and listing out blockchain type, consensus, availability of smart contracts, supplementary functionalities, performance, etc.

Next, we critically analyze the reviewed literature in terms of percentages for each class of the blockchain-based music industry concept, blockchain

architecture, consensus, etc. Next, we evaluate the performance and identify strengths, weaknesses, and review gaps.

6.1. Inspection of individual systems

Table 2 stresses the comprehensive inspection of blockchain-driven music industry systems towards music industry attributions, blockchain attributions, and publicized time.

The first column of Table 2 identifies the blockchain-based music industry perception. As blockchain-related attributes, we use blockchain architecture (skeleton), consensus type, and availability of smart contracts or not. Next, we specify the supplementary functions included in the specified framework, followed by a brief description of its performance and published year.

Table 2. Inspection of blockchain-driven music industry systems.

Perception	Framework	Blockchain skeleton	Blockchain consensus	Self-executing contracts	Supplementary functionalities	Performance	Published time
Blockchain-based musical platforms (D1)	Blockchain-based IoMusT [17]	Generic	Generic	Yes	Copyright, royalty payments	None	2022
	Fan engagement [97]	Traditional	PoS	Yes	Feedback mechanisms, fan rewards	Secure, stable, and decentralized solution	2023
	Decentralized music sharing [98]	Traditional	PoAuthority	Yes	IPFS, access control	324 pens per second throughput	2019
Decentralized music apps (D2)	Music streaming application [18]	Traditional	PoW	Yes	IPFS, Pay-per-play model	25% mined tokens contribute to paying artists	2019
	Copyright management [99]	Traditional	PoW	Yes	Tokenization, copyright management, royalty payments	Provides security and transparency in copyright protection	2022
	Music NFTs player [100]	Traditional	PoS/PoW	Yes	NFT	Improved scalability and security	2023
	DeMusic [101]	Traditional	PoW	Yes	Tokens	Feasible with respect to cost and overhead	2020
Author attribution, monetization, and royalty payments (D3)	Music streaming application [18]	Traditional	PoW	Yes	IPFS, Pay-per-play model	25% mined tokens contribute to paying artists	2019
	DMS [19]	Traditional	PoS	Yes	Royalty fee model	Low gas fee consumption	2022
	Smart Royalties [102]	Traditional	PoAuthority	Yes	NFT	None	2023
	Music royalty payments [103]	Generic	Generic	No	None	None	2021
	Royalty payments [104]	Traditional	PoW/PoS	Yes	DApps, donation options, IPFS	Feasible implementation	2022
	Artists and Remix RP [105]	Traditional	PoW/PoS	Yes	IPFS, hashing, fingerprinting	Average latency is 0.9-2.8s	2021
Preventing ticketing frauds (D4)	NFTicketing [106].	Generic	Generic	Yes	NFT	Good throughput in primary ticket market	2023
Music recommendation (D5)	Music recommendation system [21].	Generic	Generic	Yes	Two-schema based recommendation	User loyalty enhancement improvement	2021

Table 2 continued

Table 2 (continued). Inspection of blockchain-driven music industry systems.

