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Faculty of Business Economics

Master of Management

Master's thesis

An investigation and assessment of blockchain applications for royalty management processes in the music industry

Bob Vrijhof

Thesis presented in fulfillment of the requirements for the degree of Master of Management, specialization Business Process Management

SUPERVISOR :

Prof. dr. Mieke JANS

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Management Summary

Blockchain technology piqued the interest of many after it garnished widespread popularity through its most popular application to date; Bitcoin. Because the technology is still in its infancy, the world is still exploring in which way it adds value to the rapidly innovating environment we currently live in. The music industry is one of many industries that is struggling to modernize its way of working. However, blockchain technology is coined as one of the potential disruptive forces that can finally help the music industry innovate and move forward into a future that is fair for all stakeholders involved, not just those that hold money and power.

This study aims to find out whether blockchain technology *is* truly of added value to the music industry by investigating and assessing its possible applications in royalty management processes . In order to do that, we first paint an image of the music industry's past and current state through existing literature, and explain how royalty management processes are structured. Building upon this knowledge, the analysis starts by delineating the issues that are experienced in royalty management processes through conducting seven semi-structured interviews with a variety of industry professionals, as described and motivated in chapter one's research methodology. As comes forth from these interviews, the main problem areas within royalty management processes are found in data management, the industry's regressive stance on technology and innovation, and the constraints that come forth from laws, regulations and policies. Several needs are then formulated that should be addressed in order to solve the issues at hand, as laid out in chapter three. These needs form the building blocks for the proceeding chapters.

The literature review in chapter four adds to these building blocks by providing an in-depth look into blockchain technology and its potential applications. Chapter five then uses this knowledge to filter out the issues and needs that are not subject to technological improvement, but rather form limitations. As a result of this filtering process, this study proposes the implementation of five different applications: (1) a blockchain based decentralized database, (2) a smart contract based payment infrastructure, (3) data standardizing smart contracts governed by artificial intelligence, (4) a data visualization dashboard, and (5) the integration of audio fingerprinting technology. However, this research also concludes that even though blockchain technology's potential looks exciting on paper, it isn't feasible in this day of age due to numerous unsolved constraints regarding industry culture, politics, laws and regulations. For that reason we recommend running scalable pilots in music industry niches while keeping an eye on the industry's progress. Furthermore, we recommend major and powerful stakeholders to re-evaluate their role and sustainability in the music industry.

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List of Abbreviations

AI	Artificial Intelligence
CD	Compact Disc
dApp	Decentralized Application
DLT	Distributed ledger technology
DoS	Denial-of-Service
DSP	Digital Service Provider
GDPR	General Data Protection Regulation
IFPI	International Federation of the Phonographic Industry
R&D	Research and Development
SME	Small to Medium Enterprise
ISRC	International Standard Recording Code
ISWC	Internation Standard Musical Work Code
MP3	MPEG Layer 3
MRO	Mechanical Rights Organization
OECD	Organization for Economic Cooperation and Development
P2P	Peer-To-Peer
PoA	Proof-of-Activity
PoS	Proof-of-Stake
PoW	Proof-of-Work
PRO	Performance Rights Organ

1 Introduction

"We cannot be afraid of perpetual change in the music industry, because that dynamism is driving growth. There's so much disruption and so much new technology, we're just going to have to fasten our seatbelt and show a high degree of sensitivity and willingness to listen. While disruption is challenging, it's also going to be very exciting and create a lot of value."

- *Jonathan Dworkin, CEO Universal Music Group (IFPI, 2018)*

The past couple of decades has seen the music industry embrace numerous radical innovations, including the introduction of the radio and CD. However, the current digital age is seemingly the most challenging yet. While revenue streams pummelled around the turn of the century, royalty management processes have become increasingly complex in recent years. This complexity is further strengthened by the introduction of music streaming moguls like Spotify and iTunes, and their enormous data streams (Atkinson, 2017).

Major corporations like Spotify and Warner Music Group are dominating the industry, while their impact on transparency and innovation raises questions. On the other end, artists are barely enjoying the fruits of their labour while they are the sole creator of the music industry's product (IFPI, 2018).

Grammy award winning artist Imogen Heap has been one of the first major artists to shine a light on blockchain technology's potential application in the music industry, through her collaboration with blockchain start-up *Ujo Music*. Blockchain is a *Distributed Ledger Technology* (DLT) which enables a database to be shared and synchronized across a network. What makes blockchain technology special, is that it is not controlled by one central authority (Nakamoto, 2008). After gaining widespread interest through its most popular application, the Bitcoin, blockchain technology has been criticized as much as it has been recognized as the new radical innovation the world has been waiting for.

This study takes a deeper look into what exactly is causing the issues in royalty management processes. Furthermore, it investigates which blockchain applications can be used to improve these royalty management processes, and assesses their suitability, viability and limitations.

1.1 Research Statement

The following research question has been formulated as the basis of this study:

> ***Main research question:*** *How can blockchain technology be used to improve royalty management processes in the music industry?*

The term 'royalty management processes' refers to all of the processes concerned with the collection and distribution of royalties.

The main research question has been split into five different research questions in order to get a more detailed overview of the elements that it is comprised of. These research questions are summarized as follows:

> ***RQ1:*** *How is the music industry structured?*
> ***RQ2:*** *How are royalty management processes structured?*
> ***RQ3:*** *What is blockchain technology?*
> ***RQ4:*** *What issues do royalty management processes have?*
> ***RQ5:*** *Which applications does blockchain technology provide to improve royalty management systems?*
> ***RQ6:*** *Which limitations are imposed on the implementation of blockchain technology in royalty management processes?*

By addressing these research questions we aim to find common ground between royalty management processes and blockchain technology. The first three research questions are descriptive in nature and have a bigger focus on theory and readily available information. Thus, these research questions will allow us to get a more general understanding of the relevant underlying principles (Baarda, 2010). In contrast, the latter two are more exploratory in nature. According to Bougie (2016), exploratory research questions can be defined as research question that aim to get a better understanding of phenomena that are unclear and suffer from serious limitations with regard to preliminary research.

Because of the limited scope that this study will be able to address, the decision has been made to put its main focus on the music industry's so-called *digital age*. A description of the music industry's digital age can be found in subsection 2.1.3.

1.2 Methodology

The purpose of this subsection is to justify and define the research methodology that will be used throughout this study. First we will take a look at the research design and the philosophy behind the chosen research methods. After that, the method of data collection and data analysis will be further defined.

1.2.1 Research Design

The initial phase of this research aims to answer RQ1, RQ2 and RQ3 through conducting a literature review. Because the subjects in this research are of contemporary nature due to their rapidly changing landscapes, the literature mainly makes use of recently published journal articles and news pieces article as well as reputable reports and web pages. The literature review makes sure that the research effort is positioned relative to existing knowledge and allows the researcher to look at the problem from a specific angle, which shapes thinking processes and sparks useful insights in the topic at hand (Bougie, 2016).

The second phase of this research aims to answer RQ4, RQ5 and RQ6. Because this phase is of exploratory nature, qualitative research methods performed in a non-contrived setting are deemed most suitable in its execution. Non-contrived settings are settings in our natural environment where events proceed normally instead of artificially (Bougie, 2016). Qualitative research methods provide data in the form of words and can originate from a wide variety of primary and/or secondary sources. Baarda (2010) supports this statement, and adds that qualitative research is generally used in situations where the research questions are broad and where there is little prior knowledge on the subject. He further states that it aims to provide new insights through the analysis of data derived from snippets of conversation, observational reports or collections of documents rather than hard, quantifiable data with a solid statistical basis.

The empirical part of this research will be performed on the basis of the grounded theory approach as first described by Strauss and Corbin (1967). The grounded theory approach is a commonly used set of procedures that is used to develop an inductively derived theory from qualitative data. Some important tools that are used in this process include theoretical sampling, coding, and constant comparison of the coded data in order to make sure that new data fits the theory that is derived from old data. Baarda (2010) solidifies the grounded theory approach by mentioning subsequent steps in the process. He states that is important to start with organizing the qualitative data into 'units of information', so it brings together pieces of information. The next step will be to analyse all of the units of information in terms of their relevance to the research. It is important for this step to be handled as an iterative process.

Then, unnecessary data should be reduced and the data that is left over should be labelled and coded accordingly. Ultimately, the data should be viewable in a clear and structured manner.

1.2.2 Methods Of Data Collection

The literature review in the initial phase of this research will be carried out by making use of selected sources of secondary data. Secondary data is data that is readily available from other sources (Bougie, 2016). These sources are mainly found via the online library of Hasselt University, Google Scholar, and the libraries of both Hasselt University and Maastricht University. Furthermore, closed websites like Statista have been accessed through the Hasselt University subscriptions as well. The majority of the contemporary sources has been found through Google's search engine and through tips from people within the researcher's network.

Primary data is data that is collected first-hand. The primary qualitative data in this research has been collected by conducting interviews with experts in the field of royalty management processes. Alshenqeeti (2014) states that conducting interviews has several advantages and disadvantages, as summarized in table 1.

Advantages	Disadvantages
High return rate	Time consuming
Fewer incomplete answers	Small scale study
Can involve reality	Never 100% anonymous
Controlled answering order	Potential for subconscious bias
Relatively flexible	Potential inconsistensies

Table 1 – 'Advantages and disadvantages of interviewing' (Alshenqeeti, 2014)

The interviews have been conducted with the use of a semi-structured list of questions via video chat, or on location. A semi-structured list of questions allows the interviewer to pinpoint certain specific subjects while allowing for probing questions, in case the initial answer is unclear and requires additional explanation. Furthermore, semi-structured interviews allow the interviewer to divert from protocol if necessary. This might lead to a deeper understanding of the subject at hand (Bougie, 2016).

For this research, a semi-structured list of questions is used because the dataset is based on different perspectives - each participant should be able to provide a different answer to the same question. Furthermore, these perspectives help the researcher to interpret the eventual data. For an explanation of what *labels, publishers, distributors and performance rights organizations* (PRO/MRO) do and which different types of *royalties* and *licenses* exist, please refer to chapter two.

The interviewees have been sourced by contacting various specifically targeted companies via phone and e-mail. Furthermore, social media platforms *LinkedIn* and *Facebook* have allowed the researcher to get in contact with people through his own network. Table 2 provides an overview of the experts that have been interviewed for this research, which point of view they offered to the research, their current and past employers, and their occupation.

Name	**Company**	**Point of view**	**Occupation**
Mars Mertens	OurMusic.Biz (Past: Buma/Stemra, Ziggo)	DSP Publisher Distributor PRO/MRO	Music licensing, copyright and digital exploitation consultant
Chris Davies-Smith	Enhanced Music Publishing (UK)	Publisher Artist	Publishing Administrator
Sander Petit	Petit Legal	Legal Artist	Attorney-at-law specialized in music, media & entertainment, intellectual property and contracts in the creative industry
Rene Dekker	Cannonball Media	Artist Label Technical Publisher	Project manager for newly developed royalty management systems and record label owner
Tim Ramakers	Project Five	Technical	Royalty management system developer
Simon de Koning	Qudoc *(Past: Universal Music Group, Amp.Amsterdam)*	Artist Publisher	Music supervisor. Sync music licensing and new business development consultant. Co-founder copyright automation start-up.
Oliver Way	EPM Music	Artist Label Distributor Publisher	Label owner, distribution and publishing company owner, DJ/Producer, booking agent for globally renowned artists.

Table 2 – 'List of interviewees'

1.2.3 Method Of Data Analysis

The data analysis is based on the grounded theory approach, as initially described by Strauss and Corbin (1967). As part of the grounded theory approach, this study makes use of a needs assessment. According to Watkins, West Meiers, and Visser (2012), the results of a needs assessment will help to guide the subsequent decisions regarding the design, implementation and improvement of projects, programs and processes.

The following steps have been followed in the analysis process:

Step 1: **Transcribe recordings**
The recordings have to be transcribed in order to be able to process the interview data into a text format.

Step 2: **Define specific issues**
The specific issues within the problem areas are defined.

Step 3: **Define main problem areas**
The specific issues within the problem areas are then further defined in detail.

Step 4: **Categorize content within problem areas**
The transcribed data are then categorized into the main overarching themes areas.

Step 5: **Categorize problem areas into overarching themes**
The problem areas are then categorized into three overarching themes.

Step 6: **Situational analysis and need identification**
Through a situational analysis of the grouped issues, needs are identified.

Step 7: **Linking needs to possible applications**
The needs will be linked to possible blockchain applications, keeping account of which issues they solve and which issues form limitations in their application

1.3 Limitations

Firstly, It is important to understand that the music industry is an extremely big and complex web of processes and stakeholders. This means that this study is only able to provide a summarized and generic view of its current state. As a result, the decision has been made to mainly focus on recorded music in the digital era, even though live music and music publishing have been included as well – to some extent. Also, the main focus is put on business processes while these are often intertwined with legal and constitutional processes.

Secondly, the interviewees that participated in this work are mainly professionally active in the Dutch, German and English markets. The outcome of this work is heavily reliant on the data that these interviewees provide. This means that the outcome is mainly applicable to the North-West European music industry, and also explains why the focus in this work is sometimes laid on the markets that are active within this area.

Thirdly, this work was made with time constraints and as a result the sample size was limited to seven, which likely lead to distortion in the data outcome due to a lack of argumentation for some of the issues that were experienced. Also, inexperience with interviewing techniques by the researcher likely introduced some bias into the data. The latter interviews that were taken were perceived to be of higher quality.

Lastly, the *Performance Rights Organization's* (PRO's) are subject to a lot of criticism, and multiple attempts by phone and e-mail have been made to get in contact with European PRO's, including *Buma/Stemra* (NL), *PRS for Music* (UK) and *Sabam* (BE). Unfortunately none of them responded, so there was no opportunity for a fair hearing. However, some of the interviewees are ex-employees and have thus provided some insights into their perspective.

2 The Music Industry

2.1 Introduction

Ever since its early beginnings, the music industry has proven to be surprisingly resilient to its rapidly changing environment. However, the digital era is likely the most challenging yet. This chapter aims to provide the reader with an overview of the music industry, its historical context, as well as its current organisational structure and the challenges it is facing. Furthermore, this chapter looks into the structure of royalty management processes and the challenges that they pose today based on existing literature. These challenges will be outlined, elaborated on and validated in chapter three.

2.1.1 Definition

As a whole, Hesmondhalgh (2007) defines the music industry by dividing it into three different segments: recording, publishing and live performances. Table 3 provides a more detailed explanation of these three segments based on additional information by Leurdijk, Slot, and Nieuwenhuis (2012) and PRS for Music (2018)

Sound recording	Music publishing	Live performing
Production of original (sound) master recordings	Acquiring and registering copyrights for musical compositions	Performance of music in front of live audiences by a performance artist
Sound recording activities in a studio or elsewhere	Promoting, authorizing and using these compositions in recordings, radio, television, motion pictures, live performances, print and other media	Generally includes performances at small venues and gigs, busking, popular concerts, classicbal concerts, festivals and theatres.
Production of taped (non-live) radio programming, audio for film, television etc.	Distributing sound recordings to wholesalers, retailers or directly to the public	

Table 3 – 'Definition of the music industry in segments: recording, publishing and live performances' - adapted from Hesmondhalgh (2007), Leurdijk et al. (2012) and PRS for Music (2018)

The UK government department on culture, media and sports also devises a definition of the music industry based on different dimensions, but separates the industry into activities rather than segments as shown in table 4 (Department for Culture & Sport, 1998).

Core activities	Supporting activities	Related activities
Production, distribution and retailing of sound recordings	Music press, multimedia content and digital media	Internet/e-commerce
Administration of copyright in composition and recordings	Retailing and distribution of digital via internet	Television and radio
Live performance (non-classical)	Music for computer games	Film and video
Management, representation and promotion	Art and creative studios	Advertising
Song writing	Production, distribution and retailing of printed music	Performance arts
Composition	Jingle production	Interactive leisure software
	Photography	Software and computer services

Table 4 – 'The music industry: core activities, supporting activities and related activities' (Department for Culture & Sport, 1998)

In contrast, Williamson and Cloonan (2007) argue that there is no such thing as a unitary music industry and believe that there is too much primacy with regard to recorded music in its definition. Rather, they state that the music industry exists of a plurality of discretely functioning music industries of which recorded music is merely a small piece of the puzzle.

2.1.2 Sheet Music and the Rise of the Recording Industry

The development of the earliest form of a music *industry* coincided with the evolution of book printing technologies in the mid 15th century, also referred to as the *sheet music* industry. As these techniques progressed, mechanical systems for printing sheet music were developed for the first time and allowed the labour-intensive process of producing sheet music to become feasible and lucrative. As a result, sheet music became more accessible and musical styles started spreading and developing quickly. Up until the 18th century, producing and printing sheet music was mostly done by aristocracies and churches. However, in the mid-to-late 18th century composers like Wolfgang Amadeus Mozart were among the first to begin seeking commercial opportunities to market and perform their music (Leurdijk et al., 2012). Since sound recording technologies did not exist at the time, the majority of the industry was comprised of live performances in private- and public places. This era came to an end with the introduction of the phonograph in the late 1880's, and the subsequent introduction of radio broadcasting in the 1920's (Gronow, 2013).

Even though theatres, concert houses, operas and clubs were still doing live performances, the power of radio allowed artists to break through in what was then called the "record industry". As a result, new possibilities for commercialization were slowly making the recording industry into a multi-billion dollar industry. This was further supported by other major technological developments in the early 20th century including magnetic tape, the band recorder which played these tapes, and transistors which made radios portable (Gronow, 2013).

Subsequently, the late 20th century marked a time in which commercial expansion and corporate consolidation of the music industry was built on these innovations, led by a few corporate giants (for more information, see subsection 2.1.4). By the beginning of the 1980's the cassette and the CD, together with portable listening solutions like Sony's famous Walkman, had been introduced. Record companies' back catalogues were opened up as consumers started to replace their vinyl collection with CD's. The industry exploded and the figures showed; the US music market alone grew by 60% percent between 1990 and 1995. (Leurdijk et al., 2012).

2.1.3 The Digital Age

Initially, the rise of the digital age was seen as a big threat by the music industry. However, it wasn't the first time that similar statements were made in an industry that holds a plethora of radically innovative periods, for example through inventions like tape and radio (Rogers, 2013). Back in 1989 a group of German engineers from the Fraunhofer Institute for Integrated Circuits found a way to compress music into a format that was able to be transferred through the internet with the use of optic cables, by eliminating all frequencies that can't be heard by human ears. This technique is what produces the digital music format called MP3 as we know it today. With use of this new digital format, consumers were now able to store large amounts of music on hard drives and share them through the internet (Wikström, 2013). Physical music formats like vinyl and CD became less and less important whilst digital solutions gained more and more popularity through the world wide web. As a result, the industry started losing control of intellectual property rights, and by the turn of the century the industry started suffering from falling sales, negative growth and financial losses after years of prosperity.

In their search for an answer to these issues, the industry quickly came to a conclusion, and gave birth to a new phenomenon: *"piracy"* – referring to the practice of file sharing via the internet (Leyshon, 2014). At this point, the internet started changing the classical physical structures of the industry by interchanging them with modernized, digital distribution networks. Furthermore, the internet facilitated communication throughout the whole distribution chain and lowered the entry barriers by decreasing transaction and production costs. This allowed more specialized companies to replace the dominance of the major record labels (Graham, Burnes, Lewis, & Langer, 2004).

