MUSIC ROYALTY PAYMENT SCHEME USING BLOCKCHAIN TECHNOLOGY

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MUSIC ROYALTY PAYMENT SCHEME USING BLOCKCHAIN TECHNOLOGY

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Almigdad Yahya Ibrahim

ABSTRACT

M. Sc. Thesis

MUSIC ROYALTY PAYMENT SCHEME USING BLOCKCHAIN TECHNOLOGY

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Karabük University
Institute of Graduate Programs
The Department of Computer Engineering

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The process of the production and distribution of music involves a large number of business entities and middlemen which can cause a great deal of issues. Royalty payments are payments made to musicians and composers when their work is used by other entities. When it comes to royalty payments, musicians face a slew of challenges, the most significant of which is a lack of transparency and payment delays. This research aims to introduce a new model to handle the process of royalty payments, a model that improves the transparency in handling royalty payments and reduces the delay of payments. The model was designed utilizing the blockchain as a facilitator, a list of features needed to accommodate the model then a collection of modules was designed and developed as a proof of concept. The model was then validated against the set of objectives and qualitatively evaluated to determine how it can improve and contribute to solving the mentioned issues. The research also investigates some of the ramifications of integrating such a paradigm, which can shift the balance of power towards previously existing powers in the music industry or towards emerging technologies such as blockchain.

Key Words : Music industry, royalty payments, music shares, blockchain, cryptocurrencies.

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ÖZET

Yüksek Lisans Tezi

BLOCKCHAIN TEKNOLOJİSİ KULLANILAN MÜZİK ROYALTY ÖDEME ŞEMASI

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Müziğin üretim ve dağıtım süreci, çok sayıda ticari kuruluş ve aracı içerir,bu büyük sıkıntılara neden olabilir. Telif hakkı ödemeleri, müziği başka kuruluş tarafından kullanıldığında sanatçılara ve bestecilere yapılan ödemelerdir. Telif hakkı ödemeleri söz konusu olduğunda, müzisyenlere göre , en önemlisi şeffaflık eksikliği ve ödeme gecikmeleri olan bir dizi zorlukla karşı karşıya gelir. Bu araştırma, telif ödemeleri sürecini idare etmek için yeni bir model, telif ödemelerinin idare edilmesinde şeffaflığı artıran ve ödemelerin gecikmesini azaltan bir model sunmayı amaçlamaktadır. Model, bir kolaylaştırıcı olarak blok zinciri kullanılarak tasarlandı, modeli barındırmak için gereken özelliklerin bir listesi, ardından bir konsept kanıtı olarak bir modül koleksiyonu tasarlandı ve geliştirildi. Daha sonra model hedefler kümesine göre doğrulandı ve söz konusu sorunların çözümüne nasıl katkıda bulunabileceğini ve nasıl iyileştirilebileceğini belirlemek için niteliksel olarak değerlendirildi. Araştırma ayrıca, güç dengesini müzik endüstrisinde önceden var olan güçlere veya blok zinciri gibi yeni ortaya çıkan teknolojilere kaydırabilecek böyle bir paradigmayı entegre etmenin bazı sonuçlarını da araştırıyor.

Key Words : Müzik endüstrisi, telif ödemeleri, müzik hisseleri, blok zinciri, kripto para birimleri.

Bilim Kodu : 92431

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CONTENTS

Page

Page

Page

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

PART 1

INTRODUCTION

1.1. RESEARCH BACKGROUND

According to a study made by Nielsen's Music in 2014, 93% of the people in the United States listen to music, and spending more than 25 hours a week of listening time. People listen to music in all sorts of places, it can be at home, at work, formal or informal gatherings, and using all types of devices and technology. this heavy and constant use of music created a big industry around it. the music industry is estimated at 45$ billion globally, and 15$ billion is the share of recorded music alone; therefore, evolving over time to include many professions and entities to manage it, for example Publishers, distributors, record labels, artist, producers, and live performances and many more. The industry has moved in sync with the technology, and every era of technology comes with its benefits and challenges. Furthermore, since music was first created and sold on vinyl records, it has progressed to CDs, digital files, and finally streaming, which is what is currently being used, and while these technologies do not necessarily render each other obsolete, each has taken its time as the mainstream of music to end-users [1–5].

The blockchain is considered "cutting edge" technology due to its revolutionary concept and nature, which gives it the ability to disrupt and change almost all of our industries, from government, healthcare, and finance to music. The blockchain technology introduced in 2007 developed in 2008 and launched in 2009 as the technology behind the crypto currency bitcoin. Additionally, the technology provides an immutable transparent ledger with records of all transactions in a peer-to-peer network, with each peer having a copy of the ledger, resulting in a transparent and secure data [1–5].

The blockchain, as one of the most recent technologies, has caused some disruption in the music industry. People have discovered that the music industry's complex, often unstructured, and chaotic nature has created many problems that can be solved with blockchain. The blockchain will not only help in organizing some of the chaos, but it will also help artists get paid more quickly and fairly [1–5].

1.2. PROBLEM STATEMENT

Current state of royalty payments lacks transparency and indirect way of payment resulting in delays and sometimes absence of payments, which makes it harder for artists to sustain and practice their craft [1,2,5–7].

Royalty payment information is untraceable. Moreover, Payment recipients receive payments in a variety of methods, with little to no information regarding how much money was gathered and where it came from, this is due to the large number of middle-men handling it. Additionally, different entities handle different types of royalties, and each entity handle it in a different way. Moreover, giving adequate of information about these transactions can provide more transparency, and help artist make better decisions [1,2,5–7].

Payments are delayed and, in some cases, fail to reach the artist, this is due to many parties being involved. Additionally, music labels and publishers pay in a different frequency than Performance Rights Organizations. Moreover, the cost of payments in the traditional models like cheques and wire transfers means that payments are subjected to thresholds. Therefore, artists will receive payments very late upwards to one or two years. However, a faster and cheaper payments will encourage new artist to participate and help established artist sustain their work [1,2,5–7].

1.3. RESEARCH OBJECTIVES

The main objective is to design and develop a royalty payment model, utilizing the blockchain technology to provide instant payments, and reliable information to artists and collaborators.

To develop a royalty payment scheme where transaction information is clear to all parties involved, and instant payments where artist and other recipients receive their payments directly whenever the royalty payer makes it. Moreover, this can be achieved by using the blockchain smart-contact feature and the immutable ledger for the transactions and payments. Thus, providing the artist and collaborators with the instant-payments and all information related. Additionally, creating a better environment and a better music industry eco-system.

To validate and evaluate the proposed scheme against traditional scheme, in terms of model, payment time, and payment cost. Additionally, evaluate the proposed scheme against other blockchain based solutions and projects. Thus, giving a better understanding of how the scheme provides contribution to the domain.

1.4. RESEARCH QUESTIONS

From what was gathered about the music industry and the problems mentioned above. The following questions were formulated to lead our research.

How the blockchain based model adds more transparency and reduce payment delay to royalty payments?

How to evaluate the blockchain based system against the traditional system and other projects?

1.5. SIGNIFICANCE OF THE STUDY

This section will address the beneficiaries of the developed model. Moreover, by integrating such a model in the music industry eco-system, the entities in the music industry and specifically in the royalty payments, will have more transparency and less delay. Which is due to traditional payment methods and model.

The proposed model will benefit the artists and collaborators where they will receive their shares instantly when it gets received by the system, avoiding any delays. Additionally, they will have a clear view of the information related to the payments. (PROs) or Performance rights organization will add more transparent and unified payment method to artists; therefore, encouraging more artists to join the collective. publishers, publishing admins, labels, and distributors, these parties will be introducing more transparency to their business, and consequently making it more inviting for artists and copyrights holders.

Additionally, the research will benefit future researchers and academics in the domain, as it may serve as a tool to help further studies and innovation in the music industry.

1.6. SCOPE

The base of the analysis in this research is the information collected from previous work in relation to the research questions. This is done to collect facts and also to find relevant views on what to can be done to improve the current state of development, and the technical environment. Furthermore, how the music industry environment will possibly be affected? The proposed model is designed based on the study and analysis of relevant scientific literature and the models of established companies in the field. Moreover, the research introduces a new model of royalty payments and only a proof-of-concept demo.

1.7. SUMMARY

In this chapter a brief introduction to the music industry was given. followed by an introduction to the blockchain technology, and its use within the music industry. Afterwards, the problems faced in royalty payments were stated. furthermore, the research questions and objectives were defined. Followed by the significance of research to each entity in the music eco-system was. finally, the chapter closes by the scope of the research.

PART 2

LITERATURE REVIEW

2.1. THE MUSIC INDUSTRY ECO-SYSTEM

The term “music industry” refers to the collection of entities associated with the creation, distribution and manufacturing of music. The creators - singers, producers, musicians, songwriters, and the various parties are managed by [1,2]. According to L. Co-operative, the music eco-system consists of [1]:

2.1.1. Record Labels

Record labels are the companies that carry the recording and production of music. Music masters, which are the authorized original recording of artists, are usually copyrighted under these labels. Record labels facilitate the production of music by 1) investing in artists and profit from music sales; 2) paying for manufacturing; 3) distribution to retailers; 4) Marketing and promotion of records.
However, the role of record labels has changed over time to promote and market the artists and music. This is a direct result of the low cost and ease of production and distribution in the digital era of music.

2.1.2. Producers

Music producers, alongside the artists, oversee the making of the music within the timeframe and budget. Additionally, producers turn the artist's vision or idea of the song from a concept to a complete product.

2.1.3. Promoters

Music promoters can be classified into two types of promoters; 1) live performance promoters, who are responsible for promoting live shows and events such as concerts and festivals. 2) music marketers, whose job is to promote the music to the public by utilizing various social media and press tools. This process typically generates more traffic and gets more radio plays.

2.1.4. Publishers

The music publisher’s main domain is music licensing. The duty of a publisher is to ensure the artist receives and collets their due royalties.

2.1.5. Artist & Repertoire

Artist & Repertoire (A&R) is an entity under the record label, solely responsible for finding and signing new artists to the record labels. Their responsibilities also extend to nurturing the artist and providing them with the optimal environment that can help elevate their talent. Additionally, A&Rs also ensure the artist's music is commercially viable.

2.1.6. Radio Pluggers

Radio pluggers, otherwise known as song pluggers, incentivize radio show hosts to play the artist's music on their shows. The performance indicator of radio pluggers is usually assessed by the number of songs they manage to play on the radio and the length of the plays. Radio pluggers typically maintain an amicable relationship with radio hosts.

2.1.7. Distribution Companies

Distribution is the process of delivering music to the public. Labels ship physical records to regional distributors, who then disseminate the product to local retailers.

In the case of digital music, however, labels may send them directly to digital marketplaces such as iTunes and Spotify, which are considered an amalgamation of a distributor and retailer.

2.1.8. Publicists and Public Relations (PR) Agencies

Publicists are responsible for generating press and controlling the public view of their clients. In the music industry, they will push artists for features in the press, and sometimes with other artists, they usually have established connections within the industry itself.

2.1.9. Performing Rights Organizations

Performance Rights Organizations (PROs) are the entities that keep a record of how often an artist's work has been played, the number of plays, and the amount of royalties due to the rights holder.

2.1.10. Digital Marketplaces

Digital marketplaces are where the music gets sold in digital form. Digital marketplaces are open to labels and independent artists alike. These marketplaces are designed in a way that allows labels and/or independent artists to offer their music directly to the consumer. Digital marketplaces include iTunes, google play music.

2.1.11. Streaming Platforms

Streaming platforms are platforms where users can listen to the music on-demand for free or for a cost. These platforms include Spotify, SoundCloud and YouTube.

2.2. THE MUSIC SUPPLY CHAIN

Now that an idea about entities involved in the music industry was formed, the figure below shows how these entities work together and the flow of product (music) from start to the end users.

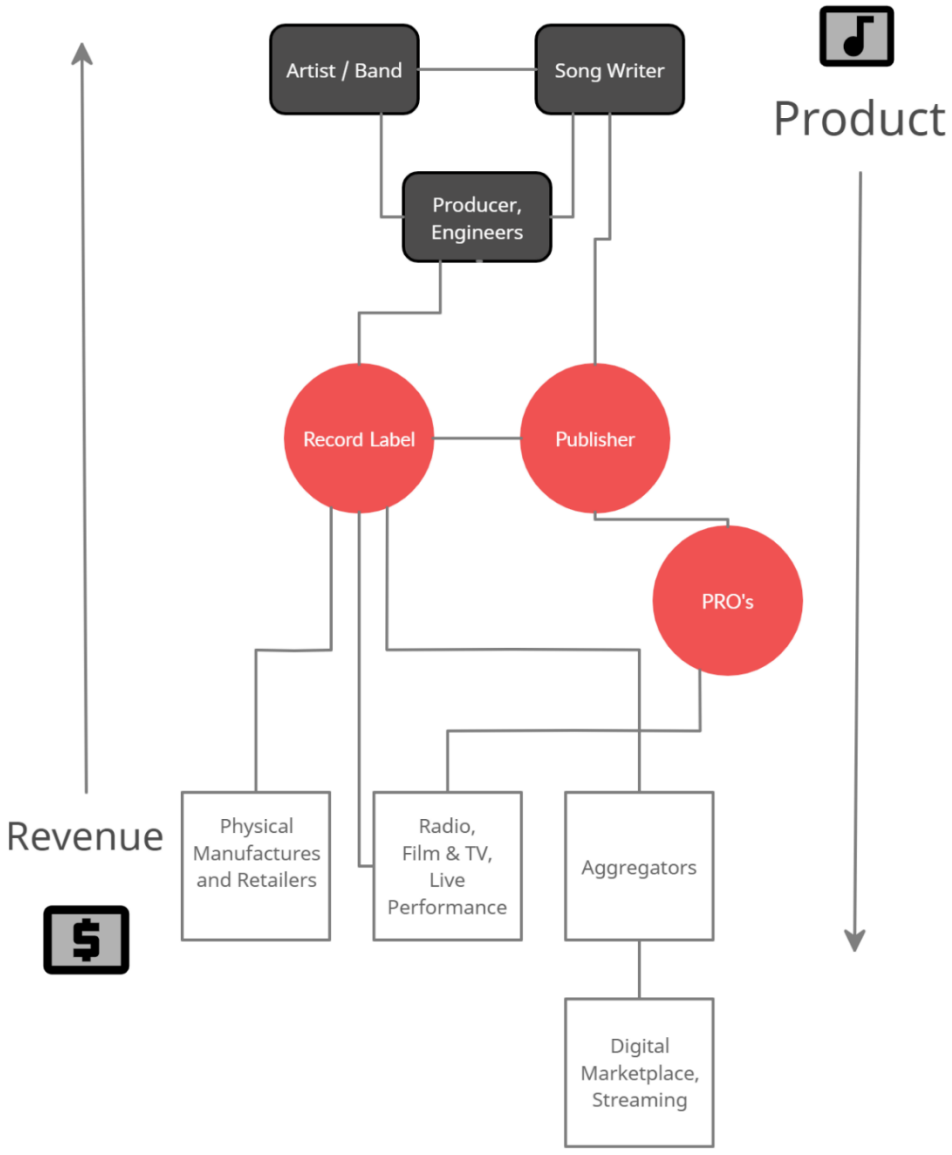

Figure 0.1 Recorded music supply chain [2].