Perception	Framework	Blockchain skeleton	Blockchain consensus	Self-executing contracts	Supplementary functionalities	Performance	Published time
Piracy prevention (D6)	Fair rewarding [20]	Traditional	PoW/PoS	Yes	Fair rewarding mechanism, penalty scheme	Reduction in illegal downloading of copyrighted music files	2022
	Bmcprotector [107].	Traditional	PoW	Yes	Encryption, watermarking, versioning	Transaction rate of 123000 per day	2018
	DRM [108]	Generic	Generic	Yes	Asset assertion token	Secure cross platform reader to control data flow	2018
	Global music assurance [109]	Traditional	PoW	Yes	Token distribution	Several use cases presented	2018
	Music wallet [110]	Generic	Generic	No	Converted to blockchain structure leveraging algorithms	Acceptable performance difference compared to ordinary audio player	2021
	RobustCPS [111]	Traditional	PoW	No	Singular value decomposition, fingerprinting	Superior performance compared to others	2020
Digital rights management systems (D7)	DRM [112]	Traditional	PBFT, PoW/PoS	Yes	Stable coin	Increment of surplus value	2023
	Decentralized music copyright operation [113]	Traditional	PoW/PoS	Yes	Coordinates interests among stakeholders	Feasibility of the model tested	2021
	Music distribution [114]	Generic	Generic	Yes	Music blocks	No performance analysis	2020
	IP protection [115]	Traditional	BFT	Yes	Cryptography, NFT, filtering algorithms	A scenario verifies the degree of protection	2022
	Securing music sharing [116]	Traditional	PoS	Yes	Internet database, copyright protection, royalty payments	Eliminate copyright infringement	2021
	Music copyright protection [117]	Traditional	Generic	Yes	Deep neural network	95.11% qualified rate, 75.6% recognition rate	2021
	Music resource copyright management [118]	Traditional	Generic	No	Cryptography	No performance analysis	2020
	Music compilation and copyright protection [119]	Traditional	IPBFT	No	Deep learning	0% error rate under sufficient users	2020
	Music recognition [120]	Traditional	Generic	Yes	Feature extraction algorithm, cryptography	System pressure increases with analog connections	2022
	Music CP [121]	Traditional	Generic	No	Authentication, digital audio watermarking	Embedding time of algorithm is within 2s	2023
	DRM [122]	Traditional	PBFT	Yes	Digital watermarking	Security analysis shows that system is secure against malicious users	2021
Music supply chain automation (D8)	Semantic-driven MT [123]	Traditional	PoW	Yes	Semantic driven approach	Reduction in time for deployment of new web pages	2019

Table 2 continued

Table 2 (continued). Inspection of blockchain-driven music industry systems.

Perception	Framework	Blockchain skeleton	Blockchain consensus	Self-executing contracts	Supplementary functionalities	Performance	Published time
Metadata optimization and tracking (D9)	Metadata traceability [22]	Traditional	PoS	Yes	Linked data sets, sidechains, access control	No performance evaluation	2020
	Metadata on blockchain [124]	Traditional	PoW	Yes	IPFS, BigchainDB	No performance evaluation	2017
Disintermediation (D10)	Opus [125].	Traditional	PoW	Yes	IPFS, cryptography	Several case studies presented	2016
Licensing (D11)	Blockchain-mediated licensing [126].	Generic	Generic	No	Ricardian contracts, tokenized music license	No performance evaluation	2020
	Intellectual rights protection [127]	Traditional	Generic	Yes	Smart propertized digital content, cryptography, Side chains	Resistant to licensing related threats	2021
	Piracy control [128]	Traditional	Generic	No	License generation	Provide more protection to copyright	2022

6.2. Overall critical inspection

Figure 6 visualizes the dissipation of blockchain-driven music industry towards music industry attributions, blockchain attributions, and publicized time.

As visualized by Figure 6a, D7 (Blockchain-rooted digital rights management system) is the most probable (28.2%) BC-driven music industry perception, after D3 (15.4%), D6 (15.4%), D2 (10.3%), D1 (7.7%), D11 (7.7%), D9 (5.1%), D4 (2.6%), D5 (2.6%), D8 (2.6%), and D10 (2.6%). Next, in the BC-driven music industry**,** 79.4% of proposals draw upon a traditional blockchain, while the rest (20.6%) draw upon a generic BC skeleton, as visualized by Figure 6b. In addition to that, as visualized by Figure 6c, a lot of proposals (35.9%) have been intended to draw upon general consensus, followed by PoW (25.7%), PoW/PoS (12.9%), PoS (10.3%), and all that. At last, when scrutinizing the changing of proposals pertaining to the BC-driven music industry, as visualized by Figure 6d, it is noticeable that the perception has been pioneered roughly by 2016, uplifted until 2021, and collapsed later.

It is very clear from the review analysis that PoW and PoS have been the dominant choices of consensus for most of the blockchain-driven music industry platforms. Thus, proof-based consensus had been dominant compared to the vote-based consensus such as PBFT, IPBFT, and BFT. The underlying reason could be due to the fact of widespread adoption, robust infrastructure, extensive developer support, etc. Moreover, they can offer network-level openness and decentralization, which aligns with artist empowerment and disintermediation goals in the music industry. On the other hand, vote-based consensus, which is frequently utilized in permissioned blockchains, has been rarely used in musical platforms, and it can be owing to the fact that it requires trusted validators and predefined participation.