At the helm of this major industry change was a company named *Napster*, a so called *peer-to-peer* (P2P) file sharing network that allowed users to share unauthorized MP3 files overnight, for free and with just the simple click of a button. When trying to compete with illegal alternatives that are essentially free of charge, the legal versions would need to be just as convenient. This meant that the perceived value of an album dropped from fifteen dollars to nearly zero dollars (Mulligan, 2015). A lot of research was done during these years, and their conclusions wildly varied. Where some studies stated that piracy was breaking down the industry, others argued that unauthorized file-sharing drove consumers to spend a lot more money on different segments of the music industry – concert tickets within the live music segment for example (Rogers, 2013).

According to De Leon (2017), the music streaming industry nowadays is generally divided into two different sectors: internet radio (like *Pandora, iTunes Radio*) and so called *on-demand* platforms (like *Spotify*, *Deezer*). Apple was the first company to successfully tap into the digital music market with the introduction of its online music retailing service *iTunes* in 2003. Because iTunes encompassed the same sense of simplicity that Napster offered its users, it was very efficient in convincing rights holders and consumers to embrace it. However, it was still not as attractive as the illegal market was to many (Wikström, 2013). After several years of struggling, the industry finally managed to regain control of the digital side of the music industry by moving from an *ownership* model to an *access* model. Spotify was one of the first *digital service providers* (DSP) to introduce such a cloud-based music access model in 2006 (Mulligan, 2015).

Music streaming services like Spotify and Deezer mainly earn revenue through two different streams: advertisement and subscriptions. Consumer that do not wish to pay for a subscription have to deal with advertisements. Those who pay for a subscription get their advertisements removed (Rethink, 2013). After over a decade of decline, the music industry showed its first signs of recovery in 2012 thanks to the impressive growth of the digital music sector. However, the market is still very much in recovery. Companies like Spotify, Apple Music and Deezer have yet to turn a profit while record companies like Universal lost major parts of their business and still need time to recuperate from their recent investments. However, they still believe there is huge potential to grow (IFPI, 2018).

Driven by online engagement and streaming services, digital revenues are now accounting for over half of the market. By the end of 2017, 176 million worldwide users were subscribed to paid music services. However, total industry revenue was still 30% lower than during the market's peak in 1999. Figure 1 provides an overview of the music industry revenues between 1999 – 2017 (IFPI, 2018).

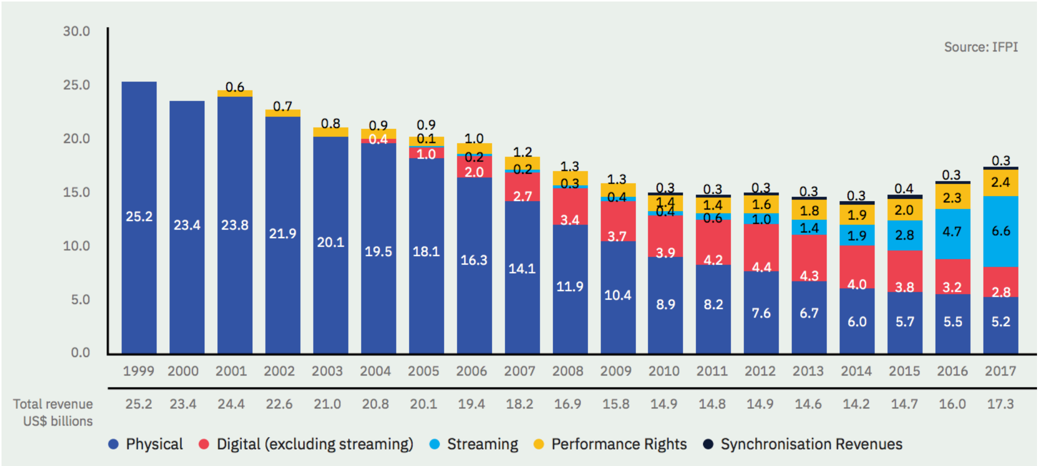

Figure 1 –'Global recorded music industry revenues 1999 – 2017 (US$ Billions)' (IFPI, 2018)

The decline in revenue did not affect all stakeholders similarly. As a matter of fact, artists and songwriters were the most negatively affected because of the introduction of DSP's like YouTube and Spotify into the supply chain. As a result, the supply chain saw an increase of information asymmetries which strongly impacted the music industry's revenue model. (Richardson, 2014) For a more detailed overview of the music industry's supply chain and its components, see sections 2.3 and 2.4.

As shown in figure 2, the recorded music market is now divided into five different revenue segments including revenues from physical sales, digital sales of songs and albums, streaming subscriptions, and synchronization revenues. Figure 2 shows each segment's market share in 2017 based on information by Warner Music Group (2017) and the IFPI (2018).

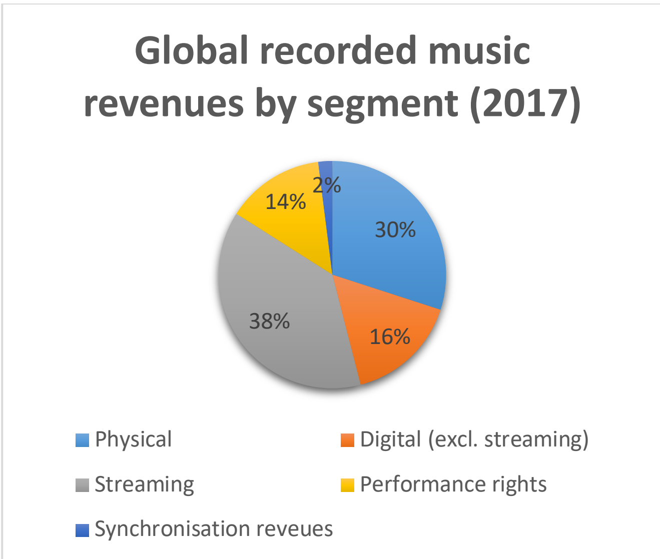

Figure 2 – 'Global recorded music revenues by segment (2017)' – adapted from Warner Music Group (2017) and IFPI (2018)

The music industry's growth is fuelled by paid subscription revenues since 2016. Streaming has not only been embraced by the music industry and its consumers, it has managed to open up a new world of opportunities driven by modern technology (Rogers, 2013). Professional streaming platforms and online music sharing websites are the most popular way to access music online for European consumers in 2016, according to a study carried out by Statista (2017) with about 14,000 respondents aged between 15-45. The results can be seen in figure 3.

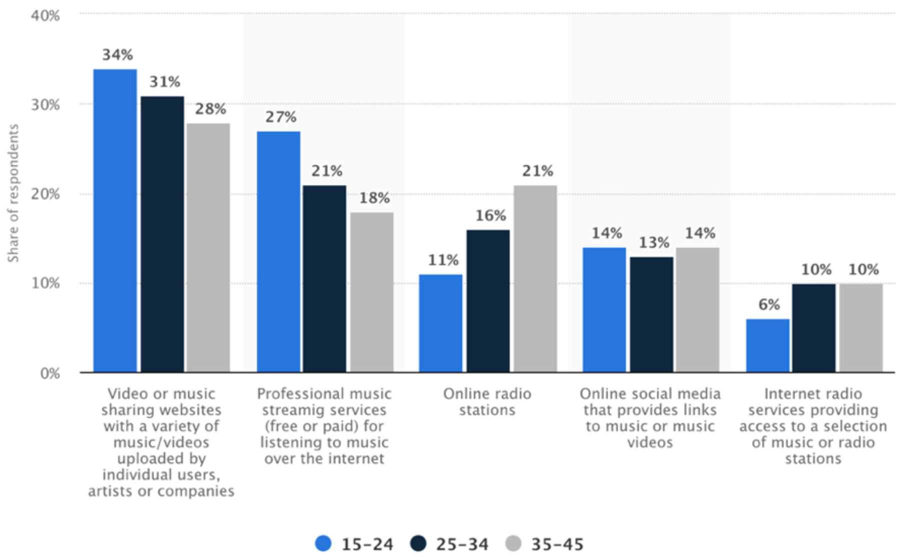

Figure 3– 'Types of services used to access music online in Europe in 2016, by age' (Statista, 2017)

As of October 2018, Spotify registered 5.243.000 people in the Netherlands alone. This means that they are now delivering their service to 36.2% of the entire Dutch population and are part of the top 30 most used platforms in the Netherlands, surpassing *Netflix* and *AliExpress*. This astonishing increase of over 20% (since 2017) shows once more that digital service provides are continuously gaining ground in the music industry (Gfk, 2018). To get a further idea of what the global music streaming market looks like, figure 4 shows the amounts of subscribers and the relative market share in percentage for the eight most popular DSP's in 2018 (MIDiA, 2018).

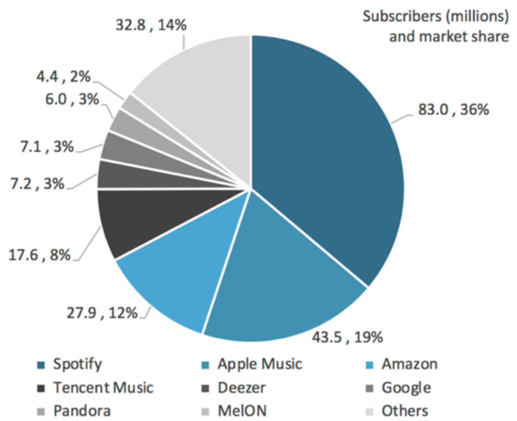

Figure 4 - 'Subscribers (millions) and market share of DSP's in 2018' (MIDiA, 2018)

2.2 Stakeholders

2.2.1 Major Record Companies

The music industry as we know it today is dominated by large multinational music firms called *majors*, and various small and medium sized enterprises (SME's). The presence of majors started during the 1980's, when the *'big six'* – EMI, CBS , BMG, Polygram, WEA and MCA – initially settled down as the dominant record companies in the industry. By 2004, Sony bought CBS Records to form Sony Music and subsequently merged with BMG under the same moniker (BBC, 2004). Polygram merged with MCA and then formed Universal Music Group, which also took over a majority of EMI's recorded music interest (The Guardian, 2012). Nowadays, EMI is part of Sony as a subsidiary of Sony/Atv Music Publishing with Sony owning a 90% stake in the company (The Guardian, 2018). This means that the industry is now composed of three major record companies, as opposed to six. Originally the main functions of the majors were to acquire master recordings and to promote, distribute, and sell copies of these recordings to the end consumer. However, since physical sales have been declining, their main focus has primarily shifted to the exploitation of intellectual property rights. Many of the majors originated as record labels, but have grown into publishing, distributing, retailing and other functions. (Aris & Bughin, 2005).

Table 5 gives a more detailed overview of the majors in their current state, based on information from the IFPI (2018) and Music Business Worldwide (2018). The numbers are based on the global sales of recorded music in 2017, and their comparison to the previous year in percentage.

Revenue type	Universal Music Group	Sony Music Entertainment	Warner Music Group
Total revenue	$5,152m (+9.76%)	$3,852m (+5.35%)	$3,127m (+10.58%)
Streaming revenue	$2,227m (+11.28%)	$1,648m (+25.97%)	$1,435m (28.22%)
Physical revenue	$1,306m (-4.13%)	$1,171m (-8%)	$663m (-6.33%)
Total revenue share (2018)	42.47%	31.75%	25.78%

Table 5 - 'Overview of the major stakeholders' revenue streams in 2017 and 2018' - adapted from IFPI (2018) and Music Business Worldwide (2018)

According to Leurdijk et al. (2012) many independent SME's in the music industry have distribution deals with the majors or operate independently under their wing. Since independent SME's are generally more flexible they provide a solid foundation for creativity and innovation to flourish. Also, they are more capable of tapping into niche markets – the majors help them to finance their activities and leverage their intangible assets (copyrights).

2.2.2 Main Stakeholders

Table 6 gives an overview of the main stakeholders involved in the music industry's supply chain, based on information by Fetscherin (2004), Mulligan (2015) and Shepard (2017).

Stakeholder type	Activities performed	Example
Songwriter	Creation of musical content, mainly by writing texts and melodies. Some performers also act as songwriters and vice-versa.	Bob Dylan, Stevie Wonder
Performer	Actual performance of the musical content.	Jimi Hendrix, The Beatles
Record Label	Forming the brand that governs the promotion, distribution and sale of audio recordings, as well as Artist & Repertoire (A&R) activities through which new talent is discovered and supported. Separated into small labels (indie) and large multinational corporations (majors).	Motown Records, Warner Music Group
Digital Music Distributor	Delivering digital music files from the record label (or artist) to the Digital Service Providers.	TuneCore, Songflow, Distrokid
Physical Music Distributor	Delivering physical music from record labels/artists to physical retail stores. Often physical distributors also facilitate deals between producers of the physical product and the artist/label. Some distributors also act as retailers and vice-versa.	Bertus, Juno
Publisher	Acquiring and registering copyrights for musical compositions. Promoting and authorizing the use of these compositions in recordings, radio, television, motion pictures, live performances, print and other media. Distributing sound recordings to wholesalers, retailers or (in some cases) directly to the public. Some publishers also act as record labels and vice-versa.	Sony/ATV, BMG, Universal
Performing Rights Organization (PRO)	Collecting performance royalties in the name of performers and songwriters, protecting intellectual property.	Buma (NL), Sabam (BE)
Mechanical Rights Organization (MRO)	Collecting mechanical royalties in the name of performers and songwriters.	Stemra (NL), Sabam (BE)
Digital Service Provider (DSP)	Delivering digital music to end users by providing downloads, on-demand streaming or digital radio. Also referred to as 'aggregator'.	Spotify, Deezer, iTunes
Physical Retailer	Distributing physical music formats like vinyl and CD by providing them through online- or offline stores.	Plata Morgana, Decks.de, Juno

Table 6 - 'Overview of the main stakeholders in the music industry' – adapted from Fetscherin (2004), Mulligan (2015), and Shepard (2017)

2.3 The Downstream Supply Chain

Since this research is mainly focused on recorded music in the digital era, this subsection will provide an overview the downstream supply of recorded music including the newly introduced DSP's. The supply chain starts with songwriters and performers. Even though these are generally handled as separate entities by law, they are both the ultimate rights holders and they are treated very much alike. However, since they are a very scattered and autonomously operating group of stakeholders, their leveraging power towards other stakeholders tends to be weak – especially in the case of independent/small artists. This also weakens their position in the value chain and affects their income from the licensing agreements they make with labels and PRO's (De Leon, 2017).

Artists and songwriters get their music produced into a song structure with producers, whom get their music enhanced sonically by a mastering engineer in order to make sure their music sounds optimal in a variety of settings (i.e. nightclubs, car radios and laptop speakers) (O'Dair, 2016). This results in a *master recording*, that is sent to record labels whom take care of the financing, recording, manufacturing, promotion and marketing of the music. The manufactured end products (either digital files or physical products like vinyl and CD's) and their licenses are then delivered to the distributors whom make sure they end up in physical retail stores, or at the online portals of DSP's (also referred to as *aggregator*). In turn, artists often receive advance payments. Furthermore, publishers make sure that the songwriter's and performing artist's rights are registered with PRO's. This flow from the creator to end consumer is shown in figure 5 (Hosoi, Joseph, Stainken, & Caro, 2016).

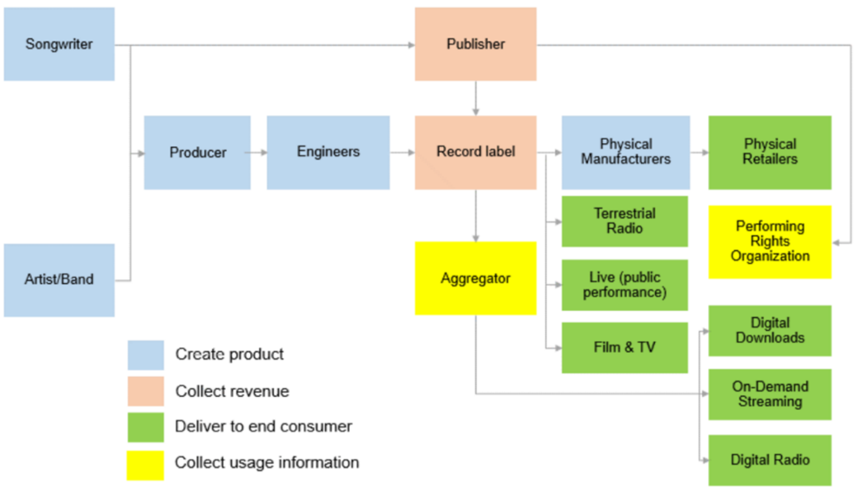

Figure 5 – 'Recorded music supply chain in the digital era (big artists)'(Hosoi et al., 2016)

2.4 The Upstream Supply Chain

After the end consumer purchased the product, an upstream supply chain from end consumer to creator comes into play that deals with financial streams in the form of royalties. In order to be able to pay royalties to the rightful owner, an intricate web of intellectual properties and their registration is involved. This subsection aims to provide an overview of the upstream supply chain of recorded music by taking a look at the various kinds of intellectual property that are present, and explaining the types of licenses and corresponding royalties that are attached to them. Furthermore, it looks at some of the issues that are experienced.

2.4.1 Recordings And Compositions

Even though a *'song'* is mostly referred to as a single entity, the music industry commonly separates it into two different elements: the *musical composition* itself, and the *sound recording* of this composition.

Music Composition
The music composition is everything about a song that can be written down on paper. This includes *notes, chord progressions, arrangements, melodies, lyrics* and so forth. Generally, the *composer* (classic term) is the person whom writes down the composition in different music genres. In case lyrics are involved, songwriter is the contemporary term. Songwriters obtain copyrights for their music compositions. In case a song has multiple authors, the copyright is often broken down in percentages (Rosenblatt, 2017). Music compositions can be identified with use of their corresponding *International Standard Musical Work Code (ISWC).* ISWC codes are used to prevent confusion in case musical works share similar titles, or when musical works are distributed across national boundaries and allow easier digital tracking (ISWC, 1995).

Sound Recording
A recording artist performs (parts of) a musical composition in a recording studio. By doing so, the recording artist creates an audio recording over which they have the exclusive right to copy, distribute and perform. Sound recordings can be identified by their *International Standard Recording Code (ISRC).* ISRC codes work similarly to ISWC codes; they prevent confusion about ownership and allow producers to take claim and control their work (Sena, 2014).

2.4.2 Copyrights and Ownership

According to Sullivan (2015), a copyright can be defined as "a legal right that grants the creator of an original work exclusive rights to determine whether, and under what conditions, this original work may be used by others". In the music industry, copyrights come into existence when music is created by songwriters or performed in a studio by recording artists. Music publishers represent songwriters and their copyrights on compositions through publishing contracts, which often pay the songwriter a signing bonus or publisher advance. The publishers in turn handle the distribution of the copyright and their corresponding licenses, and make sure the copyright is registered to the artist so they can receive royalties from the PRO.

On the other hand, recording artists and their copyrights on sound recordings are typically represented by record labels. The label managers handle the reproduction and distribution licenses. Furthermore, they manage licenses for other purposes like *remix licenses* through which other artists use the sound recording in their own music, and *sync licenses* through which parts of the sound recording are used in video applications (ie. television commercials) (Rosenblatt, 2017). There are different types of rights involved with licenses – governed by publishers or labels – that in turn generate a different type of royalty. These are explained in-depth in section 2.4.3.

