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Distributed Ledger Technology Applications in the Recorded Music Industry: Analysis of Fairness and Transparency

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Abstract

Digitalization caused structural changes in the distribution of recorded music, with undesired outcomes for musicians. Unpaid consumptions from music piracy, the value gap between intermediaries and creators, the difficulty to locate rightsholders and mediate licensing, and unpaid royalty black boxes have been pointed out. A new technology known as blockchain, or more generally distributed ledger technology that achieved a partial disintermediation in the financial sector has been explored and applied to provide use cases for the music industry since the mid 2010s. Theoretically, it is ideated for DLT to be applied to track the creation, transaction, usage of creative works as digital files and allow music dissemination in a peer-to-peer manner, with the goals of achieving fairness and transparency in the value chain. Many start-ups and blockchain based projects have sprung up over the past decade, but because DLT is a multifaceted technology, it is being applied in different ways that do not necessarily involve transparent transactions or decentralized governance which was anticipated to create fair outcomes for creators. This study uses a DLT taxonomy developed by other researchers and an empirical observation of 34 currently active cases of DLT applications for recorded music to create a use case typology that allows an analysis of how DLT is being implemented in each use case type and evaluate whether they offer improvements regarding fairness and transparency compared to the status quo. The findings reveals that disintermediating effects are limited due to incomplete decentralization and conditions for creators are affected by business logic of the new DLT intermediaries.

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CMO	Collective Management Organization
DAO	Decentralized Autonomous Organization
DApp	Decentralized Application
DLT	Distributed Ledger Technology
DRM	Digital Rights Management
DSP	Digital Service Provider
GRD	Global Repertoire Database
ICO	Initial Coin Offering
IFPI	International Federation of the Phonographic Industry
IP	Internet Protocol
MW	Musical Works
MLC	Mechanical Licensing Collective
NFT	Non-Fungible Token
PBFT	Practical Byzantine Fault Tolerance
PoW	Proof of Work
PoS	Proof of Stake
PRO	Performance Rights Organization
SEC	Securities Exchange Commission
SHA	Secure Hash Algorithm
SR	Sound Recording
TCP	Transport Control Protocol
UGC	User Generated Content
WIPO	World Intellectual Property Organization

1 Introduction

The recorded music industry has been greatly affected by digitalization as music is increasingly consumed in digital formats. The ease of copying music files gave rise to popularity in peer-to-peer illegal file sharing, which was soon replaced by legitimate streaming services and content sharing on social media platforms. Competing with free, these means of music consumption pay little sums of money to musical artists. From the perspective of critical political economy, the fair renumeration to the creator of these cultural goods has come under debate. The so-called 'value gap' between creators and the intermediaries, especially powerful new tech intermediaries, and the major labels who retained power from positions of legacy after digitalization is an issue.

Suggestions to update the copyright regime have been made, but recent efforts attempt to make use of blockchain technology or more precisely distributed ledger technology (DLT) as a solution to replace intermediaries with decentralized structures and automated means. Areas of ideated application span from the creation of a shared copyright database, instant and micropayments, new licensing models, crowdfunding and other new monetization modes, with the notions of 'fairness and transparency' in the value chain as normative goals.

Based on theoretical implications these application use cases sound promising, but in actual implementation there remain obstacles. The problem of scalability, rigidness of code in accommodating contracts for music licensing, the so-called garbage-in-garbage-out problem for recording data, volatility of cryptocurrencies and lack of regulations and legal uncertainty are some of the concerns already pointed out.

This paper aims to identify the use cases for DLT application in recorded music which are existing in the present day, and to evaluate whether these applications achieve the goals of fairness and transparency. Through this analysis, the paper answers the research questions:

Which of the ideated DLT use cases for recorded music have been implemented?

How are these applications implemented regarding the deployment attributes of DLT and the terms of service offering?

Are these implementations 'fair and transparent' as claimed?

A multi-case case study is employed, to examine the actual state of projects that apply DLT in use cases for recorded music. From the collected use cases, a typology of use cases is developed through analytical generalization, focusing on the function and technique. Due to the plurality of DLT application methods and deployment attributes, how DLT is implemented affects the outcomes. Drawing on a taxonomy of general blockchain use cases developed by other researchers which define how DLT is implemented, each use case type is matched with the general taxonomy. This reveals the governance structure, areas of transparency achieved, or certain points of centralization introduced in many of the use cases creating new intermediaries. The development of a typology also allows a comparison to be made with services offered by the existing intermediaries. A focus on improvements in welfare, circulation, and control is placed in the determination of fairness and transparency. Do the DLT based platforms pay artists or take fees? If so what are the costs and percentages of commission? Are the licensing terms fair? How does it compare to traditional intermediaries? Who decides what is circulated and what becomes visible?

The findings reveal that in the current form of implementation, DLT based applications for recorded music only incrementally improve some functions of the value chain, and do not necessarily offer disintermediation. While new paths of monetization are offered, the new intermediaries tend to impose terms that are disadvantageous to creators.

The paper is structured into the following chapters. Chapter two lays out the theoretical background of the research, which begins with the state of the recorded music industry and problems of the current copyright regime under digitalization. An introduction to DLT and DLT applications for the music industry is provided through existing literature. Chapter three explains the method applied in order to derive a typology from multiple cases and steps taken to conduct an analysis. Chapter four describes the research results, with an explanation and evaluation of use case types observed. Chapter five reflects on the research method and results, followed by a discussion on the implication of the findings. Chapter six is dedicated to a conclusion and summary of the paper.

2 Background and Theoretical Framework

Current literature on the music business exposes problems for creators in the post-digitalization and internet era. Proposals to resolve these problems through the application of blockchain technology are introduced, followed by an introduction on the blockchain technology itself. The most recent studies in the domain of blockchain applications for recorded music suggest application areas with its benefits and limitations, yet a framework to critically evaluate the typical applications in music are missing.

2.1 Digital disruption in the recorded music industry

This section explains the current state of the recorded music industry and its inherent problems that became especially prominent through the digitalization of music and development of fast speed internet networks, shortcomings of the legal frameworks and institutions to regulate and enable the development of a healthy market for music in the digital environment.

2.1.1 The business and economics of recorded music

Ever since the means to transfix music onto a replay-able format was invented, worthy performances have been captured, distributed, and commodified. This created the recorded music industry, sometimes called the recording industry. The recording industry belongs to a wider and complex interdependent eco-system of *the music industries*, which include music publishing, live music, merchandising, music journalism, and more, but ultimately condense to activities intermediating the relationship between the creator and the fan[1] (Negus, 1996, as cited in Nordgård, 2018, p. 6). The pluralistic form is emphasized to maintain that the field is complex and comprise of various stakeholders, as is the case with *the cultural industries* (Hesmondhalgh, 2019, p. 29). This multi stakeholder environment is a key factor in Nordgård's analysis of challenges that the music industries face in adapting to the digital environment. The incapacity to react resulting in inefficiencies and monetary

[1] The creator and the fan are both irrational parties, as Simon Frith interestingly points out (Frith, 2001, as cited in Nordgård, 2018, p. 6).

losses, stems from three main factors which are, the dynamic of intertwining intermediaries with varying agendas and standards, which now extend to the exogeneous yet complimentary tech industry exerting increasing power, and the interdependency with the role of policymakers that shape structure around copyrights (Nordgård, 2018). Our paper focuses on the recorded music industry and changes to music distribution in the contemporary environment, yet a step back to observe the cultural industries is useful to obtain an understanding of the economic workings.

Hesmondhalgh (2019) defines the core of cultural industries as those who "are centrally concerned with the industrial production and circulation of texts" (p. 15), (or in other words, content), and identifies four distinct problems that these industries commonly face, which are: high production costs and low *re*production costs, the difficulty to estimate success amounting to higher risk, the requirement to strike a balance between creativity and commerce, and the economic nature of the goods produced resembling semi-public goods (pp. 30-38). The cultural industries typically respond to the problems raised above by five common reactions: offsetting misses against hits by creating a repertoire, integration of business sectors (vertically, horizontally and internationally) creating media conglomerates, relying on copyright law and other means to create artificial scarcity, the use of formatting such as genres and series, and finally, by maintaining a stronghold on distribution channels but a loose control over creators (Hesmondhalgh, 2019, pp. 30–38). Because the recorded music industry is part of the cultural industries that create cultural goods, there is an interest in the normative discussion of how these goods should be produced and distributed as well as how creators should be rewarded in their labor, from a critical political economy perspective (Hesmondhalgh, 2016, 2019; Hesmondhalgh & Baker, 2011; Negus, 2019; Sirois & Wasko, 2011). These concern "the particular nature of cultural work, and how it might be organized and rewarded; and the centrality of distribution or circulation in determining which products get to which audiences and in what form" (Hesmondhalgh, 2019, p. 272).

Specific economic characteristics of recorded music have been pointed out. As recorded music becomes increasingly digitized, they have become pure informational goods which are non-excludable and non-rivalrous (making them a quasi-public good), have informational asymmetry in regards to the quality of the good giving larger firms an advantage due to network effects, and have distinct cost structures (Dolfsma, 2005).

Analysis on the economic nature of digital goods reveal the reasons for the difference in cost structures broken down into lower costs for search, replication, transportation, tracking and verification (Goldfarb & Tucker, 2019). Low replication costs and the public goods characteristics make music susceptible to the free-rider problem where contents are easily copied and shared (commonly referred to as music piracy). Music as a digital good has characteristics of a durable good, which gives advantage to a bundled renting strategy over the selling strategy under a set of conditions such as the existence of piracy and when effective Digital Rights Management (DRM) tools can be implemented to limit access (Rayna, 2006).

2.1.2 The shift to digital and the 'value gap' under digital formats

The recording industry initially experienced digitalization as a threat due to illegal copying of music files cannibalizing revenue from legitimate sales, especially with the rising popularity of peer-to-peer file sharing software in the late 1990s that allows users to locate and share copies of media files (Glynn S., 2014; Nordgård, 2018). Many legal battles were fought between the music industry and music pirates as well as the piracy enablers, resulting in new legislations to regulate the internet (Lessig, 2004). It was predicted early on though, that internet speeds will increase to accommodate on-demand access models to music via streaming, and replace peer-to-peer file sharing that requires downloading content, even if the streaming models charge a small fee (Lessig, 2004). It would then become a matter of not how to ban illegal sharing of intellectual property, but on how to compensate the creators.

More recently the music industry has been resettling around embracing online distribution of music as an opportunity to gain alternative revenues such as licensing to streaming services offering a subscription based access model to music in a bundled library, or ad-supported revenue share models from platforms allowing streams or usage of music via user generated content (UGC) on services such as YouTube or TikTok (Brandes, 2021; Watson & Leyshon, 2022). Streaming platforms and online stores for digital music are commonly referred to as digital service providers (DSPs) in the music industry.

Figures reported by the International Federation of the Phonographic Industry (IFPI) indicate how sales of recorded music in physical formats such as CDs and Vinyl have been experiencing a steep decline since the early 2000s, with downloads and other

digital formats unable to compensate for the loss, the total global industry revenue for recorded music bottomed in 2014, after showing overall recovery owing to the new streaming formats gaining wider acceptance, as shown in Figure 1. The IFPI reported that in 2022, 67% of total industry revenue derived from streaming formats, a combination of subscription-based audio streaming (48.3%) and ad-supported streams (18.7%), amounting to 17.5 billion US dollars (IFPI, 2023).

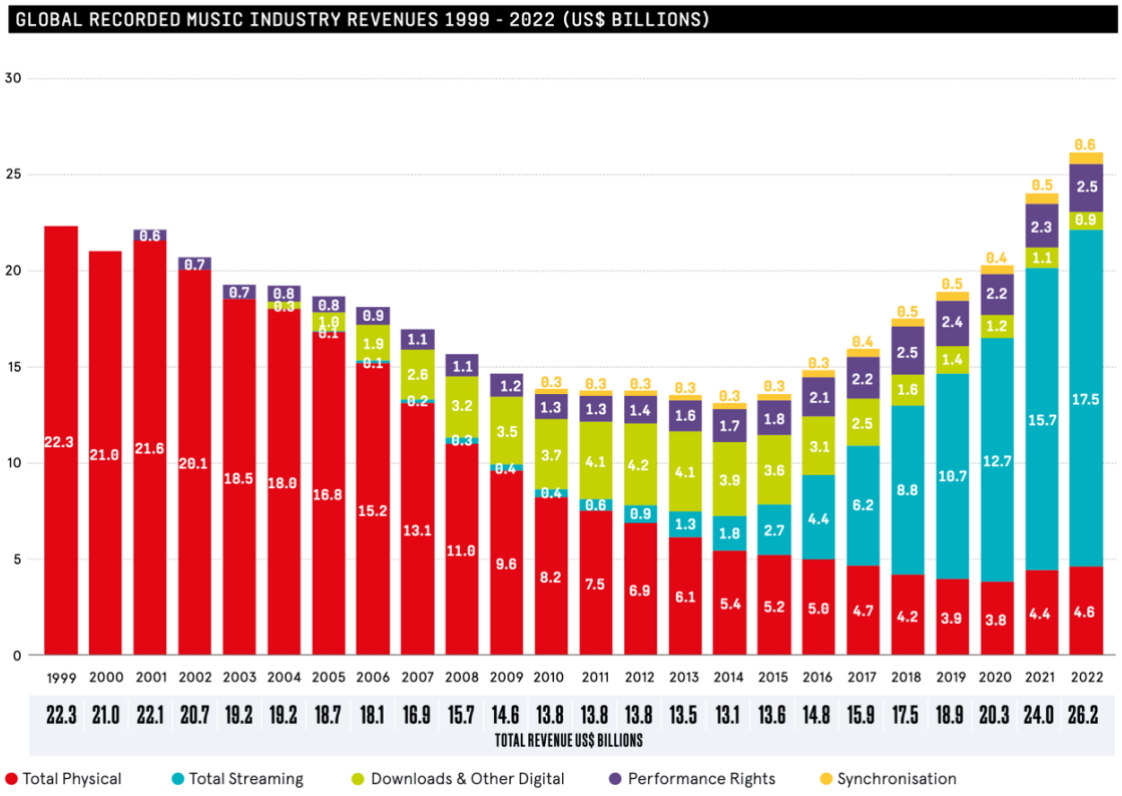

Figure 1: Global recorded music industry revenues (IFPI, 2023, p. 6)

This shift to digital, and specifically the industry dynamic of music streaming platforms gaining a central economic position in the recorded music industry, has garnered attention from researchers in domains of cultural and media studies as well as business and economic fields, and its implications on the creation and consumption of music has been critically discussed. Platform studies reveal that streaming companies are replacing traditional gatekeeping and taste making through algorithmic recommendation systems (Bonini & Gandini, 2019), which exert influence over the supply side and creation of music resulting in an optimization of creative practices (Maasø & Spilker, 2022; Morris, 2020). The high tension between the new tech industries who rely on content, and the recorded music industry who provides content, has been probed from economic and business contexts (Negus, 2015, 2019; Nordgård, 2018; Watson & Leyshon, 2022).