Next, we can critically evaluate the strengths and weaknesses of the reviewed blockchain-based music industry works, as shown in Table 3. As evident from Table 3, it is obvious that in blockchain-driven music industry platforms, security is high, there exists good payment to artists, there is good copyright protection, there is high user loyalty, there is low piracy, there is a high recognition rate, there is a low error rate, there is a low embedding time, there is high music ownership, and there are low licensing threats.

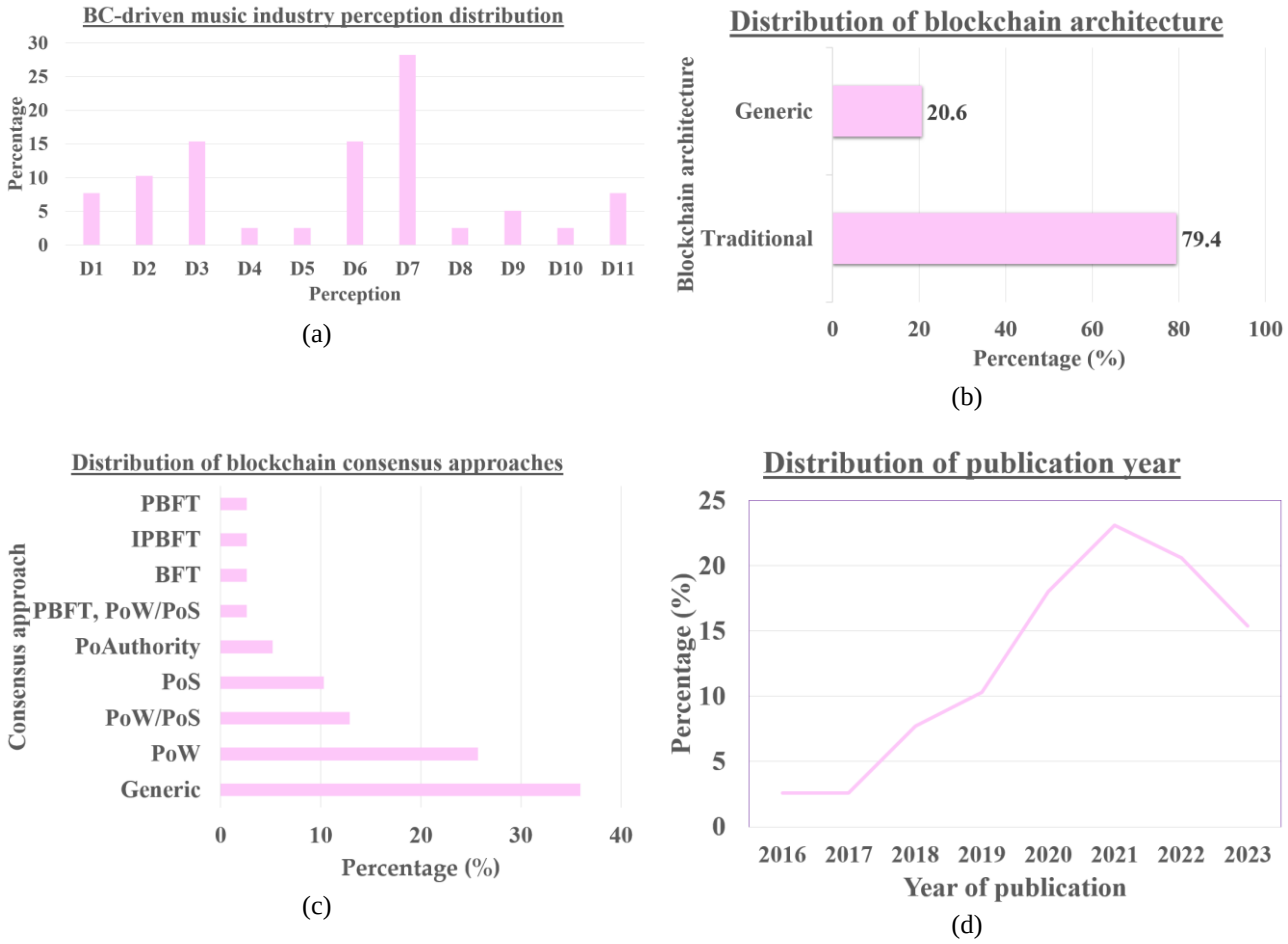


Figure 6. Overall inspection (a)BC-driven music industry perception (b) BC skeleton (c) BC consensus (d) Produced time.