As the figure above illustrates, artists work on music then hands the music to labels, publishers, and promoters which in turn hand it over to end user outlets i.e., stores,

streaming platforms, TV, Radio…etc. This model works in reverse when it comes to revenue consumers pay for music from the available outlets. In general, the revenue is collected by the platforms then handed to labels, publishers, PROs, and promoters. These entities then hand it over to the artists. This flow of revenue creates a low incentive for these entities at the start of this supply chain to pay these entities later down the chain which generates a lot of problems, delays, and lack of transparency. Those are some of the major issues that will be discussed later [2,6].

2.3. THE DESIGN SCIENCE RESEARCH (DSR)

Design Science Research (DSR) or design science research methodology (DSRM) is a paradigm when it comes to problem-solving that aims to enhance human knowledge and technology by the creations of innovative artifacts, these artifacts improve the environment and solve problems in where they were deployed. The DSR gives the newly created artifacts and knowledge in its results paired with why the artifacts enhance the application context [8]. DSR was rooted in (Simon 1996) engineering and the sciences of the artificial, DSR is widely used in computer science and by well-renowned research institutes such as MIT and Stanford, the DS process followed includes six activities: defining the problem and or motivation, defining the objectives, design and implementation, result demonstration, evaluation and communication [8,9]. More illustrated in Table 1.

Table 0.1 DSRM activities [8].

Activities	**Description**
Problem identification and motivation	Define the specific research problem and justify the value of a solution.
Define solution objectives	Infer the solution objectives from the problem definition and the determination of what is feasible.
Design and development	Create the artifact. Such artifacts are potentially constructs, models, methods, or instantiations.

Demonstration	Demonstrate the use of the artifact to solve one or more instances of the problem.
Evaluation	Observe and measure how well the artifact supports a solution to the problem.
Communication	Where appropriate, communicate the problem's importance, the artifact ‘s utility and novelty, the rigor of its design, and its effectiveness to researchers and other relevant audiences such as practicing professionals.

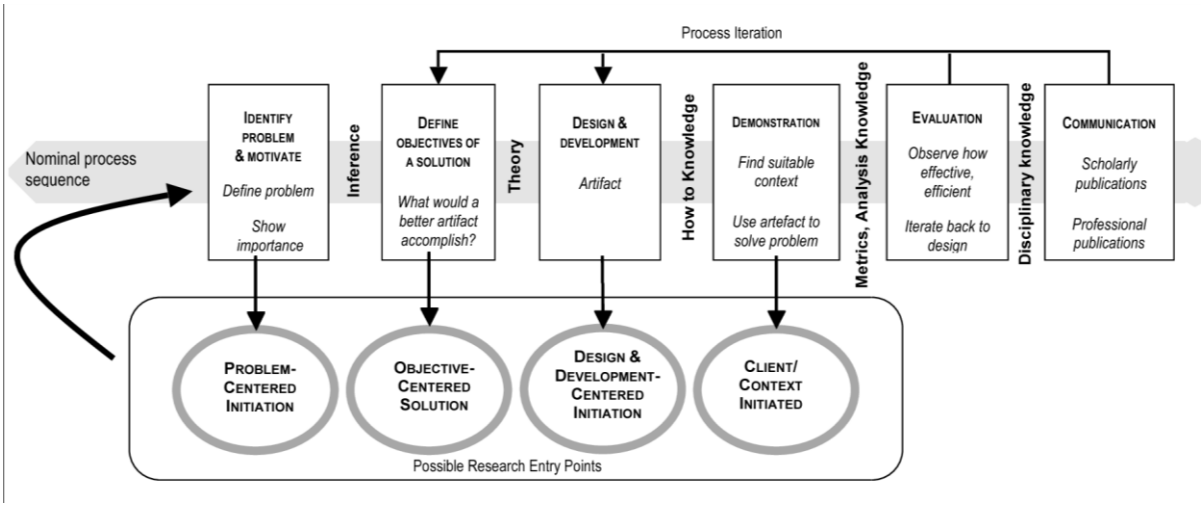

Figure 0.2 Methodology framework [9].

2.4. THE AGILE DESIGN AND DEVELOPMENT PROCESS

Agile is consider as an umbrella of software development framework, it’s a framework for software engineering that starts with planning then deployment with iterative and incremental interactions throughout the life-cycle of the project. The goal for agile is to reduce the cost of the development process with the ability to embrace the changes without the risking rework or the process [10]. Agile was chosen as the software design

and development method over the other traditional methods for many reasons summered as follows:

Table 0.2 Agile vs traditional methods [10].

Parameter	**Traditional Methods**	**Agile Methods**
Ease of Modification	Hard	Easy
Development Approach	Predictive	Adaptive
Development Orientation	Process Oriented	Customer Oriented
Project Size	Large	Small or Medium
Planning Scale	Long Term	Short Term
Management Style	Command and Control	Leadership and Collaboration
Learning	Continuous Learning while Development	Learning is secondary to Development
Documentation	High	Low
Organization Type	High Revenue	Moderate and low Revenue
Organization's Number of Employees	Large	Small
Budget	High	Low
Number of Teams	Multiple	One
Team Size	Medium	Small

2.4.1. Feature Driven Development (FDD) Method

Feature-driven development is one of the approaches that fall under the agile methods umbrella, it manages small incremental changes that lead to functional software. The feature is a function of the software that the user needs or values [11].

2.4.2. FDD Life Cycle

FDD life cycle consist of five sequential processes; Development of Model, this step defines the project context and scope by the experts and team members. Build the feature list, in this step the requirements and model are defined and are used to build the feature list. Plan by feature, from list defined in the earlier step; the plan will be in order of priority to the customer and the dependency between these features. Design by feature, this is the iterative step each iteration takes a certain amount of time and this step produces the diagrams and any needed design package then reviewed for approval. Build by feature**,** the final step in FDD in this stage the designs defined earlier is implemented then inspected and tested, this step is also an iterative step and after the iterations are done and the desired state is achieved then the features are published as a new or changes to ready-made features [10].

Figure 0.3 FDD process [10].

2.4.3. Advantages and Disadvantages of FDD

Advantages, FDD is a highly adaptive method and very flexible to changes. Deliver high-quality and better outcomes after each phase. The results of each iteration can be delivered in a timely manner, which will help to gather quick feedback [8]. But FDD also has some disadvantages, there is small guidance about the requirement gathering, analysis, and risk management in FDD. Requires an expert team and a high level of skills in design and modeling. FDD does not take into consideration the urgency of the projects [8].

2.4.4 FDD In the Context of the Research

FDD was chosen for this research for the above-mentioned advantages and its applications on similar projects when it comes to software development, and its ability to accommodate the needs of our model, i.e., fast with good quality turn around and low cost.

2.5. THE BLOCKCHAIN TECHNOLOGY

2.5.1. Blockchain

“First proposed by mystery man/woman/group Satoshi Nakamoto around 2007, developed through 2008, and launched in early 2009 ”.[5] Blockchain is defined as a decentralized or distributed ledger of transactions stored as blocks and these blocks are connected together forming a chain hence the name blockchain. The validity of these transactions is agreed upon by peers on a decentralized network and all protected by cryptography [11–13]. The “node” in the blockchain is referred to the client that holds or owns the block, nodes can store a complete copy of the distributed ledger [11–14]. The “block” is where the most recent transactions which haven’t been entered in other blocks is kept, thus a block is similar to a page of a ledger or record book [11–14].

2.5.2. The Blockchain Architecture

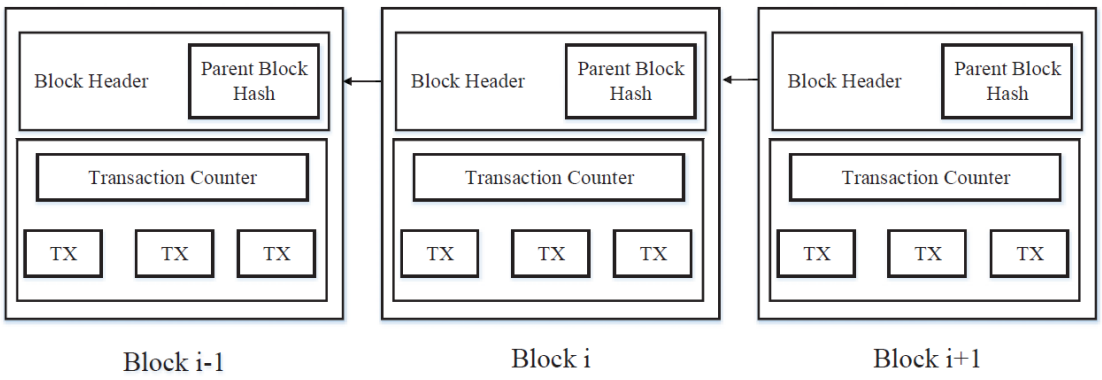

Figure 0.4 Example of the blockchain architecture [12].

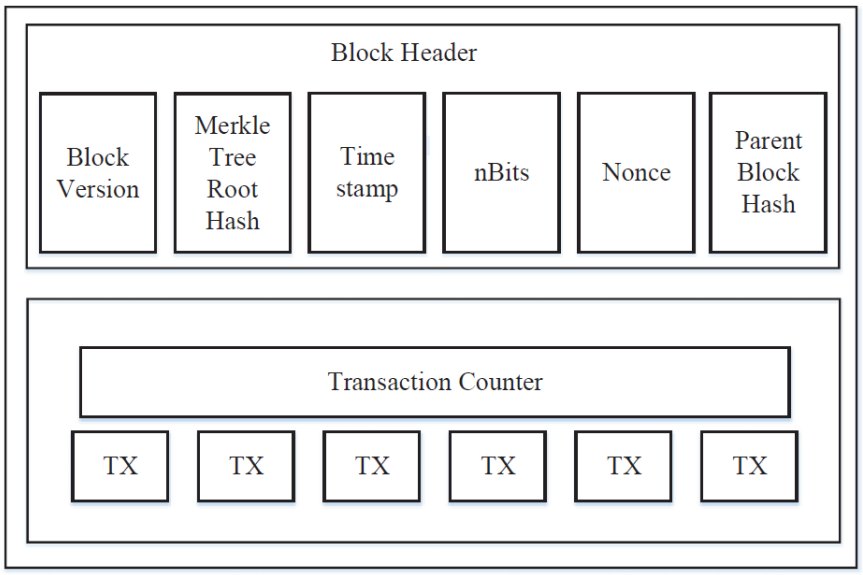

Figure 0.5 The Block structure [12].

2.5.3. Consensus Algorithm

Consensus in blockchain means that all the nodes in the blockchain agree on what is the truth and a Consensus Algorithm is the way or approach used to determine the next block in a blockchain. This is the one and only version of the truth, it is used to keep the blockchain data valid and stops any external entities from derailing the system and forking the blockchain [12–15].

2.5.4. Evolution of the Blockchain

Blockchain 1.0, or bitcoin is considered as the first application of the blockchain technology, introduced as a peer-to-peer system, Nakamoto formed the genesis block, where other blocks got mined from [13,14]. Later on, came Blockchain 2.0 and contracts. In 2013 Ethereum introduced by the its CEO vitalik buterin added to the blockchain technology new features and functionalities that allow the blockchain to store other assets and execute smart contracts taking the blockchain from being only a cryptocurrency to a platform for developing decentralized applications [13,14]. Blockchain 3.0 and applications, a new wave of blockchain technologies emerged such as IOTA, NEO and many more, these platforms developed to overcome the major

issues of the 1.0 and 2.0 application and designed on the FFM concept (fast, fee-less, miner-less) [13,14].

2.5.5. Advantages of Blockchain Technology

Decentralization: The blockchain is decentralized in its nature and that can be a benefit because it dramatically reduces the need for third party and "middle-men" [12].

Transparency: Transactions on the blockchain are available to every member of the chain, this precipitates more transparency and establishes more trust in the validity of the data [12,16].

Faster Transactions: In some cases, the transaction time is faster than the traditional banking system, which approximately takes days to complete a transaction. Blockchain technology greatly reduces the transaction time to minutes and sometimes seconds due to the lack of third-party approval. Everything is done on the network and by the participants themselves [12].

User-control: The blockchain is made of blocks that are run and hosted by blockchain members. These members collectively are in control and it is not on the hands of a single entity [11].

Security: The blockchain technology is more secure than any traditional system. Given that it does not have a single-entry point which makes the penetration and control of the blockchain very hard. Moreover, the information on the chain is encrypted which adds another layer of security [12].

2.6. THE USE OF BLOCKCHAIN IN THE MUSIC INDUSTRY

This part will explore how blockchain can solve some of the issues faced in the music industry.

2.6.1. Music Licensing

The smart-contracts are used to simplify the licensing of music. Given the transparency and immutability of the blockchain, it will be more secure and trustworthy for an artist to license their work on the blockchain. The Process is straightforward and transparent; the artists will release their work on the blockchain and retain their rights for the work, the platform will handle issuing the license to the consumers and a unique license will be embedded in the file itself [1,2,5,6].

2.6.2. Intermediaries

The blockchain introduces the opportunity to establish a peer based and crowdfunded music platforms and marketplaces. Moreover, the blockchain is operated and run on the nodes. These can be the artists and users which shifts the power to them and gives artists more leverage and also benefit the users by providing more affordable platforms [1,2,15].

2.6.3. Piracy

The blockchain-based solution as mentioned above can lead to more affordable platforms, which can substantially reduce piracy. Additionally, a blockchain-based solution, can provide incentives for users to participate in the blockchain and use the platform. For example, users can get rewards from sharing and listening to music on the platform. Such an incentive-oriented approach will reduce piracy [1,16,17].