A claim that new online intermediaries such as YouTube as content hosting services are illegitimately retaining the value provided by and owed to creators (protected by the 'safe harbor' provisions of EU and US law that grant internet intermediaries immunity from hosting copyright infringing user-uploaded content), was coined as the 'value gap', a term popularized by the IFPI through their industry reports 2015 through 2018 addressing these grievances (IFPI, 2015, 2016, 2017, 2018). A counterargument presented by the Computer & Communications Industry Association disputes the existence of such a value gap, pointing out that the healthy growth of revenues for the recording industry were the result of efficiency savings of digital distributions being passed on to the record labels, which in return have not been passed on to the artists by the labels themselves (de Posson, 2019). The Competition and Markets Authority, a government branch of the United Kingdom, analyzed that revenue shares from music streaming platforms in the UK in 2021 were distributed mainly to the recording company (37%), followed by retention at the streaming company (32%), and 16% and 12% respectively to the recording artists and songwriters, as shown in Figure 2 (Competition and Markets Authority, 2022). The report concluded that from a competition perspective, an intervention to break up monopolies in the domain of music and streaming industries would have limited effect on the welfare improvement of creators and consumers and therefore not appropriate, but called for a broader policy debate surrounding optimal distribution of revenues under the framework of copyright law.

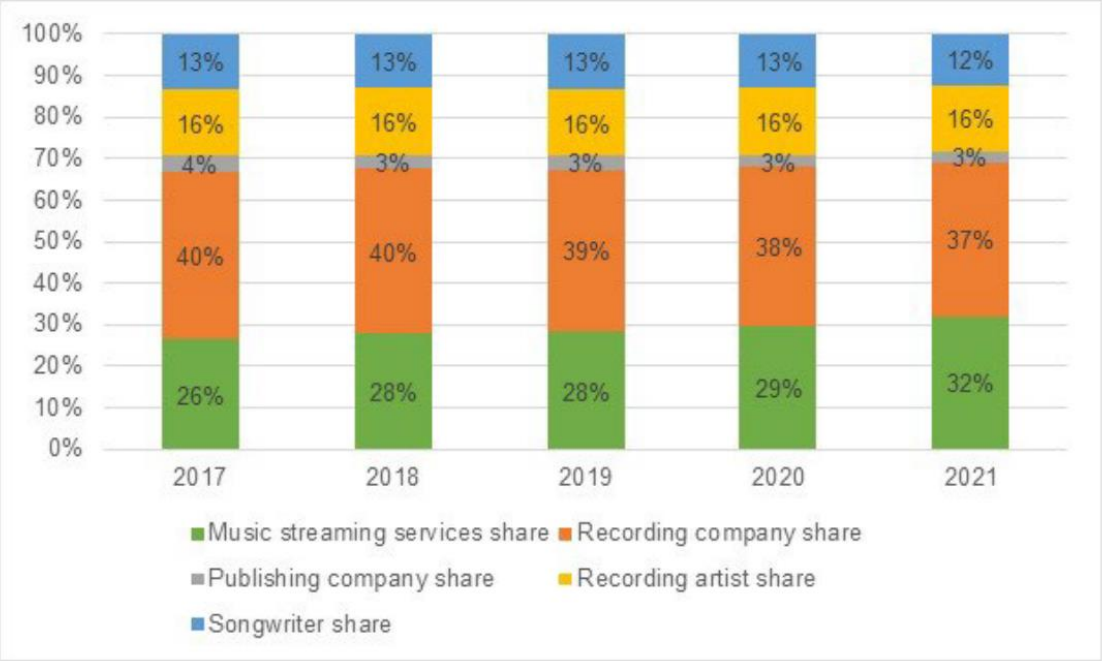

Figure 2: Distribution of streaming revenues in the UK (Source: CMA analysis of data from the largest music streaming services (Amazon, Apple and Spotify), the major music companies and some independent labels (Competition and Markets Authority, 2022, p. 65))

IFPI has ceased to address the value gap in their reports since 2019, ongoing to the most recent issue (IFPI, 2019, 2020, 2021, 2022a, 2023). It appears, the IFPI represented mainly by major labels have come to embrace these platforms as business partners. Despite these developments, this has not stopped the issue of low revenues paid out to creators being a focus of scrutiny and discussion under the term 'value gap' now more widely applied to the whole of industry dynamics, and critical voices question the long-term sustainability of how the current mainstream music platforms operate (Hesmondhalgh, 2021; Leyshon & Watson, 2021; Towse, 2020). A specific criticism is aimed at the lack of transparency and skew in the ways the streaming revenues are being paid out to the benefit of major record labels. Instead of the current 'pro-rata' model that divides revenues according to total streams, suggestions to incorporate a 'user-centric' model that would distribute the revenues according to what each subscriber listened to have been made, but the implementation of such scheme requires accounts held for each user and is expected to be cumbersome (Goldman Sachs, 2023; Hesmondhalgh, 2021; Nordgård, 2018).

2.1.3 Copyright law, Collection societies, and Private ordering

As previously stated, the recorded music industry relies on copyright laws in order to maintain scarcity of the goods. Copyright laws vary by region on what is protected and for how long, and as such there is no international copyright law, but have been somewhat harmonized through international treaties (Frith & Marshall, 2009; Sellin & Seppälä, 2017). The main aspects can be simplified as follows. Recorded music contains two sets of works that are protected, the sound recording itself, and musical works which are the underlying composition. Each of these works enjoy a bundle of rights that exclude others from activities such as making *reproductions* (whether digital or physical. For musical works the reproduction is called a mechanical reproduction right), *adaptations* (such as cover versions of a song, sampling and arrangements creating derivative works), *public performances* (replaying or performing via broadcast or in person) and *synchronization* (usage of music in video formats), which can then be licensed to others for use (Frith & Marshall, 2009; Sellin & Seppälä, 2017).

Copyright laws grant—by the power of state in each territory, exclusive rights to exploit creative works to their authors under an economic rational to incentivize production of music, but the enforcement of these rights are not automatic and rely on complex interactions between institutions along the supply chain and also internationally (Andersen et al., 2007). In order to exploit the rights through licensing, authors usually transfer control and/or ownership to parties such as record labels (for the sound recording) and music publishers (for compositions), at the same time rely on collective management systems administered by royalty collecting societies that have developed in each territory (Ficsor, 2022; Handke & Towse, 2007; Noti-Victor, 2020). Table 1 organizes the scheme for music licensing and fee collection in the instance of the United States, showing how each use case requires multiple licenses administered by different entities, as well as the inconsistent fee structures and permission policies, which Noti-Victor points out are a result of the historic policy decisions leading up to the current regime, influenced by the lobbying power of various segments in the music industries. The scheme shown in Table 1 depicts the typical case where the sound recording is controlled by or transferred to the label through a master license agreement and the musical work is transferred to the publisher via publishing agreement.

Use Case	Work	Rights	Granting Permission	Fee Determination	Obtainer	Collected and distributed by
Physical copies	SR	reproduction	voluntary	free market	(label pre-controls)	Distributor + label
	MW	mechanical	compulsory (statutory)	policy driven court rate	label	Harry Fox Agency
Terrestrial Radio	SR	none	unnecessary	no fee	-	-
	MW	performance	(blanket by PROs)	free market (court rate cap)	radio stations	PROs (ASCAP, BMI, SESAC)
Digital Radio	SR	performance	compulsory (statutory)	market-mimicking court rate	digital radio stations	SoundExchange
	MW	performance	(blanket by PROs)	free market (court rate cap)	digital radio stations	PROs (ASCAP, BMI, SESAC)
Downloads	SR	reproduction	voluntary	free market	DSPs	Aggregator + label
	MW	mechanical	compulsory (blanket) / direct	market-mimicking court rate	DSPs	MLC / Publisher
on-demand Streaming	SR	reproduction	voluntary	free market	DSPs	Aggregator + label
	MW	mechanical	compulsory (blanket) / direct	market-mimicking court rate	DSPs	MLC / Publisher
	MW	performance	(blanket by PROs)	free market / court rate	DSPs	PROs (ASCAP, BMI, SESAC)
UGC	SR	synchronization	voluntary	free market	(user)	platforms + labels
	MW	synchronization	voluntary	free market	(user)	platforms + publishers

Table 1: Music licensing by use case in the United States (table prepared by author based on Noti-Victor (2020))

SR: Sound Recording MW: Musical Works PRO: Performance Rights Organization MLC: Mechanical Licensing Collective

DSPs: Digital Service Providers (streaming platforms and other online music distribution services)

* PROs and the MLC are all collecting societies. In some countries the performance rights and mechanical rights are collectively managed by a joint Collective Management Organization (CMO).
** UGC for User Generated Content. Users rarely obtain synchronization licenses, so the platforms mediate this by a pre agreement with rightsholders, or through ContentID in the case of YouTube, which allows identification of infringement and usage negotiation of copyrighted works.

The United States copyright regime is just one example of how rights are organized and negotiated, and each territory has developed their own set of laws and collecting societies. Collecting societies have entered into agreements with each other that allow the transfer of fees collected in one region to the respective rights holders in another territory, but the transfer induces additional time and deductions (Klingner et al., 2021).

Andersen et.al (2007) analyze that due to power imbalances, license mediating interactions are prone to conflict and at times even exploitation, in favor of major labels/ publishers and collection societies in more developed countries, making the copyright regime "enormously bad at creating a 'fair' income distribution"(p.27). Copyright law's tendency to overprotect firms at the expense of creators and consumers, and inefficacy especially in the digital environment, is pointed out by other researchers as well (Klein et al., 2015; Noti-Victor, 2020; Towse, 2009).

The multiplicity of types of use, international variants in copyright laws, high volume of new works created[2] creates challenges in enforcing copyrights. Delays in payment spanning years, as well as the existence of large sums of unallocated royalties are widely acknowledged (Nordgård, 2018; Passman, 2015; Rethink Music, 2015; Robinson, 2023).

In addition to enforcement, making use of copyrights by allowing others to obtain licenses and pay for such use of works is equally crucial. Industry efforts to create international standards for handling music meta-data and technological measures to automate processes attempt to alleviate some of these problems, but difficulties remain in intermediating the correct licenses to users, due to the lack of an appropriate framework (Watson & Leyshon, 2022). Artistic practices such as sampling and creation of derivative works are also greatly limited as a result (Corrado, 2019; Rachum-Twaig, 2016).

In order to correctly allocate royalties and mediate licensing, the creation of a global and public database to locate rightsholders has been proposed multiple times —the most promising was the Global Repertoire Database (GRD) project initiated by the European Commission in 2008, or the International Music Registry funded by WIPO (World Intellectual Property Organization), but none have thus far succeeded because the

[2] Works are automatically granted copyright the moment a work is created in most states, because the Berne Convention prohibits formalities for protection.

proposed centralized solution resulted in conflicts of interest, and data remains siloed at various intermediaries (Ficsor, 2022; Milosic, 2015; Nordgård, 2018; Sellin & Seppälä, 2017).

Where public regulation and copyright laws fail to accommodate the needs of the market, private ordering, a form of private regulation by contract and technology substitute the act of regulation for intellectual property in the digital domain (de Filippi, 2012; Rothman, 2014). On the one hand private ordering can impose stricter rules for uses of works than allowed by law, through means such as DRM and Terms of Service (TOS) imposed by service providers, often criticized as unduly restricting the public's right for fair use of works. On the other hand, private ordering may also be used to loosen the copyright restrictions by allowing a wider choice of rights to be retained, one such effort is the development of the the Creative Commons license, a standardized and computer readable legal contract widely used to create works with 'some rights reserved' rather than the default status 'all rights reserved'(de Filippi, 2012; Lessig, 2004; Rothman, 2014). Empirical studies observe the increasing power of platforms to define the boundaries of rights for content creators and consumers alike, through the use of such private ordering (Quintais et al., 2023). Lawrence Lessig (2004), founder of Creative Commons, argues for a reform of law that can balance rewarding creators and at the same time allowing the sharing of information in order to allow culture and creativity to thrive. This could be by a levy of tax on file sharing technologies and a compulsory collective licensing scheme, although there will be a need to monitor usage to allow fair distribution and set an appropriate levy based on estimated losses (Glynn S., 2014; Lessig, 2004)

2.1.4 Summary of problems and proposals for a decentralized solution

The problems so far outlined can be summarized as follows:

—an inability to create artificial scarcity in the digital domain making recorded music nearly free.

—the lack of a transparent and fair mechanism to intermediate creators and listeners in the new digital formats.

—difficulties in creating a comprehensive central database to locate rightsholders.

—dependency on multiple middlemen each with monopoly powers that distort equitable remuneration and dissemination.

The nature of these problems has led to suggestions to explore the application of a new technology that aimed to decentralize and disintermediate financial transactions —the blockchain (O'Dair et al., 2016; Rethink Music, 2015; Silver, 2016).

O'Dair et al. (2016) highlighted four areas where blockchain may contribute: support the creation of a shared music database, frictionless royalty payments, increased transparency and control for creators, and new monetization schemes. Yet the transformative force of the blockchain technology will not immediately benefit the music makers, as it is a multifaceted platform technology and therefore *how* it is implemented will impact the outcomes (De León & Gupta, 2017; Silver, 2016). In the next section a brief introduction on the characteristics of the blockchain technology and categorizations of implementation are given.

2.2 Introduction to Blockchain and Distributed Ledger Technology

As a primer to introducing DLT applications in the music field, a general overview of the characteristics of blockchain technology is presented in this section.

2.2.1 Definition of blockchain and Distributed Ledger Technologies

Blockchain has no generally agreed definition and is a generic term applied to a group of emerging technologies using distributed ledgers (Treiblmaier, 2020) that has a unique value proposition to use algorithms instead of institutions to facilitate trust for transactions (Labazova et al., 2019). The term blockchain comes from the block-based data structure of cryptographic hashes and nonces which form a chain of recorded

transactions, as described in the original whitepaper for Bitcoin written in 2008 (Nakamoto, 2008; Treiblmaier, 2020). In the various implementations that followed, not all exhibit a block or chain-like structure therefore the more broader term Distributed Ledger Technology (DLT) is suggested to be more appropriate (Treiblmaier, 2020), but in this paper the term blockchain and DLT will be used interchangeably reflecting the overlapping usages of the term in literature cited.

2.2.2 Bitcoin as the originating concept

The Bitcoin project as a proof of concept succeeded in creating an artificially scarce digital currency without the need of a central bank to control supply or clearing houses to validate transactions, by combining preexisting technologies public-private key cryptography and peer to peer technology, with a unique consensus mechanism called proof-of-work that incentivize networks to participate in maintaining versions of the ledger as well as disincentivize dishonest validations, creating an immutable and timestamped record of the state of transactions (De Filippi & Wright, 2018). The ledgers on the Bitcoin blockchain are hosted by any willing participant (thus the term distributed), public for read access and un-permissioned for write access, and are like a shared book that anyone can read and write on but can arrive at an agreement on which version is honest (De Filippi & Wright, 2018).

Bitcoin achieves this by making it prohibitively expensive to make false entries into the ledger, requiring a process called proof-or-work to add a new block, which includes a digest of the historic transactions, to the ledger (Hardle et al., 2020). Each block contains transaction information that is cryptographically hashed into a string of numbers and characters. Hashing algorithms are a one-way mathematical function that can take input data of an exponentially large size and transform it into a fingerprint of the original data into a fixed-length short output (Hardle et al., 2020; Tasca & Tessone, 2019). Blocks include the previous block's hash as a header, creating a chain of transactions, that is shared across all network participants. Adding a new block to the chain rewards the participant with a new bitcoin, but there is an adjusted difficulty programmed to allow the addition of a new block, requiring the participant (called *miners*) to guess a number (called a *nonce*) to be added to the previous record of transactions that will create a special new hash that begins with a set number of zeros (Hardle et al., 2020). Once the correct nonce is found and block is added, other participants can easily validate that the nonce is correct by hashing the known

transactions with the announced nonce, to replicate the special hash. If the transactions were tampered with, then the hash output would be completely different, and the other participants would not accept the new block as a valid chain. This makes it prohibitively expensive to change the history of the chain due to the computing power required.

Immutability, transparency, trustless cooperation and decentralization are features often touted in reference to blockchain technology in general, but are based on this originating concept, as the technology developed into varying forms that do not necessarily display such features, as outlined in the following sections.