Table 3. Analysis of strengths and weaknesses of reviewed blockchain-based music industry frameworks.

Feature/Parameter	Strength	Weakness
Security	High [97, 99, 100, 20, 122]	
Throughput	High (324 PPS) [98], Good [106, 107]	Low [123]
Payment to artists	Good [18, 104, 112]	
Copyright protection	Good [99], High [20, 113, 115, 116, 117, 118, 119, 120, 121]	
Scalability	High [100]	Low [120]
Cost	Low [19]	Considerable [101]
Overhead		Considerable [101]
Latency		0.9-2.8 s [105]
User loyalty	High [21]	
Piracy	Low [20, 107, 108, 109, 110, 111]	
Recognition rate	75.6% [117], High [120]	
Error rate	0% [119]	
System pressure		High [120]
Embedding time	< 2s [121]	
Code generation time		Considerable [123]
Music ownership	High [125]	
Licensing threats	Low [127]	

On the other hand, we can identify a set of weaknesses in the blockchain-driven music platforms as high overhead and latency, high system pressure, and high code generation time. Moreover, there exists some debatable evidence for features such as throughput, scalability, and cost, so that they cannot be explicitly identified as strengths or weaknesses.

Now, we can identify gaps in the conducted blockchain-driven music industry review, such as no performance evaluation under quantum computer threats, lack of empirical validation, and very low focus on several components in the music industry, such as preventing ticketing fraud, music recommendation, music supply chain automation, and metadata optimization and tracking.

Now, we can provide a summary comparison of the traditional music industry with the blockchain-driven music industry using Table 4.

Table 4. Comparison of the traditional music industry against the blockchain-driven music industry.

Feature	Traditional music industry	Blockchain-driven music industry
Piracy	Considerable	Low
Copyright protection	Low	High
Royalty payments	Drawbacks exist	Transparent
Loyalty	Low	High
Licensing threats	High	Low
Overall security	Low	High

7. Discussion

In this section, we discuss the capabilities and the adversities of the concept of a blockchain-based music industry.

7.1. Capabilities

7.1.1. Efficient royalty payments

Research in [129] has shown that blockchain can be effectively utilized for creating a novel business framework in the music field by creating a fair accounting scheme for efficient royalty payments. Blockchains can easily implement smart contracts that will send royalties to the music creators when their music is played or downloaded on the music platform. These payments can be made using cryptocurrencies or non-fungible tokens that are compatible with blockchains, and the payment can be made instantaneously without any bank delay, etc. Moreover, blockchain DApps can facilitate the selling of songs to listeners and may provide options for the users to donate to the artists in order to increase the income of them even more. Moreover, blockchains can be utilized to track when an artist's work is used (streamed/downloaded/re-distributed) in the platform by fusing with other detection techniques and providing royalties to the creators appropriately.

7.1.2. Disintermediation

In literature, blockchain has been shown as a strong candidate to provide disintermediation by removing third parties involved in the distribution of music while maintaining copyright and distributing royalty payments [130]. In the traditional music world, there are a lot of intermediaries involved when distributing a musical work to listeners, like record labels, publishers, collection societies, etc. However, in a blockchain-driven music industry environment, the requirement for these intermediaries is minimized, as music creators are provided with an opportunity to post their content on a blockchain-driven music platform directly. Blockchains are decentralized and lack third parties/intermediaries inherently, despite some degree of intermediation can be available based on the blockchain type, if necessary. Due to this, music creators are more benefited, as a percentage of royalties is not wasted on intermediaries.