2.6.4. Royalty Payments

For royalty payments, smart-contracts can be utilized for the process where every time the user buys or streams music the blockchain will handle the processing of payments to artists who stand to benefit from the musical works. Royalty payments are considered one of the main streams of revenue for artists and this research is dedicated to analyzing and proposing a model to improve and solve problems in this area [1,2,6,18].

2.7. MUSIC ROYALTIES

Royalties are defined as payments made in exchange for the right to use another party's property [19]. Musical royalty payments are what every rights owner receives from the revenue generated from musical works use or consumption. Music royalties go to recording artists, publishers, songwriters, composers, and other copyrights holders. Depending on the artists signed deal, usually everyone in the music supply chain gets a cut form the royalties varying in percentages [1,2,6,7,18].

There are four kinds of music royalties depending on the copyright and use:

2.7.1. Mechanical Royalties

Mechanical royalties are paid for the production and or distribution of musical works, be it physical or digital i.e., CDs, vinyl, cassettes, digital downloads, and streaming. So, for instance, when a record label presses a CD of an artist's song, they are due a mechanical royalty. These royalties are due to whoever owns the mechanical license to reproduce and distribute the musical works, mechanical royalties are collected by the performance rights organization and paid out to whoever registered as rights holder, can be a music label or artist [21–24].

2.7.2 Public Performance Royalties

Public performance royalties are generated from the works being performed, recorded, or streamed publicly i.e., TV, restaurants, bars, clubs, live concerts…etc., PRO organizations negotiate licenses for public performances and monitor their usage. They also collect and distribute the royalties generated to the rights holders [20–22].

2.7.3. Synchronization Royalties Or (SYNC)

Synchronization royalties or (SYNC), are paid for the use of music paired or 'synched' with media, holders of the Sync licenses use the works in films, television, commercials, video games advertisements…etc. [20,21,23–25].

2.7.4. Print Music Royalties

Print music royalties are paid when the musical works are printed or transcribed for example sheet music, this type of royalty is not very common for most artists [21,26].

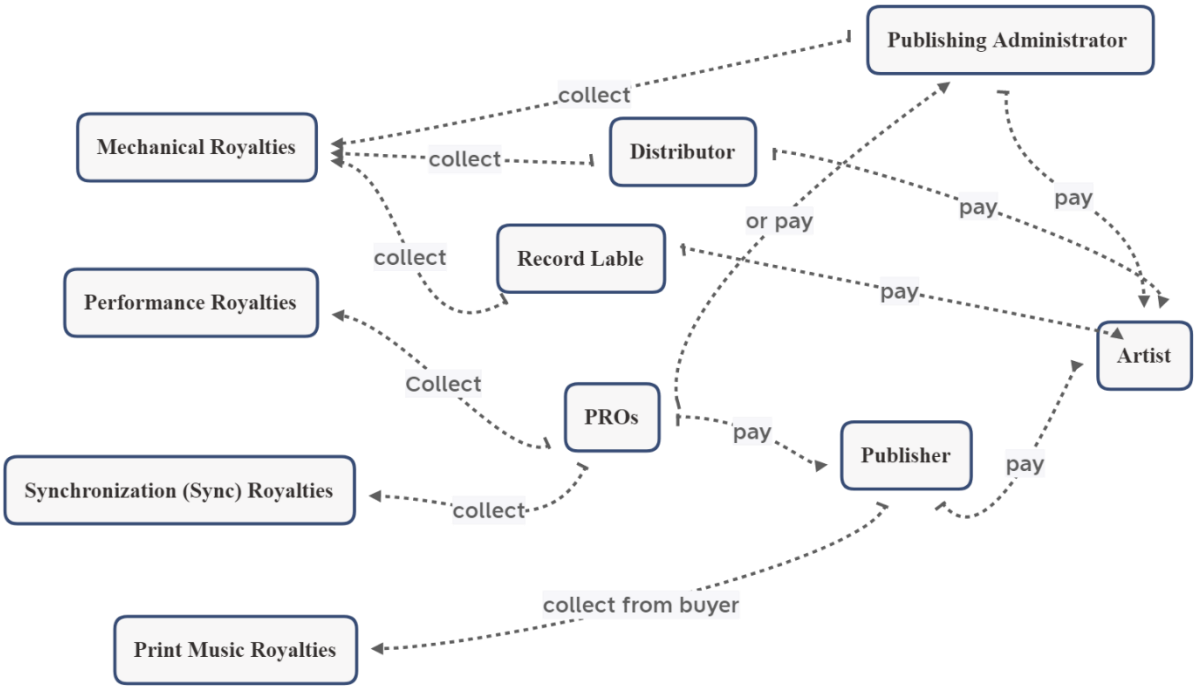

Figure 0.6 Collection and payment of musical royalties [20–28].

The figure above shows which entities collect what type of royalties, and we can see how the artist gets paid from every entity last, the implication is that each of these entities has its own policy when it comes to dealing with the artist which can cause the problems mention earlier [20–28].

2.8. BLOCKCHAIN BASED SOLUTIONS FOR MUSIC ROYALTIES

2.8.1 Music Royalty's Identification and Collection and Distribution Using Respray Pi (Musicbeetle)

By Serrão, Carvalho et al, 2016 titled "Intelligent Music Royalties Collection and Distribution System"

They introduced a music royalties system directed for PROs and music users. The system is responsible for collecting the royalties from different business music users and distributing them to the copyright's beneficiaries. Businesses, in this case, are businesses that incorporate music as a maid part of their business and go through the proper and legal channels to purchase the rights to use these works for example Radio, TV, music festival ...etc. The beneficiaries, in this case, are entities that have the right to receive royalties. The MusicBeetle system consists of two different components; the first is a client-side component that automatically identifies music being used and creates a report of all the music used during a certain period of time. The second is a set of cloud-based services that register different music licensees, their usage profiles, and information. For the system to work music users have to install specific hardware, a respray pi called "MusicBeetle box" connected to the music sound system. The figure below shows how the system works [29].

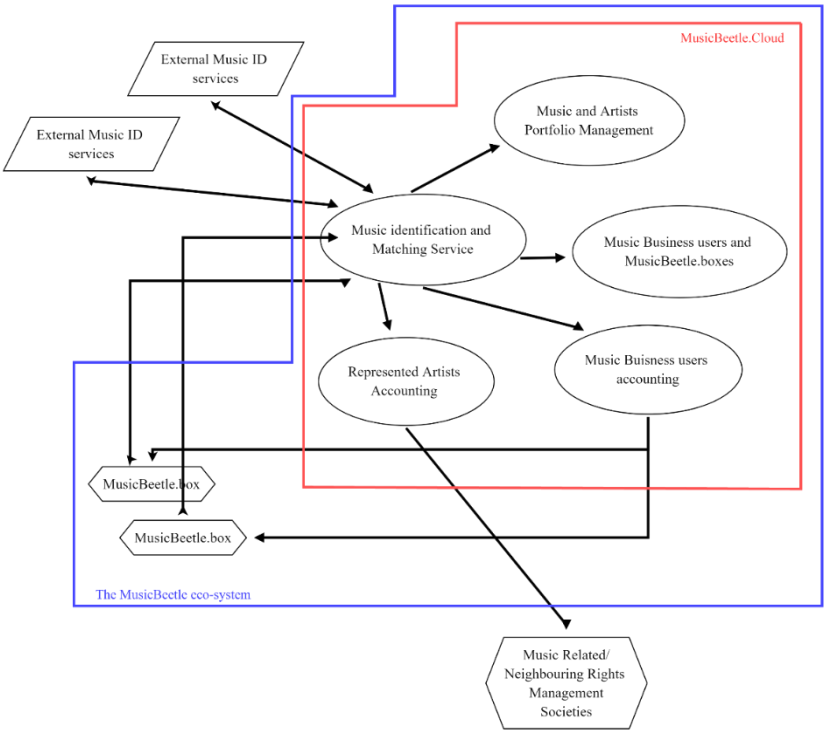

Figure 0.7 Music beetle system model [29].

2.8.2 The Black Box of Music Royalties

By Elshan, Ebel et al, 2021 titled "*Opening the Black Box of Music Royalties with the Help of Hybrid Intelligence*".

The study proposes and introduces design requirements for a hybrid intelligence system for music royalties, the authors identify design requirements both inductively from expert interviews and deductively from theory and present a first prototypical instantiation of the system. The results conclude that the system requires, a Continuous and Aggregated Display of Tracking and Monitoring. efficiency and Speed Enhancing Components to foster the cooperation between Humans and Machines. an inclusion of Control Mechanisms by the Human-in-the-Loop an interactive Feedback Cycle Between Humans and Machine [7].

2.8.3. Ujo Music

Ujo Music is a ConsenSys extension and it is a platform that uses cryptocurrency and smart contracts for music and where artists interact directly with the end-users. It uses the Ethereum blockchain as a base, the platform digitalizes artists' music rights and metadata. The model of revenue in Ujo is that streaming is free at the moment but there are future plans to include payment for streaming, also users can buy music and the money goes directly to the artists they can also “tip” artist where the money also go directly from the user wallet to the artists' wallet, Ujo uses a wallet called MetaMask, as for the artists there no fees required to use the platform however there are small fees when it comes to music listing on the network [30].

2.8.4. Vezt

Vezt claims that they are the First Music Rights Marketplace, “*Vezt is the first mobile app where music fans can share royalty rights for songs and recordings by artists they love. We exist to improve the music industry by providing artists, songwriters, and producers with funding sourced directly from their fans on a global basis. In exchange, fans get the right to receive royalties earned by their favorite songs and recordings.”- vezt website.* The platform collects the royalties from PROs, Labels, and publishers and split the shares between artists and their funders. Before the revenue is generated artists put their song or work in an ISO™ (initial song offering®) same concept as the ICO and here the ISO includes a date where royalty rights will be made available to the public and then fans can invest in the artists they believe in, eliminating the need of financing from a music label where the fans doing the financing [31].

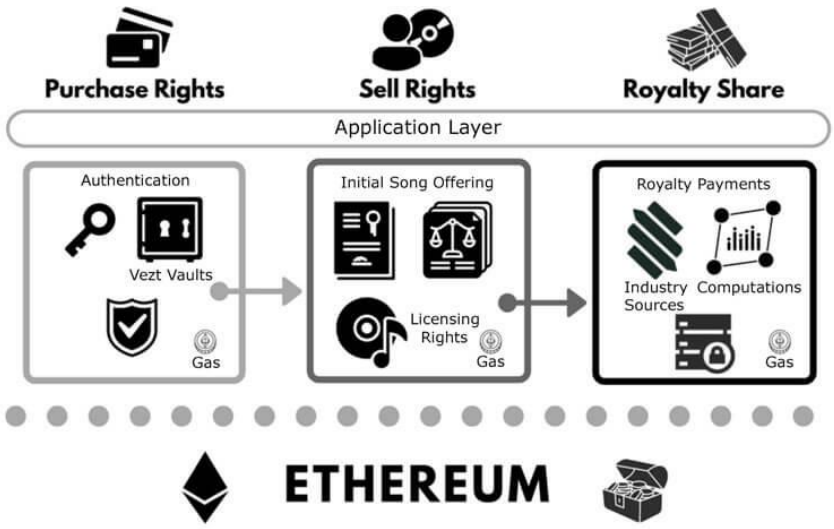

Figure 0.8 The model of vezt and the process of selling rights of music [31].

2.8.5. Blòkur

Blokur define themselves as a platform that helps musicians and music companies get paid what they should, when they should. Blokur works mainly in the music publishing data, Blokur reduces costs and increase revenue for labels and collective management organization through automation and better data enabled by blockchain and machine learning, according to Blokur their technology consists of two layers, the first layer automatically surfaces conflicts in rights data and the second layer reconcile data from multiple sources [32].

2.9. THE STATE OF BLOCKCHAIN BASED SOLUTIONS FOR MUSIC ROYALTIES

Throughout the literature, it can be seen that most of the work done with blockchain is business and profit-focused and not solely dedicated to the solution of the industry's problems, notwithstanding the fact that blockchain technologies solve some of these issues. A sizeable number of the blockchain startups that were founded in recent years have had a model that results in removing or replacing one of the entities in the music

industry ecosystem. This in turn results in difficulties adopting these new technologies in a very chaotic and change-reluctant industry.

2.10. ISSUES AND GAPS

The proposed technology stated above addresses and provides solutions to some of the types of music royalties. Namely mechanical royalties, and performance royalties. The solutions will exclude print and some sync royalties to other platforms or channels.

2.10 SUMMARY

To briefly conclude everything that has been stated thus far, this chapter further discussed music royalties and blockchain technology. Subsequently, this chapter, deliberately examined works and solutions that utilize blockchain technology as a foundation for solving the problems faced in music royalties. Finally, this chapter considered the state of these works and some of their inherent issues and gaps.

PART 3

METHODOLOGY

In this section the methodology used to conduct this research will be introduced, explaining the activities that has been carried out, and highlighting what each activity represents and what has come out of the activity. following the DSR methodology.

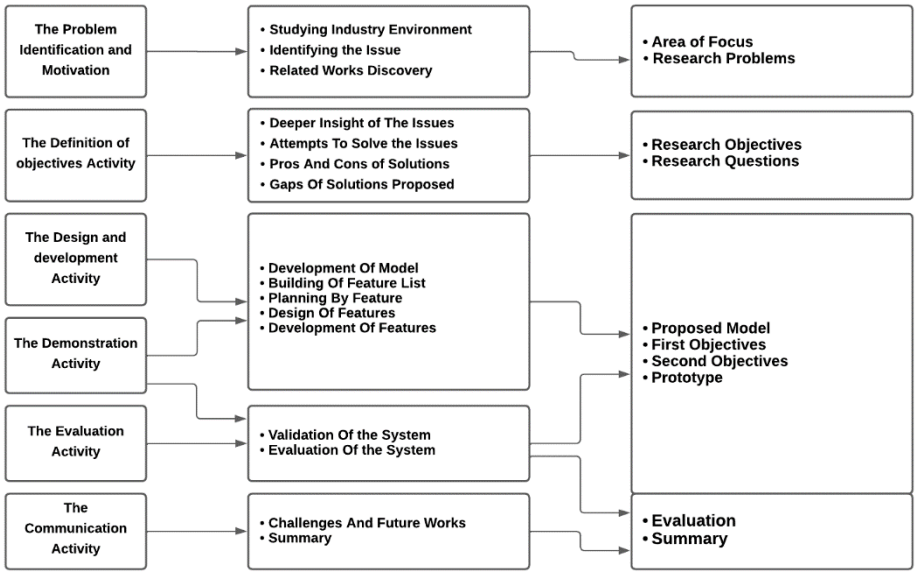

Figure 0.1 Research methodology framework.