2.4.3 Royalties and Licenses

Royalties are the financial streams connected to recorded music which form a vital source of income for most artists and songwriters in the music industry. The type of royalty payment is dependent on the type of license that is involved. To make a clear distinction, most royalties fall under four different categories as described by Leurdijk et al. (2012), Rosenblatt (2017) and the PRS for Music (2018):

Performance royalties	Performance royalties are paid to copyright holders and grant a license to perform the music in public. This also includes music played on the radio or in public places like a nightclub or a restaurant. The royalties apply to both sound recordings and musical compositions, which means that the public performance license generally has to be obtained from both a publisher and a record label. Performance royalties are commonly collected by PRO's.

Mechanical royalties	Paid to copyright holders, grants a license to copy and sell music on a mechanically reproduced medium like vinyl or CD, but also digital downloads and streams. The term *mechanical* still stems from the pre-digital era. Mechanical royalties are commonly collected by *Mechanical Rights Organizations (MRO's).*
Synchronization royalties	Paid to copyright holders, grants a license to use (or 'synchronize') music with visual media output like tv commercials, movies or video games. These royalties apply to both sound recordings and musical compositions. Synchronization royalties are commonly collected directly through the publisher.
Print royalties	Paid to copyright holders, grants a license to transcribe musical compositions in order to print and distribute or reproduce them on paper. In these days, print royalties are the least common type of royalty. Print royalties are commonly collected directly through the publisher.

2.4.4 Royalty Flows

In order to get a clear understanding of the different upstream flows that come into play when licenses are granted and royalties are due, the figures below show a simplified example of the most common process flows. In general, nearly every middleman mentioned below takes a royalty share ranging between 10-30% of the total amount (Thomson, 2015). The figures below are based on information by Thomson (2015) and Rosenblatt (2017), and adapted to fit the Belgian and Dutch markets.

Upstream Royalty Flows For Musical Compositions

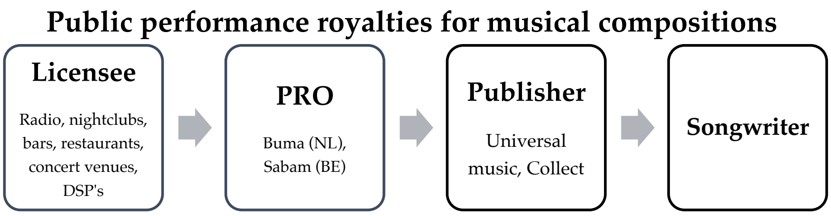

Figure 6 – 'Royalty flow for public performance royalties of musical compositions' - adapted from Thomson (2015) and Rosenblatt (2017)

Mechanical royalties for musical compositions

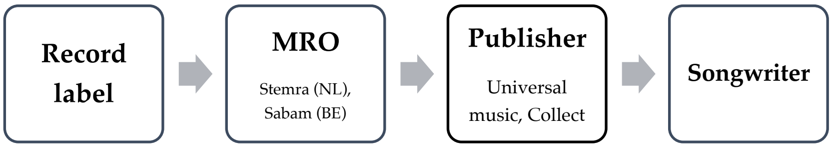

Figure 7 – 'Royalty flow for mechanical royalties of musical compositions' - adapted from Thomson (2015) and Rosenblatt (2017)

Synchronization royalties for music compositions

Figure 8 – 'Royalty flow for synchronization royalties of musical compositions' - adapted from Thomson (2015) and Rosenblatt (2017)

Print Royalties for music compositions

Figure 9 – 'Royalty flow for print royalties of musical compositions' - adapted from Thomson (2015) and Rosenblatt (2017)

Upstream Royalty Flows For Sound Recordings

Public Performance royalties for sound recordings

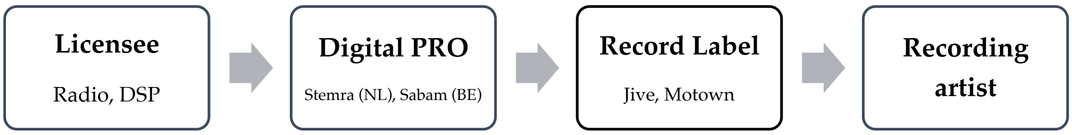

Figure 10 – 'Royalty flow for public performance royalties of sound recordings' - adapted from Thomson (2015) and Rosenblatt (2017)

Synchronization for sound recordings

Figure 11 – 'Royalty flow for synchronization royalties of sound recordings' - adapted from Thomson (2015) and Rosenblatt (2017)

In order to get a complete and detailed overview of all of the process flows in the recorded music industry, please refer to Appendix A.

2.5 Problem areas In Royalty Payment Processes

The industry is dealing with a variety of problems when it comes to royalty management processes. This subsection shortly describes the main problem areas that stood out when studying existing literature. These are subsequently used as a backbone in the interview process. Building upon the interview data, chapter three will intend to provide a more in-depth look into these issues and their causes, as well as other issues that came forth from the data.

Data Management	Stakeholders along the whole supply chain are struggling to manage and process the enormous amounts of data involved. (Berklee, 2015; IFPI, 2017)
Transparency	Non-disclosure agreements and non-transparent business processes are plaguing the supply chain. This seems to highly influence efficiency and trustworthy relationships, and validity of data (Berklee, 2015; Jacobson, 2017; Rogers, 2013)
Technology and innovation	The industry is dealing with outdated technology that makes it difficult to for stakeholders to understand and process each other's data. This is strongly affecting efficiency and progress in times when it is most needed. (De Leon, 2017; Heap, 2017; IFPI, 2017)
Industry politics, laws and regulations	There is ample room for improvement in the field of industry politics, laws and regulations. The value gap in which artists are underpaid and through which huge black boxes are accumulating, as described accordingly by the IFPI (2017), is for the most part caused by irregularities in this field.

2.6 Conclusion

This literature review in this chapter shows that the music industry can be divided into three different segments; sound recording, music publishing and live performing. The industry has a rich history in which it has shown to be resilient to many different radical innovations like the vinyl record and the CD. However, the digital age has proven to be the most challenging yet. The introduction of DSP's and the birth of online piracy has created new, challenging business models that have caused majors declines in revenue since the industry's peak in 1999. However, recent years have been showing signs of improvement. Paid subscription revenues seem to have opened up a new world of opportunities driven by modern technology, and as a result, revenues are slowly crawling back up.

Literature has also shown that the record industry exists of a complex web of stakeholders and processes. The main stakeholders in the digital era are songwriters and performers, record labels, distributors, publishers, rights organizations, digital service providers and physical retailers. Major record companies have been holding a firm grip on the industry since the 80's, constantly expanding their field of business into that of other stakeholders - with many SME's operating under their wing. At the same time, royalty management processes in the down- and upstream supply chain are becoming increasingly complex. According to the literature reviewed, these issues mainly relate to the fields of data management, transparency, technology and innovation, industry politics, laws and regulations.

3 Issues In Royalty Management Processes

3.1 Introduction

This chapter will take an in-depth look at the issues that are experienced in royalty management processes based on data provided by music industry professionals through semi-structured interviews. As described in chapter one, the analysis is based on the grounded theory approach and aims to provide a detailed overview by systematically categorizing the data into themes. The end of this chapter will conclude the findings of the analysis, and with that form the basis upon which the subsequent chapters will build.

3.2 Data Analysis

The data shown in the tables 7, 8 and 9 comes forth from the interview transcripts. The transcripts have been dissected into specific issues (white column), which have then been connected to the color-coded problem areas. These problem areas were subsequently grouped into three overarching themes that are similar to the problem areas that came forth from the literature review in section 2.5: "Data Management", "Technology & Innovation" and "Laws, Regulations and Politics". In other words, the tables have been categorized from right-to-left, but are read from left-to-right. As most of the issues regarding transparency in the music seem to be related to data, the choice has been made to categorize that theme under data management instead.

Please note that the numbering used in the columns is not based on any kind of hierarchy, but purely used as a tool for referral. Also, the annotations P1 to P7 represent the interviewees mentioned in chapter one, in random order. This is done in order to keep a certain degree of anonymity, since some data can be regarded as sensitive.

3.2.1 Data Management

Data Management

Problem Area 1: Data Processing

1.1 Lack of data display

P1: "A lot of the issues we experience are to do with getting the data from the PRO's and providing it in an easy and understandable way to our customer. That is difficult because the data is a mess."

P5: "With regard to data analytics, bar to none is shared by DSP's so it's hard to get an overview of the data."

"Adding statistical insights to royalty systems would be a big plus to me. Then you can actually get some insights into your music and use it to your advantage – this is interesting to many stakeholders including artists, labels, distributors etc."

"DSP's should provide some form of statistic from their own royalty systems, like Spotify does in a way. So you can see where listeners come from, how many clicks were generated, where they geographically come from, which device was used etc. Many DSP's don't provide insights into what they do."

P6: "If there is a standardized reporting format, it will increase transparency toward the artists because it enables companies to create proper overviews of their data."

P7: "We have to make proper statistical overviews of the statements ourselves because we have to present it to our labels."

1.2 Complexity & Quantity

P1: "We have to put everything into a spreadsheet line-by-line, which is extremely time consuming."

P2: "Spotify created tons of extra data and we are totally not capable of processing it at this moment."

"I know someone that manages very old, highly popular compositions with more than 2000 versions. It's incredibly difficult to monetize them because every country has its own way to process data."

P3: Data processing is complex and time consuming. I sometimes get an excel file with 250000 lines coming from 10 different DSP's that I have to process manually."

"If I make a single mistake when processing data, it tends to automatically cause a lot of issues. If I can't locate the error, I have to redo all of my work."

P4: "Many artists don't have the knowledge or time to process royalty statements"

"Royalty statements are very unclear. There are hundreds of pages with information.

P7 "The royalty statements are huge and have so many tiny amounts in them, this is one of the biggest issues."

"The statements are so big and unclear, it's very hard for artists and labels to get their head around where the money comes from."

1.3 Difficult to match data

P1: "Sometimes we get 75 different versions of a song, but you don't know what version is going to be the one that gets all the radio airplay and where the money is. If some weird, unproperly registered version of a song is used a lot, the money will get lost"

P2: "Compositions have an ISWC code and recordings have an ISRC code. The problem is connecting these two, and keeping them connected, like for example when an acoustic cover is made on youtube, then it's very difficult to connect it to the composition. This happens a lot."

P3: "There is currently no clear connection between ISWC and ISRC codes. This makes it difficult to pay the rightful owners in an honest way"

"Especially the link between compositions and their recordings is an issue: it is completely missing so it is really hard to connect them."

1.4 Lack of standardization

P4: "One solution would lie in a worldwide consensus on how to deal with data and payments."

P6: "What stands out to me is that nothing is standardized. I would've expected some kind of standardized reporting format, but it's just not there. We have to process data from many different DSP's and all of the files we get are different formats using different calculations."

"Now, maybe nine DSP's provide a country of origin in their data and one doesn't. Then all the statistics are incorrect and the report is a lot less trustworthy and valuable."

"If there was a standardized reporting format, this would allow independent companies around the world to improve their systems as well."

Theme	Problem Area	Issue	Participant	Quote
Data Management	Problem Area 2: Data Collection	2.1 Poor Monitoring Methods	P1:	“In some countries they listen to the radio for an hour per week and use that as a basis to pay artists. If your track was not played in that one hour, you will not get paid as an artist”
			P2:	“A lot goes wrong when music ends up on TV or the internet. It is not monitored properly so we don’t know where and when exactly something has been broadcast and whether the PRO has paid the correct amount”
			P3:	“PRO send out massive files with lists of unclaimed music to all possible claimants. They can then look at the lists and claim what’s theirs. A lot of it gets either double claims or no claims at all.”
			P4:	“We still don’t know where which song was played by whom, which remix it was, who the lawful owners are, etc.”
		2.2 No Verified Public Database	P3:	“There are no publicly available databases to source information from. There are several independent open-source models like music brains, but these aren’t verified sources. You’re highly dependent on information from record labels or PRO’s.”
			P6:	“The idea of a global music repertoire excites me. Although, if it comes into existence it has to be open source; not something set up by one of the majors for example.”
	Problem Area 3: Data Registration	3.1 Wrongly Registered Data	P1:	“Often times artists don’t even know what tracks they have made – they definitely don’t tend to have a complete list. There are even cases of spelling mistakes that cause the system to be unable to match up their data”
				“Sometimes we get 75 different versions of a song, but you don’t know what version is going to be the one that gets all the radio airplay and where the money is. If some weird, unproperly registered version of a song is used a lot, the money will get lost”
				“There are plenty of artists and labels that have had registrations set up 15/20 years ago and never gave it a second thought. They assume that because there’s some money coming in, everything is done correctly. But often times it is not.”
			P3:	“DSP’s are responsible to pay royalties to the rightful owner – the problem is that they don’t know who they are because the music isn’t registered properly.”
			P4:	“It is important that metadata is properly registered, and that names of artists are mentioned properly on DSP’s like Spotify and Youtube. If that’s registered incorrectly, royalties won’t be paid out. I have many examples of this happening.”
		3.2 Unregistered Data	P2:	“A lot of music is not registered with the PRO’s in the world of sync royalties. Especially when the publisher is an advertising agency, because they do not see any benefits in it.”
	Problem Area 4: Data Transparency	4.1 No provision of data	P1:	“If you give PPL a mandate to collect royalties for you, they won’t provide very detailed data.”
			P4:	“It is very difficult to check whether the source of the information in statements, and the corresponding calculation, is correct because this data is not publicly available. Now it’s all based on good faith.”
			P6:	“I still don’t understand why a record company is unable exactly explain the artist where his music was listened, how much, by whom etc.”
		4.2 No insight into processes	P2:	“From my point of view, I feel like the royalty processes for the composers that I work with aren’t very transparent
			P3:	“I certainly do not find the royalty management processes transparent because the artist rarely has any insight in what happens in the money flow. I believe there is a lot of room for improvement.”
				“However, artists can’t directly calculate their income relative to the amount of plays. It is dependent on many different factors like the country it was played in and there’s not enough insight into these factors. Some of those factors make a huge difference.”
				“Transparency is absolutely a threat to the majors, they have no benefit from it so they keep their processes to themselves.”
			P7:	“For pressing vinyl we have to pay mechanicals to the PRO. We’re supposed to get that back, minus their fee. But after 20 releases we still haven’t seen any of it and we have no idea where the money’s gone.”
		4.3 Data Protection	P4:	“A common excuse used in the industry is to say that their lack of transparency comes forth from the fact that a lot of their data is interconnected with private company data.”
				“Not all companies in the supply chain want to be open about the deals they make with each other or the information they have access to.”

Table 7 - 'Data management in the music industry: problem areas and issues'

3.2.2 Technology & Innovation

Theme	Problem Area	Issue	Participant	Quote
Technology & Innovation	Problem Area 5: Technology	5.1 Using Outdated Technology	P1:	"Technological development is definitely behind in the music industry. A lot of PRO's are very old fashioned and backwards which leads to a lack of innovation.
			P2:	"The hardcore backend of the music industry runs on extremely old technology – like the Common Work Registration (CWR) dating as far back as the 70's." "We cannot process Spotify's huge amount of data because we are forced to work with this outdated technology"
			P7:	"A lot of money gets lost in the void because the systems are so antiquated, but there are still more and more companies that get better at finding solutions to track down the royalties for artists and labels."
		5.2 Not- Or Misusing Technology	P1:	"I was speaking to one of the majors last week and he said they're happy with music recognition technology because it increases efficiency, but it efficiency doesn't outweigh the amount it hurts them as a business" "Up until recently there wasn't really any music recognition technology but recently some countries started implementing it, and it works amazingly well to collect data" "The majors have recently started working together on creating a 'golden recording', which links all the different versions of a song to that single version to make sure the registration is correct worldwide."
			P2:	"Very few companies use automatic recognition software to track their music. But it is definitely worth the time and energy because it can yield a lot of money in the end. There are just a few 28ehavior28ed companies that do this."
			P2:	"A lot of companies are trying to replace existing technologies. However,I think that we will be able to use new technologies in the end by combining them with existing systems, rather than fully replacing them."
			P4:	"Fingerprinting technology is not used very often, while it would be a good solution to the issues we have with data collection. The technology is already pretty developed, and could easily be connected to existing tech like KUVO from pioneer or the set-list app from SENA."
	Problem Area6: Innovation	6.1 Lack Of Interest	P4:	"There isn't really a necessity for innovation to a lot of stakeholders. It's mainly important to the artists and their own efficiency." "It is easier for companies to let the untraced money sit in a black box and generate interest revenue than to make sure it's paid to the right people."
			P7:	"It is not in their benefit to figure out how to give people more money – it's not in their interest so they drag their feet as long as they can. Eventually they'll have to do it."
		6.2 Slow technological Progress	P3:	"Innovation is really slow paced. I've been in this industry since 2004 and little has changed." "Internationally, some majors are talking about standard data formats like DDEX, but there is certainly not enough progress and implementation at this point while the DDEX working group has existed for years."
			P5:	"It took the industry years to embrace the technology that industry 'enemies' like Napster introduced. The entertainment industry as a whole just develops itself so slowly. They should take an example from the adult industry, which is always 40 steps ahead."
			P7:	"Even though they've got millions of euro's and pounds to spend on new technology, they're still playing catch-up. The industry has been talking a long time about getting the statements more streamlined."

Table 8 - 'Technology & innovation in the music industry: problem areas and issues'

3.2.3 Laws, Regulations & Politics

Laws, Regulations and Politics

Problem Area 7: Politics

7.1 Corruption

P1: "In some countries there is a lot of corruption involved with the PRO's"

P7: "Some PRO's are really crooked and I'm pretty sure there's money going to politicians here and there."

7.2 Political Influence

P1: "Many of the PRO's around the world are non-profit, government chosen monopolies. We can't change what they do according to law, and we can't lobby in 55 different countries. "

P2: "Let's not forget that the majors held a lot of Spotify shares, which had an influence on the industry's progress"

P4: "The global music registry failed in 2014 because many of the big stakeholders in the industry left the negotiation table. They don't have any benefit from having detailed insights into where the money should go."

Problem Area 8: Policies & Procedures

8.1 Company Culture

P1: "Buma/Stemra couldn't justify their administration fees relative to their spending. Since they're non-profit, they started to do invoices and tax administration one year ahead. As a result they can get more bonuses and staff, and ultimately more money to spend"

"The collection societies are understaffed while having to handle millions and millions of tracks and euro's."

"As a publisher, a lot of people I know started working at a PRO and left after a few years; it's a good way to get to know how the industry works but it's not good for their organization."

P2: "Some majors get to keep between 20 to 60 percent of what's left of the publishers share at the end of the year, which is a very weird an unfair system because they don't put in the work required. They like to keep it like this."

P4: "Buma/Stemra are very careful about taking a position regarding technological innovations like Blockchain. Unless they have one, they avoid the discussion."

P7: "There's too many people involved in the PRO's keep changing around constantly. I'm sure they're pretty much all the same in that sense."

"All of the PRO's seem to work in a very similar fashion."

"If I want to contact someone at a PRO I have to e-mail a standard e-mail address and I get a number which I have to use to communicate with – it can take forever to get a response and it's a very unpersonal way of communicating. Sadly, this is embedded in their culture."

"As a distributor I can't talk to somebody from a specific department if needed, just people that deal with FAQ's."