7.1.3. Reduced fee and quicker payments

Due to the non-requirement of collection societies or publishers to engage in royalty payments, the fee for paying them is eliminated on blockchain-driven music platforms. The payments are very quick and automatic due to the availability of smart contracts, and they remove the third-party fee that would have to be paid on traditional music platforms. Due to the transparency of blockchains, music creators can track their flow of royalties without paying a fee to auditors that would have to be paid in a traditional system. The transactions in blockchains cause a lower transaction fee compared to traditional, expensive infrastructure and expensive license agreements with record labels.

7.1.4. Facilitate author attribution

Author attribution has been degraded with the emerging of digital music, where third parties have the opportunity to engage in music piracy by redistributing or selling the music without giving proper attribution to the original authors. Due to the fusion of blockchain in music platforms, authors can be given proper attribution by implementing copyright protection mechanisms and royalty payments to provide attribution to the authors each time their work is utilized on the music platform. As blockchain platforms also allow tokenization, music owners can sell their tokens in secondary markets to earn funds that can be utilized for creating future musical works. Blockchains can further incorporate additional protection mechanisms like cryptography, watermarking, fingerprinting, and versioning methods to prevent music privacy and reinforce copyright protection.

7.1.5. High automation and metadata management

The metadata of a musical work is an important parameter that contributes towards its success, as incorrect metadata can bring losses to the creators. It includes author information, licensing, ownership, etc. that are required for subsequent copyright protection and royalty payments. Blockchains can implement metadata tracking schemes and verify the correctness of metadata by engaging peers using their distributed consensus approaches. Better metadata management can result in better curating of musical services, making the whole music industry more effective. Moreover, blockchain transactions in the music industry are highly automated than traditional music platforms that involve human third parties for music publishing, distribution, recording, auditing, etc. On the other hand, blockchains make use of cryptocurrencies, tokenization, and smart contracts to automate processes like copyright protection and royalty payments, which is highly advantageous than traditional platforms.

7.2. Adversities

7.2.1. Volatility in cryptocurrencies

Cryptocurrencies are naturally volatile in nature, and their trading prices can change quickly over time. As the blockchain-driven music industry often pays royalty payments in terms of cryptocurrencies, the actual margin of profit for music creators can be highly varied due to cryptocurrency volatility. Thus, there can be a risk of gaining a low profit for the musical work when the cryptocurrency value is lower in the market. However, this condition is not permanent, as market factors can change rapidly over time. Thus, the disadvantage is that the profit margin is not fixed, in contrast to traditional music platforms where the profit from sales of fixed assets like CDs is usually fixed. This further provokes waiting by the music creators to look for the best opportunity, so that they have to spend extra energy searching for market statistics, which can result in long waiting times.

7.2.2. Mismatched interests in stakeholders

In blockchain-driven music platforms, usually for the artists to post a musical work to the

blockchain, its metadata is required to be verified by peers on the musical platform using distributed consensus approaches like PBFT. However, these peers can be different stakeholders in the industry, like other artists, producers, etc., who may have different interests and desires, so they may not act in the desired way due to their own personal interests. This can pose a challenge for the music platform, since the distributed approach intended for collective agreement is compromised by personal interests. For example, an artist who is in revenge with another artist may vote on legitimate metadata by another artist as not legitimate to take revenge from that artist.

7.2.3. Resistance from established intermediaries

In the traditional music ecosystem, there are indeed many intermediaries like record labels, publishers, and collection societies, as reviewed in the literature, who serve for different purposes in the process of music distribution and licensing. However, due to the integration of blockchain with the music industry, the intervention of these intermediaries is minimal since authors can directly publish their work with licensing, copyright measures, and royalty payments without any intermediaries thanks to smart contracts, cryptography, algorithms, and artificial intelligence. Thus, these intermediaries can strongly oppose the integration of blockchain in the music industry since it reduces their income.

7.2.4. Educational barriers

One of the main barriers to integrating blockchain in the music industry is the scarcity of knowledge and proficiency among the stakeholders in the music industry and also the authorities who need to implement the system. The blockchain concept is still new, and people tend to have poor knowledge of the mechanisms behind the blockchain. Due to this, authorities may have difficulties implementing the system in the real world. On the other hand, music stakeholders who have been accustomed to traditional music creation and distribution may have difficulty transferring from the traditional system to the blockchain-based system due to a lack of knowledge. For example, the music creator should know how to post his created music on the blockchain platform by entering the correct metadata and should have knowledge of how to configure the settings for licensing, copyright protection, the information flow of the musical work, and rewarding mechanisms by himself without any support from intermediaries. In contrast, in traditional systems, these intermediate tasks are handled by the intermediaries, and the author needs not to have special knowledge or training, but only to pay for them.