3.1. THE PROBLEM IDENTIFICATION AND MOTIVATION

This activity defines the research problems and communicate the context and the environment; thus, putting everything in perspective. Additionally, it provides the motivation for the researcher and communicates the value of the solution to the reader [33]. In the activity a comprehensive study on the current music industry environment was conducted to have a better understating of how it has evolved over time, and understand what entities play which role in the eco-system. Therefore, leading the research to what problems being faced by the involved entities in the supply chain of

the music industry. Music royalties is considered one of the main sources of income for most musicians and most of the legal disputes in the music industry is around the subject of royalties. Thus, becoming the motivation, which is to focus and contribute in this area of the music industry. A comprehensive study was done on music royalties to understand what makes it important? what types of royalties exist? and how it is being handled in the current state of the industry. Moreover, study and exploration of how the payments are being handled was done coupled with what pain points and frustrations faced by the parties involved in the process, and consequently leading to understanding which areas of payment needs to be reworked and remodeled. A comprehensive study was carried on the evolution of the solutions which been applied to tackle some of the issues in royalty payments. Thus, leading to what gaps these solutions haven't addressed, and what are the possibilities of solving and filling such gaps.

3.2. THE DEFINITION OF OBJECTIVES ACTIVITY

This activity defines the objective of the solution which is derived from the problem defined in the first activity, and it explores what is possible and feasible. Additionally the objective can be quantitative and explain how it can be better than the current solution, or it can be qualitative and describe how a new solution is expected to support solutions to problems addressed [33]. In the activity a review and study on blockchain technology in general, and how it can be used in the music industry was conducted. Thus, to study what possible solutions and what can help solve the problems collected in the first activity. A study and revision done to related studies, problems these studies tackled, how each solution was conducted, and what results it provided. Subsequently, what can be improved in these solutions, and the gaps that can be filled.

3.3. THE DESIGN AND DEVELOPMENT ACTIVITY

This activity provides the artifact conceptually. the DSR artifact can be a designed object that contributes to the research. in this stage the functionality and architecture is determined for the actual artifact [33].

3.3.1. Development of Model

As the first step in FDD, and based on the objectives defined earlier, a model was designed to explore how the different entities interact with one another. Additionally, what features the system needs that can lead to the achievement of the objectives and solve the research problems. The model needs to accommodate the need of artist to register their musical works, royalties, and royalty recipients. Additionally, the modal needs to remove the control of revenue from collecting entities, and provide all parties with transparent information about the flow of revenue, in order to reduce the delay and provide more reliable information. Therefore, the model also needed to provide an alternative to traditional payment methods. Thus, solve and deliver both objectives. The model consists of 3 main actors, collectors, payers and receivers. Moreover, collectors decide the amount of payment, payers will send funds into the blockchain, and receivers accept payments through the blockchain payment system.

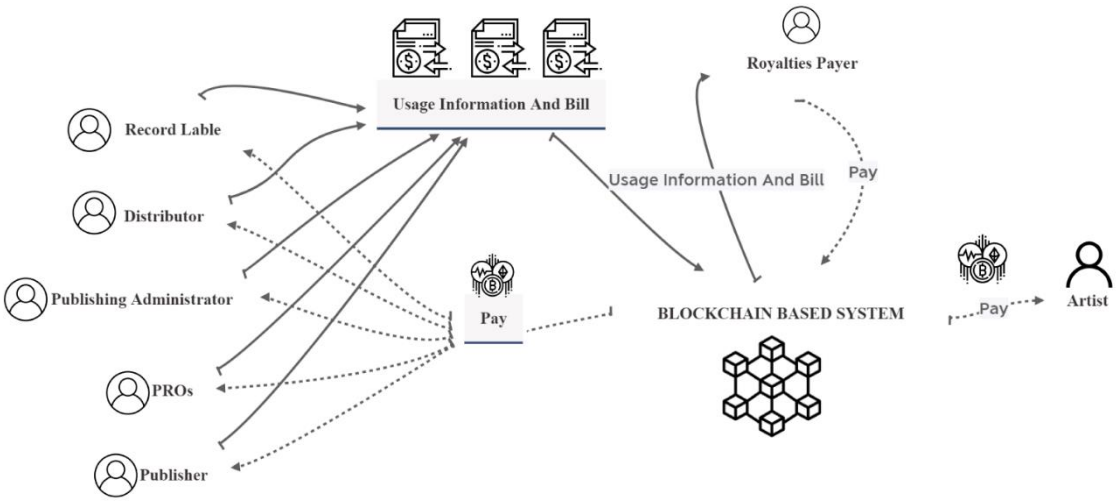

Figure 0.2 Blockchain-based royalty payment model.

3.3.2. Building Of Feature List

From the model conceived earlier a list of features was created as a requirement of the system:

- Add and registering of (Artists, musical works, collaborators and clients.
- Billing of clients form collaborators who have the responsibility of collection of royalties.
- Processing of payments to all recipients.
- Reporting of payments and transactions.

3.3.3. Planning By Features

For the system to accommodate the features and requirements defined earlier the following list of modules was defied:

- Artist Module: to handle information of artists.
- Songs Module: to handle information when it comes to songs.
- Collaboration: to handle information of creating and defined collaborations on a song.
- Billing module: to issue bills of royalty payments
- Payment module: to pay all recipients of royalties
- Transaction module: to handle reporting

3.3.4. Design and Build of Features

After the modules were defined, the process of designing and building each module came. Starting by the artists module, which will add the basic information of artists and the address where they will receive their payments. The song module which will register songs, and its dependent on the artist module where it links each song to the artist that owns it. The collaboration module comes after that, utilizing information form the artist and song modules to link other artists and collaborators to a song. Thus, they can receive their dues of royalties. Follows, the billing module which will utilize

information form the songs to bill clients. After that the payments module, which collects the information form the billing module for the amount, and information from the collaboration module to make the payments to each recipient. Additionally, it will push all the information to the transactions module which will create the reports of payments.

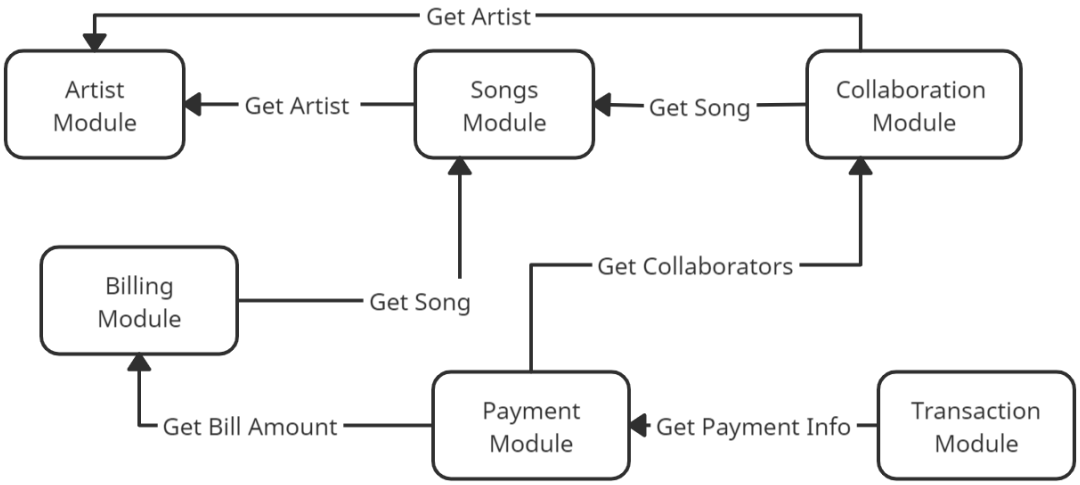

Figure 0.3 Design by feature.

3.3.4.1. Activity Summary

A new royalty payment model was designed to replace the current model, and provide solutions that meet the objectives set from the previous activity. A list of features was defined to accommodate the model, after that a list of modules was specified, then the design and development of the module was carried, resulting to the delivery of the objectives.

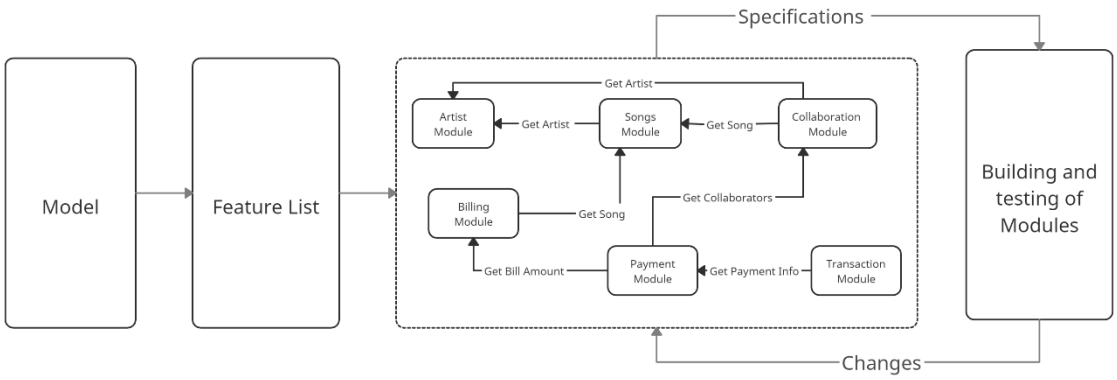

Figure 0.4 Activity summary.

3.4. THE DEMONSTRATION ACTIVITY

This activity displays the use of the artifacts and how it can solve one or more of the problems defined earlier. It can be in the form of an experiments, case study, proof-concept or any other appropriate form [33]. Blockchain based application was created. Thus, a blockchain environment on a local machine was setup. Moreover, the application is to test the model designed in the earlier activity, and which objectives can be achieved in this solution.

3.5. THE EVALUATION ACTIVITY

This activity evaluates the artifact and how well it solves the problem. Moreover, it involves the comparison of the results of the solution to an observed result. The form of the evaluation varies depending on the nature and context of the problem. Eventually, at this stage researcher can decide whether to iterate back to earlier activities or continue [33]. The first step was to evaluate the traditional modal with the proposed model from a higher level. Thus, see if the proposed model can help solve the problems mentioned earlier. Additionally, explore if taking the handling of payment from the entities handling it in the traditional modal will help in solving the issues of transparency, and delay of payments. After that the modal was evaluated when it comes to the speed and cost of transactions. Additionally, explore if the blockchain technology when it is applied to the proposed modal can make the payments faster or not. And if yes, how much would it cost to make these transactions. Moreover, is it suitable enough to replace the traditional methods or not. Lastly

evaluation of traditional model vs the developed model, and evaluation of the approach or the solution chosen in the new model vs projects and other solutions made in the royalty payments domain. The evaluation was made only on what each solution provided in terms of features, given the fact that they all shared the same technology which is the blockchain technology.

3.6. THE COMMUNICATION ACTIVITY

This activity communicates all aspects of designed artifact, and problems to relevant stakeholders. Depending on the audience and research goals the form of communication is decided [33]. As the final activity the solution evaluation is presented to communicate the findings. Moreover, the possible issues that might occur when implementing the new model, and some of the challenges facing the implementation is communicated.

3.7. SUMMARY

this chapter discussed in detail the activities done to conduct the research. Leading with the problem identification and motivation, which highlights the process of exploring the problems faced in the music industry. followed by the definition of objectives, explaining how the objectives have been set for the research. After, the design and development activity, which shows the process followed for the design and development of the model. The Demonstration Activity came right after. Thus, explaining which form of demonstration of the solution was followed. After that, the evaluation activity was mentioned, to highlight how the model was evaluated. Finally, The Communication Activity, which explain how the findings were communicated.

PART 4

THE DESIGN AND DEVELOPMENT OF THE MUSIC ROYALTY PAYMENT SCHEME

In this section a new approach for royalty payments and how it's going to fit within the music industry will introduced, after that a demo as a proof of concept will be introduced. As mentioned earlier the artist, and music royalties' beneficiaries receive payments from collectors directly, which caused the problems introduced in the early chapters. The new approach will rearrange the model so the entities responsible for the collection do not handle the payment. Consequently, these entities will provide the collection information (i.e., how much royalties are due and to what body of work), then the client or royalty payer will pay these royalties to their respective recipients. Finally, these payments will be distributed through the blockchain network, based on predefined shares enforced by a smart-contract.

4.1. CONCEPTUAL MODEL

The model operates as follows:

The artist will add the musical works and meta data (i.e., song info, other artist who collaborated in the song …etc.). Based on this information, the collection entity being a publisher or PROs/Collection society, will post bills for the royalty payer. The Royalty payer then will pay the bill posted. The system receives these funds and distributes these payments to their respective recipients.