"For the moment it is still a mess, I get these huge excel sheets from PRS that is unmatched income from DSP's. I don't understand why. We are a distributor, all info we give to them is correct; ISRC codes and everything. Then somehow, in between sales via the DSP and getting back to the PRO information suddenly disappears and they act like they don't know who the money should be paid to. I don't get this at all."

8.2 Bureaucracy

P1: "Sometimes it takes 8 weeks to process and post data registration forms manually because of bureaucratic reasons – often thousands at a time."

"Some countries like Germany and Spain only accept physical registration documents because they have to do so by law."

P7 "Whenever we register stuff with Buma/Stemra, for some reason they send me stuff that I have to sign. And they don't even do it on a regular basis, sometimes they do sometimes they don't."

8.3 Black Boxes

P1: "There are massive black boxes that exist of unclaimed money. It sits there gaining interest and after a certain amount of years it will be divided by members of the PRO based on shares or it will be used to sponsor cultural events or bonuses – like Buma/Stemra does with Amsterdam Dance Event (ADE)"

P2: "The majors end up profiting since they have all of the big artists that are losing money because of errors in the systems, while the money accumulates in their blackboxes"

Theme	Problem Area	Issue	Participant	Quote
Laws, Regulations & Politics	Problem Area 8: Policies & Procedures	8.4 Messy Royalty Statements	P3:	"CCID invoices are causing the biggest blackbox at this moment."
			P4:	"There has to be a way for both parties involved in the sending and receiving of royalty payments to verify which calculation or source has been used for certain kinds of information. Responsibility for proper verification should also be put with both parties involved, not just one."
			P7:	"I often have get paid in Pounds and my statements are in Euro's… then I have to try and match it to a statement because there is no reference number used. Matching payments is a job in itself, you just can't tell which one's which. Then they often link to another set of statements which they call STMP group statements in which they link different statements together." "They send me this group statement with many different statements combined, but I get them individually as well. And to make it even more confusing they will stick some of them on an FTP."
		8.5 Irregular Payments	P4:	"Also, payments occur at irregular intervals which is difficult for some indie musicians that are heavily reliant on a monthly income."
			P7:	"The payments from most PRO's come in randomly as well. It could be three weeks after a statement or they might not even have paid it."
		8.6 Monopolistic Competition	P4:	"Because Buma/Stemra have a lawful monopoly, it's hard to go around them. They either collect everything for you, or nothing at all."
			P7	"Another issue is that there is no competition. Most of these PRO's are government backed. If there would be competition in the market, then I think they should start watching their backs and we would see some progress."
		8.7 Unfair payment distribution	P2:	"What still hasn't changed is that my 10 euro subscription fee with Spotify is still divided based on artist market shares. If I listen to artist X all week, I would want my 10 euro's to go to artist X. Such a 'user centric payment system' is used successfully in smaller alternative platforms."
			P3:	"We get data from the DSP with regard to royalty streams that have to be divided between certain labels on a contractual basis. The way this happens seems very unfair to me because it's mainly based on the amount of plays and revenue market shares. Artists who get played a lot get a big piece of the pie, popular independent artists with very specific target groups don't." "I'm a big fan of user centric licensing; a model in which a DSP's revenue is, for example, split based on subscriptions rather than putting all the money on a big pile and then sharing it based on >30 second plays."
	Problem Area 9: Laws & Regulations	9.1 Outdated laws	P1:	"Many music registration laws have been falling behind for ages "A lot of the issues we experience have to do with the law. The technology is present, but laws dating from the 60s, 70s, 80s and 90s are often making it very difficult to implement"
		9.2 Legal restrictions	P1:	"We can't change what the PRO's do according to law "
			P4	"In America and China there isn't a lot of willingness to change laws in order to make sure that metadata is registered properly."
		9.3 Inefficient Statutes & Regulations	P4	"There are some difficulties with regards to Buma/Stemra's statutes and regulations; especially their regulations with regards to innovation because they're a lawful monopoly." "Organizations should be forced to correctly register their metadata through contracts. This also creates precedents in case errors are made, so people/organizations can't (for example) blame it on their interns – they just didn't put in the effort to get it sorted properly for the artist. This benefits everyone in the end, but mainly the artists." "We need better agreements on registering metadata for music, there is a lot to be won in that field. There are way too many errors made in the registration process."

Table 9 - 'Laws, regulations & policies in the music industry: problem areas and issues'

3.3 Situational analysis and need identification

To aid to the clarity of this chapter's conclusion, the music industry's supply chain will be separated into three different segments, as shown in figure 12.

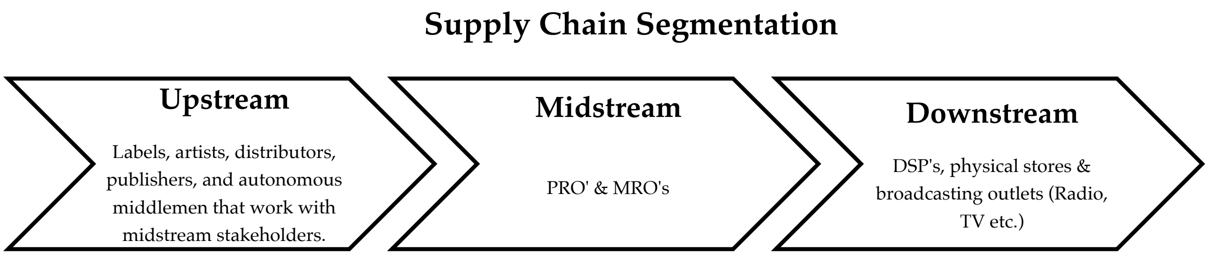

Figure 12 - 'Music industry supply chain segmentation'

The following subsection concludes the data analysis by providing a situational analysis of the issues experienced in the relevant problem areas. Furthermore, it will describe the needs that should be addressed in order to solve the issues at hand. These serve as the building blocks for the blockchain literature review in chapter four, and the possible application areas that are defined in chapter five.

3.3.1 Data Management: Overview

Data Management

Problem Area 1: Data Processing

Issue 1.1: Lack of data display

Situational analysis	Many mid- and downstream stakeholders do not provide any form of data display in order to get an understandable overview of their data. Also, there is no standard format they provide their data in. As a result, upstream stakeholders are struggling to process their data into a viewable format, which drastically affects transparency and efficiency.
Needs	▪ Simplified data display ▪ Verified public database ▪ Standardized data format

Issue 1.2: Complexity & quantity

Situational analysis	Upstream stakeholders are struggling to process the data they receive from mid- and downstream stakeholders. The statements they receive are extremely large in size and often difficult to understand. Furthermore, when processing data from statements there is a very low margin for error: making small mistakes can cause a lot of issues and adds to complexity.
Needs	▪ Simplified data display

Issue 1.3: Difficult to match data

Situational analysis | It is difficult to match compositions and their ISWC codes to recordings and their ISRC code because there is no database with information to easily link this data. Furthermore, songs often have many different versions which makes it difficult for downstream stakeholders to get an overview of which data should be matched.

Needs

- Verified public database
- Simplified data display

Issue 1.4: Complexity & quantity

Situational analysis | There are no industry-wide standardized reporting formats, many downstream stakeholders provide their data upstream in a different way. As a result, upstream stakeholders are struggling to process their data into a clear and understandable format. Furthermore, this makes it difficult for developers to optimize their systems.

Needs

- Standardized data format

Problem Area 2: Data Collection

Issue 2.1: Poor monitoring methods

Situational analysis | Midstream stakeholders are often using very poor methods to monitor both the ownership of sound recordings and compositions and their use by downstream stakeholders like television and radio. As a result, data is often faulty or incomplete and responsibility for correcting errors is shifted upstream.

Needs

- Data recognition tool
- Verified public database

Issue 2.2: No verified public database

Situational analysis | There is a lack of publicly available, verified databases from which stakeholder in the supply chain can source information regarding compositions and recordings. As a result, data is often incomplete or unmatched.

Needs

- Verified public database

Problem Area 3: Data Registration

Issue 3.1: Wrongly registered data

Situational analysis

Upstream stakeholders are often distorting data streams by wrongly registering their data. In case there are errors made during the registration, for example a misspelled artist name, often times royalties can simply not be matched and paid accordingly.

Needs

- Simplified and verifiable data registration process
- Verified public database

Issue 3.2 Unregistered data

Situational analysis

In some cases, upstream stakeholders do not register data when it is in their own self-interest. Advertising agencies that also act as publishers and use compositions for their advertisements for example. As a result, royalties can't be paid out and the licensee is not charged.

Needs

- Verified public database
- Revised data regulations

Problem Area 4: Data Transparency

Issue 4.1: No provision of data

Situational analysis

Mid- and downstream stakeholders often don't respond to data requests from upstream stakeholders. As a result, they can't explain the origin and validity of information specified on the statements, making the data untrustworthy.

Needs

- Verified public database

Issue 4.2: No insight into processes

Situational analysis

Upstream stakeholders barely have any insight into the processes that mid- and downstream stakeholders use to process their data. As a result, it is impossible for small upstream stakeholders to know what how their ending balance was calculated.

Needs

- Transparent and simplified payment processes

Issue 4.3 Data protection

Situational analysis

Downstream stakeholders argue that a lot of the public data is interconnected with private company data, which causes a lot of the data to be kept private in order to protect sensitive information.

Needs

- Revised data regulations

3.3.2 Technology & Innovation: Overview

Technology & Innovation

Problem Area 5: Technology

Issue 5.1: Using outdated technology

Situational analysis	Stakeholders alongside the whole supply chain have to deal with industry standard outdated technology, like the Common Work Registration (CWR) format and software whose core principles date back to as far as the 70's. However, use of this outdated technology seems to be accepted by midstream stakeholders as they adhere to an old-fashioned and antiquated approach – which is not beneficial to upstream stakeholders as they struggle to process the constantly increasing amounts of data.
Need(s)	▪ Progressive industry regulations

Issue 5.2: Not- or misusing technology

Situational analysis	At this point in time a lot of existing technology is not being used, or not being used to its full potential. Furthermore, it is mentioned that the industry should not try to place existing systems as a whole, but rather merge them with modern technology. Mentioned are fingerprinting technology (like the app Shazam) and other music recognition technologies. The reason for this is that implementation of these technologies is mainly being governed by major mid- and downstream stakeholders, whom have little benefit from efficiency as it costs them money in the long run. For now, these modern technologies is mainly used by specialized upstream companies.
Need(s)	▪ Progressive industry regulations

Problem Area 6: Innovation

Issue 6.1: Lack of interest

Situational analysis	As mentioned earlier, mid- and downstream stakeholders tend to have no interest in innovative solutions that increase their efficiency. Efficiency ultimately means that they have to pay more money to upstream stakeholders, rather than collecting it in their black boxes, earning interest revenue and using it for PR purposes.
Need(s)	▪ Progressive Industry regulations ▪ Increased Decentralization

Issue 6.2: Slow technological progress	
Situational analysis	Innovation and adaptation to the digital era has been moving at a really slow pace. Working groups exist for years before decisions are made – if they are even made in the end – and opportunities for innovation are either seen as a threat or very slowly adopted. Little example is taken from other industries while the budgets for R&D are certainly there.
Need(s)	▪ Progressive industry regulations

3.3.3 Laws, Regulations & Policies: Overview

Laws, Regulations & Policies

Problem Area 7: Politics

Issue 7.1: Corruption

Situational analysis

Some interviewees mention that it is difficult to deal with some of the midstream stakeholders because they operate in corrupt environments, both internally as well as externally.

Need(s)

- Reforms on macro level
- Reforms on micro level

Issue 7.2: Political influence

Situational analysis

Since many of the midstream stakeholders are government backed monopolies, they tend to have a lot of political influence within the industry on national level. Furthermore, organizational political influence has also been exercised by some of the upstream majors through holding share majorities in downstream stakeholders. The blocked attempt to make the *Global Music Repertoire* (a global rights database) in 2014 is a prime example of the political influence the majors have in the industry.

Need(s)

- Increased decentralization
- Reforms on macro level
- Reforms on micro level

Problem Area 8: Policies & Procedures

Issue 8.1: Company culture

Situational analysis

Many of the midstream stakeholders seem to be dealing with a culture that is very focused on their own interest, instead of that of the whole supply chain. They are understaffed and constantly changing staff. As a result it is difficult to build client relationships. This is likely because they believe that having personal relationships with other stakeholders is not in their benefit; just like taking an outspoken position about technological innovations. This type of company culture seems to be guarded through a total lack of transparency and communication, and this shows in many of the applicable problem areas.

Need(s)

- Cultural change

Issue 8.2: Bureaucracy	
Situational analysis	Bureaucracy is negatively affecting efficiency by slowing down data processing and registration processes. For example, countries like Germany and Spain, still deal with physical registration documents. In the Netherlands, the clients of midstream stakeholders are often faced with annoying, inconsistent and seemingly unnecessary bureaucratic processes that .
Need(s)	▪ Simplified and verifiable data registration processes

Issue 8.3: Black boxes	
Situational analysis	The midstream stakeholders are accumulating large amounts of unclaimed money in their so called 'black boxes'. This is in their benefit, because it yields interest money. Furthermore, after a certain amount of years the unclaimed and locked-up black box money can be used to 'sponsor' cultural events like the Amsterdam Dance Event (ADE). These black boxes are reinforced by inefficient business processes and slow paced innovation.
Need(s)	▪ Transparent and simplified payment processes

Issue 8.4: Messy royalty statements	
Situational analysis	The processes between up-, mid- and downstream stakeholders are often inefficient. Payments are sometimes made in Pounds while statements are provided in Euro's. As a result, matching payments to statements is difficult for upstream stakeholders – especially because the statements aren't properly labelled with reference numbers or bundled together.
Need(s)	▪ Transparent and simplified payment processes

Issue 8.5: Irregular payments	
Situational analysis	Payments from mid- and downstream stakeholders often happen at irregular intervals. Mainly independent upstream stakeholders that are dependent on income from downstream stakeholder are often insecure about their monthly income – as they have no insight in how much it will exactly be or when it will exactly arrive.
Need(s)	▪ Transparent and simplified payment processes

Issue 8.6: Monopolistic competition

Situational analysis	Many midstream stakeholders are government-backed monopolies. As a result, there are no alternatives to choose from and there is no incentive for these stakeholders to perform better or innovate, since there is barely any competition to be wary of.
Need(s)	▪ Increased decentralization

Issue 8.7: Unfair payment distribution

Situational analysis	Downstream stakeholders often handle unfair and non-transparent payment distribution methods. Major artists tend to get the biggest piece of the pie based on plays and market share. Furthermore, the payment processes are not transparent. A user centric payment system in which fees are directly based on user's listening behaviour is mentioned as a fair system.
Need(s)	▪ Transparent and simplified payment processes

Problem Area 9: Laws, Regulations & Politics

Issue 9.1: Outdated laws

Situational analysis	A lot of outdated laws and regulations are at the core of many of the industry's issues – dating as far back as the 60s and 70s. As a result, implementing new technology is more difficult and data registration processes are inefficient.
Need(s)	▪ Modernized laws & regulations

Issue 9.2: Legal restrictions

Situational analysis	All of the stakeholders in the supply chain are tied legal restrictions that are difficult to change, both nationwide as well as globally (China and America are mentioned as problematic). This mainly affects data registration- and processing.
Need(s)	▪ Modernized laws & regulations

Issue 9.3: Inefficient statutes & regulations

Situational analysis	The statutes & regulations imposed by midstream stakeholders are holding back innovation. Especially the regulations with regards to the registration of metadata are inefficient and should be changed because the processes are prone to error.
Need(s)	▪ Revision of statutes & regulations

3.4 Conclusion

In conclusion, table 10 summarizes the aforementioned needs, and the issues that are related to them (numbered in random order). These needs will be used as building blocks for the blockchain applications that are proposed and reviewed in chapter five.

Need	**Issue(s)**
1. Simplified data display	1.1 Lack of data display 1.2 Complexity & quantity 1.3 Difficult to match data
2. Verified public database	1.3 Difficult to match data 2.1 Poor monitoring methods 2.2 No verified public database 3.1 Wrongly registered data 3.2 Unregistered data 4.1 No provision of data
3. Standardized data format	1.1 Lack of data display 1.4 Complexity & quantity
4. Data recognition tool	2.1 Poor monitoring methods
5. Simplified and verifiable data registration processes	3.1 Wrongly registered data 8.2 Bureaucracy
6. Transparent and simplified payment processes	4.2 No insight into processes 8.3 Black boxes 8.4 Messy royalty statements 8.5 Irregular payments 8.7 Unfair payment distribution
7. Increased decentralization	6.1 Lack of interest 7.2 Political influence 8.6 Monopolistic competition
8. Progressive industry regulations	5.1 Using outdated technology 5.2 Not- or misusing technology 6.1 Lack of interest 6.2 Slow technological progress
9. Revised data regulations	3.2 Unregistered data 4.3 Data protection
10. Reforms on macro level	7.1 Corruption 7.2 Political influence
11. Reforms on micro level	7.1 Corruption 7.2 Political influence
12. Cultural change	8.1 Company culture
13. Modernized laws & regulations	9.1 Outdated laws 9.2 Legal restrictions
14. Revision of statutes and regulations	9.3 Inefficient statutes & regulations

Table 10 - 'Summary of needs and issues in royalty management processes'

4 Blockchain Technology

4.1 Introduction

The blockchain first came into existence when a mysterious mind named Satoshi Nakamoto – whose name is likely a pseudonym as the writer prefers to stay anonymous – released a white paper titled 'Bitcoin: A Peer-To-Peer Electronic Cash System' back in 2008. In this paper, he first described the blockchain as a "purely peer-to-peer version of electronic currencies" (Economist, 2015). A 'peer-to-peer' network refers to a network of computers that are interlinked through the internet without the use of a central control system. Electronic currencies, like Nakamoto's Bitcoin, are currencies that only exist on a virtual network (Lemieux, 2013).

The underlying architecture that Nakamoto developed in his paper was mainly created with economic needs in mind. For example, he stated that making micro transactions would now become feasible, whereas these were previously impossible to do with a credit card due to payment fees. Furthermore, the time it would take to make a transaction would be a lot shorter with the use of his algorithm because it operates without the oversight and management of the banking systems we are used to. This also meant that there would be a much stronger degree of anonymity for users of the blockchain (Halaburda, 2016). These banking systems and their high transaction fees came into existence because there was a need for a third party to validate, safeguard and preserve transactions in order to prevent fraud (Crosby, 2016). However, what really catapulted Bitcoin's popularity was the distrust in the government that arose from the crisis of 2007-2008. Even though the triggering of the financial crisis had a plethora of reasons, the common thought around its explanation could be found in our economy's reliance on an inherently imperfect central authority (Roth, 2015).

4.2 General Principle

The blockchain is a decentralized distributed database of records, or in other words an online 'book', that keeps track of all of the transactions that are executed within the system and shared among all of its participants. The information that is entered within the system will never be erased, and each transaction that is recorded within the system has to be verified by a majority of participants in order to be accepted as a valid transaction. Because it is decentralized, there is no need for a third party to act as a middle man (Crosby, 2016). There are two features that distinguish the blockchain from other systems. First of all it is public, which means that anyone can view all of its data at any time. Next to that, it is encrypted, which means that it uses public- and private keys to guarantee some form of security for its users (Mougayar & Buterin, 2016).