2.2.3 Expansion of DLT capabilities through smart contracts

Although revolutionary, the functionality of Bitcoin was limited to the exchange of the specific digital currency supplied on the chain (called cryptocurrencies), and explorations to implement the mechanism to store other types of data and techniques to expand the functionality of blockchains emerged (De Filippi & Wright, 2018). One of these expansions was to implement the ability to store a small computer program code on the ledger and automatically execute them when conditions were met, called a smart contract, first implemented by the Ethereum blockchain in 2015 (De Filippi & Wright, 2018). The functionality allowed for the creation of various applications to be built on the blockchain called Decentralized Applications (DApps) that opened up the possibility for wider use cases (De Filippi & Wright, 2018; Swan, 2015).

2.2.4 Positioning of the blockchain technology within the internet

Blockchains and smart contracts are a type of application layer protocol that sit on top of the Transport Control Protocol (TCP) and Internet Protocol (IP), as such can be viewed in parallel to other application protocols for the internet such as HTTP and SMTP (see Figure 3). Much like the many online services that are currently built on HTTP, various online services can be built on top of blockchain based networks as DApps, but vary in the level of decentralization depending on the ways it interacts with the blockchain (De Filippi & Wright, 2018).

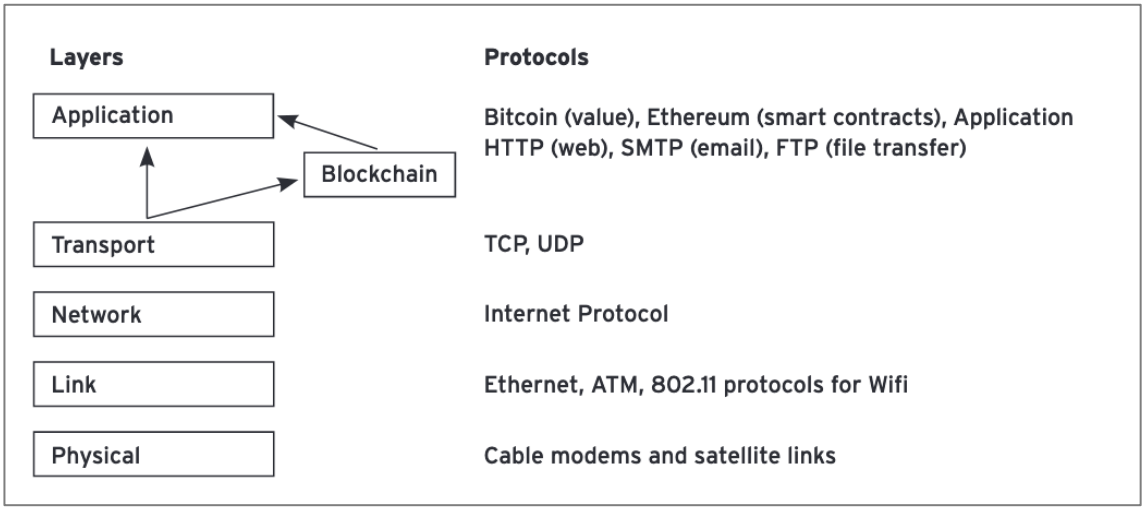

Figure 3: Blockchains within the TCP/IP layers (De Filippi and Wright, 2018, p. 49)

2.2.5 Decentralized Applications (DApps)

Decentralization is another term which lacks definition but is widely used without specificity in the discourses surrounding blockchain, and requires a responsible employment of the term (Schneider, 2019). It may refer to separate and independent axes of architectural, political, or logical spectrums of decentralization and centralization (Buterin, 2017, as cited in Schneider, 2019). One important aspect to note is that the use of decentralized technologies do not guarantee decentralized social outcomes, as history indicates that the decentralization of power in one area has consistently resulted in the recentralization in another (Schneider, 2019).

This being said, the basic architectures of DApps can be classified into three patterns displaying varying levels of architectural decentralization: Self-Generated Transactions, Self-Confirmed Transactions and Delegated Transactions —according to Wessling and Gruhn (2018), which roughly translate to a similar architecture classification proposed by Zheng et al. (2023) as Native Client as a DApp, Smart Contract as a DApp, and Web & Contract as a DApp. These classifications are organized in Table 2 (modification to split the types by Zheng et al. was amended by author). A definition of the architecture type along with pros and cons are listed in the table, which have a tradeoff relationship between user experience and security, as well as requirement of trust towards the DApp provider which introduces a point of centralized control.

DApp architecture classification by Wessling & Gruhn (2018)	DApp architecture classification by Zheng et al. (2023)	Definition, pros and cons
Self-Generated Transactions	Native Client as a DApp	Users interact directly with the blockchain or smart contract. Code needs to be published in order to use. Pro: Requires the least trust within the infrastructure as the transactions cannot be manipulated. Most secure. Con: Requires strong technical understanding for the user, therefore error prone.
	Smart Contract as a DApp	
Self-Confirmed Transactions	Web & Contract as a DApp (interaction with blockchain by user)	Users confirm a pre-written code presented by a DApp provider website. Pro: Secure and convenient. Con: Requires trust in the DApp website providing the transaction details. Without the published source code, the user will not know the full implication of the code execution.
Delegated Transactions	Web & Contract as a DApp (interaction delegated to DApp website backend)	Users interact with a website provided by a DApp provider Pro: Most convenient and user does not require a crypto-browser or wallet. Con: Requires the most trust in the DApp provider and causes a centralized problem.

Table 2: Architectural patterns of DApps
(table prepared by author based on Wessling & Gruhn, 2018; Zheng et al., 2023)

2.2.6 Amendments to deployment attributes and differing governance approaches

In addition to smart contract and DApp deployments, the functionality of blockchains have been customized in different ways with the purpose of allowing for scalability or adding layers of privacy and control, by amending different technological attributes of the protocol.

Amendments to deployment attributes of blockchains have been identified in areas of *read access* of the ledger (public or private), *validation/writing access* (un-permissioned or permissioned), *consensus mechanisms* (most common are Proof-of-Work (PoW), Proof-of-Stake (PoS), or Practical Byzantine Fault Tolerance (PBFT)) and *anonymity* levels (pseudonymous, identifiable, and in specific cases anonymous) (Labazova et al., 2021). These amendments affect the governance structure of DLTs allowing a blockchain to operate not only in a decentralized manner but also in a centralized manner or as a consortium of member institutions. Labazova et.al (2021) organizes governance approaches into three patterns. A decentralized approach allows public access and un-permissioned validation, but consensus mechanisms require resource intensive PoW or PoS, and confidentiality is not granted. A hybrid approach consists of vested members creating a consortium and allows for a less energy intensive but communication-heavy PBFT to be used for making consensus, with selective transparency. A centralized approach limits participation to private read access and permissioned validation, using resource-saving self-developed mechanisms for finding consensus. The three approaches are organized in Table 3.

Governance approach	Participation	Main consensus mechanism
Decentralized	Public and Un-permissioned	PoW or PoS
Hybrid	Private and Un-permissioned but identifiable trusted parties Public and Permissioned	PBFT
Centralized	Private and Permissioned	Self-developed mechanisms

Table 3: Governance approaches to DLT (table prepared by author based on Labazova et al., 2021)

2.2.7 Data exchange integrations between on/off-chain systems

Features to allow interactions with data stored off-chain were also introduced, which are key to the development of DApps as they allow systems outside of the blockchain to interact with on-chain data or smart contracts (Six et al., 2022). These include the use of designated external services called “oracles” that push the data of the outside world into smart contracts which would allow real world events to be programmed into the conditions triggering smart contracts (De Filippi & Wright, 2018). The data oracles provide may operate as black-boxes not fully revealing how the specific results are derived reducing the transparency of the operation (Labazova, 2019). Another form of

off-chain data integration is managed through storage of data on other locations on the internet, preferably using other peer to peer networks such as the Inter Planetary File System (IPFS) and referencing the link in the metadata stored on the chain (De Filippi & Wright, 2018; Ito & O'Dair, 2019). This would be relevant for use cases in music because data regarding music is rather large compared to what can be economically stored on the ledgers (Galphat et al., 2023; Tharun et al., 2023).

2.2.8 Cryptocurrencies as Native Assets

The cryptocurrency, which is the asset native to the blockchain, has also expanded to display various attributes and functions. In the Bitcoin project, a 'coin' (commonly denoted as BTC) is awarded to the validators of the network (as a 'block reward') which contribute to secure the integrity of the chain through PoW. This also acts as a way of introducing new supply of the native asset into the system (Tasca & Tessone, 2019). In PoS (or delegated proof-of-stake, which can mitigate the plutocratic tendency of the mechanism) coins are awarded to validators who lock in or 'stake' a set amount of coins as an incentive to be honest, and here the native asset is also integral to the consensus mechanism of maintaining the network. When a transaction on the network is made, users pay a transaction fee (in the Ethereum network this fee is called a 'gas fee') in order to request validators to include the transaction information on the ledger. These cryptocurrencies or 'coins' are valued and traded due to the computing costs (or opportunity costs in PoS) related to the activity of validation. On the other hand, in private and permissioned networks where validators are trusted and known entities who require no incentive to participate, native assets to incentivize honesty and participation is unnecessary and therefore do not require a cryptocurrency to operate (Tasca & Tessone, 2019).

2.2.9 Tokenized Assets and NFTs

Besides native assets or 'coins', other forms of digital assets can be recorded and transferred on the ledger. These assets called 'tokens' are independent from the validation and block creation rewards and are introduced to the system through 'Tokenization', an act of embedding ownership information onto the chain with the use of smart contracts (Tasca & Tessone, 2019). Tokenized assets or 'tokens' are arbitrary digital assets that are recorded on top of an existing blockchain network (Tasca & Tessone, 2019), which may serve various purposes within a value ecosystem created by

the issuer of the token, such as paying for a service or a utility provided in the DApp , as a representation of voting rights in the governance of the DApp, or for additional security in the implementation of the DApp (Willing, 2023). New tokens may be issued by anyone meaning that the value of a specific token is only good as its issuers promise to deliver a certain utility or promise to grant ownership of an asset that is meant to be represented in the token.

Cryptocurrencies as native assets are fungible [3], meaning each coin is perfectly equivalent to each other (Ferro et al., 2023), but in the case of tokens, depending on the code embedded in the smart contract, tokens can be created with fungible or non-fungible properties (Tasca & Tessone, 2019). On Ethereum, the most popular smart contract enabled blockchain, standardized smart contracts for the use of creating tokens have been developed as token standards, such as the ERC-20 standard for fungible tokens, ERC-721 for non-fungible tokens (NFTs), and ERC-1155 that supports bundled NFT creation that may serve as editions of unique tokens or used as a utility token (ethereum.org, n.d.; Ferro et al., 2023).

Fungible tokens resemble securitization of shares in a company or points that can be redeemed for a service, whereas NFTs act as a way to translate properties of scarceness and uniqueness into the digital domain (Ferro et al., 2023). This attribute of scarceness and uniqueness lead to ideation for NFTs to represent a digital versioning for various goods, but in practical implementation, NFTs can only record metadata that *represent and point to* a reference somewhere on the internet that may contain a digital file or further details about the asset in question. Furthermore, because anyone can create an NFT, the issuer may not have control over ownership of the goods to begin with. Therefore, the usage of an NFT as a proof of ownership of the good it represents is incomplete without trust in the issuer and the accompaniment of a traditional legal contractual agreement, as well as a tamper proof method to store any related digital files outside of the chain (Ferro et al., 2023).

[3] Although coins are fungible by default, through the use of add-ons such as the Colored Coin protocol, the possibility to create a Bitcoin that is distinguishable from the rest making them non fungible have been introduced (Tasca & Tessone, 2019).

2.2.10 Taxonomy development for blockchain applications

Due to the aforenoted modifications to the original concept that birthed the term blockchain, there exist a multitude of implementation forms, and a need arises to be precise in defining how the technology is being implemented in individual use cases. Efforts to categorize the application variants for blockchain have been made by multiple researchers.

Swartz (2017) differentiates applications into 'radical' and 'incorporative' implementations, the former type of implementation attempting to replace existing intermediaries and the latter used by existing intermediaries to improve processes, noting that this differentiation exists on a spectrum. Elsden at al. (2018) classifies application areas into a typology consisting of seven overarching classes that display a resemblance in domains and features. A systematic literature review by Six, Herbaut and Salinesi (2022) extracted a total 15 categories of design patterns combined composing 120 unique application patterns of implementation, and three DApp architecture patterns (as previously introduced in section 2.2.5).

Labazova et al. (2019) develops a taxonomy for blockchain applications that defines six areas of application, 25 use cases, each use case defined with technical characteristics under eight dimensions. The eight dimensions consist of four deployment attributes read access, write access, consensus mechanism, anonymity level, and four additional properties consisting of customizability through smart contracts, data exchange type, encryption, and history retention. In later research by Labazova et al. (2021), an additional dimension asset/token type is also considered, as well as a few modifications and consolidations in use case types which are reduced from 25 to 14 use cases. This taxonomy by Labazova et al. (2019) and Labazova et al. (2021) was deemed the most developed of the various categorizations reviewed because it defines the combination of characteristics used for each use case, and useful in the sense that the taxonomy excludes combinations of characteristics that are ineffective or unsuitable, creating a manageable list of use case types with defined attributes and properties. These use cases, as organized in Table 4, was chosen to be used in the analysis of this paper throughout section 4 Analysis of Identified Use Case Types, in order to identify the actual implementation methods in the typical DLT use cases for recorded music.

Application Area		Use case	Blockchain Governance	Read Access		Write Access		Consensus Mechanism			Anonymmity level			event handling	data exchange	encryption	history retention
				Private	Public	Permissioned	Un-permissioned	PoW / PoS	PBFT	self developed	Anonymous	Pseudonymous	Identifiable				
Financial Transactions	1	**Anonymous cryptocurrencies**	decentralized		x		x	x			x			none	transaction logs	totally encrypted	whole
	2	**Cryptocurrencies, Wealth Storage, Micropayments**	decentralized		x		x	x				x				unencrypted	
	3	**Interorganizational cross-border and micro-financial transactions**	hybrid	x			x		x				x			partially encrypted	
	4	**Centrally issued financial instruments**	centralized	x		x				x			x				
Enforcement / Smart contracts	5	**Enforcements between individuals**	decentralized		x		x	x				x		custom		unencrypted	
	6	**Interorganizational Enforcements**	hybrid	x			x		x				x			partially encrypted	
	7	**Centrally issued enforcements**	centralized	x		x				x			x				
Asset Management / Data Management	8	**Authentication and ownership, audit trails, access management**	decentralized		x		x	x				x		built in event		unencrypted	
	9	**Interorganizational asset management**	hybrid	x			x		x				x			partially encrypted	
	10	**Enterprise asset management**	centralized	x		x				x			x				
Storage	11	**Decentralized storage**	decentralized		x		x	x				x			content	totally encrypted	
Communication	12	**Messaging**	decentralized		x		x	x				x				unencrypted	recent
	13	**IoT communication**	decentralized		x		x	x				x					
Ranking	14	**Reputation & rating**	decentralized		x		x	x				x			transaction logs		

Table 4: Taxonomy of blockchain applications (table prepared by author based on Labazova et. al 2019, and Labazova et. al 2021)

2.3 DLT applications in the field of music

DLT applications for music has been researched from the side of the music industry experts, as well as from the position of legal and computer science researchers. This section begins by firstly outlining the suggested use cases for DLT in the field of music that are ideated to improve the current system. Second, critical considerations and limitations that have been pointed out from legal, technical and sociocultural perspectives are introduced. Third, a short list of recent studies for technical implementations is introduced to gain an overview of state of the actual developments. Finally, efforts to categorize and make sense of DLT application developments in the field of music requires attention, as this will allow for critical evaluation and discussions to follow for further policy debates surrounding the adoption and regulation of this emerging field. The research from existing literature shows a trench in between ideation and actual technical implementations and reveals a lack of a framework to critically evaluate the various types of implementations.