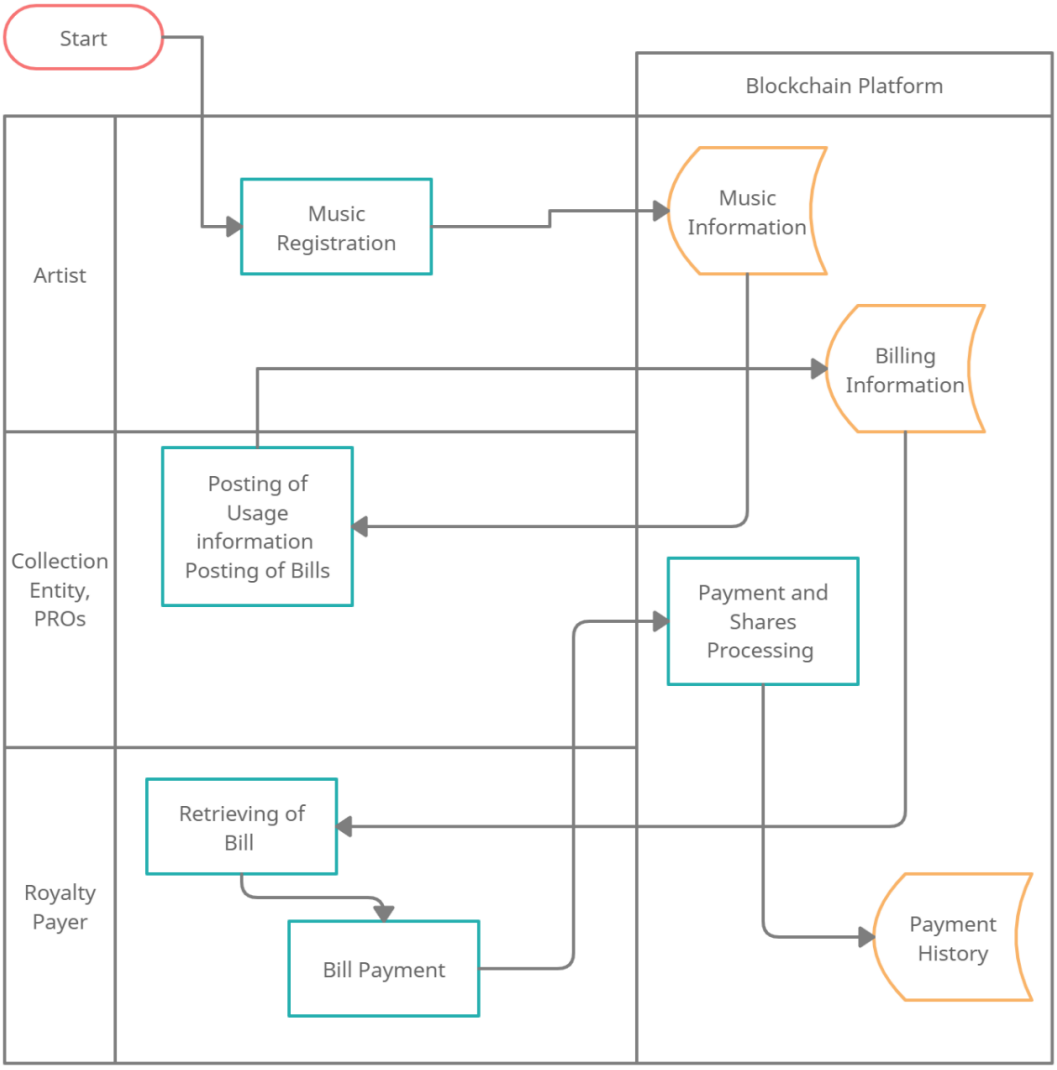

Figure 0.1 The conceptual model.

The figure above shows the process of royalty payment processing from start to finish highlighting the process and data stored on the blockchain.

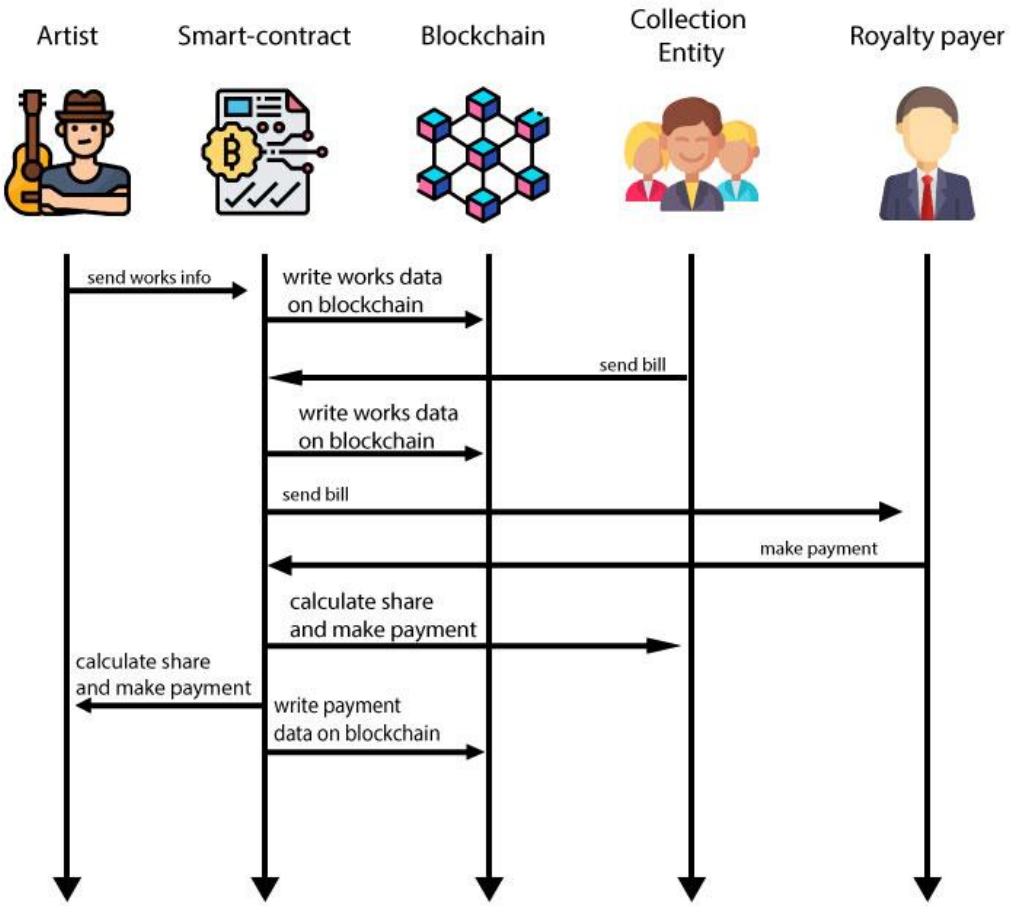

Figure 0.2 Dataflow diagram.

The figure above highlighting actions done by each of the entities on them model and the relationship of each entity to other entities.

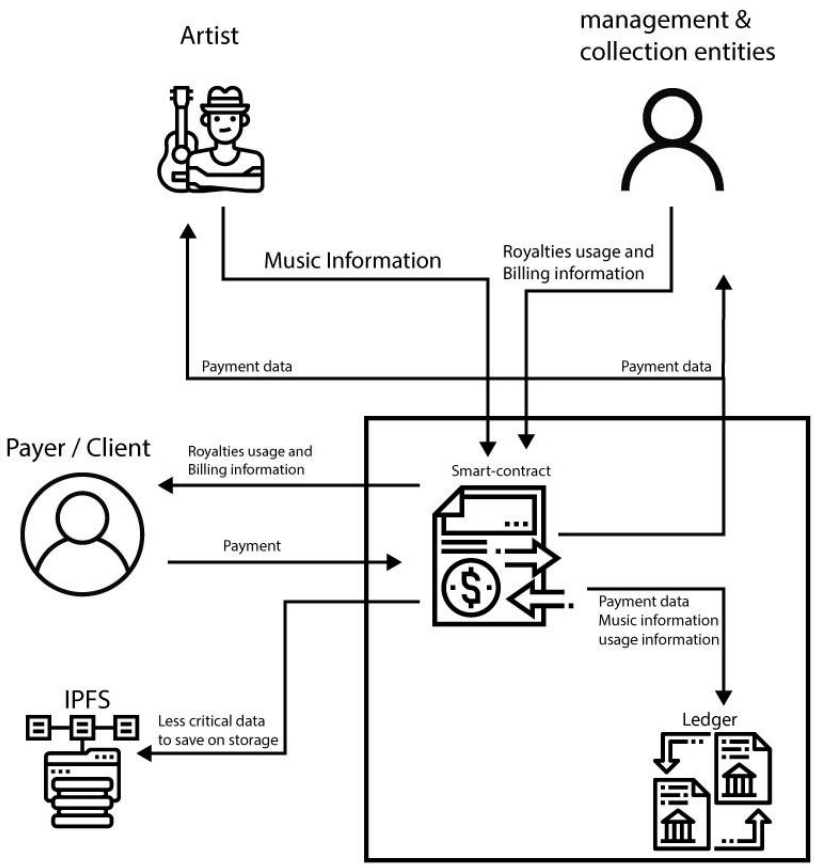

Figure 0.3 DATA handling on a blockchain environment.

In terms of how this model can work on a blockchain based system, only payment relevant data will be stored directly onto the blockchain, that would be all involved entities addresses and payment history. Additionally, the music meta data will be stored in a peer-to-peer file system for example The InterPlanetary File System (IPFS), then the smart contract will process payments, and record information both on the blockchain and on the IPFS.

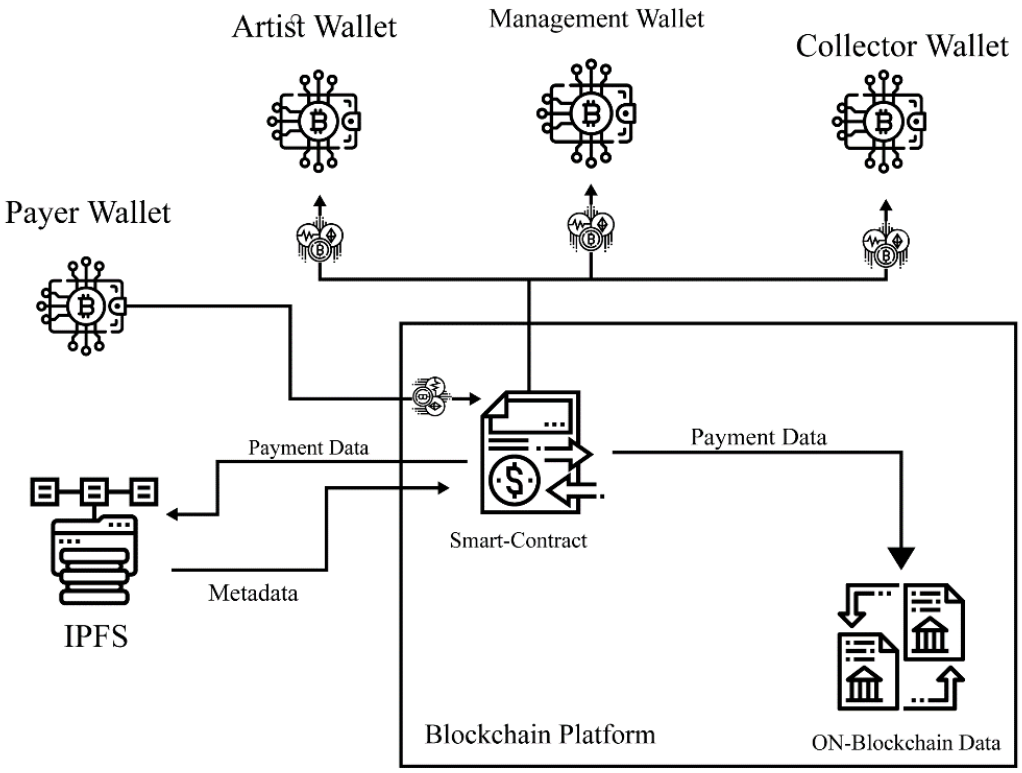

Figure 0.4 payments handling on a blockchain environment.

After the data population on the system, it will be a recurring process of billing and payments. Depending on the policy of the collection entity and their collection frequency (i.e., every month, 3 months, 6 months…etc.).

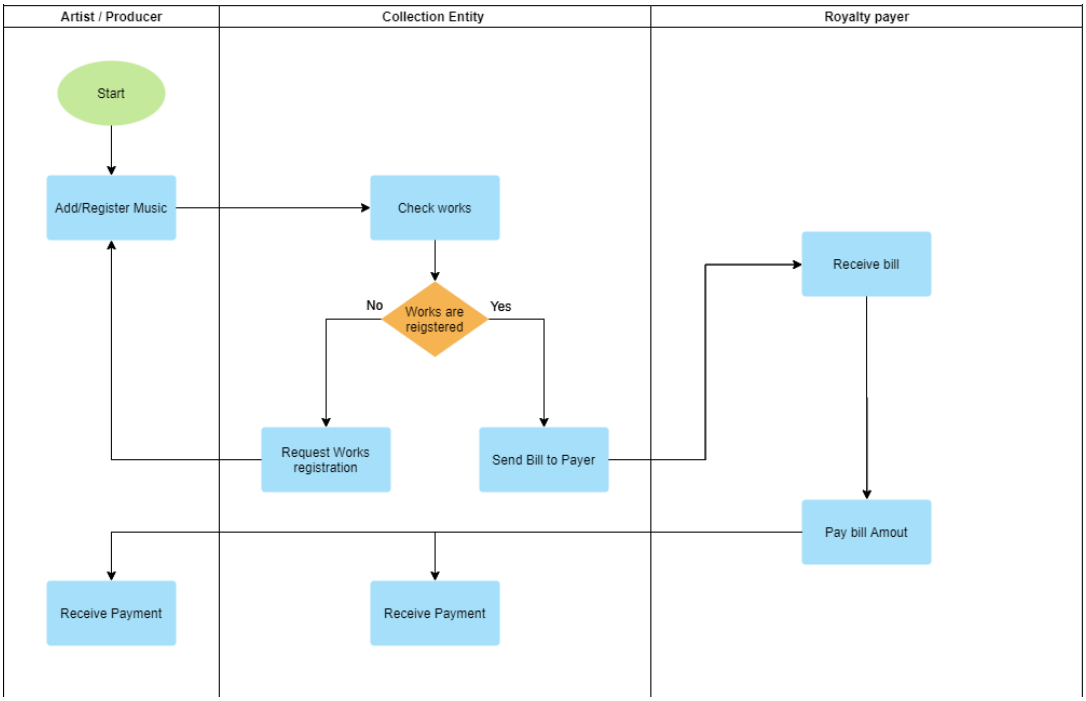

Figure 0.5 Billing and Payment Process.

The figure illustrates in detail the process of payment in the blockchain system and the flow of the process between entities in the model.

4.2. THE MODEL PROOF OF CONCEPT PROTOTYPE

As a proof of concept, a small in terms of scale prototype was developed on a local Ethereum blockchain, to perform an experiment on how the model is going to operate on the blockchain.

Table 0.1 Protype specifications.