4.3 System Architecture

4.3.1 Cryptographic Concepts

Cryptography is the study of mathematical systems that can be used to solve two different security issues that relate to the transferring of data or messages through private or public systems. On the one hand there are privacy issues in which information can be extracted from a message without compliance of the sender. On the other hand there are authorization issues, which means that messages can be injected with information that was not intended by the sender (Diffie & Hellman, 1976). Kumari (2017) states that cryptography can be defined as "the transformation of readable and understandable data into a form which cannot be understood in order to secure data". Cryptography has a long history, finding its origin as far back as around 800 AD through the invention of frequency analysis by an Arab mathematician called Al-Kindi. Medieval cryptography techniques were slowly further developed until the 19th century, when people like Edgar Allen Poe (around 1840) and Gilbert Vernam (1917) made large steps in the advancement of cryptography techniques. However, it wasn't until the existence of the world's first programmable digital electronic computer called *"Colossus"*, created during the second world war in 1943, that modern cryptography started making its way into our world (Pandya, Ram, Thakkar, Madhekar, & Thakare, 2015).

The information that is subject to be hidden is called the *plaintext*. Through encryption, the plaintext will become *cipher text* – an unreadable string generated by an algorithm often called a *key*. Cipher text can, in turn, be decrypted back to plain text through two different types of algorithms that are commonly used in modern cryptography (Kumari, 2017).

Symmetric Key Cryptography
Symmetric key cryptography is also known as *private-key cryptography*. These algorithms make use of the same underlying mathematical function to produce both the encryption and decryption key. Because of this, these keys can either be similar or different from each other (Pandya et al., 2015). If symmetric key algorithms are used, both the sender and the receiver need to have a copy of the secret key in order to encrypt and decrypt the data (Kumari, 2017).

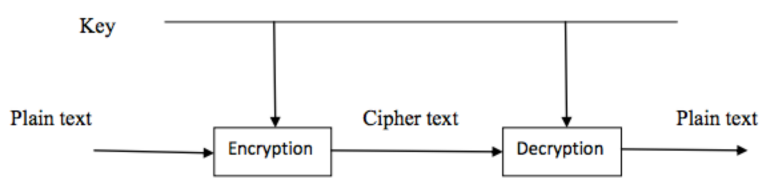

Figure 13 - 'A visual representation of symmetric cryptosystems' (Kumari, 2017)

Asymmetric Key Cryptography
Symmetric algorithms use similar keys to encrypt and decrypt the data. This, however, forms a problem with secure key management. Since the sender and receiver should communicate the keys to each other first, a secure network is required. For this reason, asymmetric key algorithms were proposed by Diffie and Hellmann in 1976 (Pandya et al., 2015). In this system, one key encrypts the information and another key, which has an underlying mathematical relation, decrypts it. The computer which then sends the cipher text encrypts it with the receiver's public key *and* the sender's private key. This way, both sender and receiver can authenticate each other's identity and protect the secrecy of the message (Kumari, 2017). Through this system, two parties that communicate over a public channel enable themselves to create a secure means of communication in which privacy and authenticity is safeguarded. (Diffie & Hellman, 1976)

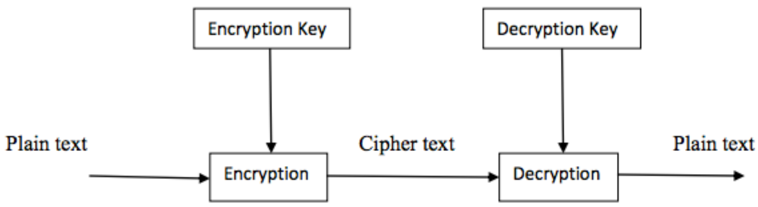

Figure 14 - 'A visual representation of asymmetric cryptosystems' (Kumari, 2017)

These days cryptography is mainly used for five different goals: confidentiality, authentication, data integrity, non-repudiation systems (which prove that the messages between sender and receiver were indeed sent and received) and access control to prevent unauthorized use of resources (Kumari, 2017). In their 1976 paper, Diffie and Hellman (1976) stated that in order to create a system that would be capable of replacing the written contract with an electronic alternative, a digital system needs to be developed which that adhere to the same, or very similar, properties – like blockchain.

4.3.2 Transactions On The Blockchain

Transactions on the blockchain network are made with electronic *coins*, which can most easily be described as a chain of digital signatures. Previously we needed a central authority like a bank to check whether the coin was being double-spent, but now the blockchain ledger allows us to publicly see all of the transactions made by the previous owner(s) of the coin (Nakamoto, 2008). This is done by making use of digital signatures that are created with 'hashes', that are encrypted with use of asymmetric cryptography. During the transaction process, a coin is sent to the public key of the receiver via a published message on the blockchain which is partially signed using the private key of the sender to verify his or her identity – similar to an autograph on paper (Böhme, Christin, Edelman, & Moore, 2015).

Coins are transferred to the new owner by putting a signature on the hash of both the previous transaction and the public key of the new owner, and then adding these to the end of the coin. In order to be able to spend this coin, the receiver of the coin will then have to prove ownership by verifying the private key. The receiving party verifies the digital signature and thereby shows his ownership of the corresponding private key by using the sender's public key belonging to that specific transaction. The history of a coin's transactions is irreversible and can be checked by the recipient at all times (Roth, 2015).

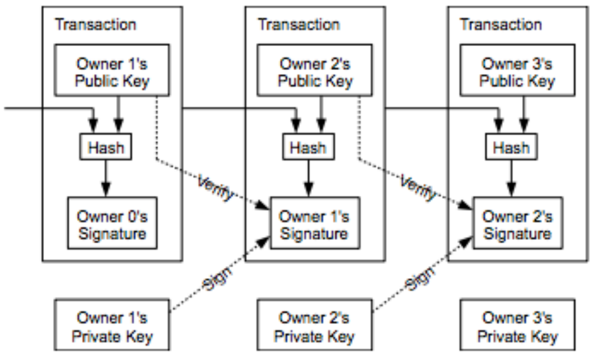

Figure 15 - 'A visual representation of the transaction system on the blockchain network' (Nakamoto, 2008)

In this process, blockchain users utilize wallets. These wallets are a piece of software that can be used to store one or multiple different tokens and coins and their corresponding private keys. Some blockchain developers create dedicated wallets for their own blockchains, whereas others create wallets that accept all the different coins or tokens that run on the same blockchain. They are divided into two different types. Firstly there are 'cold' wallets, which function offline and tend to be less susceptible to security hazards which is why they are often used for longer periods of cold storage. Secondly, *hot* wallets are available which are connected to the internet and are primarily used for day-to-day trading .

4.3.3 Hashing And Blocks

Hashing means that the blockchain takes its generated transaction data as its plaintext, and outputs it into a fixed length of bits. This is not the same process as public- or private key encryption, because hash signatures cannot be decrypted. The goal of hashing is to store a large amount of data safely – in this case it hashes the full current state of the blockchain which has to be agreed on by both parties. Since Bitcoin uses hashing algorithm *SHA-256*, it always outputs 256 bits. This makes it easy for the system to 'forget' about the huge amount of input data, and just remember the hash output. (Appel, 2015) All of the transaction data is timestamped and then added to a block which is part of a chain of blocks, hence the name blockchain. Following the chain of blocks all the way to its beginning will lead the user to the Genesis block, which was the first block ever in existence that held 50 bitcoin (Crosby, 2016). A unique hash is now generated for each block which indicates that the transaction belongs to a block, and that specific block only. Once the hash has been generated, it is widely published within the network. As a result, everyone in the network can verify that a transaction was done in a set moment of time by looking at the hash and its corresponding timestamp. The hash output can be recalculated using the SHA-256 algorithm, and if the hash output has changed it means that the content of one or multiple blocks in the chain (which in this case forms the input) has been tampered with (Roth, 2015). By doing so, we can verify that a specific transaction was indeed the first transaction, and thus it prevents double-spending of the coin. (Nakamoto, 2008).

4.3.4 Proof-of-Work

A Proof-of-Work (PoW) system provides a defense mechanism against network abuses and cyberattacks including spam and Denial-of-Service (DoS) attacks. The term spam applies to a message that is unsolicited and often sent in bulk. (Dwork, 1993). A DoS attack is performed by flooding a network with service requests in an attempt to overload the system and make it temporarily or permanently unavailable. Bitcoin's PoW system is based on Hashcash, which was proposed by Adam Back in 1997. Back's Hashcash requires a small amount of computational power from the sender of a message to add a Hashcash stamp to the header of the message. It is highly unlikely for spammers to spend their computational power on this because the sum costs of the computational effort (mainly compromised of electricity and hardware) will be higher than the benefits of sending the spam. Verification of the stamp for the receiver is effortless (Back, 2002). In the case of the blockchain however, Hashcash PoW is used for block generation by making use of '*mining*'. Every participant on the blockchain can make his or her computer compute (or '*mine*') difficult calculations on the network and by doing so verify transactions in a block. For every verified block, the miner gets a reward – often in the form of a digital currency like bitcoin (Nakamoto, 2008). Mining requires a lot of computational power, time and money and the difficulty of verifying transactions (and thus the required computational power) increases over time. As a result, removing or changing blocks requires a near impossible amount of computational power. This is what makes the PoW system safe and reliable. (Crosby, 2016) However, some criticism on PoW includes the fact that verifying Bitcoin now uses extreme amounts of electricity. Furthermore the Bitcoin blockchain's scalability is not lucrative, since it only allows 7 transactions per second and a new block every 10 minutes. Finally, there are centralization issues since most of the hashing power is held by large mining farms which can – in theory – perform a 51% attack when they attain >50% of the computational power in the network. As a result, they will be able to double-spend by reversing recent ledger history or carry out a PoW-DoS attack which means they refuse to include certain transactions in the blocks that they generate (Bentov, Lee, Mizrahi, & Rosenfeld, 2014).

4.3.5 Proof-of-Stake

Proof-of-Stake (PoS) is an alternative way of verifying transactions within the blockchain. It still uses an algorithm and a similar way of verification as PoW does, but the way it is executed is different. Whereas those who compute the most will get the biggest reward in case of PoW, with PoS there is no direct reward for verifying a block. Instead, those who possess the largest chunk of a coin are seen as the most trusted validators in the blockchain and receive the smallest transaction fees. If they choose to tamper or alter a block's history, they risk losing (a part of) their coins as a punishment (Chepurnoy, 2016). Some criticism on PoS involves the fact that it also tends to suffer from a form of centralization since early adopters of a blockchain tend to have a large stake and are thus able to get an unbeatable share of coins while having very low transactions fees. This prevents others from attaining a similar status (Bentov et al., 2014).

4.3.6 Proof of Activity

Proof of Activity (PoA) is a modernized protocol first proposed by Bentov et al. (2014). It builds upon Adam Back's initial PoW system and the later introduced PoS system by combining both into a single protocol. In PoA, the standard PoW process is applicable when miners are trying to outperform each other through computing power. However, in case a new block is found it switches to a PoS system wherein the new block contains only a header and the wallet address to which the reward is sent. This header is then validated by a random group of validators which are chosen based on the amount of coins they own. The block will only get verified when all validators sign it. Fees and rewards are split between the miners and the validators.

4.3.7 Forks

Since a blockchain is a protocol, everyone in the network has to adhere to its rules. In some cases, different groups foresee a different future for a blockchain. Performing a fork can be a solution to this problem. Within the blockchain network, a fork means that the blockchain is split in multiple directions. As a result, the separated blockchains do not accept each other anymore. Typically, two types of forks are used: a *soft* fork which makes the set of rules more strict and forces the old nodes to upgrade, and a *hard* fork which loosens up the set of rules, and splits up the blockchain in two separate entities. In the case of a hard fork, both blockchains can thrive separately if the community decides to do so. A good example of this is the fork that formed Ethereum and Ethereum classic. (Berentsen & Schar, 2018)

4.3.8 Deployment Environments

Table 11 depicts an overview of the different types of environments on which a blockchain can be deployed, based on information by Ekparinya, Gramoli, and Jourjon (2018).

Type of blockchain	Explanation
Public	Opened to anyone who wants to access the system. Furthermore, anyone is allowed to read and write, which means they generally rely on the Internet as a tool of communication. Bitcoin is an open blockchain.
Private	Most restrictive form of blockchain. Write permissions are only given to certain people within an organization and as a result, a private blockchain is more susceptible to security hazards. This type can be deployed in, for example, the network of a single company.
Consortium	More restrictive form of public blockchain in which read and/or write permissions can be restricted to only certain participants. Often deployed in environments in which multiple organizations (like a consortium of financial institutions) compete with one another.

Table 11 - 'Types of Blockchain'(Ekparinya et al., 2018)

4.4 Cryptocurrencies

4.4.1 Introduction

Cryptocurrencies can be described as transferable digital assets that are secured by cryptography. All of the cryptocurrencies that we know to date have been created by private individuals, organizations or firms. Because cryptocurrencies are not directly redeemable for any government fiat like Euro's or Dollars, or any commodities like silver or gold, the cryptocurrency market is a market of so called *'competing private irredeemable'* currencies (White, 2015). Up until recent years, using physical cash in the form of coins and bills had been the predominant way for us to purchase goods and services. With the introduction of electronic banking, credit cards and other forms of digitized cash, we have gotten rid of some of the negative aspects of handling physical cash while at the same time losing some of the perks that made physical cash a pleasant method of payment. Ultimately, electronic cash aims to combine the best of both worlds by trying to regain control of…

Security	A coin should never be able to be spent twice and no one should be able to counterfeit it.
Privacy	Making payments should not reveal the customer's identity, nor should it be possible to trace the previous owners and transactions made with the coin.
Efficiency	The infrastructure should be fast, simple and affordable (in terms of hardware). Furthermore it should make management processes less complex by getting rid of intermediaries (Milutinović, 2018).

4.4.2 Types

The first ever cryptocurrency was the Bitcoin. All of the cryptocurrencies that came after Bitcoin are called *altcoins*, short for alternative coins. Not all of the altcoins are alternative versions of bitcoin, because some of them have very different goals or purposes and use different architectures. Another type of cryptocurrency, beside coins, are *tokens* that are used in dApps (decentralized applications) built on the blockchain. With these tokens, we are able to 'feed' the dApps in order to generate its desired output. Take for example the payment of a smart contract within the Ethereum network (Milutinović, 2018).

To date, Bitcoin is still the most dominant cryptocurrency with a market cap of about 50%. Table 12 shows the market dominance ratio's (rounded) of the top 5 cryptocurrencies around the end of September 2018, and provides a short explanation of their functionality in order to get an idea of the main points of interest for investors of blockchain technology at that particular point in time.

	Name	Market cap (% of total)	Explanation
1	Bitcoin	50%	Secure, decentralized digital money that can be openly traded (Nakamoto, 2008).
2	Ethereum	10%	Tamper free application and contract building platform (Buterin, 2014).
3	XRP	10%	Currency of the Ripple network, which is a shared public ledger that uses a consensus process for payments, exchanges and remittance (Todd, 2015).
4	Bitcoin Cash	4%	Bitcoin fork that aims to increase bitcoin's block size and thus transaction speed (Javarone & Wright, 2018).
5	Litecoin	2%	A fully open-source, peer-to-peer, decentralized global payment network (Litecoin, 2017)

Table 12 - 'Top 5 cryptocurrencies: market cap and explanation' (Buterin, 2014; Javarone & Wright, 2018; Litecoin, 2017; Nakamoto, 2008; Todd, 2015)

According to the authoritative website CoinMarketCap.com – a website which keeps track of the comparable fiat price and total value of outstanding shares (market capitalization) of all of the existing cryptocurrencies we know as of today – the market for cryptocurrencies has been growing immensely in recent years. Where the total cryptocurrency market offered a variety of about 1000 cryptocurrencies in October 2017, as of the end of September 2018 this amount has nearly doubled to 1990 (CoinMarketCap, 2018). However, the cryptocurrency markets are still dominated by big players with a lot of money – often referred to as 'whales' – and their market capitalizations are nothing compared to those in traditional stock markets. As a result, cryptocurrencies are extremely volatile (Berentsen & Schar, 2018).

4.5 Applications

4.5.1 Smart Contracts And Payment Architectures

A smart contract manages the exchange of value and money between parties, but does this in a different way than the traditional contracts that we know by making use of the Ethereum blockchain. With regard to smart contracts, this study proceeds to focus on the Ethereum network as it is the most popular and commonly used blockchain based transaction architecture of its sort. Ethereum is different from bitcoin in the way that Ethereum allows users to create dApps and corresponding smart contracts, instead of just using the Ethereum token as a means of payment. Smart contracts allow users to exchange anything of value (i.e. money, shares, data) in an instant through a set of pre-defined rules that have to be verified by the network (Buterin, 2014). There are multiple attributes which make smart contracts more viable alternatives to standard contracts:

Autonomy	The parties involved in a smart contract will not have to be in contact after it has been initialized because its life-cycle will run and conclude itself automatically (O'Dair, 2016).

Decentralization	Smart contracts and files are stored on totally independent online servers and are thus theoretically unable to be influenced by third-parties. The Ethereum blockchain safeguards the content by making use of PoW (Crosby, 2016).
Transparency	Smart contracts eliminate the chance of dispute at later stages as the terms and conditions are thoroughly checked and put into place when all parties involved agree to them. Also, there is a need for precision in contract detailing which keeps all the information open for everyone – as a result efficiency that is lost through communication gaps can be restored. This ensures transparency during transactions (O'Dair, 2016).
Self-Sufficiency	Smart contracts are able to automatically execute their own outcome with infinite complexity. This means that once they have received the necessary input (generally in the form of tokens) they can, for example, issue equities or provide data to the rightful owner as specified in the contract (O'Dair, 2016).
Flexible pricing	Users of the Ethereum network can be charged dynamically based on various factors like, for example, purchase frequency or demographics.
Speed	Payments are concluded as fast as the block time allows the payment to be processed. In the case of Ethereum this is currently 15 seconds, in the case of Bitcoin this is currently 10 minutes because of its lacking scalability (De Leon, 2017).
Safety and trust	Smart contracts with automated coding are amongst some of the safest data encrypted technologies in current times because they meet the highest safety standards. This makes smart contracts trustworthy and lessens the requirement of litigation and courts (Pratap, 2018).

4.5.3 Integration with other technologies and applications

In combination with other technologies like cloud computing and artificial intelligence, Blockchain opens up a plethora of uses in our digitalized world. Integrating blockchain with other technologies creates new eco systems that are capable of excelling the digital transformation of our economy and society (OECD, 2017). The main reason for blockchain suitability for integration lies in the fact that it is very foundational in nature, and forms a framework upon which other applications can build (Marr, 2017b).

Data Storage

The blockchain allows us to centrally store and instantly update complex webs of data and corresponding metadata in hashes, making the information needed by users of the blockchain platform directly available (O'Dair, 2016). Metadata is data which describe the content and quality of data, like terms of use and contact information (OECD, 2005). Because of the blockchain's peer-to-peer architecture there will be less need for a wide variety of middlemen that handle the data. As a result, licensing and management processes are strongly simplified, and because of the blockchain's peer-to-peer architecture there will be no more need for a wide variety of middlemen that handle the data. This is helpful, because there is a lot of discrepancy in the way these middlemen capture and report their data. (De Leon, 2017). Furthermore, as blockchain systems have garnished information over a longer period of time, the system will also be able to act as a copyright database (De Leon, 2017).