2.3.1 Ideations and potential for DLT application in the field of music

Already around 2015 briefly after the concept of smart contracts were introduced and the smart contract enabled Ethereum blockchain was deployed, many authors began to ideate use cases for blockchain to transform the digital music landscape. An advocacy brief by Rethink Music (2015), an initiative of the Berklee Institute for Creative Entrepreneurship, argued that the current industry critically lacks transparency and there is a need to promote fairness, and therefore encouraged (along with other recommendations for the industry and policy makers) the investigation of blockchains and cryptocurrencies to be used as the new royalty distribution mechanism in the music industry. In another report around the same time, four main areas of use were proposed, to assist the creation of a shared music database, to allow frictionless royalty payments, increase transparency and control for creators, and to create new ways to access capital (O'Dair et al., 2016).

Intellectual property management through the use of DLT has garnered much attention, due to the ability to create immutable time-stamped records to prove the existence of a creative work, smart contract usages for access control and automated payments, or through tokenization of intellectual property allowing representation of rights and the transfers of rights (Bodó et al., 2018; De Filippi et al., 2016; Ferro et al., 2023). Corrado

(2019) analyzes the current legal structure which makes the practice of sampling inaccessible for most musicians, suggesting an industry wide licensing system and the utilization of DLT to lower transaction costs of usage tracking and royalty payments.

New monetization models that do not rely on the copyright regime have also been envisioned. Usage of micropayments to allow tipping, or rewards paid to promotional activities by fans are observed (De León & Gupta, 2017)

Among various applications of DLT in the wider multimedia management field, the music field was found to be the most prominent user of blockchains (Shrestha et al., 2020), and there is a high volume of investment and research activity geared towards DLT applications in music, perhaps due to the music sector's 'unique positioning in culture and economy' that allows the sector to be an attractive ground for experimentation for blockchains, as a 'low risk and high profile partner' that can 'increase commercial, public, and regulatory acceptance' (Silver, 2016, p. 60).

2.3.2 Critical insights and identified problems

While much potential for benefits were being touted, various obstacles were also identified, technologically, legally, and over concerns in sociocultural dimensions, and experts from these domains weighed in, signifying the interdisciplinary efforts required to achieve a working model that would live up to the claims of an improved fair and transparent system.

Technologically, scalability is considered an issue because of the mass amount of data that needs to be handled to create a database or mediate usage tracking and royalty payouts, due to the fact that there is a vast amount of music in the world with an estimated 35 million songs in iTunes as of 2013, and a daily billion streams on Spotify as of 2015, it is questioned whether blockchain systems can scale to this extent and accommodate mass adoption (Baym et al., 2019; Wishnia, 2019).

The distributed ledgers are designed to record only minimum metadata and limited lines of code, meaning that the music files themselves will be stored elsewhere on the network such as on the IPFS (Ito & O'Dair, 2019), and although tokens may be used to authorize access, unless there are measures to prevent these music files to circulate outside of the boundaries of the DLT infrastructure, DRM will be ultimately ineffective (Bodó et al., 2018; Ito & O'Dair, 2019; O'Dwyer, 2017).

Integrity of the data that is fed into the system is another issue, because there is no way to guarantee the authenticity of information that is not native to the blockchain, a reliance on a trusted third party arises (De León & Gupta, 2017; Ito & O'Dair, 2019; Wishnia, 2019). For example, illegitimate claims of ownership can be recorded, and while works can be registered and timestamped, anteriority does not guarantee provenance (Ito & O'Dair, 2019). A crowd sourced reputation system to validate authenticity could theoretically be envisioned, but experts remain skeptical as it is difficult to imagine a crowd sourced system to replace the intensive review and reporting processes that the collection societies conduct as due diligence (Silver, 2016). Even when the initial registration is legitimate, copyrights exist outside of the blockchain in the current system and therefore could be transferred without being recorded on the ledger breaking the chain of provenance (Ito & O'Dair, 2019; O'Dair, 2019).

Legal considerations of smart contracts and its ability to handle the complex clauses seen in traditional contracts have also been pointed out. De Filippi and Wright warn that while transactions via smart contracts may be considered legally valid allowing parties to enter into commercially binding relationships (as far as in regions where no formalities exist for contract formation and the sole 'intent' of parties to be contractually bound suffice), smart contracts itself are not contracts in a legal sense, but rather bypasses and eliminates the need of a judicial system by automating the execution of performance obligations via code. Therefore, contractual clauses which are not binary and open-ended such as to 'act in good faith' cannot be modeled into a code based and computable format (De Filippi & Wright, 2018, p. 77). Hybrid forms of combining a traditional contract in natural language with smart contracts, called smart legal contracts, will be required to handle complex nature of legal contracts for music licensing (Adjovu & Fabian, 2020; Bodó et al., 2018; Ferro et al., 2023).

Some open questions concerning the legal status of blockchain based interactions arise from the pseudonymity of users, which lead to a problem in case of breach of contract and remedy, and how to resolve jurisdictional conflicts (Bodó et al., 2018). Pseudonymous users and the decentralized nature of DLT based systems will make pirating activities difficult to halt, or pin liability to infringing users (De Filippi & Wright, 2018, p. 124; De León & Gupta, 2017).

Silver (2016) documents the developments in the excitement and hype around the application of blockchain for the music industry, and identifies three areas of potential benefits which are: to create an architecture for rights data and licensing exchange, lowering transaction costs to create a viable business model for the longtail, and to improve efficiencies in the current leading intermediaries. While the technology theoretically exhibits potentials, Silver takes a sobering look to caution that an immediate democratizing effect will not occur by applying the technology, because of the various ways blockchain is implemented, and due to the difficulty in translating a technology that was effective in disintermediating the financial industry and applying them to the music industry, which have a trove of structural and cultural differences between them. To elaborate, the context of data in music is not as binary as that of the financial industry, and the music industry is affected by values such as cultural integrity which need to be modeled to gain acceptance, besides simple monetary incentives (Silver, 2016).

Other literature support this conservative approach with managed expectations rather than envisioning a radical revolution through the obsoletion of intermediaries, but at the same time, owes credit to blockchain as a ‘convening force’ that engaged discussions of transformation throughout the value chain (Baym et al., 2019).

2.3.3 Recent studies towards technical implementation

Presented in this section is an overview on some of the recent studies found that involve implementation proposals for DLT applications in recorded music. A systematic review is not in the scope of this work, and only a limited portion of the body of research is introduced, intended to gain a basic understanding of the state of actual developments regarding technical implementation. A short description of the proposal as described in the study and some limitations that were acknowledged by the study or observed by the author (denoted as author observation) are organized in Table 5.

Title (author, year)	Short description of implementation proposal
	Limitations of the implementation proposal
Blockchain-mediated Licensing: Legal Engineering for Artist Empowerment (Adjovu & Fabian, 2020)	Development of the Practical Tokenized Drafting method, a combination of legal engineering and automated transactions in order to create a Tokenized Music License for musical works in the form of an NFT using the Ethereum network and Open Law protocol.
	The tokenized contract is limited to handle all copyrights of a work as a bundle, may be prone to jurisdiction shopping by the licensor, payments are limited to ETH (native asset of the Ethereum blockchain called Ether) , and usage is limited to specific circumstances.
Research on Decentralized Music Sharing Model Based on Consortium Blockchain (Gao & Zhang, 2019)	Proposal of a decentralized music sharing model based on blockchain technology and IPFS, using smart contracts to obtain the decryption key to access the music file.
	(author observation) There are no means considered in the proposal to prevent illegal uploads of music files.
Fair rewarding mechanism in music industry using smart contracts on public-permissionless blockchain (Halgamuge & Guruge, 2021)	A decentralized music file-sharing platform based on a public permission-less blockchain, where uploaders are rewarded when a file is downloaded, with implementation of a penalty scheme for adding illegal music files.
	(author observation) The upload of a new music file requires a consensus and approval from the network members. What constitutes an illegal upload and how this is detected is not defined. The application requires payments to be made in cryptocurrencies as rewards to the network and to the musicians, this cost is unclear and may face issues with adoption.
Blockchain-Based Music Wallet for Copyright Protection in Audio Files (GürfiDan & Ersoy, 2021)	A blockchain-based music wallet application and database that stores metadata and encrypted versions of the sound file. To restrict access to unauthorized listeners, users obtain encryption keys for sound files that allow playback which are dynamically generated from the blockchain.
	The payment process to charge for plays and pay royalties are not considered in this study and is to be integrated in future research.

Table 5: Recent studies towards DLT implementation for recorded music (table continues to next page)

Title (author, year)	Short description of implementation proposal
	Limitations of the implementation proposal
Towards an Open and Scalable Music Metadata Layer (Hardjono et al., 2019)	Explores the development of an open access music 'creation metadata' layer separate from rights and ownership information, that includes factual information such as creator credits, song identifier codes, cryptographic hash of the sound recording files.
	Two additional layers (licensing and royalties management layer and music assets layer representing music as digital tokens) will need to be developed in order to allow new services to be built based on this registry. The industry needs to adopt common operational and technological standards to ensure interoperability.
Blockchain-based digital rights management systems: Design principles for the music industry (Ciriello et al., 2023)	Identifies the design requirements of a blockchain enabled DRM system for music. The solution can be achieved by storing rights metadata on a public distributed ledger, by validating metadata through a consensus mechanism on a permissioned blockchain, and by algorithmically enforcing royalty payout via stable coin through a smart contract.
	The design principles are high level principles and has high projectability, requiring technical solutions from multiple domains.
Consortium Blockchain Smart Contracts for Musical Rights Governance in a Collective Management Organizations (CMOs) Use Case (Kapsoulis et al., 2020)	A permissioned blockchain application for governance and management of musical rights endorsed by smart contract development. Intended for use by collection societies' staff to detect and resolve conflicting asset claims. Uses internal tokens to incentivize users to make careful input as each update requires a transaction fee.
	Only suitable for storing relatively small amounts of data (music metadata) and not suitable for multimedia storage. Even with the limited metadata, recording a batch of 10,000 claims (which is a normal amount in the music industry) took 10 hours to process.

(continued. Table 5: Recent studies towards DLT implementation for recorded music)

2.3.4 Framework for evaluation of DLT applications in the music industry

The claim that blockchain is a multifaceted platform technology (De León & Gupta, 2017) holds true, and many areas of application and implementation measures are observed in the field of recorded music alone. A simple claim that DLT might be able to disintermediate and improve the recorded music industry, can neither be supported or disputed because it requires a more detailed specification.

A systematic literature review for impact of blockchains on intellectual property management (including wider multimedia, patents and trademarks) presents benefits and challenges under a PESTLE analysis framework (Bonnet & Teuteberg, 2023). Through this analysis the authors identified the dual nature of DLT, where the same benefits identified were also mentioned as a challenge. For example, the issue of security was ranked highly as a benefit and a challenge at the same time, presenting a dichotomy.

A framework to categorize the DLT application use cases specific to the music industry could be useful for further evaluation and avoid this dichotomy.

First of all, Torbensen and Ciriello identified that a use case would fall under the categorization of whether the use case attempts to disrupt the music industry by creating a new musician-centered supply chain, or intends to incrementally improve processes within the current structure (Adjovu & Fabian, 2020; Torbensen & Ciriello, 2019).

Shrestha, Halgamuge and Treiblmaier (2020) systematically investigated and classified 30 blockchain platforms for multimedia management, revealing the distribution of fields, chain, consensus mechanism, monetization capability, reward systems and smart contract usage. The study does not focus on the field of music specifically, and the music industry use is bundled into one single category.

A use case typology for media copyright management is proposed by García et al. (2023), consisting of four general use cases that the authors claim to accommodate all scenarios. The four use cases proposed are: Copyright Management; Digital Content Scarcity; Marketing, Fan Engagement and Fundraising; and Disintermediated Distribution. The first use case, Copyright Management considers use cases in the various stages of the copyright life cycle from inception to usage tracking. Digital Content Scarcity includes consumer to consumer sales, fraud and piracy prevention, and new ways to create revenue for artists. Marketing, Fan Engagement and Fundraising use cases improve the communication between creators and consumers, by providing new opportunities for consumers such as proving loyalty or acting as a curator or investor. Lastly, the Disintermediated Distribution use case category refers to alternative distribution channels such as music streaming platforms and Decentralized Autonomous Organizations (DAOs) that replace labels and publishers. Although the authors evaluate the proposed use cases' ability to accommodate all scenarios of use cases, there is some overlap seen between the use cases. For example, Disintermediated Distribution use

cases include usage tracking and copyright management which fall under Copyright Management, or may enable tipping functions that the authors categorize under Fan Engagement. Another critique is that the proposed use case categorization is not specific to the DLT functions employed, and use cases might rely on different aspects of the technology.

Other efforts to categorize use cases in music could not be found at the time of the research, and the review of current literature revealed that a framework to categorize and evaluate use cases in music that reflect the current implementation variations was missing.

3 Methodology

In order to answer the research question how DLT is being implemented for applications in recorded music, and whether these implementations lead to an improvement in fairness and transparency, this study uses a mixed method multi-case case study that involves qualitative analysis as well as empirical observations. The research design employed in this paper follows the 'Gaps and holes' case study type as categorized by Ridder (2017), which is useful when the focus of the study is to further develop and test existing theories through pattern-matching and analytic generalization using purposive sampling and primarily qualitative data (Ridder, 2017; Treiblmaier, 2020).

Many of the projects introduced as case studies in the literature were defunct or inactive as of the time of this research, or prematurely developed and the cases lacked documentation as is expected with research in emerging fields, which invites room for speculation and weak argumentation. Isolated cases make for a hurdle in evaluating the consequences of implementing DLT, therefore this study aims to create a typology of use cases in the field of recorded music from observation of a body of samples, which present similarities in purpose and function where DLT is utilized. The identified types of use cases can then be compared and matched with the taxonomy for wider DLT applications developed by Labazova et al. (2019) and Labazova et al. (2021) shown in section 2.2.10, that reveals how DLT is implemented regarding the various deployment attributes. Depending on the attributes, there may or may not be a decentralizing effect, or improvements in transparency. The typology also allows each type to be empirically compared with the existing system or traditional intermediaries that it intends to replace or improve, and evaluate whether there is an increased value proposal regarding fairness and transparency.

The projects were collected through purposive sampling, selecting currently active projects that use DLT as a driver and operate in the area of recorded music.

The initial sample comprise of data collected from a list of 60 companies using blockchain in the music industry which were operative as of 2019 from an academic source by Chalmers, Matthews and Hyslop (2021), adding 94 companies listed on the webpage "List of 'Music' companies" on the indexing service Blockdata operated by a

tech consulting firm (CBINSIGHTS B.V., n.d.), and further amended with 8 more projects snowballed from related literature and searches while evaluating the initial list.

Each project or company was then screened to determine whether they fit the inclusion criteria for further analysis, by investigation using information on the official websites and public communication channels such as official social media accounts. Non active projects and projects that lacked documentation, as well as projects that were not related to recorded music, and projects that do not use DLT were excluded. Furthermore, companies that do not act as intermediaries, such as consulting services and self-contained issuer and sellers of NFTs that are not artist facing (NFT collections) were excluded because they do not directly contribute to the improvement of the system. The specific criteria used for exclusion is compiled in Table 6.