Name	**Description**
Truffle Suite	Truffle suite is a development environment for blockchain dapps (decentralized applications) and smart contracts, with truffle comes ganache which is a personal blockchain for

	Ethereum development that you can use to deploy contracts, develop your applications, and run tests.
Solidity	Solidity is a curly-bracket language. It is influenced by C++, Python and JavaScript, and is designed to target the Ethereum Virtual Machine (EVM), it is used to write the smart contract in our contract.
MetaMask	MetaMask is a software cryptocurrency wallet used to interact with the Ethereum blockchain. It allows users to access their Ethereum wallet through a browser extension or mobile app, which can then be used to interact with decentralized applications, in our experiment it used to manage accounts and interact with our app (accept or reject transactions).
Web3.JS	web3.js is a collection of libraries which allow you to interact with a local or remote Ethereum node, using a HTTP or IPC connection. The web3 JavaScript library interacts with the Ethereum blockchain. It can retrieve user accounts, send transactions, interact with smart contracts, and more.
Node.JS	Node.js is an open-source, cross-platform, back-end JavaScript runtime

	environment that runs on the V8 engine and executes JavaScript code outside a web browser. In our experiment it used to build our web server and backend.
React.JS	React is an open-source front-end JavaScript library for building user interfaces or UI components. It is used to build the user interface in our prototype.

4.2.1 The Stages of Development

- Setup of blockchain environment using the “Truffle suit”.
- Creation of virtual crypto balance using ganache.
- Assigning crypto on ganache to wallet accounts using metamask.
- Writing of smart-contract to execute the calculation and handle payments.
- Setup of a webserver to host the interface of the application on a web environment.
- Design and development of a user-friendly interface.

4.2.2 The Smart-contract

The smart contract includes the main payment method with supporting methods for data population and recording on the blockchain.

Below are the smart-contract modules:

4.2.2.1 Artist Module

This module is responsible for adding artists to system, for this prototype it only registers id, artist name and artist address, in a real-life example it will has more information related to the artist. Contains two functions first one a primary function that writes this information to the blockchain and a helper function that retrieves artist name.

Artist Module Pseudocode

```
1. let nextArtistId be INTERGER and PUBLIC
2. create a key-value pairs structure of ARTIST in Array
   ARTISTS
3. Definition of ARTIST structure {
4.     let ID be INTERGER
5.     let ArtistName be STRING
6.     let ArtistAddress be ADDRESS
7. }
8.
9. define function createArtist make it Public with arguments
   (ArtistName as STRING, Artistaddress as ADDRESS) and
   Return (id as INTEGER, Name as STRING, Address as ADDRESS)
10.     START
11.         In ARTISTS array with nextArtistId as an
   identifier insert arguments nextArtistId,ArtistName,
   Artistaddress as an artist structure entry
12.         increase nextArtistId variable value by 1
13.         RETURN value of (nextArtistId,ArtistName,
   Artistaddress) as function returns
14.     END
15. define function getArtist make it Public with arguments
   (id as INTEGER) and return (id as INTEGER, name as STRING,
   address as ADDRESS)
16.     start
17.         retrieve enter with argument id as an identifier
   from Artists array
18.         return retrieved (id, ArtistName, ArtistAddress)
   as function returns
19.     END
```

4.2.2.2 Songs Module

This module is responsible for adding songs or musical works to the system, in this protype it adds minimal information such as id, song name and an artist-id reference, in real life it would hold as song related information and can also integrate song upload. It contains two functions the first one a primary function to write this information on the blockchain and helper function that retrieves song name.

Songs Module Pseudocode

```
1.
2. let nextSongId be INTERGER and PUBLIC
3. create a key-value pairs structer of SONG in Array SONGS
4. Definition of SONG structer {
5.   let ID be INTERGER
6.   let songName be STRING
7.   let artistId be INTERGER
8. }
9.
10. define function createSong make it Public with
   arguments(songName as STRING, artistId as INTEGER)
11.         START
12.                 In SONGS array with nextSongId as an
   identifier insert arguments nextSongId,songName, artistId
   as an SONG structure entry
13.                 increase nextSongId variable value by 1
14.         END
15. define function getSong make it Public with arguments
   (id as INTEGER) and return (songId as INTEGER, songName
   as STRING, ArtistName as STRING)
16.         start
17.                 retrive entery with argument id as an
   identifer from Songs array
18.                 return retrived (id, songName, artistName)
   as function returns
19.         END
20.
21.
```

4.2.2.3 Collaboration Module

This module is responsible for adding collaborators of a certain song or works and defining their shares in percentages, in this use case it also contains minimal information. Contains two functions first one to write information on the blockchain and the second one to retrieve the information.

Songs Module Pseudocode

```
1. let nextCollabId be INTERGER and PUBLIC
2. create a key-value pairs structure of Collab in Array
   Collabs
3. Definition of SONG structure {
4.   let id be INTERGER
5.   let songId be INTERGER
6.   let percentage be INTERGER
7.   let artistId be INTERGER
8.   let ArtistAddress be ADDRESS
9. }
10.
11. define function createCollab make it Public with
   arguments (songId as INTEGER,artistId as INTEGER,
   percentage as INTEGER)
12.         START
13.                 store return of getArtistAddress function
   in artistAddress variable
14.                 In Collabs array with nextCollabId as an
   identifier                insert                arguments
   (nextCollabId,songId,percentage,artistId,artistAddress)
   as an Collab structure entry
15.                 increase nextCollabId variable value by 1
16.         END
17. define function readCollab make it Public with arguments
   (id as INTEGER) and return (id as INTEGER, songId as
   INTEGER, percentage as INTEGER songName as STRING,
   ArtistName as STRING, ArtistAddress as ADDRESS)
18.         start
19.                 store return of getArtistAddress function
   in artistAddress variable
20.                 store return of getSongName function in
   songName variable
21.                 retrive entery with argument id as an
   identifer from Collabs array
22.                 return retrived (id, percentage,songId,
   songName, artistName,ArtistAddress) as function returns
```

```
23.         END
24.
```

4.2.2.4 Billing Module

This module is responsible for issuing bills to clients or royalty payers, bills of a certain song or works, in this use case it also contains minimal information. Contains two functions first one to write information on the blockchain and the second one to retrieve the information.

Billing Module Pseudocode

```
1. let nextBillId be INTERGER and PUBLIC
2.
3. create a key-value pairs structure of Bill in Array Bills
4.
5. Definition of SONG structure {
6.   let id be INTERGER
7.   let songId be INTERGER
8.   let amt be INTERGER
9.   let paid be BOOLEAN
10.  }
11.
12.  define function postBill make it Public with arguments
   (songId as INTEGER, AMT as INTEGER)
13.         START
14.                 In Collabs array with nextCollabId as an
   identifier insert arguments (nextBillId,songId,amt,false)
   as an Bill structure entry
15.                 increase nextBillId variable value by 1
16.         END
17.  define function readBill make it Public with arguments
   (id as INTEGER) and return (id as INTEGER,songId as INTEGER
   ,songName as STRING,amt as INTEGER ,paid as BOOLEAN)
18.         start
19.                 store return of getSongName function in
   songName variable
20.                 retrive entery with argument id as an
   identifer from Bills array
21.                 return                              retrived
   (id,songId,songName,amt,paid) as function returns
22.         END
```

4.2.2.5 Payment Module

This module will validate and make payments requests made by the system front-end, it contains two primary functions, first that checks the bill amount, song and percentages sent in the request with the recorded bills on the blockchain returning true or false, the second function which depends on the first one being true will transfer amount gwei to wei and send the funds to each recipient.

Payment Module Pseudocode

```
1. define function checkBill make it Public with arguments
   (billId as INTEGER, ArtistAddress as ADDRESS, getsPaid as
   INTEGER)
2. START
3. let percentagePbs be INTEGER
4. let share be INTEGER
5. Loop inside Bills Array
6. if argument billId is in The Bills Array
7. Loop inside Collabs Array
8. if argument songId is in Collabs Array AND argument
   ArtistAddress is in the Collabs Array
9. Calculate share form bill amt and percentage
10. if share equals the argument getspaid
11. Then return the value TRUE
12. END if
13. END Loop
14. END IF
15. END Loop
16. END
17.
18. define function makePayment make it Public with
   arguments(result as BOOLEAN)
19.         START
20.         IF result coming from checkBill is TRUE
21.         THEN transform share from Gwei in wei and store
   in ShareMoney
22.         execute a sendTransaction function with
23.         from:ownerAccount
24. To: artist ADDRESS
25. value: ShareMoney
26. END IF
27. END
```

4.2.2.6 Transactions Module

This module will record the payment transaction in the form of a text in our blockchain, it will serve as a reporting mechanism. The module has two functions the first one as an input to the blockchain, and the second one as the output form the blockchain where it will retrieve the desired transaction.

Transactions Module Pseudocode

```
1. let nextTransId be INTERGER and PUBLIC
2. create a key-value pairs structure of Transaction in Array
   Transactions
3. Definition of Transaction structure {
4.   let id be INTERGER
5.   let text be String
6. }
7.
8. define function recordTransactions make it Public with
   arguments (text as String)
9. START
10. In Transactions array with nextTransId as an identifier
   insert argument (nextTransId,text) as an Transaction
   structure entry
11. increase nextBillId variable value by 1
12. END
13. define function getTransaction make it Public with
   arguments (id as INTEGER) and return (text as String)
14.         start
15.                 retrive entry with argument id as an
   identifier from Transactions array
16.                 return retrieved (text) as function
   returns
17.         END
18.
19. END
```

4.2.3 The Prototype Experiments

In the experiment music information will be written in our blockchain (i.e., artists name and wallet address and song information), and then percentages will be decided for a certain song. Moreover, a bill for a song will be posted and then paid. The

experiment simulates the scenarios of each entity on the music royalty's eco-system which are:

Artists and Management: whom will add artists and song information and percentages.

PROs or Collector: will post billing information.

Payer: will reactive and pay the royalty bill.

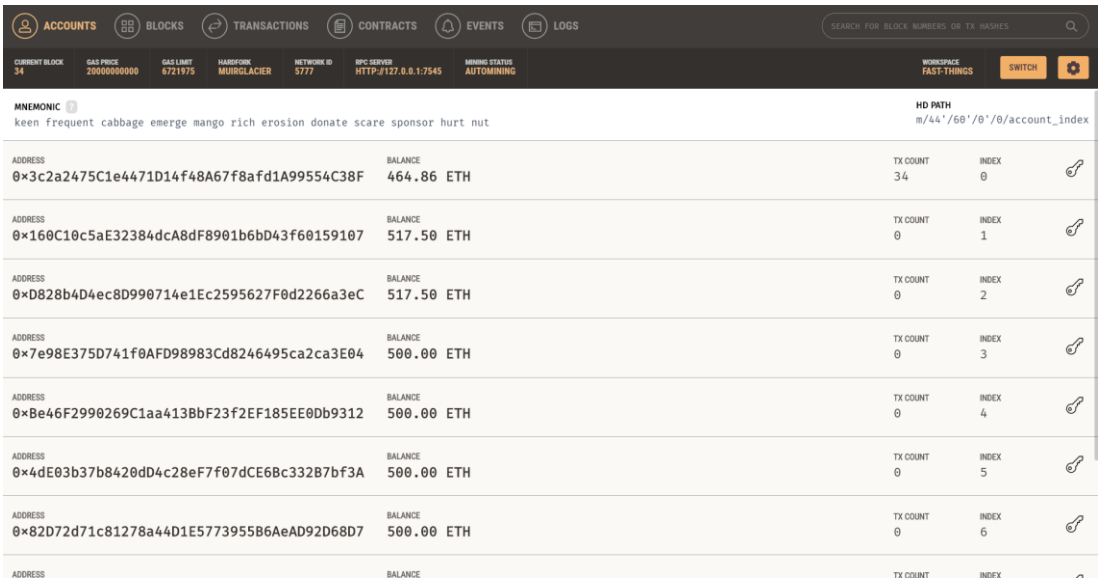

Figure 0.6 Displaying the accounts and balances on the blockchain.

The experiment will involve the first 3 accounts shown in figure 10 above. The first account will act as the owner of the contract and will be responsible for executing and deployment of contract functions and interactions with the blockchain, like reading and writing…etc.

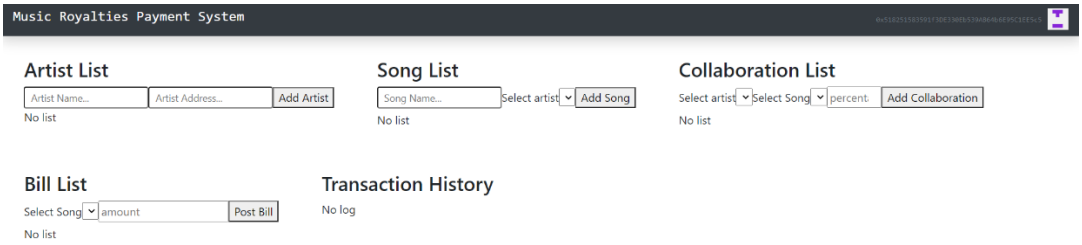

Figure 0.7 The application ui before populating the data on the blockchain.

As shown above each set of data has been assigned a section in the user interface for clarity. These sections will not show for each entity in the system in a real-life implementation and it was done this way to simplify the experiment.

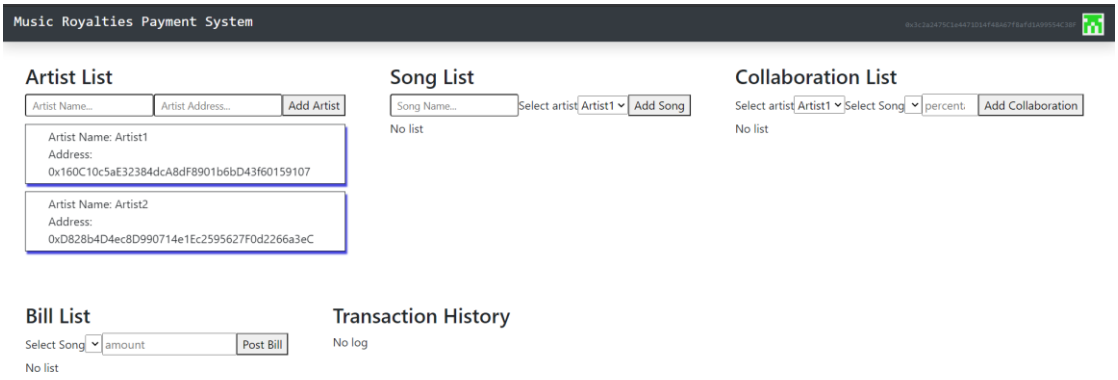

Figure 0.8 Adding artists to the blockchain.

Each artist is added with their wallet address, where they will receive their shares. information can be added depending on relevancy, data relevant to payment only was added in this experiment.