Artificial Intelligence (AI)

Artificial intelligence allows scientists to create programs that are self-learning, making them more efficient, trustworthy and secure than most human managed systems. This means that they are capable of drawing conclusions or analysing situations from datasets. AI is heavily reliant on big data, and can use blockchain databases to source, store and generate trusted and verified input and output data (Marr, 2017b). The blockchain increases reliability of AI systems and makes it possible for AI algorithms to operate with encrypted data, resulting in higher security. Also, the decision making process of AI systems can be recorded on the blockchain. This is helpful because it provides transparency and understanding of complex decision making processes. However, before AI can be fully trusted its integration will still need to be audited by humans. Some examples of what AI can do include testing smart contracts, improving the performance of hash functions, verifying data and categorizing data (van Zwanenburg, 2018).

Data Standardization
Blockchain can be used to solve data inconsistency problems across different stakeholders by making use of smart contracts. By enforcing pre-approved agreements within each transaction through algorithms embedded into the smart contract, the blockchain can automatically check whether the transaction data is up to the required standard that was agreed upon. This means that the data can only be put into the system after its integrity and validity has been ensured automatically (Lim, 2018). Furthermore, the aforementioned AI integrations can standardize data by flattening out blocks of incomplete data and processing them with machine learning algorithms into a standardized output (Niayesh, 2018).

Data Visualization
According to Gandomi and Haider (2015), *big data* is "high-volume, high-velocity and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making.". Data centres like blockchain databases can support humans that are trying to make sense of vast amounts of data by converting massive data sets into visual insights – also known as "data visualization". Data visualization is "the reduction and spatial representation of datasets in such a way as to make them more intelligible than in their pre-visualization, tabular format.". This includes a broad range of visualization types, including tables, charts, graphs and infographics (Gandomi & Haider, 2015).

Audio Fingerprinting
According to Plapous, Berrani, Besset, and Rault (2018) audio fingerprinting techniques identify music recordings by comparing them to reference databases. This is done by extracting highly discriminative content features from an audio signal and summarizing them into a "fingerprint" (Hon, Wang, Reiss, & Cavallaro, 2015). Plapous et al. (2018) mention that there are two main scientific challenges that are concerned with audio fingerprinting technologies:

1. The system should be able to identify a recording and match it to its original recording, even when it has undergone some form of audio manipulation like *equalization*, *distortion* or simply slowing down or speeding up.
2. The system's database have to stay fast and efficient while dealing with exponential growth of the size of the database.

Audio fingerprinting technology can be used to monitor radio-, TV-, web- or any other type of audio-transmission that can be recorded, like concerts and *DJ-sets*. In fact, the technology is already applied by companies like YouTube and Shazam for copyright tracking and commercial uses. (Brais, 2018).

4.6 Assessing blockchain suitability

The World Energy Council (2017) proposes six different conditions that have to be met for a blockchain solution to be applicable, out of which a minimum of four have to be met. They are:

1. There should be multiple parties sharing data.
2. There should be multiple parties updating data.
3. There is a requirement for verification – the participants need to trust that recorded actions are valid.
4. Intermediaries add costs and complexity to the supply chain.
5. Interactions are time sensitive.
6. Transactions created by different participants depend on each other

In addition, Greenspan (2016) devised a similar set of conditions in order to evaluate the applicability of blockchain technology. These can be summarized as follows:

1. There should be a need for a shared database.
2. There should be multiple parties involved that are generating transactions.
3. There should be an absence of trust between those entities.
4. There is no need for trusted intermediaries.
5. Transactions of different parties depend on each other's input.

If one of the aforementioned conditions is not met, Greenspan states that the company should consider regular file storage on a centralized database, or multiple databases that require user subscription because the power of blockchain is to be found within the fact that it is a shared database. Lastly, Gupta (2017) devised a series of questions with a similar goal. According to him, at least one of the following conditions should be met for the blockchain to be a viable solution:

- Does my business network need to manage contractual relationships?
- Do we need to track transactions that involve more than two parties?
- Is the current system overly complex or costly, possibly due to the need for intermediaries or a central point of control?
- Can the network benefit from increased trust, transparency and accountability in recordkeeping?
- Is the current system prone to errors due to manual processes or duplication of effort?
- Is the current transaction system vulnerable to fraud, cyber-attack or human error?

The framework in figure 16 summarizes the aforementioned conditions by the World Energy Council (2017), Gupta (2017) and Greenspan (2016), and can be used as a framework tool to decide whether or not blockchain applications should be considered by confirming all of the conditions in grey.

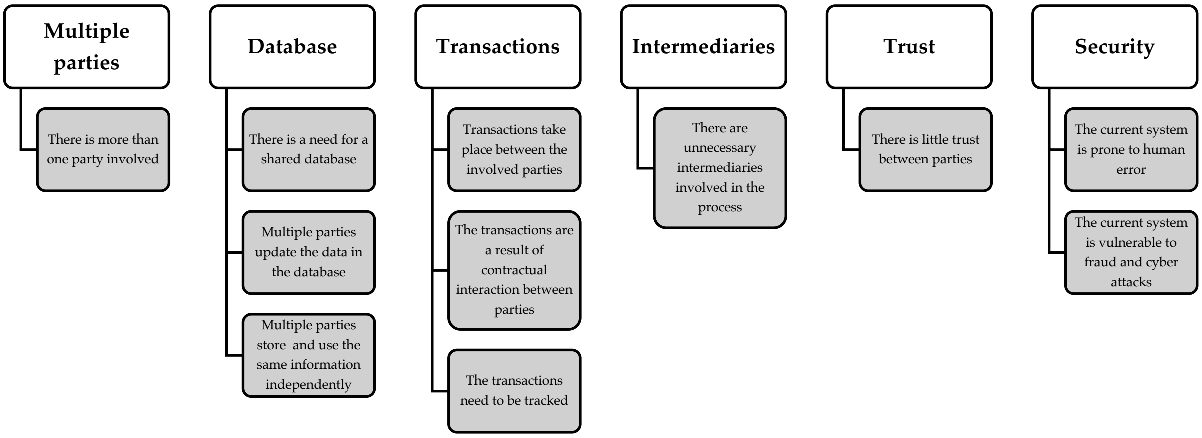

Figure 16 - 'Blockchain suitability framework' adapted from World Energy Council (2017), Gupta (2017) and Greenspan (2016)

4.7 Risks and limitations

As with any type of radical innovation, there are multiple risks and limitations involved during the adoption phase. This subsection aims to provide an overview of possible risks and limitations that are involved with blockchain technology.

Scalability & speed	There is a trade-off between scale and speed of the blockchain. Increased scale generally leads to a decrease in transaction speeds. This mainly forms issues for industries and blockchains that are rapidly increasing in size (Crosby, 2016).
Security	Blockchains are deemed fairly safe, but off-chain security should be taken into account as well. For example the storage of private keys and leaks within integrated technologies form potential future threats. Furthermore, with the future advent of Quantum Computers that have immense calculation power, cryptographic keys might be able to be cracked with brute force methods. If that happens, the whole blockchain system becomes worthless (Crosby, 2016).
Laws & Regulations	Legal issues can arise with regards to jurisdiction, liability, intellectual property, compliance with financial service regulations and data management (i.e. privacy, data protection). Because the market is still in its infancy, there is no real overview of and solution to these issues as of yet (World Energy Council, 2017). An important factor to keep account of is the recent introduction of the GDPR, which imposes extremely high data standards (Forbes, 2018). Since we still live in a centralized society governed by law making and enforcing entities, government agencies might

	slow down or block adoption by introducing new laws and regulations (Crosby, 2016)
Energy Consumption	The use of blockchain is said to increase net energy demand and this has a direct effect on costs. Because of the increasing complexity of calculations to run the PoW consensus algorithm, miners need to use hardware that consume large amounts of energy. However, private and consortium blockchains are not affected by this as they use admin-based consensus algorithms like Proof-of-Authority (World Energy Council, 2017).

4.8 Conclusion

Based on the literature review conducted in this chapter, blockchain technology seems to have a plethora of applications that might be interesting in royalty management processes. Its decentralized, distributed architecture is guarded by the power of its users and miners through cryptographic algorithms and defence mechanisms like Proof-of-Work and Proof-of-Stake. Because it makes use of hash functions, it allows for the secure storage of large amounts of data. As a result, its application works well for processes involving data that require a sense of privacy, integrity, immutability and confidentiality. Furthermore, blockchain's architecture allows for secure, automatic transactions using blockchain based cryptocurrencies. For these transactions, self-executing smart contracts can be used that provide a sense of autonomy, transparency, flexibility, speed, safety and trust. All of this happens without the need for a central authority, and without the risk of double-spending. Public blockchains like Bitcoin are open to anyone who wants to access them, and are very secure and transparent as they are fully decentralized. Private and consortium blockchains, on the other hand, form a more restricted form of blockchain that rely on a centralized authority. For that reason, they are more susceptible to security hazards.

The suitability of blockchain's core application to any industry can be assessed with the suitability framework devised in section 4.6. However, blockchain's application is not just limited to the implementation of a decentralized database with a transaction platform. The literature review has also shown that existing technologies like artificial intelligence and audio fingerprinting can be integrated in and/or built upon blockchain databases. This greatly expands the boundaries of blockchain's potential. However, as with any type of technology, there are also several risks and limitations involved in its application. This includes the trade-off between scalability and speed, off-chain security hazards, restricting laws & regulations and the excessive energy consumption needed to run the consensus algorithms.

5 Blockchain Solutions For Royalty Management Processes

5.1 Introduction

This chapter links the issues and needs in royalty management by music industry professional to potential blockchain applications that can potentially solve them. It will do so by first assessing whether blockchain solutions are suitable for the music industry, followed by an overview of the needs and issues at hand. Based on these needs and issues, suitable blockchain applications will then be proposed and reviewed.

5.2 Verification of Blockchain Suitability

There is a long supply chain involved with many different actors that are in need of a database to source their information from in order to fulfil their royalty management processes, or get an insight into them. Many of the parties involved are responsible for updating data. For example, data with regards to ownership of intellectual property is entered by upstream stakeholders. Sales and usage data is entered by downstream stakeholders. Transactions are processed alongside the whole supply chain through contracts, and there is a necessity for many parties to track the origin of these payments for the sake of transparency. Especially the midstream stakeholders are viewed as unnecessary intermediaries, since their role as a data matching intermediary is replaceable by the implementation of smart contracts (see section 5.3.2). Also, because of the high amount of non-transparency throughout the whole supply chain, there is little trust between many of the parties involved. Lastly, the current systems are prone to human error, fraud and cyberattacks.

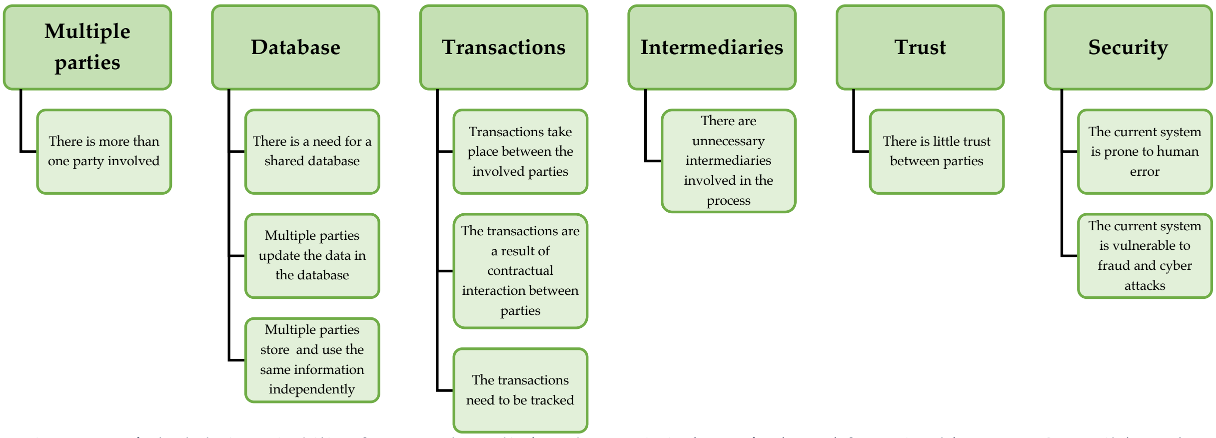

Figure 17 - 'Blockchain suitability framework applied to the music industry' adapted from World Energy Council (2017), Gupta (2017) and Greenspan (2016)

The conditions within the suitability framework that are highlighted in green have been met. In other words: all conditions have been met. This means that we can say with some certainty that there is a strong theoretical relationship between the suitability of blockchain technology, and its application in the music industry.

5.3 Relevant Issues And Needs

Relevant issues

Figure 18 shows a summarized overview of the problem areas and issues, and indicates whether the needs of these issues can likely be solved with blockchain technology (green), whether they are potentially solved with blockchain technology but tied non-technological needs like regulations (yellow) or whether they form a limiting factor since no technological solution is possible (red).

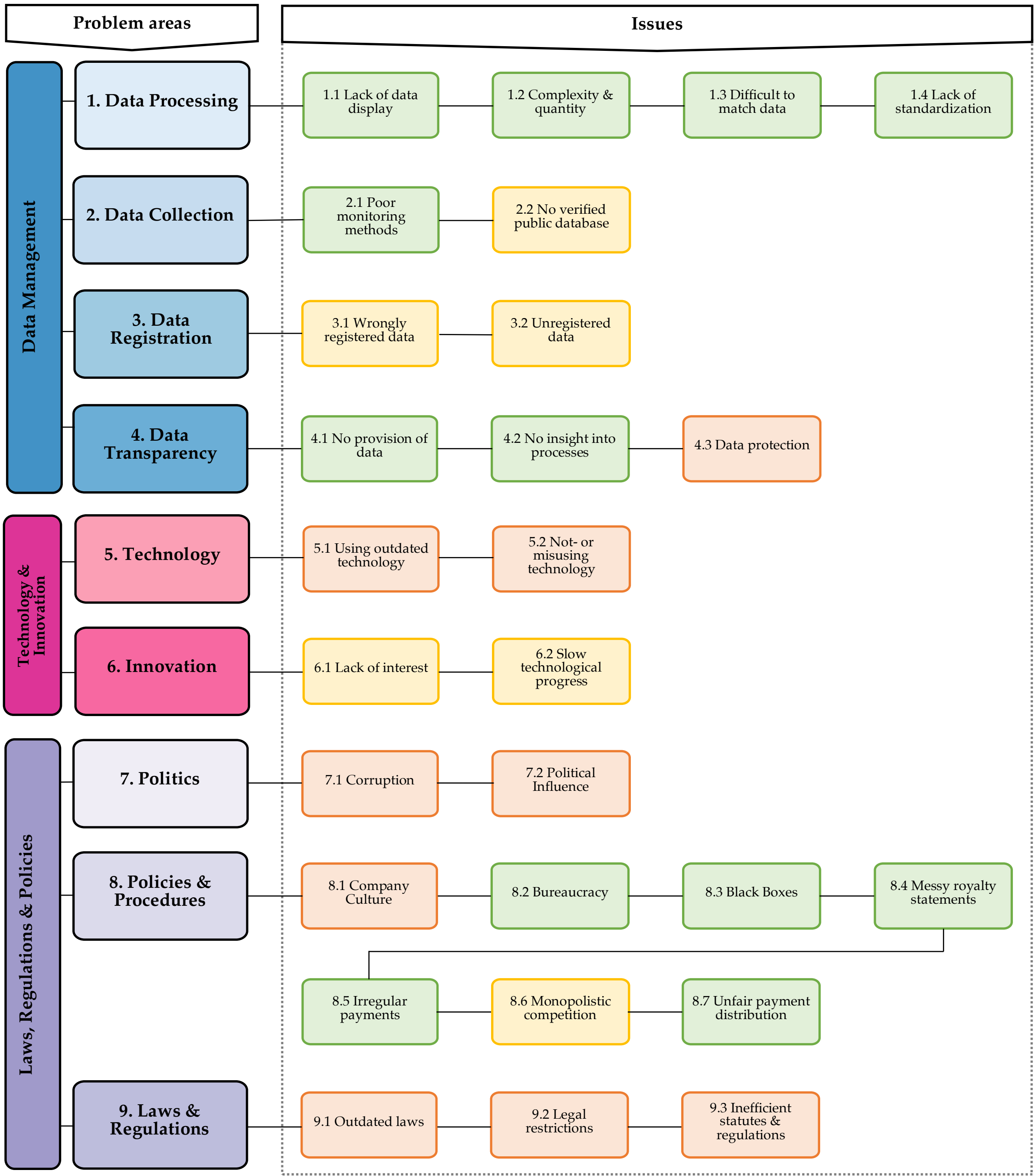

Figure 18 - 'Overview of the problem areas and issues in the music industry'

Relevant needs
Based on the aforementioned issues and the knowledge from chapter four's literature review, table 19 summarizes those needs that are deemed relevant because they have potential to be solved with blockchain technology. The irrelevant needs - which are mostly related to the issues found in politics, laws & regulations, industry standards and company cultures – are left out of this research from this point onward.

Need	Relevant?
1. Simplified data display	Yes
2.Verified public database	Yes
3. Standardized data format	Yes
4. Data recognition tool	Yes
5. Simplified and verifiable data registration processes	Yes
6. Transparent and simplified payment processes	Yes
7. Increased decentralization	Yes
8. Progressive industry regulations	No
9. Revised data regulations	No
10. Reforms on macro level	No
11. Reforms on micro level	No
12. Cultural change	No
13. Modernized laws & regulations	No
14. Revision of statutes and regulations	No

Figure 19 - 'Overview of the relevant and irrelevant needs'

5.4 Primary Blockchain Applications

This subsection reviews the primary blockchain solutions that are suitable for the needs that have to be addressed as defined in subsection 5.3, and the relevant issues that they solve in royalty management processes. These are called primary solutions, since they form the basis upon which the secondary applications function. In other words, their implementation is essential for royalty management processes.

5.4.1 Decentralized Blockchain Database

What?
A fully decentralized database that runs on a blockchain, which contains instantly updated, reliable data regarding intellectual properties, transactions and/or data needed by other integrated technologies.

Why?
Royalty management processes are complex and involve many different actors that are reliant on huge amounts of data concerning intellectual properties, licenses and payment streams. A lot of data is not made public by mid- and downstream stakeholders while upstream stakeholders have the right to know what has happened in the money streams. This empowers major stakeholders and weakens smaller stakeholders, and leads to a lack of trust between stakeholders. Furthermore, having no public, decentralized database to source information from is limiting them in their data processing and data monitoring efficiency since there is no verifiable and trustworthy source to compare and match data to.

How?
A decentralized blockchain based database would solve these issues by making verified data insightful for every stakeholder in the supply chain. By doing so, stakeholders will no longer be reliant on unverified or lacking data and are capable of creating new, innovative systems based on this database that are impossible to be created at this point in time due to the lack of publicly available data and trust. Furthermore, having insight into all data streams allows smaller stakeholder to regain some form of control by making them less dependent on major stakeholders.

Who?
Mainly up- and downstream stakeholders will have to be involved to create a blockchain based decentralized database, since they are responsible for the majority of the data inputs.

Where?
Successful implementation of a decentralized blockchain database would mainly have a positive impact on upstream stakeholders, since it improves transparency and efficiency.

On the other hand, it will likely have a negative impact on midstream stakeholders as their role in the supply chain is made increasingly redundant. Downstream stakeholders will still play an important role because of the value they deliver to the end consumer, including the sales platforms and marketing efforts. Furthermore, they can transfer and integrate their services onto the blockchain.