Reason for exclusion	Criteria
Inactivity	Official website can no longer be accessed, and a search did not lead to any relocated websites or renamed project. Alternatively, website is online but there are no new announcements regarding the project status since more than one year (as of October 2023) throughout official public communication channels.
Lack of documentation	Offering is vague and unclear, only speculated implementation plans, or underdeveloped proposals with low quality whitepapers.
Irrelevancy	Projects that do not include an offering for recorded music and are aimed for a different field. Examples are projects for live music and ticketing, games, video and visual art.
Not using DLT	There are no mentions of application of DLT in official channels or the company has explicitly stated that they have ceased to use DLT solutions.
Not intermediating	Does not offer intermediating services. Examples are consulting firms, NFT collections, listing services for other projects and other supportive services such as website builder, white label NFT creation tools, and developer tools.

Table 6: Criteria for sample exclusion

The screening process of collected samples resulted in a total of 34 individual use cases to be included in the further analysis to develop a use case typology. The complete list of analyzed cases is given in the Annex at the end of this paper, under List of analyzed cases. The sample collection and screening procedure is illustrated in Figure 4.

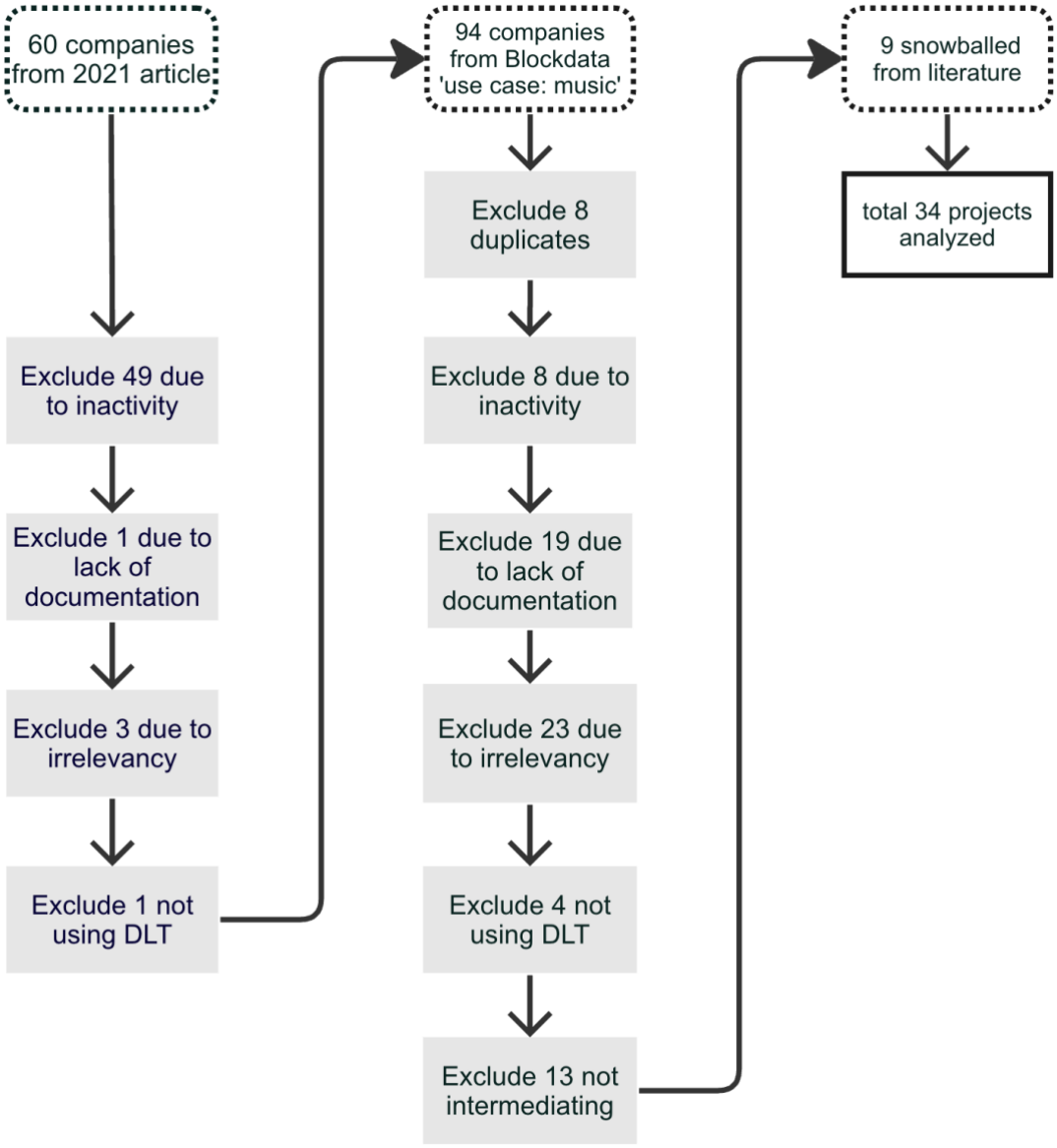

Figure 4: Sample collection and screening procedure

The remaining 34 samples were further investigated to determine what these projects aim to achieve and how DLT is utilized in order to create a typology. Figure 5 illustrates the procedure for developing the typology of use cases and analysis of use case types. The main offering and functions of DLT used for each use case was identified from information from the project website, documentation such as FAQs and user guides, press releases, white papers if available, and terms of services. The use cases were then grouped together to form resemblances in the purpose and function of DLT applied, creating a typology of use cases for DLT applications in recorded music. Next, the types of use cases identified were matched with the taxonomy developed by Labazova et al. (2019, 2021) as organized in section 2.2.10 to identify DLT attributes which will give insight into how DLT is implemented. Finally, each use case type is compared with corresponding existing services and intermediaries' offerings regarding payments and fees, licensing terms, and other benefits and risks.

The creation of this typology allows a generalization of *how* DLT is implemented in each type of use regarding the various attributes, as well as a comparison of the use case types to the current industry system that do not rely on DLT. Based on the findings, the discussion can be made, whether DLT application in recorded music leads to an improvement regarding fair and transparent outcomes as claimed or intended.

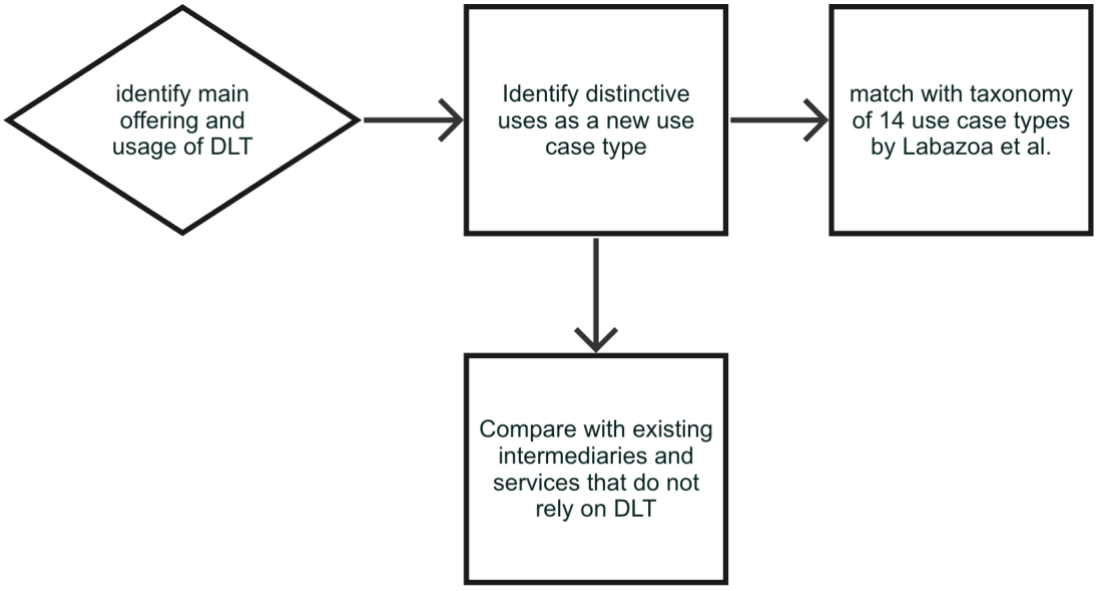

Figure 5: Process for typology development and analysis of identified use case types

4 Analysis of Identified Use Case Types

The development of a typology outlined in the method section resulted in eight overarching use case types of DLT applications for recorded music. This section will present an overview of the identified use case types followed by results of the analysis regarding each type.

4.1 Overview of use case types

The eight identified use case types are: 1. rights registry, 2. rights database, 3. free music player, 4. music player with enforced payments, 5. collectibles, 6. music securitization, 7. licensing, and finally 8. hybrids and other which are projects that combine two or more of the other use case types. Figure 6 depicts the distribution of the projects identified under each use case type.

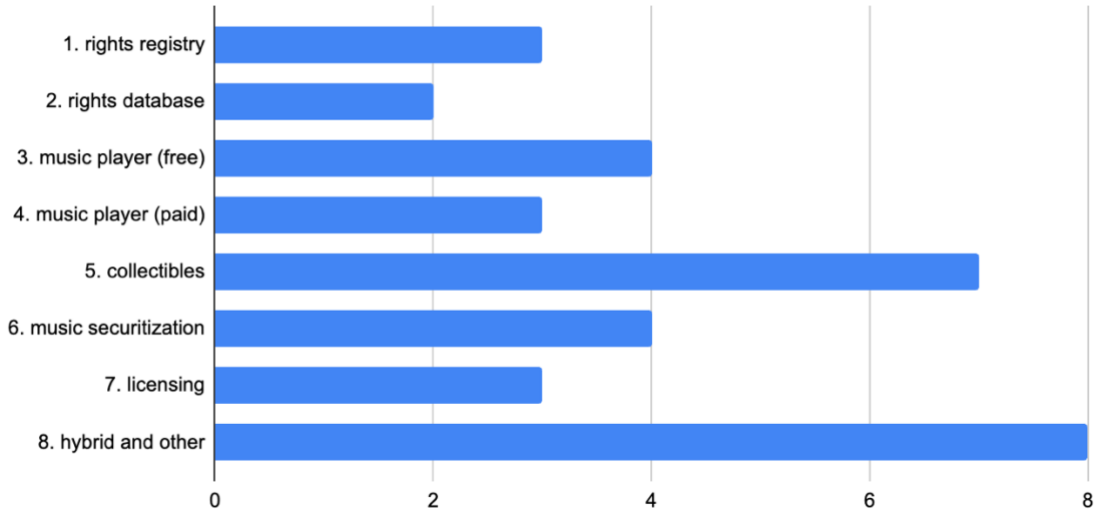

Figure 6: Distribution of analyzed use case types (n=34)

The use case types for DLT applications for recorded music can be observed across the value chain, from the registration of the work immediately after creation, after which due diligence is conducted and rights are recorded on a database, to distribution, consumption, monetization via tipping, paid streams or as sales of a digital collectible, and transfer of certain rights via securitization of royalty from streams or licensing for commercial usage. A brief description of the use case types is organized in Table 7.

Use case type	DLT function used (corresponding DLT use case taxonomy in **bold**)	Example of comparable existing service / intermediary intended to replace
1. rights registry	Hashing and time stamping on a distributed ledger (**audit trails**)	Private copyright registry services (or poor man's copyright, the act of sending oneself works via registered mail to prove existence as preemptive to legal disputes)
2. rights database	Creation of a consortium to create a shared database with customizable transparency among members (either **interorganizational or enterprise asset management**)	A transnational collection society (hypothetical), Global Repertoire Database (failed)
3. music player (free)	**Decentralized storage** with tipping enabled via **cryptocurrency micropayments**	Soundcloud and other platforms that allow music uploads of original tracks, mainly used by musicians as a promotional channel
4. music player (paid)	**Centrally issued enforcement** of **micropayments**	Streaming service (such as Spotify) + label or digital aggregator (companies that are designated to distribute music to services and handle royalty payouts for independent labels and artists)
5. collectibles	NFTs (**authentication and ownership, access management**) that may allow gated access to contents such as a downloadable track, or other benefits promised by the issuer	New monetization scheme, but comparable to various merchandise like T-shirts or collectability of vinyl records. Some NFTs allow access control to gated content such as track downloads.
6. music securitization	NFTs (**authentication and ownership**) with the aid of off-chain legal contract and payment mediation of royalties	Royalty Exchange, a platform that mediates sales of music royalty claims. Payment of advances (lump sum that is recouped from sales) paid out by record labels to artists.
7. licensing	NFTs (**authentication and ownership**) with the aid of legal contract	Music licensing agencies
8. hybrid and other	Combines various functions of the above to achieve an ecosystem.	Entire value chain from music labels, streaming services and collection societies

Table 7: Overview of use case types in DLT applications for recorded music

The following Table 8 shows the use case types for recorded music matched with the taxonomy of general DLT use cases developed by Labazova et al. (2019) and Labazova et al. (2021). Use cases for music in some use case types rely on multiple use cases of DLT to be combined in order to function.

Application Area		Use case	Blockchain Governance	1. rights registry	2. rights database	3. music player (free)	4. music player (paid)	5. collectibles	6. music securitization	7. licensing	8. hybrid and other
Financial Transactions	1	**Anonymous cryptocurrencies**	decentralized								
	2	**Cryptocurrencies, Wealth Storage, Micropayments**	decentralized			x	x				x
	3	**Interorganizational cross-border and micro-financial transactions**	hybrid								
	4	**Centrally issued financial instruments**	centralized								
Enforcement / Smart contracts	5	**Enforcements between individuals**	decentralized								
	6	**Interorganizational Enforcements**	hybrid								
	7	**Centrally issued enforcements**	centralized				x				x
Asset Management / Data Management	8	**Authentication and ownership, audit trails, access management**	decentralized	x				x	x	x	x
	9	**Interorganizational asset management**	hybrid		x						x
	10	**Enterprise asset management**	centralized		x						x
Storage	11	**Decentralized storage**	decentralized			x	(x)				x
Communication	12	**Messaging**	decentralized								
	13	**IoT communication**	decentralized								
Ranking	14	**Reputation & rating**	decentralized								

Table 8: Use cases taxonomy and use case types for recorded music

4.2 Analysis of use case types

In the following sections, analysis results of each use case type are documented. The analysis begins with an explanation on what the use case type entails. Next, typical features and functions of DLT used in the use case type is given, and where this use case type fits in to the existing taxonomy of general DLT applications. Governance structure, off-chain data exchange integrations, architecture pattern of the DApps, are discussed where possible, as these are factors that may affect the transparency of the operations. Information on reward mechanisms and incentive structures, typical payments and fees, licensing terms are contrasted to comparable existing non-DLT services where possible, as these factors have implications for fairness.

4.2.1 Rights registry

A rights registry is an artist-facing offering that allows creators to register copies of works and issue a time-stamped certificate, which can be used to prove the existence of a creative work at the registered time, intended to be used as proof in legal litigation concerning plagiarism and copyright violations. The registration does not automatically protect the work but functions as a preemptive measure in case disputes arise. Works can be registered prior to publication, and registration of unfinished works and different versions is recommended, as it offers further proof of involvement of an author in the creation process.

Three cases, Soundreef, Kendrix (by JASRAC), and Musicstart (by SACEM) were categorized under this use case type. Coincidentally all three cases were operated by collection societies, but all explicitly stated that registration is not integrated with royalty collection nor active protection of the works.

The details of implementation for each case are organized in Table 9. All three cases rely on a hashing algorithm to create an audio fingerprint from audio files and associated metadata, and records this information onto a blockchain allowing a timestamped record of the existence of a piece of music. In all three cases, the user must create a user account on the services and login to upload files and enter metadata. The interaction with the blockchain is delegated to the website backend and the user does not use a crypto wallet.