7.2.5. Complicated interfaces and processes

Blockchain processes involving music storage and distribution are typically more complicated than their traditional counterparts, mainly due to the distributed approach of operating without third parties, consensus approaches, cryptographic techniques, and other additional techniques implemented in order to achieve different tasks. This can challenge ordinary music artists to use the system without proper training since the operations are much more complicated than traditional systems and they have to operate them themselves without help from intermediaries. Due to having complex operations, the interfaces that users have to react to can also be complex due to having numerous functions where the users have to interact more than with traditional interfaces.

7.3. Empirical results and case studies

In order to safely distribute and track music material, a framework for preventing piracy called Global Music Assurance uses blockchain technology to distribute tokens among content creators, distributors, and listeners. Once the music item is released, the owner can regulate the

information flow [109]. In this system, several use cases, such as buying streaming content rights and compensating listeners by utilizing iMediaStreams Blockchain, are presented. Audius is a platform built on the Ethereum blockchain that provides the opportunity for the artists to release music independently and connect with a global audience. It provides flexible licensing, regional user rights, and access given by paying or freely [134]. Opus is a decentralized music distribution system that employs IPFS to store encrypted music files and sells the decryption keys and file hashes to listeners' smart contracts. This eliminates the need for middlemen and makes it easier to collect treasury from sales and provide a way for musicians to get paid to share their music [125]. On the other hand, Mycelia [135] is a project that includes details about the piece of music and provides transparency between the artist and the fan, where the artists can gain access to data on fans who are listening to the music.

8. Conclusion & Final Remarks

In this overview, we overlooked music production, music distribution, licensing of music, music copyright, royalty payments, piracy, and stakeholders in the music industry. After an encapsulation of blockchain architecture, we overviewed blockchain-driven music industry systems. Originating from this overview, we comprehended blockchain-driven music industry perception inside 11 functions: blockchain-based musical platforms (D1), decentralized music apps (D2), author attribution, monetization, and royalty payments (D3), preventing ticketing frauds (D4), music recommendation (D5), piracy prevention (D6), digital rights management systems (D7), music supply chain automation (D8), metadata optimization and tracking (D9), disintermediation (D10), and licensing (D11). Besides, we comprehensively inspected the overviewed papers concerning 11 functions of perception and the music industry-linked and blockchain-linked attributions. We contributed to the existing body of literature by a systematic review of the entire concept of the music industry in broad scope, not being limited to a particular field of the music industry. Using the study, two hypotheses can be drawn: the hypothesis that there exists a trend toward reducing third-party reliance and improving revenue transparency and rights for artists, while in the process there is a trend to utilize conventional blockchain with PoW/PoS consensus. Another hypothesis is that there are gaps such as a lack of practical implementation, lack of experimental validation under quantum threats, and lack of focus for music ticketing fraud prevention, music supply chain automation, music recommendation, and metadata optimization and tracking. Finally, we announced the capabilities and adversities to the perception of the blockchain-driven music industry.

8.1. Significance of the study

This analysis enhances the standard literature by furnishing advantageous knowledge interrelated with the blockchain-driven music industry. This can steer openings for the experimenters to decide the standard stirrings and diversities in the blockchain-driven music industry to proceed with unborn research.

8.2. Academic implications

As academic implications, we can state that the present study encourages deeper exploration into decentralized systems in music. Specifically, in contrast to existing reviews, it focuses on the whole picture of the music industry in broad scope, from music production to distribution, and attempts to review how blockchain is utilized for music fair monetization, media service consolidation, preventing ticketing frauds, preventing music piracy, enabling author attribution, disintermediation, licensing, etc., such that interested researchers can quickly use this work as a guideline for their future work. It also allows researchers to comparatively analyze the traditional

music distribution platforms with the blockchain-driven platforms.