When?
Recent history has seen similar, non-blockchain attempts like the Global Repertoire Database and the International Music Registry fail because majors pulled out of the negotiations as they pleased (O'Dair, 2016). There needs to be serious legal and political reform in order for a project like this to be feasible. Or, a totally new blockchain based music ecosystem has to be created in which major corporations play a minor role, and that is highly unlikely at this point in time. For that reason, feasibility of a project like this is not realistic in the short term. In the short- to medium term, its implementation could be tested on a smaller scale in music industry niches and grow from there.

Limitations
Unfortunately, the potential of implementing a decentralized blockchain database in the music industry is strongly limited by numerous factors. First of all, the music industry is dominated by large corporations that have a big influence on the industry and the way it is managed. There is a significant economic rationale at play that will likely keep the industry consolidated until it is either forced to innovate through laws and regulations, or until implementing a system of shared ownership becomes beneficial to them. This consolidation of the industry is reinforced by the fact that artists sell or license their rights to distributors and labels in turn for advance payments and services – which they are still heavily reliant on.

Another limitation has to do with the registration of data into a decentralized database. The main question here is about who governs the validity and quality of the data input of a decentralized database. Furthermore, since a decentralized blockchain ledger is immutable, its full history will always be viewable to anyone. This means that faulty data inputs, or the full list of past transactions and their data have no chance of being removed and thus form a heavy threat with regards to privacy and data protection – especially with the recent European implementation of the General Data Protection Regulation (GDPR) which stresses on the 'right to be forgotten' (art. 17), and wishes to keep European data inside Europe (GDPR, 2018). A centralized database would benefit from this kind of governance and maintenance, but would in turn become susceptible to manipulation by the governing party. In fact, using blockchain technology for a centralized database wouldn't make sense because it would defy the technology's strength which lies in its public, tamper-free and decentralized aspects.

Other types of database technology will likely work just as well for private, centralized use. Still, Heap (2017) argues that collecting societies should try to create a partially open global music registry in order to maintain their place in our now rapidly innovating world.

Examples

1. **BigchainDB**
   BigchainDB is a big data distributed database which uses blockchain characteristics: decentralized control and immutability. It is customizable and open sourced to the community, allowing everyone to use it and build applications on top of it. Furthermore, it allows for the creation of both public or private networks.
   https://www.bigchaindb.com/

2. **VeChain**
   The VeChain platform is a reliable, scalable and decentralized blockchain database that allows its users to track products with the use of secure RFID-chips and other types of smart sensors that store their data right into the public blockchain. It's already used by the car industry (i.e. theft prevention, automatic service update) and the agriculture sector (surveillance of farm environment)
   https://www.vechain.org/

Overview

Needs addressed	Issues addressed	Limiting issues
2. Verified public database	1.1 Lack of data display	4.3 Data protection
9. Increased decentralization	1.3 Difficult to match data	6.1 Lack of interest
	2.1 Poor monitoring methods	6.2 Slow technological progress
	2.2 No verified public database	7.1 Corruption
	3.2 Unregistered data	7.2 Political influence
	4.1 No provision of data	8.1 Company culture
	8.6 Monopolistic competition	9.1 Outdated laws
		9.2 Legal restrictions
		9.3 Inefficient statutes & regulations

Table 13 - 'Decentralized blockchain database overview: needs addressed, issues addressed and limiting issues'

5.4.2 Transaction Platform Utilizing Smart Contracts

What?

Blockchain based smart contracts based on dApps that connect the end consumer directly to the rightful owner(s) of the money through DSP platforms. Ideally, the smart contracts should be triggered in three different situations:

1. The smart contract is triggered by a purchase input from a blockchain based DSP sales platform.
2. The smart contract is triggered by a pay-per-click (or pay-per-stream) input on a blockchain based DSP streaming platform.
3. The smart contract is triggered by a registered usage input. Ideally, broadcasting usage by DSP's is recognized by a fingerprinting application (see section 5.5.3) and then matched to input data from radio, television or other broadcasting media to a blockchain database.

Physical retail stores could also integrate their point of sale with the blockchain database, so sales data is directly updated on the basis of smart contract inputs.

Why?
The money streams in royalty management processes are non-transparent, while intermediaries are taking large chunks of the revenues in the form of fees. The large amounts of data involved in combination with this non-transparency make it difficult for upstream stakeholders to comprehend and process their incoming money streams, as statements are increasingly immense and confusing. A lot of unnecessary bureaucracy is involved with royalty management processes and there is no policy with regard to payment frequency, making many of the upstream stakeholders reliant on irregular money streams. Also, the mid- and downstream stakeholders use vague ways of calculating the end balances, often based on unfair contracts in favour of the powerful stakeholders and corporations. Furthermore, a lot of the money gets "stuck" in midstream stakeholder's black boxes because the rightful owner cannot be located.

How?
Blockchain based smart contracts increase transparency by making all transactions and their history fully insightful. The money is instantly paid to the rightful owner(s) based on their own pre-set conditions and inputs, removing the need for unnecessary bureaucratic processes. This means that, for example, the financial output of a smart contract could be distributed between the DSP, musicians, labels and distributors in an instant with pre-defined percentages through micro-payments. Also, costs will be lower since many middlemen are cut out of the process. Since implementing smart contracts removes the need for midstream stakeholders and their complex statements, it will heavily reduce (administration) fees and completely remove the accumulation of unclaimed money in black boxes as all money is directly paid to the rightful owner. Furthermore, smart contracts allow for flexible pricing based on factors like the amount of streams by a customer, demographics like age or other factors that are difficult and inefficient to implement with current systems

Who?
Mainly up- and downstream stakeholders are involved.

Where?
The main area of positive impact will be with the upstream stakeholders, as they benefit from transparent and honest payment processes. Downstream stakeholders are forced to become transparent, but still get to deliver a valuable service to the end consumer by acting as a point of sale and thus get to keep their position in the supply chain. Midstream stakeholders become increasingly redundant as their task in the supply chain – collecting and distributing royalties – is being replaced.

Limitations
The potential of smart contracts is currently limited due to several different factors. First of all, the implementation of a payment system based on smart contracts is heavily reliant on the decentralized database as described in section 5.4.1. That means it's also susceptible to the same limitations.

Secondly, smart contracts run on crypto-currency tokens like Ethereum. As crypto markets are known to be extremely volatile, this forms a threat to its users. As long as cryptocurrencies are not widely accepted as a method of payment, they are reliant on their relative fiat exchange rates. Those relative exchange rates can decrease by as much as 80% yearly, as happened with the bitcoin throughout 2018 (CoinMarketCap, 2018). Thirdly, as long as the majors are in control of the industry they will be able to use their bargaining power to impose contracts that are not in favour of upstream stakeholders with low bargaining power, like independent artists and labels. This means that the smart contracts might not have as large an impact on their earning as expected. Also, all stakeholders in the industry will need to establish full trust in a smart contract based payment system that is based on a piece of code – something that should not be overlooked. Another limitation that shouldn't be overlooked is the block speed of a currency like Ethereum, and the scalability of the network. According to the RIAA (2017), music streaming giant Spotify reportedly generated 12,500 streams per second in 2016 – while the global streaming market grew by over 30% in 2017. Ethereum currently only handles about 15 transactions per second, even though that limit is hardcoded and it is said that it can scale up to process over a million transactions over the next couple of years (Buterin, 2014). In other words, Ethereum is currently not capable of dealing with transactions on this scale.

Finally, each country is dealing with its own jurisdiction. What is allowed within one jurisdiction, might not be allowed in the other. Since the industry as a whole, as well as many different countries (including the UK, Netherlands and Belgium) are dealing with outdated laws, they will first have to be dealt with accordingly before even being able to reach a European or even global consensus on the use of modern technology like blockchain.

When?
The implementation of a transaction system using smart contract is heavily reliant on the implementation of a decentralized database, and thus suffers from the same short-term constraints that relate to a lack of industry interest, politics, corruption and legal restrictions. Furthermore, because the cryptocurrency markets are still very young they don't tend have a solid market capitalization, which leads to volatility. As mentioned earlier the scalability of the network will have to be on par with the industry's growth – which it is not at this point in time. For those reasons, its full implementation is also not realistic in the short-term. However small scale implementations in niche markets are still potentially feasible in the short term.

Examples

1. **Fizzy Axa**
   Fizzy AXA is a French airline that is taking its flight insurance to the blockchain. If customers have to deal with delayed flights, they will automatically be notified with compensation options that are handled through smart contracts.
   https://fizzy.axa/

2. **Propy**
   Propy is a real estate marketplace that allows owners and brokers to list and sell properties in a fast, secure, safe and trusted way by utilizing smart contracts.
   https://propy.com/

Overview

Need addressed	Issue(s) addressed	Limiting issues
5. Transparent and simplified payment processes	4.2 No insight into processes 8.2 Bureaucracy 8.3 Black Boxes 8.4 Messy royalty statements 8.5 Irregular payments 8.7 Unfair payment distribution	4.3 Data protection 6.1 Lack of interest 6.2 Slow technological progress 7.1 Corruption 7.2 Political influence 8.1 Company culture 9.1 Outdated laws 9.2 Legal restrictions

Table 14 – 'Transaction platform utilizing smart contracts overview: needs addressed, issues addressed and limiting issues'

5.5 Secondary Blockchain Applications

This subsection provides an overview of the potential secondary blockchain applications, which are applications that cannot function without the integration of primary blockchain applications and that integrate other technologies. As there is some overlap between primary and secondary applications, primary applications were elaborated on more extensively.

5.5.1 Data Standardizing Smart Contracts Governed by AI

What?
Smart contracts that automatically standardize data inputs by enforcing data inputs to comply with pre-defined rules. Existing data can be corrected, categorized or redirected to correct data inputs by using AI applications that match and verify data.

Why?
The industry is struggling with large, complex amounts of unstandardized data that is difficult to match and oftentimes incorrectly registered into the system. By implementing smart contracts that enforce data standardization and allowing AI to govern new and historic data, data will become more trustful and easier to process, creating a basis for new innovations and further scientific research. A well-developed AI system will eventually be less susceptible to error, as well as more efficient, trustworthy and secure than human-based processing as it improves itself through machine learning over a period of time. Furthermore, it will be of great value to get an insight into process improvement patterns. According to Marr (2017b) AI potentially has many more application areas in the field of data management, making its potential very attractive.

How?
When a user of the blockchain wishes to register data into the blockchain, the data needs to comply with pre-defined rules coded into data registry smart contracts. As a result, the data that gets put into a block and mined for verification will always have to adhere to the same set of rules. Furthermore, AI implementation can be taught to verify the correctness of historic data by comparing it to existing data. By doing so, it will be able to prevent faulty data from getting verified into a block. Say for example there are fifty different version of a song but one of them has the artist name misspelled, AI will be able to match the data to that of other sources, or to that of historic data, and provide the registering party with a double-check notification during the registration process. Also, because AI is capable of self-learning, it is capable of drawing conclusions and analyzing the datasets in order to suggest improvements, or give insights into the learning processes. This can be helpful for future improvements.

Limitations

Since this application has to be used in conjunction with both primary applications (decentralized blockchain and smart contracts), it is also susceptible to their aforementioned limitations. As all parties using the database will first have to agree to the set of pre-defined rules, that might form a big limitation since the majors will likely not be keen to participate while they still hold the majority of the intellectual property rights and data that will have to be processed.

Examples

1. **Rulex Robotic Data Correction**
   Rulex Robotic Data Correction is an AI-based solution that automatically corrects business data errors in SAP. It has already proven to be fast, reliable and highly effective through its application in a Fortune 50 manufacturing company.
   https://www.rulex.ai/rdc/

2. **Unification**
   Unification is a company that standardizes data by using modelling tools based on machine-learning algorithms. It can map, merge, and filter data from multiple sources and generate Autonomous Machine Learnable Smart Contracts (AMLSC).
   https://unification.com/foundation/

Overview

Need(s) addressed	Issue(s) addressed	Limiting issues
3. Standardized data format 5. Simplified and verified data registration process	1.1 Lack of data display 1.2 Complexity & quantity 1.3 Difficult to match data 1.4 Lack of standardization 3.1 Wrongly registered data 4.2 No insight into processes 8.2 Bureaucracy	4.3 Data protection 6.1 Lack of interest 6.2 Slow technological progress 9.1 Outdated laws 9.2 Legal restrictions

Table 15 - 'Data standardizing smart contracts overview: needs addressed, issues addressed and limiting issues'

5.5.2 Data Visualization Application

What?
Analysing the music industry's blockchain database and visualizing it with a data display application.

Why?
The industry is struggling to make sense of the vast amounts of complex data that are involved in royalty management processes. There is no real overview of data coming from a wide variety of mid- and downstream stakeholders (i.e. sales and usage data captured in royalty statements), and because data is not standardized, it is very difficult to properly process the data into understandable overviews. Having understandable overviews of data increases transparency, and allows stakeholders to identify their strengths, weaknesses, opportunities and threats to use them to their benefit. Some companies are already visualizing the data they receive, like the company that interviewee P2 is working for as became clear during the interview. However, P2 mentioned that creating data displays is very time consuming and costly because of the aforementioned complications .

How?
By standardizing the industry's data, and by making it publicly available, (specialized data display) stakeholders will be more capable of visualizing specific data sets in data display applications like dashboards. These applications can be finetuned to the specific wish of the relevant stakeholder. For example, artists could instantly view dashboards that provide them detailed insights into their listener's demographics, as well as sales figures and broadcasting usage data. These insights can then be used in, for example, targeted promotion campaigns.

Limitations
It would be naïve to think that the major stakeholders are not already using the vast amounts of data they have at their disposal to their own advantage with use of big data analysis and data displays. In fact, Marr (2017a) argues that Spotify is a data driven company that uses data analysis in every part of the organization to drive decision making. This means that even though data is already being processed through analysis and visualisation, it is being withheld from other stakeholders that could also benefit from it. Sadly, chances of major companies like Spotify opening up are very slight as the major stakeholders have no benefit in making their data transparent, and have little interest in progressive techniques that help them with it. For that reason, also this application is limited in its potential because it is being held back by the same limitations that apply to the blockchain based database

Examples

1. **Next Big Sound**
   Next Big Sound is a third-party platform that creates data dashboards for artists by using data from Pandora, a DSP that holds a mere 3% market share and is one of the few DSP's that provides royal insights into their data.
   https://www.nextbigsound.com

2. **Histography.io**
   Histography.io is a website that sources data from the public Wikipedia database and plots it on a timeline that shows every historic event between the years 1600 to 2000. It is a prime (and fun) example of what big data analysis and visual applications are capable of.
   https://histography.io

Overview

Need addressed	Issue(s) addressed	Limiting issues
1. Simplified data display	1.1 Lack of data display	4.3 Data protection
	1.2 Complexity & quantity	5.2 Not- or misusing technology
	1.3 Difficult to match data	6.1 Lack of interest
	4.2 No insight into processes	6.2 Slow technological progress

Table 16 – 'Data visualization application overview: needs addressed, issues addressed and limiting issues'

5.5.3 Audio Fingerprinting Application

What?
Audio fingerprinting applications that are integrated with a blockchain database to monitor broadcasting (TV, radio, internet) or real-life recorded audio transmissions and create fingerprints that are matched to fingerprint profiles.

Why?
Mid- and downstream stakeholders are either using very poor methods to monitor usage of sound recordings, or they are not being transparent about this data. Furthermore, if, whether and how usage data is being processed is not clear to everyone in the supply chain as there is barely any transparency exercised with regard the exact data that is being registered and processed. Using fingerprinting applications that run on a blockchain database will not only simplify the matching process, it will also make sure that *all* usage of audio by downstream stakeholders is being registered automatically, properly, fairly and immutably.

How?
The monitored fingerprints are matched to the fingerprint profiles that are either registered in an external database, or directly on a blockchain database. These fingerprint profiles are in

turn matched to the rightsholder. Once this happens, the match creates an input for a smart contract, which is then fulfilled and executed.

Limitations

In a technological sense, there are very few limitations concerning the use fingerprinting technology. In fact, combining fingerprinting with blockchain technology will make its use even more efficient. Audio fingerprinting technology has been in development for years and is already widely used by companies like YouTube and Shazam, whom have already proven its effectiveness in private and commercial use (respectively). However, a fingerprint database that is created by a separate, centralized entity will still be able to merge its fingerprint data with a public blockchain. Since the data needed to create audio fingerprints can be sourced publicly, it is not the creation of the fingerprints that matters, but rather the matching of these fingerprint profile to the intellectual property data of the rightful owner. Recording that match in the blockchain database will eventually be the most important aspect relating to this application. However, with that in mind, fingerprinting technology will still be dealing with the same limitations imposed by the implementation of a blockchain database.

Examples

1. **Shazam**
   Shazam is an application that runs on Android and iOS. It creates fingerprints from small clips of recorded audio that are sent in by its users. The app will automatically try to identify the artist and the title of the song by matching its fingerprint to a profile in its database, and redirect the user to downstream stakeholders like Spotify or YouTube in case a match is found.
   https://www.shazam.com

2. **Google Content ID**
   Google's Content ID application creates fingerprints from (video) content uploaded to YouTube and compares it to their own database of fingerprint profiles. By doing so it aims to automatically recognize copyright infringement in content their platform, and allows rightsholders to make claims. However, YouTube is the only company that uses it, and the database only holds fingerprint profiles that are connected to music licenses from major corporations. Also, Google singlehandedly chose the majors that were allowed participate. Furthermore, it is important to note that YouTube's use of Content ID mainly serves as a shield to protect themselves from lawsuits, rather than trying to create value for other stakeholders. As a result, it is seen by many downstream stakeholders as an unfair, flawed and inefficient system (Schneider, 2018).
   https://support.google.com/youtube/answer/2797370?hl=nl

Overview

Need addressed	Issue(s) addressed	Limiting issues
4. Data recognition tool	1.3 Difficult to match data 2.1 Poor monitoring methods 4.2 No insight into processes 5.2 Not- or misusing technology 8.2 Bureaucracy 8.3 Black boxes	4.3 Data protection 5.1 Using outdated technology 5.2 Not- or misusing technology 6.1 Lack of interest 8.1 Company culture

Table 17 – 'Audio fingerprinting application overview: needs addressed, issues addressed and limiting issues'

5.4 Conclusion

This chapter has shown that the music industry seems to be very suited for a blockchain implementation as it complies to all of the dimensions within the suitability framework. In order to see whether this is also true in practice, the needs and issues that came forward from the data analysis in chapter three have been analysed and filtered with use of the information that came forward from chapter four's literature review on blockchain technology. During this process, several needs and issues were deemed irrelevant for the rest of this research. Those needs mainly relate to the issues that are found in the fields of politics, laws & regulations, industry standards and company cultures. The relevant needs, on the other hand, are coupled to two different types of blockchain applications:

1. **Primary applications**
   These applications form the basis upon which the secondary applications function. Proposed are (1) a decentralized blockchain database, and (2) a transaction platform that utilizes smart contracts

2. **Secondary applications**
   These applications function on top of the primary blockchain applications and are based on the integration of other technologies. Proposed is the integration of (3) data standardizing smart contracts governed by AI, (4) data visualization applications and (5) audio fingerprinting applications.

As comes forth from the assessment of the proposed applications, all of the applications are dealing with bottlenecks related industry's unwillingness to modernize, lacking rules and regulations, the use of outdated technology, regressive company cultures and legal constraints. Unfortunately, this means that the implementation of the proposed applications is rather unfeasible at this point in time.