Project or company name	Implementation details	Fees
Kendrix (by JASRAC, collection society of Japan)	Details are undisclosed, but mentions that the title, version, author and music file hash is recorded and timestamped on an undisclosed blockchain. Requires login. A certificate is issued as a public URL that can be shared.	Free with user registration (up to 50GB per user, free registration). Registration to the Kendrix service does not entail membership to JASRAC, but users can sign up to JASRAC from the Kendrix account.
Musicstart (by SACEM, collection society of France)	Music files and other documentation files such as TXT, PDF, JPG can be uploaded to create a hash. Hashing via Secure Hash Algorithm (SHA)-256 recoded on the Tezos blockchain. Requires login. A certificate containing the hash is issued and can be downloaded.	Free for SACEM members For non-members, €3.99 per file or €4.99 per month for unlimited registration
Soundreef (Italian collection society)	Hashing via SHA-256, on the Bitcoin blockchain. Requires login. Registration certificate is sent via email. Possible to independently verify the certificate via third parties (such as Opentimestamps) by reconstructing the hash.	Free for Soundreef members

Table 9: Cases identified as use case type 1. Rights registry

The use case type rights registry falls under the use case ‘audit trail’ of general blockchain taxonomy, and according to Labazova et al. (2019, 2021). This use case requires the use of a public and un-permissioned blockchain, because the information should be available for confirmation by the wider public. Musicstart uses Tezos (public un-permissioned PoS blockchain), and Soundreef uses Bitcoin (public un-permissioned PoW blockchain). As for Kendrix, there is no way to verify the information on the blockchain as it is a private undisclosed chain, the hashing function is unknown, thus ultimately relies on the trust that JASRAC creates and the URL domain name of the certificate.

The use case type rights registry is comparable to private copyright registration services or the so called 'poor man's copyright,' an act of sending oneself works by registered mail and leaving the package unopened. Private registry services have existed pre-dating blockchains, and relies on the same audio fingerprinting and time-stamping techniques recorded by other means (Ricolfi et al., 2011). Private copyright registries offer a cheaper alternative to the public registries (for example the US copyright office charges $45 and upwards per work, a private alternative Songrite charges $30 per work), but cannot provide trust and procedural advantages that the official registration provides, thus considered unnecessary by many, especially because copyright comes into existence without any formalities, but these services are widely seen nevertheless perhaps due to low barriers to entry (Ricolfi et al., 2011).

Because of this inherent weakness of private registries in general, it is understandable that this use case type was solely offered by collection societies that have a relatively high level of institutional trust to begin with. Combined with the institutional trust that collection societies hold, a private registry may serve as a proof of anteriority of a work. SACEM has provided their members a way to register unpublished works before implementing a DLT based solution and is not a new offering, stating that the Musicstart service will replace this function. Therefore, there may not be much increased benefits seen for artists besides the fact that these services are now offered at a lower price for non-members. One benefit that a DLT solution does offer, is that even when the entity providing the service ceases to exist, as long as the public blockchain is used and maintained, past registrations can continue to be verified. The same cannot be said for the Kendrix service, and there are no merits to their offering.

4.2.2 Rights database

A rights database is a database of published works used to locate the rights holders of a creative work, in order to negotiate licensing for use, or to pay rightsholders for usage under a mandatory licensing scheme. A public and consolidated rights database as envisioned by the Global Repertoire Database (GRD) and other initiatives have all failed due to conflicting interests of the intermediaries that hold this data, as seen in section 2.1.3. In contrast to a rights registry, a database does not include unfinished works, and only published works with complete information on the work and rights holders such as royalty splits, co-creator credits, song and sound recording identifier codes, controlling publisher and labels need to be included, thus requires a process of

due diligence. This kind of database is held at various collection societies, major labels and publishers, as well as major users of licenses such as DSPs, but a complete version does not exist, and there are inconsistencies in content and format.

Two companies, Blokur and Verifi Media were identified, that attempt to create a data alliance of industry wide intermediaries to improve the database using blockchain technology (details shown in Table 10). These offerings are B2B services with clients limited to specific industry partners, therefore implementation details are not disclosed to the wider public, but information from press releases and news articles provides some hints to what elements of DLT the companies utilize. Verifi Media has been known to use Hyperledger Sawtooth, an enterprise solution for building, deploying, and running distributed ledgers. It was unclear whether Blokur continues to utilize blockchains for data reconciliation, but in a past project, the company offered a solution using the Ethereum blockchain to track and payout royalties for music sampling.

Project or company name	Implementation details
Blokur	Offers music rights reconciliation, matching and cleaning of data from multiple rights holders and license users. In the Fantom app project of musical artist Massive Attack, sample usage tracking and payout was supported by the company. “Blokur devised a system that assigns a signature to a track’s stems – the individual channels such as vocal or bassline – tagging every sample and recording it on the blockchain […] (leaving) a copy of the fingerprint, along with the names of the rights holders from the performer to the songwriter, the publishing company and the record label, on the Ethereum blockchain.” (Armstrong, 2019)
Verifi Media (formerly Dot Blockchain Media)	Offers multi-party rights management services, data reconciliation and matching. Utilizes a combination of various technology to reconcile data. Blockchain is used to subscribe to changes and immutably track updates. Initiated a data alliance between major music company Warner Music Group, Spanish rights management entity (collection society) Unison, DSP Deezer, and music distributor FUGA.

Table 10: Cases identified as use case type 2. Rights database

The use case type was matched with use case taxonomy asset management, more specifically enterprise asset management or interorganizational asset management which are governed by a hybrid or centralized structure, that allows for selective transparency and control of participants administration capacities. It is difficult to

confirm this as the implementation details are undisclosed, but Labazova et al. (2019, 2021) lists Hyperledger blockchain (used by Verifi Media) under enterprise asset management.

As for comparable non-DLT solutions, the most comprehensive music rights database, at least for the US, might be the database constructed by the MLC because of the legislation (Music Modernization Act of 2018) that mandated the creation of this collection society, requiring the MLC to create a public bulk-and-machine-readable database (limited to musical works). Other than this, coalitions of various publishers and collection societies can be seen but none have been able to establish a dominant position, because competing rights holder organizations fear that the creation of a comprehensive database may make their own operations obsolete (Nordgård, 2018). Litigation may be the most impactful way to coerce the industry to share data, but would be limited to a national territory. Seeing that transnational efforts initiated by the EU and WIPO (World Intellectual Property Organization) have also failed, an industry initiative where cooperation is created through incentives, where each intermediary can maintain its power, might be the only way to achieve a collaborative database.

If a DLT enabled solution to create a global and industry wide database of musical works and sound recordings were to be realized, this would improve the current intermediaries' efficiency, but a fair outcome for creators can only be expected unless this efficiency is passed on to the creators.

In other use case types analyzed in the following sections, the current copyright regime that relies on the traditional distribution channels and collection societies is somewhat ignored or bypassed, by using tipping or automated means to achieve monetization of creative works, as observed in the following sections.

4.2.3 Music player (free)

The use case type music player (free) comprises of use cases that allow creators to publish and share music on a distributed platform, and allow listeners to send small amounts of payments as a tip to the creator of the content.

Four cases, Audius, LBRY, Stemstr and Wavlake were identified as this use case type. Audius and LBRY are both open-source protocols with decentralized storage to store works, and each have their own tokens to be used within the ecosystem. Stemstr and Wavlake are based on the Nostr protocol, a twitter like application that uses a

distributed hosting feature called ‘relays’, and tipping is enabled via the Bitcoin Lightning Network.

This use case type uses distributed means to host content, which does not necessarily rely on DLT, but uses the function of micropayments and cryptocurrency to incentivize users to publish or host content, and receive tips for quality content. LBRY uses DLT for the decentralized storage function as well, that requires a transaction fee to publish content. The implementation details along with payment and fee structures are organized in Table 11.

Project name	Implementation details	Fees and Payment structure Licensing terms
Audius	A streaming platform that allows tipping and option to share with various Creative Commons (CC) licenses. Powered by two off-chain services, storage (content node and IPFS) + usage tracking and indexing (discovery node). A utility token called AUDIO (ERC-20) is used for tipping, governance, and as the incentive mechanism for node operators to act in a rule abiding manner. Allows other DApps to connect through API and use Audius hosted music.	The platform does not take any fees to upload tracks, or to listen to streams. Although a payment feature for streams is planned to be implemented, currently only voluntary tips are supported. Creators can choose the license type as CC or All Rights Reserved.
LBRY	A protocol that enables the publication and viewing of various media formats, allowing tipping and content gating. The LBRY blockchain is a public proof-of-work blockchain, with native asset LBC. Combines a blockchain model and DHT (distributed hash tables) data structure for encoding and retrieving data in a peer-to-peer exchange.	The platform does not take any fees, but a transaction fee is required to publish content. Creators can receive tips from users. Creators can also set a price on the content. Creators can choose the license type under which the content shall be shared.
Stemstr	Allows distributed hosting of tracks that anyone can remix and re-post. Based on the Nostr protocol that allows relays (distributed hosting of twitter like content), with tipping enabled by the Bitcoin Lightning Network (a cost effective protocol to send micropayments in Bitcoin).	A minor transaction fee is required to send tips (called Zaps) using the Bitcoin Lightning Network. License terms are not considered.
Wavlake	Allows distributed hosting of tracks. Based on Nostr and Bitcoin Lightning Network (see above).	Same as Stemstr (see above).

Table 11: Cases identified as use case type 3. Music player (free)

The use case type free music player is comparable with online platforms like Soundcloud that is intended mainly for promotional use by artists, allowing uploads of tracks. Soundcloud is free for up to three hours of uploads, allows private links which are useful to limit free listens to other industry collaborators such as promoters and

press, and allows some monetization features for paid users. For unlimited uploads, Soundcloud charges creators €7.08 per month, which also includes ad revenue share based on streams, and a distribution service to off-platform services such as Spotify whereas Soundcloud retains a 20% commission. A donation link can be added, which connects to third party vendors.

The DLT based solutions do not have upload limits, and creators can share content so long as other network members are willing to host the content in a peer-to-peer manner. In Audius this is done by content nodes who earn tokens. LBRY uses PoW rewarding validators with the native asset LBC, which also function as a utility token within the network to be used to publish content, pay for gated content, or control the domain name of contents for better discovery. Anyone who owns LBC may have an incentive to also host content to improve the usability of LBC which would lead to increased value. In Nostr based systems content hosting is achieved by relays, a concept similar to 'follows' on twitter, meaning that another member who is interested in the content posted by a member hosts their content. To avoid the cold-start problem, users can also self-host the contents.

Whether this use case type is beneficial to creators would be determined by the total reach to potential listeners, benefits regarding fees and tips in a virtual currency, and impact on piracy.

Free music players are accessible by normal web browsers without login and do not require a listener to own any crypto asset in order to listen to music therefore can reach wide audiences. However, the tipping function relies on the listeners to own the certain crypto asset, and this would be limited to listeners who are more committed to the system such as network validators and other content publishers, or consumers who actively buy these assets to support the system. The fee structures are difficult to compare as transaction fees fluctuate with demand, as well as the price of coins or tokens used to pay for these transactions.

Impact on piracy depends on the ability of the platform to govern infringing activities. In a centrally hosted system, the platform operator uses a 'notice and takedown' procedure based on requests from rightsholders and can deactivate infringing content in a centralized manner (sometimes relying on automatic content detection systems like Content ID as seen in the case of YouTube). The platforms themselves are protected by safe harbor rules, so long as they provide adequate measures to allow reporting and

remove damaging content. Decentralized systems are censorship resistant, with no central authority that can handle 'notice and takedown' and instead rely on incentive mechanisms for network peers to behave in a desired manner. LBRY claims that compared to the existing peer-to-peer networks like BitTorrent, LBRY has advantages due to the public nature of transaction records, cost prohibitive transaction fees for significantly popular content, a domain name system that can be updated or removed, stiffer legal penalties of using LBRY to publish infringing content because it would be considered for profit. Profit could though, be a motive for publishing infringing content. A report by IFPI listed Audius to be on a watchlist for pirating websites due to its lack of ability to remove any infringing content (IFPI, 2022b).

To conclude from the above, it is questionable whether this use case type contributes in creating a fair outcome for artists. It should be noted although, YouTube and Soundcloud at the time of inception was plagued with piracy and it took more than a decade for these services to prevent piracy through improved software and operations. DLT based DApps could also evolve over time to incorporate systems to prevent piracy, and create a source of income for creators with a well-designed mechanism.

4.2.4 Music player (paid)

The use case type paid music player differs from the free music player, in that it uses enforced payments to allow listening. This use case type is somewhat premature, and the companies observed do not fully disclose their implementation details.

Three cases observed were categorized under this use case type, which are Aurovine, Emanate, and Tune.fm. Emanate announced their closure during the research period, but it was decided to be kept in the sample. Emanate and Tune.fm use internal tokens as cryptocurrency for payments to artists. Aurovine pays out in British Pounds but claims that blockchain is used in the backend to mediate payments. All three are operated in a centralized architecture requiring users to login to an account, and transactions are delegated to the website backend.

Contents could be theoretically stored in a decentralized manner, but there was no documentation regarding participation in the network as a content hosting participant. Emanate clearly stated that the music is hosted on a company server, although there were plans to implement public node hosting. The details of implementation that could

be found, and fee and payment structures as well as the licensing terms that artists must agree to in order to participate are organized in Table 12.

Project or company name	Implementation details	Fees and Payment structure Licensing terms
Aurovine	Uses blockchain in the backend to facilitate payments between users and artists. The details are undisclosed. Artists must pay a fee to join. Does not use a native asset or own token, although they intend to integrate cryptocurrencies in the future. Artists must pay a subscription fee to receive payments.	Users pay: £0.015 per stream £0.79 per download Takes £39.99 /year from artists in order to join. Takes 15% of download sales as commission. Streaming income is directly paid to artists. License terms state royalty free, allow derivatives.
Emanate (*announced closure during research period)	Uses an internal token called EMT (ERC-20) to reward creators. EOS blockchain is used to formalize and settle payments. Music is hosted on company server. Music is posted onto platform via company representative. Artists need to pay subscription fee in order to receive payments.	Payment for stream varies by algorithm, non-decentralized moderation, unclear rates. Takes 165$/year from artists to be able to be paid (in EMT), takes 10% commission for distribution service off-platform. License terms state royalty free.
Tune.fm	Uses an internal token called JAM tokenized on Hedera Hashgraph to settle payments. Unclear how music is hosted and approved for upload. Artists can receive payments only in JAM tokens.	Streaming fee is determined by service, download fee can be determined by artist, both paid in JAM token. License terms state royalty-free, no moral right.

Table 12: Cases identified as use case type 4. Music player (paid)

It is observed that use case type paid music player uses centrally issued enforcements under the general blockchain taxonomy. In two cases, tokenized assets are issued in a centralized manner by an initial coin offering, to be used as the method of payment. In theory this use case type could rely on a decentralized storage function, but this was not observed. Because uploads are centrally moderated by the service provider, there is low risk of piracy to proliferate on these platforms.

The use case type paid music player is comparable with the service provided by a digital aggregator and streaming platform combined. Most DSPs do not allow direct uploads of music and require a channel through major labels or the use of digital distributors/ aggregators such as Tune Core, CD Baby, and Distro Kid who charge artists a fee to distribute music to various platforms (Soundcharts Team, 2022). The typical fees to use services are either free with a commission or range from $20 to $60 per year for unlimited releases, or around $10 per release without a subscription (Herstand, n.d.). Depending on the subscription type, the distributor takes a commission ranging from 0% up to 20%. Compared to the retainment of revenue share from streaming by major labels as seen in section 2.1.2 Figure 2, independent releases via digital aggregators leave the artists with a larger pie of the revenue, but these services usually do not engage in promotional activities that labels provide.