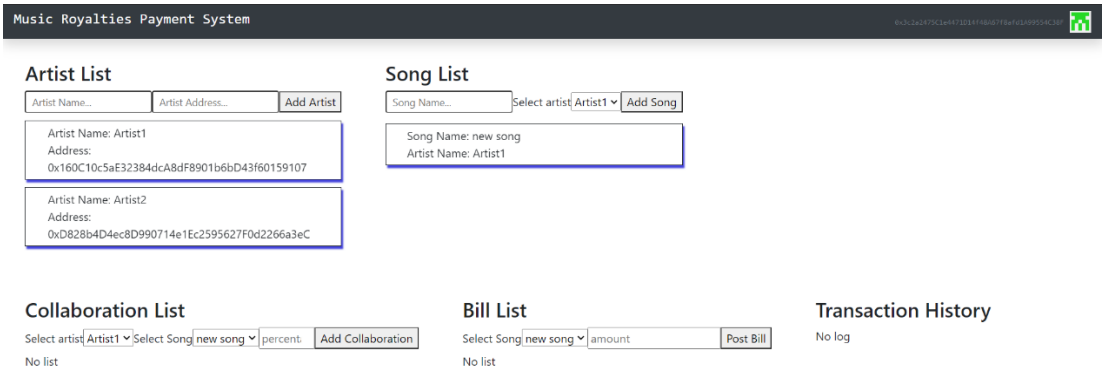

Figure 0.9 Adding a song by one of the artists.

A song was added with title “new song” and is owned by Artist1. in real-life scenarios this is the person who has the ownership right of the song. although they might share the royalties of the song with other parties.

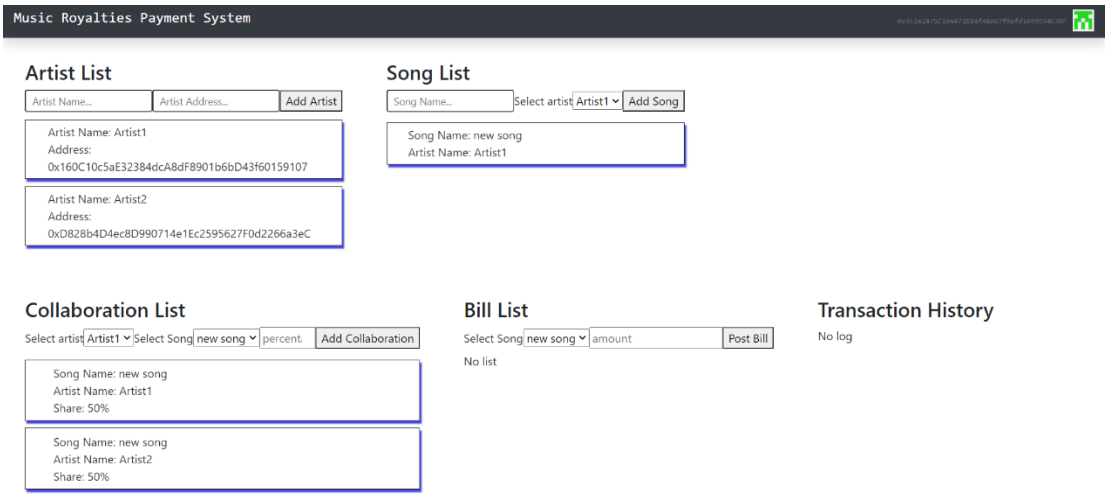

Figure 0.10 Adding collaborators and defining shares.

In the world of the music industry, the word collaborators usually referred to other artists that participated in the making a song or a body of work. that can include composers, song writers, band member and other performers. artist1 and artist2 each will receive 50% of royalties for the song that was added.

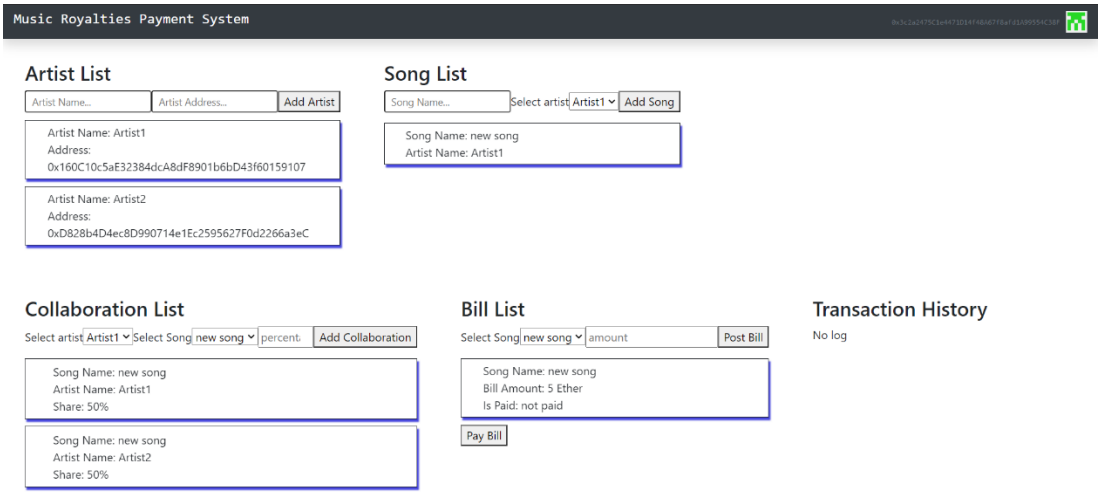

Figure 0.11 Posting a bill for song1 with the amount of 5 ether.

As shown above a bill was created with the amount of 5 ether for the usage of “new song”, in real-life scenario this will be added by the managing entity, being label or a collection society, same job they are doing in the traditional modal.

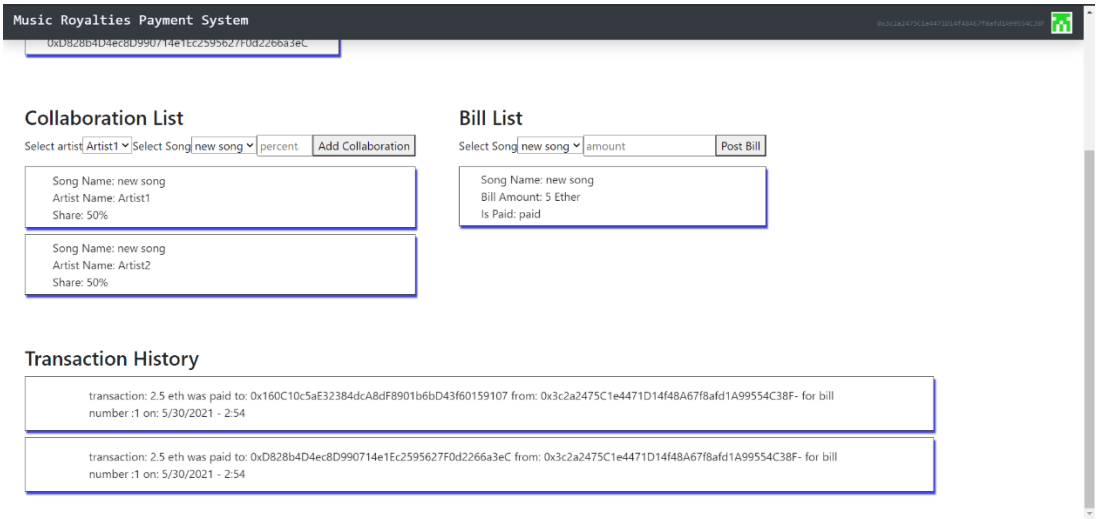

Figure 0.12 Showing transactions information after paying the bill.

This log or transaction history is to promote and add transparency to the system by showing who got paid what amount for which bill.

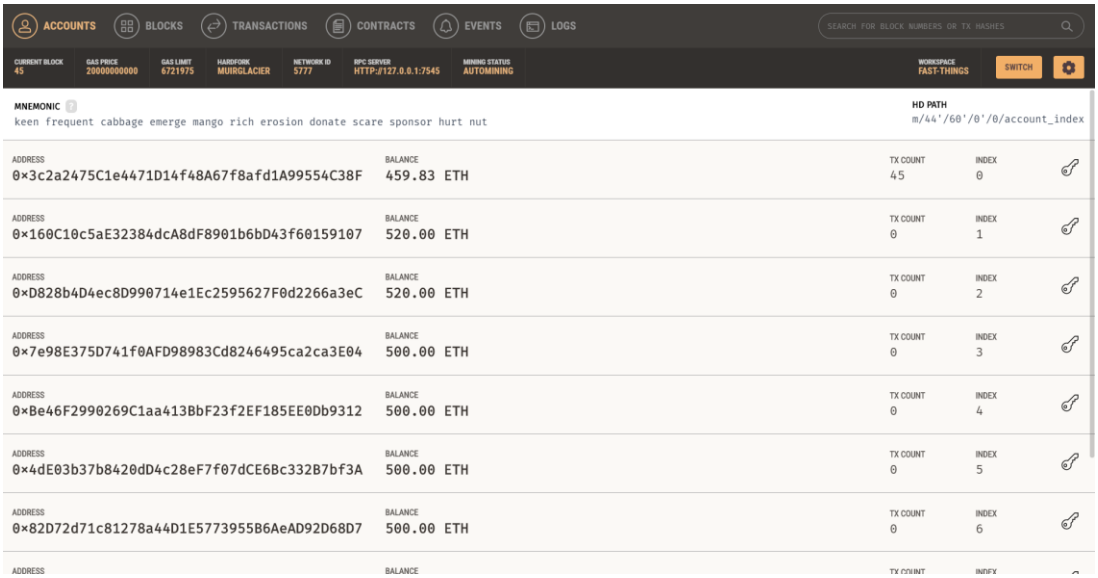

Figure 0.13 Showing new balances of the accounts in the blockchain.

As show above the first account balance decreased by 5 ether and the second and third accounts balances increased by 2.5 ether.

4.3. THE MODEL VALIDATION

To validate the system, it had to meet the below requirements to be viable option. Moreover, essentially the system is designed to integrate and replace the traditional modal which means it should be able to accommodate the basic tasks when it comes to royalty payments. Staring by the royalty collection, where it should to able to record the usage information. Followed music data handling which is tying the collected usage information to music itself. Additionally, the royalties that have been collected for a specific song usually have shares defined in contracts. Thus, the system has to accommodate for that. after that comes the process of payment, which is traditionally handled by the banks. lastly reporting of these payment transactions [1,6,23,26,28].

4.3.1. The Validation Requirements

4.3.1.1. Royalty Collection

As mentioned in the earlier chapters, the collection usually is done by collection society and PROs and sometimes publishers. They will send usage information to entities that licensed and used the music, which belongs to artist signed or managed by these collectors. and as illustrated the system gives collectors the function to send billing information to royalty payers. Thus, meeting this requirement successfully.

4.3.1.2. Music Data Handling

Music data handling means but not limited to, registration of artist and their musical works (i.e., song, compositions …etc.). and as shown earlier, the system also meets this requirement successfully. Moreover, the large data can be stored in the IPFS and references, and more critical data can be stored on the blockchain directly.

4.3.1.3. Royalty Shares and Rights Processing

This part is considered an additional separate requirement, because it is very specific to this research, not all music and data handling platforms deal with royalty shares. Royalty shares and rights processing, means the ability to assign shares to collaborators and rights holders. The system also meets this requirement, as it can assign shares using percentages on each song as demonstrated earlier.

4.3.1.4. Payment Scheme

After collection, assigning of shares, and billing comes fulfilling and paying these bills. The system should have the ability to receive and distribute payments from royalty payers to their deserved receivers that being artists, collaborates and collectors. And the system meets this requirement successfully. where payers can pay receiving entities directly with crypto. Another concern might be the instability of crypto prices,

which can be mitigated by using a stable coin or token which is begged to fiat currencies like the US dollar.

4.3.1.5. Data Communication

All the processes mention above needs to be communicated to these entities in a useable, useful and readable form (i.e., a user interface for data input and reports used as a reference for orders history) that can be in an ecommerce application or a website. The system as illustrated, it can achieve this requirement using the Web based platforms and frameworks that can communicate with blockchain networks.

4.3.2. Validation In Terms of Problems

The system meeting the requirements of a royalty payment system wasn't the only metric for validation. The system or model as a whole was also validated against the problems mentioned the earlier chapters.

4.3.2.1. Transparency

From what was discussed earlier regarding the transparency in the process of royalty payments. the model gives and improves on the process by giving an immutable ledger, and a payment information log to contribute in countering that lack of transparency.

4.3.2.2. Delay of Payments

As for the delay of payments which in large caused by the amount of "middle-men" involved in the process. even though the model proposes an extra added entity to the eco-system of the royalty payments, it acts as a facilitator of payments, taking the payment processing out of the hands of the collection entities and sends it directly to the artist or receiver.

4.4. THE MODEL EVALUATION

As mentioned earlier, the evaluation of the model is based on the comparison of use cases between the proposed model and current models and systems:

4.4.1. Old Model and New Proposed Model

as demonstrated on the following figure, the new model creates one entity where the payment processing happens. Which will make it easier for all parties involved and can accommodate all the types of music royalties.