6 Conclusions and Recommendations

6.1 Conclusions

The music industry seems to be comprised of a complex web of stakeholders that are dominated by powerful major corporations. These majors have been increasingly tightening their grip on the global market since the 80’s. As a result, independent upstream stakeholders like artists and labels have become increasingly dependent on the majors and are struggling to receive their rightful share of the money. Instead, a lot of the money ends up in the pockets of the majors and various middlemen that are involved in the royalty management processes.

There seem to be several reasons that are causing this. In the current digital era, downstream stakeholders and their customers are producing vast and complex amounts of data that are difficult to collect and process. Furthermore, it is difficult for independent stakeholders to get an insight into their data because of a lack of standardization, monitoring and transparency by mid- and downstream stakeholders. On the other hand, upstream stakeholders are often distorting their data by making mistakes during registration processes. Also, the industry is dealing with outdated technology, and many of the technologies that can be of added value are not- or misused. Part of the reason for this can be found in the lack of interest from mid- and downstream stakeholders. Since they are profiting from the unclaimed money by accumulating it in their black boxes, it is not in their benefit to improve royalty management processes. As a result, their corporate cultures and their influence on politicians and lawmakers seems to be regressive in nature, rather than progressive.

Even though blockchain technology is still dealing with several teething problems related to scalability, speed, stability, security and energy consumption, it seems to be very capable of addressing many of the aforementioned issues by implementing the primary and secondary applications proposed in chapter five. Unfortunately, this study has shown that technological applications like blockchain are not capable of solving the root of the problem, which is cultural, political and constitutional in nature. Even though the proposed technologies show high potential on paper, many of their applications are locked in a cage, and the key to that cage seems to be held by those that hold the money and the power. Unless governments and the major industry stakeholders impose a progressive attitude on corporate culture, laws, regulations, policies, and the implementation of modern technology, there seems to be a very slight chance that royalty management processes in the music industry will change for the better in the near future.

6.2 Recommendations

As we believe that blockchain technology will not have an impact on the industry in the near future, it seems to be more realistic to take a gradual approach in its application. We recommend to run small-scale test pilots of the proposed applications in niche segments of the industry that are not heavily reliant on the majors' involvement. A recent example of a company that is actively and successfully building an independent eco-system in a niche market is *Bandcamp*. Bandcamp is actively used in the *leftfield* (experimental) electronic music scene and allows artists and labels to stream and sell their music directly to the end-consumer. *PayPal* is used as a payment intermediate, and 80-85% of its revenues is directly paid to the rightful owners on a daily basis (Bandcamp, 2018). By running small-scale test pilots, the efficiency of the proposed blockchain applications can be assessed and improved until the right moment arises for its implementation. Also, successful small-scale blockchain based ecosystems can be used as a basis to expand upon into other areas of the music industry. By doing so they could start small, and grow bigger over time.

Secondly, we recommend the majors and other powerful stakeholders to re-evaluate their role and sustainability in the music industry. Their current business models are largely based on greed and self-interest, and to some degree proceed to exist because governments and other constitutional entities allow them to, by allowing lawful monopolies and thus eliminating the need for competition and innovation. In fact, the current business models that DSP's and Spotify use are already unsustainable and are causing major losses as a result of constantly rising content acquisition costs (Dawson, 2017). Innovative platforms like Napster and KaZaa were seen as a threat and shut-down under heavy legal pressure. Ironically, their now ~20-year old peer-to-peer technology was, until quite recently, used by major downstream stakeholders including Spotify to revitalize the industry's revenue figures (Pejchinovski, 2014). The music industry majors should take an example to those in the adult industry, which are known to benefit heavily from their pivotal role in the adoption and development of a broad range of modern technologies – including blockchain and VR (Moy, 2018).

6.3 Related work

6.3.1 Studies

O'Dair (2016)'s report "Music On The Blockchain" shows some similarities in its conclusion. It proposes the implementation of a blockchain database which improves payment structures and transparency, but also states that it will be difficult to reach a critical mass and that it is heavily impacted by governance and regulations on the integrity of data. In addition, he argues that cryptocurrencies can provide an alternative source of capital for its users, and that blockchain potentially forms a big threat to mid- and downstream organization. His study sets a timeframe of 10-15 years for blockchain to be adopted.

Another similar blockchain based study, was executed by Rosenblatt (2017). This study provides a nice overview of the royalty structures and put more focus on niche applications in the music industry, including *watermarking* technology that can be used to attach metadata to audio files as a means of tracking rights. However, it does not look into the limitations of blockchain's application.

6.3.2 Projects

Ujo Music
Ujo Music is a project that was initiated by a start-up incubator called Consensys. It is built on top of the Ethereum blockchain and allows for the direct, permanent purchase of both download and sales rights of music. It claims to pay rightsholders directly, without any fees involved.
https://www.ujomusic.com/

Musicoin
Musicoin is a blockchain based DSP that uses its own cryptocurrency *(MUSIC)* to pay musicians. It has some handy features, like the possibility to "*tip*" your favourite artists. Similar to Ujo Music, Musicoin's platform is free to use and claims to pay musicians better than any streaming DSP that is currently available.
https://musicoin.org/

6.4 Future work

As a result of the limited scope and time available to execute this study, there are still many unexplored areas that are interesting to investigate for future work. Firstly, the integration of other technologies with blockchain opens up a whole new world of possibilities and could yield various other interesting results. Secondly, this study focuses on process improvement from a technological point of view. However, the legal environment concerning blockchain's application in royalty management processes seems to be very interesting as well. Some possible topic would include the impact of the GDPR, data ownership and the monopolistic competition that is induced by governments. Also, this study focused on a rather small geographical area (north-western Europe), whereas the industry is dealing with the aforementioned issues on a global scale. Similar studies could be performed in different geographical areas. Lastly, this study focused on the digital segment of the music industry. Future research could look into other segments, like that of live performing or physical music.

Bibliography

Alshenqeeti, H. (2014). Interviewing as a Data Collection Method: A Critical Review. *English Linguistics Research, 3*(1).

Appel, A. W. (2015). Verification of a Cryptographic Primitive: SHA-256. *ACM Transactions on Programming Languages and Systems (TOPLAS), 37*(2), 1-31. doi:10.1145/2701415

Aris, A., & Bughin, J. (2005). *Managing media companies: Harnessing creative value*: Wiley.

Atkinson, C. (2017). Songwriters' spat with Spotify complicates plans to go public. Retrieved from nypost.com website: https://nypost.com/2017/07/17/songwriters-spat-with-spotify-complicates-plans-for-ipo/

Baarda, B. (2010). *Research, this is it! Guide to quantitative and qualitative research* (First edition ed.).

Back, A. (2002). Hashcash - A Denial of Service Counter-Measure, 10. Retrieved from www.hashcash.org website: http://www.hashcash.org/papers/hashcash.pdf

Bandcamp. (2018). About Us. Retrieved from https://bandcamp.com/about

BBC. (2004). Sony and BMG merger backed by EU. Retrieved from http://news.bbc.co.uk/2/hi/business/3908405.stm

Bentov, I., Lee, C., Mizrahi, A., & Rosenfeld, M. (2014). Proof of Activity: Extending Bitcoin's Proof of Work via Proof of Stake [Extended Abstract]y. *ACM SIGMETRICS Performance Evaluation Review, 42*(3), 34-37. doi:10.1145/2695533.2695545

Berentsen, A., & Schar, F. (2018). A short introduction to the world of cryptocurrencies.

Berklee. (2015). Fair music: Transparency and payment flows in the music industry. *Recommendations to increase transparency, reduce friction, and promote fairness in the music industry. www. rethink-music. com: Rethink Music*.

Böhme, R., Christin, N., Edelman, B., & Moore, T. (2015). Bitcoin: Economics, Technology, and Governance. *The Journal of Economic Perspectives, 29*(2), 213-238. doi:10.1257/jep.29.2.213

Bougie, R. S., Uma. (2016). *Research Methods for Business* (7 ed.): Wiley.

Brais. (2018). How We Identify Songs. Audio Fingerprinting. Retrieved from https://www.bmat.com/blog/2018/03/01/how-we-identify-songs-audio-fingerprinting/

Buterin, V. (2014). A next-generation smart contract and decentralized application platform. *white paper*.

Chepurnoy, A. (2016). Interactive Proof-of-stake.

CoinMarketCap. (2018). Retrieved from http://www.coinmarketcap.com

Crosby, M. (2016). Blockchain Technology: Beyond Bitcoin. *AIR*(2).

Dawson, J. (2017). Why Spotify Should Ditch Its Free Tier, Add Streaming Fees. Retrieved from https://variety.com/2017/voices/columns/spotify-streaming-fees-1202506347/

De Leon, I. L. G., Ravi. (2017). *The Impact of Digital Innovation and Blockchain on the Music Industry*. Retrieved from

Department for Culture, M., & Sport. (1998). Creative industries mapping document. In: DCMS London.

Diffie, W., & Hellman, M. (1976). New Directions in Cryptography. *IEEE Transactions On Information Theory, IT-22*(6).

Dwork, C. N., Moni. (1993). Pricing via Processing, Or, Combatting Junk Mail, Advances in Cryptology. *CRYPTO'92: Lecture Notes in Computer Science, 740*, 139 - 147.
Economist, t. (2015). The great chain of being sure about things; Blockchains. *The Economist, 417*(8962), 21.
Ekparinya, P., Gramoli, V., & Jourjon, G. (2018). Double-Spending Risk Quantification in Private, Consortium and Public Ethereum Blockchains.
Fetscherin, M. (2004). Stakeholders in Digital Rights Management, The case of music industry. *INDICARE Monitor, 1*(2).
Forbes. (2018). How Can Blockchain Thrive In The Face Of European GDPR Blockade? Retrieved from https://www.forbes.com/sites/darrynpollock/2018/10/03/how-can-blockchain-thrive-in-the-face-of-european-gdpr-blockade/#36f20f5161df
Gandomi, A., & Haider, M. (2015). Beyond the hype: Big data concepts, methods, and analytics. *International Journal of Information Management, 35*(2), 137-144.
GDPR. (2018). GDPR Info. Retrieved from https://gdpr-info.eu/
Gfk. (2018). Online bereik van Spotify stijgt naar 5,2 miljoen personen in oktober 2018. Retrieved from https://bit.ly/2RbSD82
Graham, G., Burnes, B., Lewis, G. J., & Langer, J. (2004). The transformation of the music industry supply chain: A major label perspective. *International Journal of Operations & Production Management, 24*(11), 1087-1103.
Greenspan, G. (2016). Avoiding the Pointless Blockchain Project—How to Determine if You've Found a Real Blockchain Use Case. In.
Gronow, P. (2013). Recording History: The British Record Industry 1888-1931. *ARSC Journal, 44*(2), 282.
Gupta, M. (2017). Blockchain for dummies. *IBM Limited Edition, US*.
Halaburda, H. (2016). Digital Currencies: Beyond Bitcoin. *Communications & Strategies*(103), 77.
Heap, I. (2017). Blockchain Could Help Musicians Make Money Again. *Harvard Business Review, 2017*(October).
Hesmondhalgh, D. (2007). The cultural industries.
Hon, T.-K., Wang, L., Reiss, J., & Cavallaro, A. (2015). Audio fingerprinting for multi-device self-localization. *IEEE/ACM Transactions on Audio, Speech and Language Processing (TASLP), 23*(10), 1623-1636. doi:10.1109/TASLP.2015.2442417
Hosoi, T., Joseph, K., Stainken, D., & Caro, F. (2016). Disintermediation in the Recorded Music Supply Chain. *UCLA Anderson Global Supply Chain Blog, available online: http://blogs. anderson. ucla. edu/global-supplychain/2015/08/disintermediation-in-the-recorded-music-supply-chain. html (last consulted 20*.
IFPI. (2017). *IFPI Global Music Report 2017*. Retrieved from http://www.ifpi.org/news/IFPI-GLOBAL-MUSIC-REPORT-2017
IFPI. (2018). *IFPI Global Music Report 2018*. Retrieved from https://www.ifpi.org/downloads/GMR2018.pdf
ISWC. (1995). Frequently Asked Questions. Retrieved from http://www.iswc.org/en/faq.html
Jacobson, E. (2017). Music Industry Cases and Issues To Watch In 2018. Retrieved from https://www.forbes.com/sites/legalentertainment/2017/12/08/music-industry-cases-and-issues-to-watch-in-2018/#233d606c5066
Javarone, M. A., & Wright, C. S. (2018). From Bitcoin to Bitcoin Cash: a network analysis. *arXiv preprint arXiv:1804.02350*.

Kumari, S. (2017). A research Paper on Cryptography Encryption and Compression Techniques. *International Journal of Engineering And Computer Science, 6*(4), 20915-20919.
Lemieux, P. (2013). Who is Satoshi Nakamoto? *Regulation, 36*(3), 14.
Leurdijk, A., Slot, M., & Nieuwenhuis, O. (2012). Statistical, ecosystems and competitiveness analysis of the media and content industries. *European Commission*.
Leyshon, A. (2014). *Reformatted: Code, networks, and the transformation of the music industry*: Oxford University Press, USA.
Lim, Y. (2018). The promise of blockchain and standardized data. Retrieved from https://www.pmg.com/blog/the-promise-of-blockchain-and-standardized-data/?cn-reloaded=1
Litecoin. (2017). Wat is litecoin? Retrieved from http://www.litecoin.org
Marr, B. (Producer). (2017a). The Amazing Ways Spotify Uses Big Data, AI And Machine Learning To Drive Business Success. Retrieved from https://www.forbes.com/sites/bernardmarr/2017/10/30/the-amazing-ways-spotify-uses-big-data-ai-and-machine-learning-to-drive-business-success/#5305be9e4bd2
Marr, B. (2017b). Artificial Intelligence And Blockchain: 3 Major Benefits Of Combining These Two Mega-Trend. Retrieved from https://www.forbes.com/sites/bernardmarr/2018/03/02/artificial-intelligenceand-blockchain-3-major-benefits-of-combining-these-two-mega-trends/#18521bb94b44.
MIDiA. (2018). Mid-Year 2018 Streaming Market Shares.
Milutinović, M. (2018). Cryptocurrency. *Ekonomika, 64*(1), 105-122. doi:10.5937/ekonomika1801105M
Mougayar, W., & Buterin, V. (2016). *The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology* (1 ed.). New York: John Wiley & Sons Inc.
Moy, J. (2018). Blockchain Disrupts Adult Industry And Sextech.
Mulligan, M. (2015). *Awakening: The music industry in the digital age*: MIDiA Research.
Nakamoto, S. (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. Retrieved from https://bitcoin.org/bitcoin.pdf
Niayesh, F. (2018). How Unification Standardizes Data With Artificial Intelligence & Machine Learning. Retrieved from https://medium.com/unificationfoundation
O'Dair, M. Z., Beaven; Neilson, David; Osborne, Richard; Pacifico, Paul. (2016). Music on the Blockchain. (Middlesex University).
OECD. (2005). Reference Metadata.
OECD. (2017). *OECD Digital Economy Outlook 2017*: OECD Publishing.
Pandya, D., Ram, K., Thakkar, S., Madhekar, T., & Thakare, B. S. (2015). Brief History of Encryption. *International Journal of Computer Applications, 131*(9), 28-31. doi:10.5120/ijca2015907390
Pejchinovski, G. (2014). Spotify – Combining Cache, Peer-To-Peer and Server-Client Architectures for Users' Satisfaction. *Kingston University*.
Plapous, C., Berrani, S.-A., Besset, B., & Rault, J.-B. (2018). A low-complexity audio fingerprinting technique for embedded applications. *Multimedia Tools and Applications, 77*(5), 5929-5948. doi:10.1007/s11042-017-4505-4
Pratap, m. (2018). Everything You Need to Know About Smart Contracts: A Beginner's Guide. Retrieved from https://hackernoon.com/everything-you-need-to-know-about-smart-contracts-a-beginners-guide-c13cc138378a

PRS for Music. (2018). Live Performance Royalties. Retrieved from https://www.prsformusic.com/royalties/live-performance-royalties
Rethink. (2013). New business models in the music industry. *Paper, Berklee Valencia, Spain. Retrieved March, 11*, 2014.
RIAA. (2017). *News and Notes on 2017 Mid-Year RIAA Revenue Statistics*. Retrieved from https://www.riaa.com/wp-content/uploads/2017/09/RIAA-Mid-Year-2017-News-and-Notes2.pdf
Richardson, J. H. (2014). The Spotify paradox: How the creation of a compulsory license scheme for streaming on-demand music platforms can save the music industry. *UCLA Entertainment Law Review, 22*(1).
Rogers, J. (2013). *The death and life of the music industry in the digital age*: A&C Black.
Rosenblatt, B. (2017). *Watermarking technology and blockchains in the music industry*. Retrieved from https://www.digimarc.com/docs/default-source/digimarc-resources/whitepaper-blockchain-in-music-industry.pdf?sfvrsn=2
Roth, N. (2015). An Architectural Assessment of Bitcoin. *Procedia Computer Science, 44*, 527-536. doi:10.1016/j.procs.2015.03.066
Schneider, M. (2018). CONTENT ID IS STILL JUST PIRACY IN DISGUISE. Retrieved from http://www.musicanswers.org/content-id/
Sena. (2014). De digitale vingerafdruk voor producenten. Retrieved from https://www.sena.nl/makers/rechthebbenden/isrc
Shepard, I. (2017). How does the music industry work? Give me the high-level overview! Retrieved from https://www.themusicmaze.com/music-industry-work-give-high-level-overview/
Statista. (2017). *Music industry in Europe*. Retrieved from
Strauss, A., & Corbin, J. (1967). Discovery of grounded theory.
Sullivan, A. M. (2015). Cultural Heritage & New Media: A Future for the Past. *J. Marshall Rev. Intell. Prop. L., 15*, 604.
The Guardian. (2012). Universal's £1.2bn EMI takeover approved – with conditions.
The Guardian. (2018). Sony buys EMI Music Publishing for $2.3bn.
Thomson, K. (2015). Music and How The Money Flows. Retrieved from http://futureofmusic.org/article/article/music-and-how-money-flows
Todd, P. (2015). The ripple protocol consensus algorithm Review. *Ripple Labs Inc White Paper (May, 2015) https://raw. githubusercontent. com/petertodd/ripple-consensus-analysis-paper/master/paper. pdf*.
van Zwanenburg, J. (2018). Blockchain And Artificial Intelligence: The Benefits Of Decentralized AI. . Retrieved from https://www.investinblockchain.com/blockchain-artificial-intelligence/
Watkins, R., West Meiers, M., & Visser, Y. (2012). *A guide to assessing needs: Essential tools for collecting information, making decisions, and achieving development results*: The World Bank.
White, L. H. (2015). The Market for Cryptocurrencies. *Cato Journal, 35*(2), 383-402.
Wikström, P. (2013). *The music industry: Music in the cloud*: Polity.
Williamson, J., & Cloonan, M. (2007). Rethinking the music industry. *Popular music, 26*(2), 305-322.
World Energy Council. (2017). *The Developing Role of Blockchain*.
Worldwide, M. B. (2018). THE MAJOR LABELS' REVENUES GREW BY $1BN IN 2017. BUT WHO HAD THE BIGGEST YEAR? Retrieved from https://www.musicbusinessworldwide.com/major-labels-revenues-grew-1bn-2017-biggest-year/

Appendices

Appendix A – Recorded music supply chain: a detailed overview