The DLT based paid music player charges fees that are relatively higher than the non-DLT based digital aggregators, and takes similar level of commissions. For Aurovine, the payouts per streams are higher than Spotify's average payouts, but for Emanate and Tune.fm the payment can fluctuate and are paid in arbitrary digital tokens. The licensing terms are highly unfair, stating royalty free licensing (meaning that the platform is not obliged to pay any fees), and some denying moral rights (the right of the author to be attributed), or allowing derivatives to be made as default terms.

This use case type not only does not have any effects of decentralization and increased transparency, but it also imposes highly unfair terms and payment structures on artists, and in its current form of implementation shows no merit in improving fairness and transparency. The payment settlement features supported by DLT, if it offers any efficiencies, could in theory be implemented in the backend of current existing aggregators and DSPs and improve their operations, but is unassured that efficiency savings will be passed on to artists.

4.2.5 Collectibles

The use case type collectibles rely on the characteristics of digital scarcity and uniqueness that NFTs provide. This use case of DLT allows artists to create NFTs *of* music to be sold to fans as a collectible item. Off-chain benefits may be added to the NFT as a promise by the issuer, such as access to a download link of the music, access to direct chat and messaging boards, meet and greets, or other perks which can be

accessed after obtaining the NFT. Creation of an NFT by embedding information onto the blockchain and creating a new token is commonly referred to as ‘minting’.

Seven cases were identified under this use case type. The implementation details are organized in Table 13.

Project or company name	Implementation details	Fees and Payment structure
Async Art	NFT minting platform and marketplace. Music is represented as an ERC721 token on the Ethereum blockchain.	Platform takes 20-30% of sales, 5% of re-sale as commission. Royalty free, allow derivatives, no moral rights
Pianity	Platform creates and sells NFT of music of approved artists, sales in euros. Uses Arweave for storage of content. Allows benefits to be offered by artist through a private google drive link for purchasers. An internal token called PIA is used to incentivize engagement on platform, voting rights for tracks to be minted. PIA is not exchangeable and has no monetary value.	Platform takes 20% of sales and 2% of re-sale as commission. Royalty free
Public Pressure	Enables minting on the Polkadot (PoS) chain. Can be minted by artist through the platform or are minted by platform as a "curated drop”. Allows downloads of music files.	Platform takes 20% of sales and 3% of re-sale as commission. Royalty free
Serenade	Presented as a virtual record store simulating the function of traditional record shops by selling NFTs at fixed retail prices in copies of hundreds rather than limited editions. Uses ERC-721 standard on the Polygon blockchain (a layer 2 chain of Ethereum), minted by platform. NFTs act as a gate to access content, including streaming and downloads. Preview (streaming) is not possible prior to purchase.	Platform takes 30% of sales, 15% of re-sale as commission. Royalty free

Table 13: Cases identified as use case type 5. Collectibles

Project or company name	Implementation details	Fees and Payment structure
Sound.xyz	NFT marketplace/minting platform that allows owners to leave a comment on a track. Some allow owners to download a music file. Streaming on the platform allows free listening. Listing is by invitation only. Uses ERC-721A token standard on the Ethereum or Optimism (layer 2 Ethereum) blockchain. Content is stored on Arweave.	Takes 0% commission, and instead takes transaction fee from buyers. Artists need to pay miners a fee to upload tracks (0.02ETH). License terms unknown.
Supercollector	Uses ERC-1155 token standard on the Optimism blockchain. upload track via website, platform will approve and create a release of NFT.	Platform takes 10% of sales as commission. Royalty free
Zora	NFT minting platform and marketplace. Offers either ERC-1155 or ERC-721 token standard. Uses own layer 2 network on Ethereum blockchain.	Takes 0% commission, and instead takes transaction fee from buyers. Buyers pay the minting fee (the token is created when buyers purchase). Terms were not specified.

(continued, Table 13: Cases identified as use case type 5. Collectibles)

The use case type falls under the use case of Asset management, authentication of ownership under the taxonomy of general blockchain use cases, which relies on a public and un-permissioned blockchain. As discussed in section 2.2.9, an NFT merely points and refers to a certain metadata or file that offers information on what the token is intended to represent. An interface to display whatever assets these NFTs represent need to be incorporated in the NFT marketplace in order to allow trades. Visual art is the most popular form of NFT collectibles, and all marketplaces have interfaces that support the display of visual graphics associated with an NFT, and some NFT marketplaces also incorporate the function to play the sample of the music file associated with an NFT, or allow NFT holders to stream or download music. Because anyone can create an NFT, some NFT minting platforms act as a vetting intermediary to add assurance for buyers, or to avoid saturation some platforms limit the artists who can create NFTs through a voting process.

In the use case type collectibles, ownership of an NFT does not entail any claims to copyrights or ownership of the music itself, but may act as a license to copy, use,

display the music file for personal use. Terms of service of the platform state these purchase agreement terms for NFTs, and may include clauses such as droit de suit rules stating a percentage allocation for creators in secondary sales. These rules unless programmed into the smart contract, cannot be enforced when sold in other secondary marketplaces. The features offered through the interface function are not based on DLT, and while the NFT may indefinitely serve as a proof that a buyer purchased the token, there is no assurance that the service will continue to function.

The use case type collectibles is a new monetization scheme which did not exist prior to DLT, but is comparable to artists selling branded merchandise. The official status of a branded product, for example a T-shirt commemorating an album release, has value because it is associated with the artist and their works. NFTs bring this sentiment to the digital paradigm. The cost to produce an NFT is much lower than physical merchandise and may be easier to incorporate into the merchandising business for artists, but the value of an NFT, which has no actual use purpose, is questionable even considering its rarity. An analysis of the economics of collectible goods reveals that because the collectibles market is not subject to any regulation, it is prone to price manipulation (Stoller, 1984), and the high prices at which these NFTs are sold and traded, may come under public scrutiny and reputational risk to the artists associated with the NFT, especially combined with failure to provide any additional benefits that were promised at the time of the sale.

An interesting case was Serenade, which tries to emulate the function of a record shop in the form of an NFT marketplace. The NFT is sold in editions of hundreds, similar to the numbers of vinyl pressings, and priced at prices comparable to CDs and vinyl. The NFT acts as a key to access streaming and downloads of the song. Because NFTs can be sold on the secondary market, this creates an economic function similar to renting music. Users could therefore, theoretically buy an NFT and download the music, subsequently selling the NFT at a slightly lower price than the retail price. Whether this business model functions in favor of the artists is questionable. Compared to other platforms where the music of the NFT is streamed for free, Serenade limits listening to buyers, which is a better deal for artists.

Regarding transparency, since the past transactions regarding the ownership of an NFT is public, this achieves transparency, but only into the specific value chain of NFTs.

4.2.6 Music securitization

The use case type music securitization combines music NFTs with legal contracts to allow the trade of claims to cash flow from royalties arising from the music represented.

Similar non-DLT based concepts of music royalty backed securities have existed, one of the first examples is the so called ‘Bowie bond’, when in 1997 David Bowie bundled approximately 300 of his existing recordings into a security (Wishnia, 2019).

Four cases were identified under this use case type, and implementation details of each case are presented in Table 14.

Project or company name	Implementation details	Fees and payment structure Terms
anotherblock	The collectible includes a real-world legal contract specifying the terms of the streaming royalty payments and guaranteeing real-world ownership of royalty claims for the holder. Music files are not included with the purchase of the NFT, only the claims to royalty. Uses ERC-721 token standard and IPFS storage. DSP royalties pass through another block to the buyer.	A commission is levied for initial sale, platform takes 5% of secondary sales. The commission size and fees for artists differ between agreements. The contract terms between artists and platform are individual and undisclosed.
Opulous	NFTs of music called an MFT is sold as a form of crowdfunding for artists, with rewards paid out in internal token OPUL or USDC (a type of token pegged to US dollars). The reward structure is unclear, as well as the implementation details. Uses Algorand blockchain.	The NFTs are centrally issued, and the terms between artist and platforms are undisclosed.
Paperchain	Royalty claims are converted into NFTs but not sold, instead used as collateral by the platform to secure decentralized finance loans in order to pay artists an advance in correspondence to real time streaming performance. Implementation by partnership with United Masters distribution services, available to limited select artists.	Artists are paid an advance of the royalty from streaming. There were no fees specified.
Royal	NFTs are centrally issued and token standards were not specified, but the website states that the blockchains used may include, among others, Ethereum, Polygon, and Solana. The royalty claims from distributers passes through the platform and paid out to NFT holders. Some royalties are paid out directly from artists. Secondary sales are only allowed on platform.	The NFTs are centrally issued, and the terms between artist and platforms are undisclosed.

Table 14: Cases identified as use case type 6. Music securitization

The use case type is categorized under asset management, authentication and ownership. From observation of the cases, it appears that the royalty cash flow of payouts are not enforced using DLT, but rather passes through the platform in a centralized manner.

Two significant risks can be pointed out in this form of implementation. Firstly, if tokenized assets are considered to be securities, this would fall under the laws and regulations of the financial market that protects investors stipulating certain disclosures, but DLT based solutions often bypass and ignore these rules (De Filippi & Wright, 2018). Secondly, risks may arise when the platform intermediating royalty payouts cease to exist, and leaves the artists with the cumbersome task of paying out royalties to multiple owners of the NFTs which may frequently exchange hands. Because the contractual relationship is between the artists and the NFT purchaser, this leaves artists at a position of potential legal and contract breach.

Competing non-DLT based services are offered by companies such as Songvest, or Royalty Flow that operates the platform Royalty Exchange. These companies operate under the regulations of the U.S. Securities and Exchange Commission (SEC) (Stassen, 2021).

An interesting case observed was the service offered by Paperchain, which uses music securitization not as a means to sell the claims to royalties, but in order to obtain small amounts of loans through decentralized finance, in order to pay out streaming royalties to artists in a real-time manner. The performance of the track represented as an NFT is monitored in order to estimate the royalty cash flow from DSPs, which commonly takes 6 months to a year. Instead of waiting for the payout from DSPs, Paperchain takes out a loan that is collateralized by the royalty claim and allows artists to access portions of the royalty the moment it is realized, irrelevant of the actual cash flow.

The commission and fee structures were difficult to compare as the deals are individual. The innovative use case by Paperchain may offer benefits to artists, but the other cases offering sales of unregulated securities involves high risk and cannot be evaluated as beneficial.

4.2.7 Licensing

The use case type licensing attaches a license to NFTs, that allows various usage of the music represented, such as creating derivative works, permission to use the music for

commercial use, and in synchronization to videos. Three cases were observed under this use case type. The implementation details as well as fees and payment structures, licensing terms that can be used are organized in Table 15.

Project or company name	Implementation details	Fees and payments Licensing terms
Arpegi Labs	Offers a browser-based digital audio workstation and minting platform that ensures attribution by recording sounds and metadata as an NFT, allows free remix/ sampling. The NFT is created on the Polygon or Mumbai (test net) blockchain.	Free to use, no possibility to monetize Licensing options currently supported are limited to CC0 by Creative Commons, which allow derivatives and commercial use without attribution (author note: contradicts with attribution requirement)
Dequency	Offers a marketplace for music synch licensing. The platform will mint an NFT of approved tracks, licensee can purchase the NFT to obtain the track file and pdf of a contract stating license terms. Content is saved on IPFS or other similar peer-to-peer networks. Uses the Algorand blockchain.	The platform charges 15% (5% as commission +10% credit card fee). Licensing for commercial usage in various services such as apps and games, and synchronization. The platform takes 30% commission for off-platform licensing.
Oursong	Users can mint an NFT (ERC1155) with a choice of license to be attached. There are no features to enforce payments of royalties that arise from commercial use of derivative works other than the sales of a remix NFT, and relies on the compliance of licensees. Uses the Polygon blockchain.	The platform takes 12.5% of sales and 5% withholding to pay PROs Licensing terms can be chosen from four options, that defines commercial use, creation of derivative works, share of royalties in derivative works.

Table 15: Cases identified as use case type 7. Licensing

The use case type relies on the function of asset management, authentication and ownership under the general blockchain taxonomy, supported by a legal contract. It relies on a public and un-permissioned blockchain to allow the peer-to-peer exchange of NFTs and ability to verify the authenticity of the NFT.

Music licensing for creating derivative works and synchronization requires clearance from all rightsholders and is usually mediated by licensing agencies who obtain rights and offer music as a catalogue or negotiate terms on an individual basis on behalf of the

rightsholders. The fees can vary widely depending on the nature of the use, extent of exposure, how music is used and any other factors that may come into consideration for the parties.

In order to allow free usage of works, many authors utilize the Creative Commons license, with the choice to allow or retain permissions to create of derivative works and commercial usage of music, with or without attribution requirements. Even when attribution is required, authors may not fully know where their works are used. The use case offered by Arpegi Labs intends to make the process of tracking the use of works automatic, by recording the music metadata as an NFT within the music production software they provide. Any subsequential uses of the music remixed into another song in the software will be recorded as a transaction and a new NFT. Curiously, the licensing option is limited to the least restrictive CC0 type license which is specified as no requirement of attribution, allow derivatives and commercial usage. There is no possibility to monetize the works on the platform.

Dequency and Oursong offers the ability to sell music licenses for commercial uses in a peer-to-peer manner using NFTs as a proxy. A legal contract is attached to the NFT stating the licensing terms.

Dequency records licensing agreements on the Algorand blockchain. After the tracks are vetted by the platform, the music is listed on their marketplace, available for licensees to ‘mint’ the license as needed for each audiovisual or commercial project. This license cannot be resold.

Music licensing terms allowing derivative works may include revenue share from the derivative work to the licensor of the original track. Oursong allows this form of revenue share split, but in the current implementation form, the revenue share is limited to the resale of the ‘remixed’ NFT when the transaction occurs on the platform. Revenue share from sales on other NFT marketplaces as well as any other royalties that may arise from the distribution are not supported and relies on the licensee to comply.

A similar non-DLT based alternative service is offered by platforms like Songtradr, that charges 20-40% commission for synchronization and licensing earnings. DLT based solutions offer the service with a lower commission and in some cases adds an interesting prospect for the ability to track subsequential use of the music in a limited framework. There remains a need for a trusted intermediary to vet the rightsholder’s claims to the ownership of the music for licensees to be assured they will obtain a valid

license, unless this can be tracked from the inception of music by relying on monitoring the music creation software such that Arpegi Labs provides. Although in the current form of implementation the benefits are limited, this use case type could potentially create a future scenario where all music is tracked and recorded from inception to reuse, if such features are incorporated in all music creation software and consumption means, which for the foreseeable future is unlikely.

4.2.8 Hybrid and other

Hybrid use cases combine more than one use case type and attempt to emulate parts of the music distribution ecosystem, but all projects in this type were either under development or operating in a closed beta. Many of the projects issue a token to be used within the ecosystem, either as an artist token that is used to purchase services offered by the specific artist or to be used merely as a proof of fandom, or issued as a utility token that is used for transactions within the ecosystem to buy and sell content. In these implementations, the tokens are issued prior to the actual service being deployed and are traded under a speculative expectation that the value of these tokens will increase. As observed in the previous sections for paid music players and licensing, enforcement of royalties arising from streams and other usage were prematurely developed, and there are no existing cases that support the viability of a DLT based ecosystem allowing peer-to-peer distribution and royalty payment enforcement.