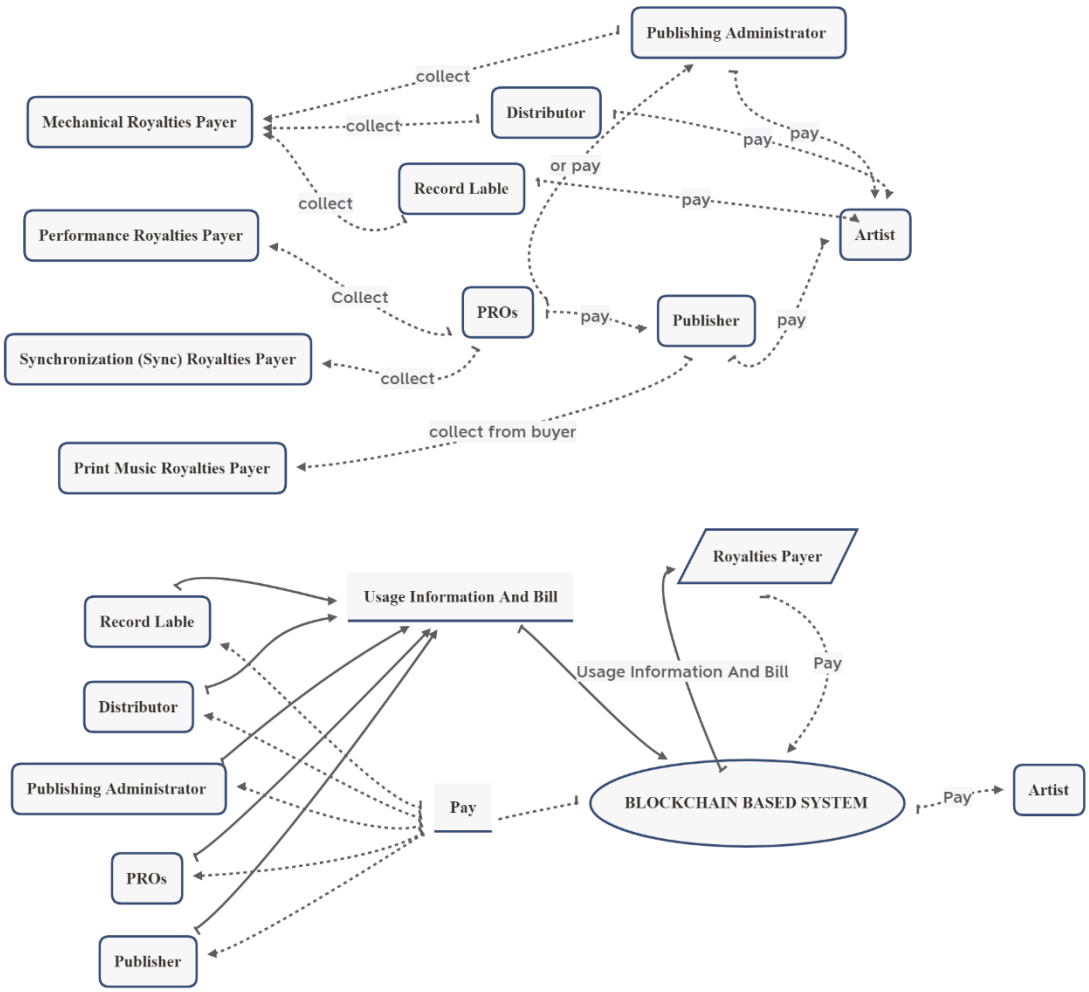

Figure 0.14 Model comparison between traditional (top) and new model (bottom).

4.4.2. Payment Cost and Transaction Time

Traditionally payment between accounts is done in various ways. credit cards for example has a 2-3% transaction cost due to the amount of parties involved in the transaction. Additionally, it takes 2 days to clear the transaction. Automated Clearing House (ACH) costing around 1.96$ and takes 2-3 days to process. Wire transfers taking around 1-5 days to clear the transaction and costs 15-75 depending on the bank, and if its in-house bank transfer or to other bank, and if its domestic or cross-border transfer. Moreover, Ethereum transactions which may be different on the cost which can be determined by how fast you want the transaction to be cleared by the network. At the time of writing this, the highest transaction cost (gas fees) recorded is 405 gwei which is 0.0018$ and lowest is 89 gwei which is 0.0004$ transaction time for this transaction wasn't acquired. However, transaction time according to gas-time calculator is 0.29$ for less than 2 minutes clearing time, and 0.19$ for less than 5 minutes. These transactions include domestic, and cross-border. given that the Ethereum network is not location bound [34–39].

Table 0.2 Traditional payments vs Ethereum. cost and transaction time [34–39].

Method	Transaction time	Cost in $
Check	3-7 days	$15-20$
Credit/Debit Card	2-3 days	0.25$ & 2-3%
ACH	2-3 days	1.96$
Wire Transfer	1-5 days	35-75$
Ethereum	0.5-5 minutes	0.007-0.1$

As demonstrated on the following figure, it takes more time to do payment processing in the traditional systems or model than in the proposed blockchain-based model. it takes days for clients to allocate funds to collection societies, and later takes days also to allocate these funds to artist, due to the implications of using bank payments. while the artist receives their shares eventually the collators are not incentivized to process and transfer funds faster. However, with the new model there is more incentive because everyone receive their shares at the same time [30,31,40].

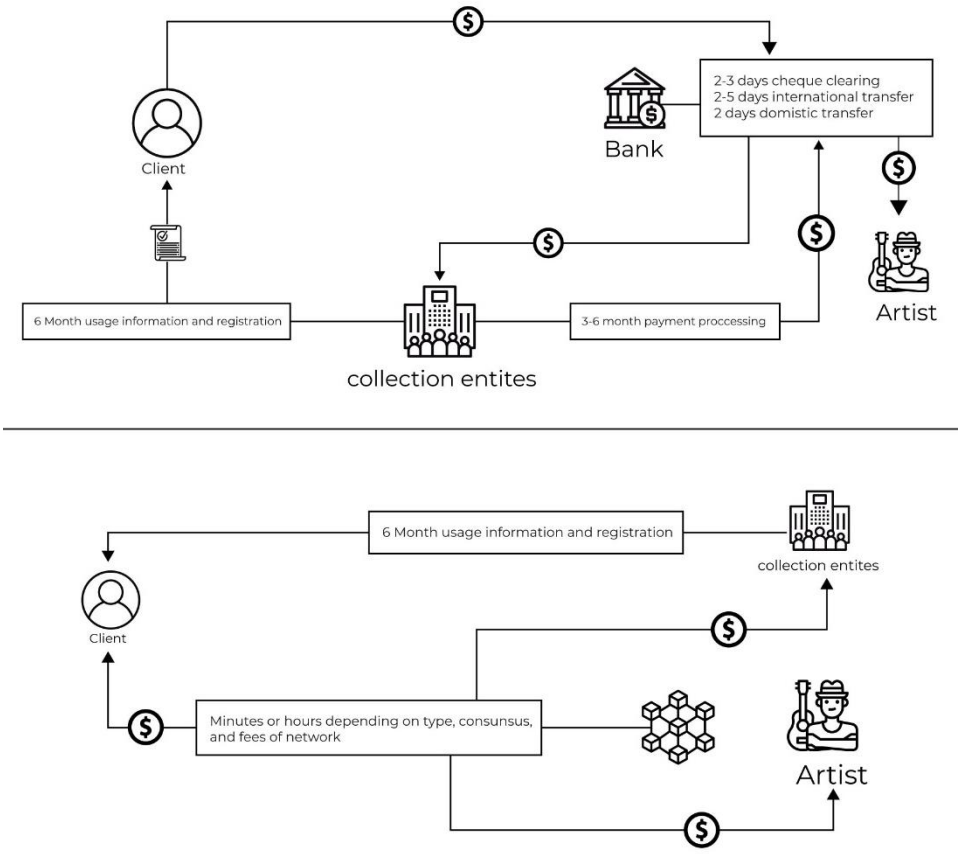

Figure 0.15 Comparison traditional models (top) and blockchain-based model (bottom).

4.4.3. Model Evaluation Comparison with Other Blockchain Based-Projects and Systems

To evaluate the proposed model with other solutions mentioned in earlier chapters, the evaluation was divided in three sections. where each section represents a part of a royalty payment system, which was mentioned earlier in the system validation. these sections are: payment, royalties (collections and processing), and data and information (processing and handling).

The check symbol(✓) indicating that the system provides the service or feature. the cross symbol (✕)indicating that the system does not provide the service or feature.

while the recycle symbol (🔄) indicating that the system provides the service or feature partially.

The following table display the payment comparison in terms of A) defining of shares which is a major part in the process of registration of royalties which will decide the beneficiates from a certain body of work. B) Billing clients who use the musical works in any form of commercial use. C) the processing of these payments which are made by the clients [2,5,29–32].

Table 0.3 Systems payment handling comparison.

	Music Beetle	Ujo Music	Vezt	Blòkur	Proposed model
Defining of shares and ownership	✗	✓	✓	✗	✓
Billing of clients/users	✗	🔄	✗	✗	✓
Direct payment to beneficiaries	✗	✓	✓	✗	✓

The following table displays the royalties handling comparison in terms of A) royalties collection. which is the process of detecting and registering the use of the musical works by clients. Traditionally it's the job of PROs and collection entities. B) sync royalties processing. C) performance royalties processing. D) mechanical royalties processing. E) print royalties processing [2,5,29–32].

Table 0.4 Systems royalties handling comparison

	Music Beetle	Ujo Music	Vezt	Blòkur	Proposed model
Royalties Collection	✓	✗	🔄	✗	🔄
Sync royalties handling	🔄	✗	✓	✗	✓
Performance royalties handling	✓	✗	✓	✗	✓
Mechanical Royalties handling	✗	✓	✓	✗	✓
Print Royalties handling	✗	✗	✓	✗	✓

The following table displays the information processing comparison which is the last criteria, and it is in terms of A) payment transaction information which are the logs of who paid and for which musical works. B) usage information which is what works are being used in what context. This can be useful when it comes to analytics and marketing. C) music data storage and handling which is the storage of all the data that gets inputted and processed in the system [2,5,29–32].

Table 0.5 Systems information handling comparison

	Music Beetle	Ujo Music	Vezt	Blòkur	Proposed model
Payment transaction information	✗	✓	✓	✓	✓
Usage information	✓	✗	✓	✓	⟳
Music Data storage and handling	✗	✓	✗	⟳	✓

PART 5

CHALLENGES AND FUTURE WORKS

5.1. IMPLEMENTATION CHALLENGES

The blockchain like any technology can solve a lot of issues, but can also come with challenges and problems that face the effective implementation of it. To use the blockchain in the current music industry it has to be reshaped, and a new eco-system has to be created for musicians and parties involved within the industry.

Even though transparency can be one of the benefits of what blockchain can bring to the table, it can also be a challenge given how the business side of music is handled. Some information needs to be omitted, this can be of interest to both artists and labels. Traditional industry participants, such as record labels, becoming significant shareholders or investors of blockchain-based intervention projects is a serious problem. Once record labels have a majority stake in these initiatives, musicians will lose control and be at the hands of middlemen once more. Traditional industry actors buying musician tokens and having a controlling stake in the artist's success is a related issue that may occur. Another similar issue is that established industry players will join in a musician's musical work ICO and own a significant portion of the musical work on a platform like Vezt. This problem could be solved by asking traditional industry companies, particularly large record labels, to whitelist their addresses and sign contracts agreeing to use only those addresses. On another side, major musicians are all under contract with major record labels. Thus, transitioning to blockchain-based interventions is unlikely in the near future. The major record labels, in particular, have complete control over how most people listen to music. Thus, for the blockchain, to remove their monopoly on distribution channels will be extremely difficult [1,2,15,18,31].

The blockchain is fairly a new technology and can still be considered in the early-mid stage. Consequently, resulting in most of the general public having a little to no knowledge of it. given how it can be used in the music industry, where the main users are the artist and normal music listeners, they need at least some knowledge to be able to use it. for instance, artists need to have knowledge about how the eco-system of a blockchain based music industry works, and be familiar with concepts like cryptocurrencies, wallets, public keys, smart-contracts, …etc. Recently the blockchain industry made a significant progress in terms of awareness in the art space. with the use of Non-fungible Tokens (NFTs). NFTs are data units kept on a blockchain that are used to verify the authenticity of various digital properties. The case of musician Daniel Allan can be a good example, while Allan songs got millions of plays in 2020, Allan received a few hundred dollars. Over 2021 Allan has been selling thousands of dollars' worth of digital copies of his electronic pop tunes as NFTs. He spent months nurturing relationships with NFT fans, building an online community of committed followers, and then using that popularity to amass 50 ETH ($140,000 on the day of trading) in a one-day campaign to crowdfund his future album [1,2,15,18,41,42].

5.2. FUTURE WORKS

The blockchain will have big challenge when it comes to integration with the legacy systems. Old data have to be reshaped and reconfigured so it can be added as a record, which new records can be built on top of. The ability to create a single, complete copyright database clearly depends on the compatibility of any blockchains used to store such data, something that Hyperledger is working on right now. Data gathering and reconciliation must be standardized, more research and work in this area can help advance and push the envelope in the right direction. Moreover, the blockchain is very resource-consuming with the current state of technology. and without a steady revenue these projects and companies mentioned earlier would have hard time competing with the major players. This area in particular needs more study, especially on optimizing the data stored on the blockchain, which can help in reducing the cost of implementation [1–3,6,29].

5.3. CONCLUSION

In this thesis, a background of the music industry and how it has evolved over the years was given, with an examination of the eco-system of the music industry. Thus, focusing on the revenue stream and the role of the parties involved, coupled with an introduction of the blockchain technology and its application, on all kinds of industries and in the music industry. The problems faced when it comes to royalty payments was explored. which is considered an important stream of revenue for artists, paired with the objectives and questions of this research. Followed by the significance and beneficiaries of the study and the scope of the research.

The second chapter gives a review and examination of the related literature. Starting by the music industry supply chain. then giving details and context to the issues introduced in the first chapter. Followed by the design science methodology and the Agile design and development method. Moreover, the blockchain was reviewed with its terminologies and architecture. followed the use of the blockchain in the music industry. then a review of music royalties was given, and explaining the types of royalty payments and the model of collection and payment. Followed by an exploration of related works and projects that tackled some of the problems in the music industry that may or may not use blockchain as a technology for its platform. The state of blockchain based solutions for the music royalties was given. Followed by the issues and gaps which inspired the proposed model.

The methodology followed in this research was introduced with its framework and how the major points were explored, referring to the activities and steps followed to conduct the research. Which start by problem identification, definition of objectives, design and development, demonstration, evaluation and lastly communication.

The proposed model was then explored and how it was going to transform the process of royalty payments. Followed by and explanation of the model process and how it can fit in a real-life implementation. Moreover, a prototype experiment was introduced with its specifications, and the tools used to mimic a use case of royalty payments using the Ethereum blockchain. Followed by a validation of the model against the

problems and objectives, and whether it can meet those objectives. Moreover, an evaluation of the old model was done, in comparison to the proposed model, in terms of payment, and transaction time. Followed by evaluation against other blockchain based solutions.

The final chapter gives an insight on the challenges that may face the implementation of such model in the current music industry. Followed by the future works, explaining what the area needs at the moment in terms of research.

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RESUME

Almigdad Yahya Ibrahim Aldoma was born in Khartoum, Sudan in 1994, and he graduated elementary education in this city. He completed high school education in ALMANAR High School, after that, he started undergraduate program in Future University Sudan, Department of information Technology in 2011. Then in 2020, To complete M. Sc. education, he moved to Karabük University.