8.3. Practical implications

This study demands the requirement of practical implementations of blockchain-driven music frameworks for various tasks involved in the music creation and distribution process, as only a few case studies and empirical validations exist. Empirical performance should be better understood to properly deploy the blockchain-driven music industry in real-world scenarios.

8.4. Study limitations

In this work, there is a tendency for the interpretations to be subjective, owing to the fact that we use narrative synthesis leveraging descriptive summaries instead of meta-analysis. As we considered all reviewed (selected) work as equal, without treating them based on their level of reputation (even though selected by prioritizing journals), there is a tendency for a minor level of tendency for the review analysis results to change. Finally, the low prevalence classes of the review analysis may have lower significance.

8.5. Propositions

Originating from the adversities discovered, beneath propositions can be contributed to impede them.

- Since the music creators have the capability to control when and how the music in the blockchain-based framework is distributed to the end-users, they can initiate transactions when the cryptocurrency value in the market is high. Alternatively, they may use tokenization, like non-fungible tokens, instead of volatile cryptocurrencies for their musical transactions. Moreover, if they want to trade their cryptocurrencies for real money, they can wait for the best time, when the cryptocurrency rate is high, for fund exchanging.
- Blockchains can implement secondary measures to track the behaviors of stakeholders. Rewarding mechanisms can be implemented to penalize stakeholders who may behave maliciously driven by personal interests and positively reward good users who act in the desired manner. This can significantly reduce the number of stakeholders who are driven by personal interests and increase the possibility of them working for the development of the music platform.
- In order to reduce the opposition from intermediaries, instead of going to a pure blockchain-driven music platform, authorities may think to go for a hybrid solution where there exists some degree of traditional music sharing where the music creators have the option to select whether they implement the blockchain-driven system or the traditional system. This will provide traditional intermediaries to earn an income from the system and also make the framework user-friendly, as users who are not comfortable with blockchain-driven implementation can select the traditional publication method.
- In order to transfer from traditional systems to blockchain-driven music platforms, especially, the music authors have to be trained with knowledge related to blockchain and the mechanism of operation of the novel system. At least, the users should have training on how to operate the user interfaces and set all the settings for licensing, copyright protection, music distribution, and royalty payments in detail. On the other hand, technicians should have immense knowledge of blockchain in order to implement the system. So, educational sessions need to be arranged for them.
- In order to make the system simpler, the designers may create user friendly graphical user interfaces that provide real-time instruction on how to operate with hints and tutorials that teach the way of operating to the user using the interface itself. Moreover, researchers may find better implementations for blockchains that are

more scalable, like mesh blockchain, to make the blockchain operations more effective and have better performance, leading to lower complexities in the overall system.

8.6. Future pathways

First, in order to adapt blockchain into the music ecosystem, researchers may find blockchain architectures compatible with being engaged in the music domain, like the innovation of novel consensus approaches that are more suitable for copyright management. Moreover, in the future, academicians may come up with new tokenization techniques or cryptocurrencies that are less volatile than existing ones in order to reduce the fluctuations in profits for the creators. Additionally, this field needs to have techniques to simplify the complexities introduced by the blockchain into the music platform by shifting the workload/burden of music creators that may exist in current implementations to computer automation. As we identified a lack of experimental validation under quantum attacks and a lack of empirical studies as a few of the gaps in the existing blockchain-driven music industry, future work should cater to this deficiency by at least experimentally validating the frameworks by considering quantum computer threats and, where possible, implementing the system practically and obtaining the empirical results. As only very few studies are present for music ticketing fraud, music recommendation, music supply chain automation, and metadata optimization and tracking, future work should concentrate more on these aspects in the blockchain-driven music industry.

Acknowledgment

The authors would like to acknowledge the help of reviewers who provided valuable comments to improve the quality of the article.

Conflict of Interest

Authors declare no conflict of interest.

Data Availability Statement

No additional data or additional materials were utilized for the research described in the article. The metadata of the literature review itself was used for the review analysis.

Declaration of generative AI-assisted tools

No AI tools were used for this research. All papers were reviewed manually, text was completely written, and all images were manually drawn without any AI involvement by the authors.

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