Eight use cases were categorized under this type. The following Table 16 summarizes implementation details on the cases observed.

Project or company name	Implementation details
Bitsong	Hybrid of collectibles and fan tokens, music player, using own currency called BTSG (initially created as an ERC-20 standard token, currently migrated to Cosmos standard token). Music player and NFT marketplace is under development.
Copyright Delta	Hybrid of timestamping rights registry, licensing and distribution, automated royalty payouts and other features under development, operating in closed beta.
Gala Music	Hybrid of collectibles, music player, and licensing. Enables its users to own, buy, sell, transfer, and share unique digital rewards that can be interacted with on the platform. Owning music NFT (ERC-1155 standard) gives neighboring rights for streams on platform (paid in a test token called BEAMS, cannot be transferred), player is under development.
KOLO	Hybrid of music player and music securitization. Focuses on classic music. Sales of NFT that grants streaming royalty from the specific streaming platform planned to be deployed, that is paid out in own internal currency KOLO (ERC-20 standard).
LimeWire	Hybrid of collectibles and paid music player. Subscription based gated content platform (like Patreon) that makes each post into an NFT to be given to subscribers as a digital collectible that can be resold. Issued LMWR token (ERC-20 standard) which is to be used for pay-per-view of content without subscription, but the feature is not yet deployed.
MediaVerse	Research project that plans to implement smart legal contracts for copyright management and a stable coin called MV-coin (ERC-20 standard) as a means of royalty payment. Combines rights registration, licensing and transfer of ownership represented as fungible and non-fungible tokens, automatic execution of royalty payouts. (Surinx et al., 2021)
MODA DAO	A Decentralized Autonomous Organization (DAO) that pays out grants to implement various projects such as collectibles, NFT enabled music player, metaverse events. Membership and voting rights are controlled by a token called MODA (ERC-20 standard).
Zimrii Music	Platform for artist tokens which can be used to buy merchandise. Artists can also issue NFT of various creative works as collectibles.

Table 16: Cases identified as use case type 8. Hybrid and other

The digital currencies which are used to pay for music also act as a way to compensate developers and network participants, and are promoted under the ethos of allowing the artists and fans to be partial owners of the platform and have a stake in the success of the platform and its artists. Some projects incorporate the so-called ‘super distribution’

model or ‘band equity’ model (Silver, 2016) that allows fans to be rewarded for promoting content that they have purchased, or own a small stake of the artists success in the form of artist tokens or fan tokens, incentivizing promoting activities on behalf of the artists. Silver criticized this type of implementation as lacking considerations for cultural credibility, and an unfit example to literally apply financial incentive mechanisms of DLT based solutions into the music sector.

The digital currencies for the eco-system are issued as tokenized assets mainly using the ERC-20 smart contract token standard for fungible tokens, which can represent any kind of asset and are widely used as means to raise funds through an Initial Coin Offering (ICO) where tokens are created and sold to the public. There is a high level of information asymmetry associated with ICOs because of a lack of regulation regarding disclosures (De Filippi & Wright, 2018, pp. 99–104). The SEC ruled that the LBC (LBRY Credits) coin offered by LBRY, Inc. who created the LBRY protocol (introduced in section 4.2.3) was offered as a security, as it was pre-mined and sold prior to the deployment of the services, and fined LBRY, Inc. with 11 million dollars which lead to the company to shut down due to debt (Barash, 2023). This has not yet resulted in the protocol to wind down, or the circulation of LBC to stop, as LBRY was one of the few working and viable decentralized models that does not rely on one central company to operate. Other projects may not be as robust, and may not have the proper incentives in place to encourage developers to continue to develop a viable product after the initial sales of the token. In the hybrid use case types, artists typically do not buy tokens to participate, but offer their intellectual property to the platform in order to earn tokens. As seen in the analysis of paid music players and collectibles, in order to bypass the existing copyright laws, platforms tend to impose terms that require artists to allow free streaming and give up royalties in a traditional sense, and in some cases even moral rights. Although tempting to imagine a system where the platform is owned and governed by its contributors, the reality of the current state of implementation is that there is a lack of transparency in operations and these use cases do not offer a fair outcome.

The Media Verse project plans to implement stable coins that are pegged to fiat currencies, but the method to stabilize the coin is to be developed. The project also states that they have not solved the issue of the so-called garbage-in-garbage-out problem, where works are registered by its users, rightful ownership cannot be verified.

5 Discussion

The analysis of use case types for DLT applications for recorded music revealed whether current forms of implementations can offer benefits regarding fairness and transparency. In this section the analysis results will be critically reflected upon, and the implications that can be drawn from the results are discussed.

5.1 Limitations of the research

The analysis is bound by limitations due to the chosen methodology. This study incorporated purposive sampling and collection of data through publicly available information on DLT use cases for recorded music. This limits the boundaries of sample collection to use cases that are widely promoted to the public, and may not include initiatives that are internal and confidential. The sample collection omitted inactive projects, and is subject to a survivor bias, whereas there may have been projects that were technically viable but failed due to a lack of funding, marketing initiatives and adoption.

As DLT is an emerging technology, the general taxonomy of use cases is not exhaustive and there may be new use cases and implementation features, attributes of new concepts that were not considered in the study but may have influenced the analysis and typology generation.

While this study aims to create a typology from observation of cases in a positivist approach, generalization of the use cases requires interpretation, and evaluation of constructs such as fairness involves subjective assessments. To avoid subjectiveness as much as possible, literature reviews on the subject of critical political economy in the cultural industry is employed to draw opinions of other researchers, and the evaluation of fairness is ultimately decided by empirically observable monetary risks and benefits. Consideration of the value of the tokens and distribution among network participants, or which works gain visibility in ranking and how this is determined also affects fairness, but this was beyond the scope of the study.

5.2 Summary of results and implications of the analysis

Eight use case types were identified, which are: 1. rights registry, 2. rights database, 3. music player (free), 4. music player (paid), 5. collectibles, 6. music securitization, 7. licensing, and 8. hybrid and other use cases that combine more than one of the use cases identified.

Type 1. Rights registry utilizes a decentralized governance blockchain to create a timestamped record of the existence of a digital file using hashing algorithms that can be proofed via third party protocols by anyone so long as the blockchain is maintained. The use case offers limited benefits as private registries in general lack trust and do not offer active protection of copyrights, and can only be used as a preemptive measure in case of litigation which may or may not be accepted by court as proof.

Type 2. Rights database creates a consortium of data controlling entities, utilizing a hybrid governance structure or centralized governance structure blockchain. This use case type may improve the existing intermediaries operations, but it was unclear to what extent this implementation achieves the goals of reconciliating data and pass on efficiency savings to artists.

Type 3. Music player (free) utilizes decentralized storage use case of DLT that relies on a decentralized governance blockchain with micropayments in cryptocurrencies. This use case type faces problems due to pirated material proliferating on the platform due to the distributed nature of content uploading and hosting. Although content can be made visible to a wide audience, by relying on tipping, music is distributed for free and may not offer a fair outcome.

Type 4. Music player (paid) utilized centrally issued enforcements and micropayments in cryptocurrencies as well as fiat currencies in some cases. Although decentralized storage functions were also envisioned this was not implemented in any of the cases observed. The DLT implementations were governed in a centralized structure, which offer no improvements regarding transparency. Music is uploaded in a centralized manner which can prevent pirated materials on the platform. The payment terms for the artists were not fair compared to the existing non-DLT services.

Type 5. Collectibles , 6. Music securitization and 7. Licensing all rely on NFTs to represent music, which can be traded in a decentralized manner. The use case types rely on a decentralized governance blockchain that records the tokenized assets, but because

anyone can issue a token, there remains a need for a vetting authority to give buyers an assurance and in many cases NFTs are issued by the platform operator. Additional services may be offered along with the sales of an NFT, and the web interfaces to allow these services to function, issue contracts, or to allow royalty payouts, are managed by the platform which creates a point of centralization adding a new intermediary to the value chain. Transactions of NFTs are transparent, but only with regards to the sale and resale of NFTs, and there is no added transparency for music usage off-chain. Terms offered to the artists allow limited flexibility in licensing terms and although the use cases provide an alternative monetization path, the terms were considered unfair.

Type 8. Hybrid and other use case type envision an ecosystem of music assets living on-chain, but all cases observed were prematurely developed and relied on internal currencies issued as tokens, which are sold prior to the deployment of the services which they are intended to be used for. In the current form, this use case type did not increase fairness and transparency for artists, due to the lack of maturity of services and the unregulated environment of token sales.

Radical implementations that obliviate the need for intermediaries require a hybrid form of implementation where the entire value chain from creation to consumption of music stays on the chain. A working model under this kind of hybrid implementation was not observed at the time of the study, and remains difficult to imagine, as music is produced and consumed in various formats.

Although blockchains introduce the concept of digital scarcity, this is limited to the on-chain assets that can represent real world goods under limited circumstances, and the creative works itself in many of the cases observed were paradoxically disseminated in abundance, free to listen, instead relying on tips or gains from speculative trading of tokens.

Hybrid use cases that create a new economy with its own internal currency that compounds in value as more users adopt and buy into the network, do although, present an interesting new paradigm for co-creation in a commons-based approach. Genre theory suggests that creative works are not made in a vacuum and the current copyright system which attributes creation to a uniformly defined ‘author’ has limitations in reflecting the nature of artistic creation (Rachum-Twaig, 2016). A tokenized economy that redistributes the wealth of the network to its contributors, may achieve a function similar to the tax levy and collective distribution scheme as envisioned by some

researchers as discussed in section 2.1.3. For a fair system to evolve, it would require developments in legal regulation regarding token issuance and engineering of token distribution mechanisms that allow fair renumeration based on contribution that take into account the complexities of the creative industries, as well as further research for scalability, stability in value, and reliable measures for on-chain and off-chain integration of data.

This study categorically compared how DLT is applied in various use case types for recorded music, identifying the typical deployment attributes for implementation and conditions of services offered to creators. The study contributes to the existing body of literature by offering an insight to the actual state of DLT applications in the recorded music industry through a typology creation which allows clarification of deployment attributes and allows comparisons to be made with non-DLT services.

6 Conclusion

Digitalization caused structural changes in the ways recorded music is distributed and consumed. Inefficient operations as well as the lack of fairness and transparency in the value chain have been widely criticized, and new means to intermediate fans with creators is being explored, with an expectation placed on DLT to solve the many problems in the industry. Because DLT is a multifaceted technology, there is a multiplicity of implementation methods, and the ways DLT is applied and how services are offered to the creators and consumers will affect the outcomes of fairness and transparency.

This paper began by posing the research question, which DLT applications for the recorded music industry have been implemented so far, and in which form, and whether these implementations achieve fairness and transparency. Existing literature on the topic of the recorded music business under digitalization reveals the shortcomings of the industry to appropriately compensate creators, due to a combination of structural power balances, lack of data cooperation, and limitations of copyright laws. An explanation on DLT and its variations and patterns of implementation is outlined, followed by a literature review on DLT applications in the area of recorded music. It was revealed that although there is considerable interest and effort geared towards applying DLT in order to transform the digital music value chain, a framework to categorically evaluate the state of DLT applications for use cases in recorded music was missing.

Through an empirical analysis of observed cases, the study categorized 34 sampled use cases into eight use case types that represent a similarity in the area of application and the specific deployment attributes of DLT applied based on analytical generalization, which were then compared to the existing non-DLT based service offerings.

The analysis of use case types revealed that there are incremental improvements that DLT based solutions can offer in aiding operations in various parts of the value chain for recorded music. A timestamped rights registry on the blockchain can offer a semi-permanent record of the creation of a digital file, which can persist regardless of the registry service provider as long as it is recorded on a public blockchain, and the blockchain is maintained. Data reconciliation through a consortium of data holders could improve operations of DSPs and collection societies and reduce unpaid royalties. Decentralized storage creates an incentive for users to host content eliminating the need

for a central server, and micropayments can offer a way for artists to earn money through receiving small tips from a crowd of fans. Centrally issued enforcements may pave a way for micropayments for music streaming to be handled more efficiently in the backend of DSPs, allowing a pay-per-stream system. NFTs can offer new monetization paths and the possibility to track and monetize music from subsequent sales and usages so long as the transactions remain on chain. In most forms, there remains the need for a central authority to vet rights, restrict or allow uploads of music, or manage a web service or interface that allows the functions to be usable, which introduces a point of centralization and control, reducing transparency. Without a central point of control, piracy and illegitimate claims of copyright ownership would pollute the system.

The findings confirm that DLT based applications have not radically transformed or fully decentralized the recorded music value chain, but instead are creating new intermediaries and points of centralization. Transparency is only achieved for certain on-chain transactions which only represent a fraction of the recorded music value chain, and significant parts remain opaque. The payment and licensing terms offered by new DLT intermediaries are often more unfair compared to traditional intermediaries. Problems arise from volatility of fees and payments, rigid terms of licensing, lack of regulations, and poor integration with off-chain systems which are crucial in authenticating legitimate copyright ownership and piracy prevention. Radical implementations envisioned to disintermediate the value chain and operate in a decentralized manner require tracking creative works from inception through consumption and redistributing value, but working models are still premature and face technological and legal hurdles as well as adoption issues.

In summary, DLT applications have not delivered on its claims to achieve the goals of fairness and transparency in the distribution of recorded music in the digital environment. Further research and development is needed to offer improved solutions. This paper hopefully provided clarity in the areas where DLT applications for recorded music require improvements to achieve these goals.

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Annex

List of analyzed cases

	Project / company name	URL
1.	**KENDRIX (Jasrac)**	https://kendrix.jp/
2.	**Musicstart (Sacem)**	https://www.musicstart.com/
3.	**Soundreef**	https://www.soundreef.com/en/
4.	**Blokur**	https://blokur.com/
5.	**Verifi Media**	https://www.verifi.media/
6.	**Audius**	https://audius.co/
7.	**LBRY**	https://lbry.com/
8.	**Stemstr**	https://stemstr.app/
9.	**Wavlake**	https://wavlake.notion.site/
10.	**Aurovine**	https://aurovine.com/
11.	**Emanate**	https://info.emanate.live/
12.	**Tune.fm**	https://tune.fm/
13.	**Arpeggi Labs**	https://www.arpeggi.io/
14.	**Async Art**	https://www.async.art/
15.	**Pianity**	https://pianity.com/
16.	**Public Pressure**	https://app.publicpressure.io/
17.	**Serenade**	https://serenade.co/
18.	**Sound.xyz**	https://www.sound.xyz/
19.	**Supercollector**	https://supercollector.xyz/
20.	**Zora**	https://zora.co/
21.	**anotherblock**	https://anotherblock.io/
22.	**Opulous**	https://opulous.org/
23.	**Paperchain**	https://paperchain.com/
24.	**Royal**	https://www.royal.io/
25.	**Dequency**	https://dequency.io/
26.	**OurSong**	https://www.oursong.com/

	Project / company name	URL
27.	**Bitsong**	https://bitsong.io/
28.	**Copyright Delta**	https://www.copyrightdelta.com/
29.	**Gala Music**	https://music.gala.com
30.	**KOLO**	https://www.kolo.market/
31.	**LimeWire**	https://limewire.com/
32.	**MediaVerse**	https://mediaverse-project.eu/
33.	**MODA DAO**	https://www.moda.audio/about
34.	**Zimrii Music**	https://www.zimrii.com/

Statutory Declaration

I herewith formally declare that I have written the submitted thesis independently. I did not use any outside support except for the quoted literature and other sources mentioned in the paper.

I clearly marked and separately listed all of the literature and all of the other sources which I employed when producing this academic work, either literally or in content.

I am aware that the violation of this regulation will lead to failure of the thesis.

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