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Music Royalties Management Using Blockchain

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Master in Computer Engineering

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TECNOLOGIAS
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Department of Information Science and Technology

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Resumo

Pagamentos de royalties na indústria da música são um processo demorado e com pouca transparência. Os artistas geralmente são os últimos a obter alguma informação com relação aos pagamentos de royalties e em alguns casos, os pagamentos não são efetuados à entidade correta. Nesta dissertação são analisados os principais fatores que dificultam este processo de pagamentos de royalties e como o uso de tecnologias Blockchain poderá eliminar esses problemas, obtendo assim informação correta e transparente acerca dos pagamentos. Para identificar esses problemas e possíveis soluções, conduziram-se algumas reuniões com um especialista do domínio assim como também foram analisados artigos relacionados com o tópico. Foi desenvolvido um protótipo de acordo com as necessidades que foram previamente discutidas com o especialista do domínio e que demonstram pagamentos automatizados de royalties, eliminando assim o período de espera que tradicionalmente pode levar até três anos.

Palavras-Chave: blockchain, distributed ledger technology, DLT, indústria da música, sistema de pagamentos de royalties.

Abstract

Royalty payments in the music industry take a long time and lack transparency. Usually, the artists are the last to know anything regarding their royalty payments and in some cases, payments are not made to the correct entity. In this dissertation the main factors that make the royalties payment process such a difficult one are analysed. Also, how the use of Blockchain technologies can eliminate these problems, making it possible to obtain correct and transparent information about payments. To identify these problems and possible solutions, some meetings were conducted with a domain expert and articles related to the topic were analyzed. A prototype was developed according to the needs that were previously discussed with the domain specialist that demonstrate automated royalty payments, eliminating the waiting period that traditionally can take up to three years.

Keywords: blockchain, distributed ledger technology, DLT, music industry, royalty payment systems.

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List of Abbreviations

PRO – Performance Rights Organization

AMAEI – Associação de Músicos Artistas e Editoras Independentes

ORDE – Open Rights Data Exchange

DSR – Design Science Research

IT – Information Technology

Dapp – Decentralized Application

MCO – Media Contract Ontology

MVCO – Media Value Chain Ontology

AVCO – Audio Value Chain Ontology

IdM – Identity Management

NFT – Non-Fungible Token

DLT – Distributed Ledger Technology

BPMN – Business Process Model Notation

Chapter 1 – Introduction

1.1. Topic Context

The music industry is a complex system involving many entities. Between the artist and the consumers there is the involvement of the Publishers, Labels, Retailers, Performance Rights Organization (PRO) and more recently the Streaming Digital Service Providers (Arcos, 2018). Since the emergence of Streaming Digital Service Providers music can be easily accessible and streamed to the consumers but payments to the artists is slow and lacks transparency.

A major issue for the creators in the music industry is that they are the last to see any profit and they have little to no information about how their royalty payments are calculated and don't get access to the aggregate data about how and where people are listening to their music (Heap, 2017).

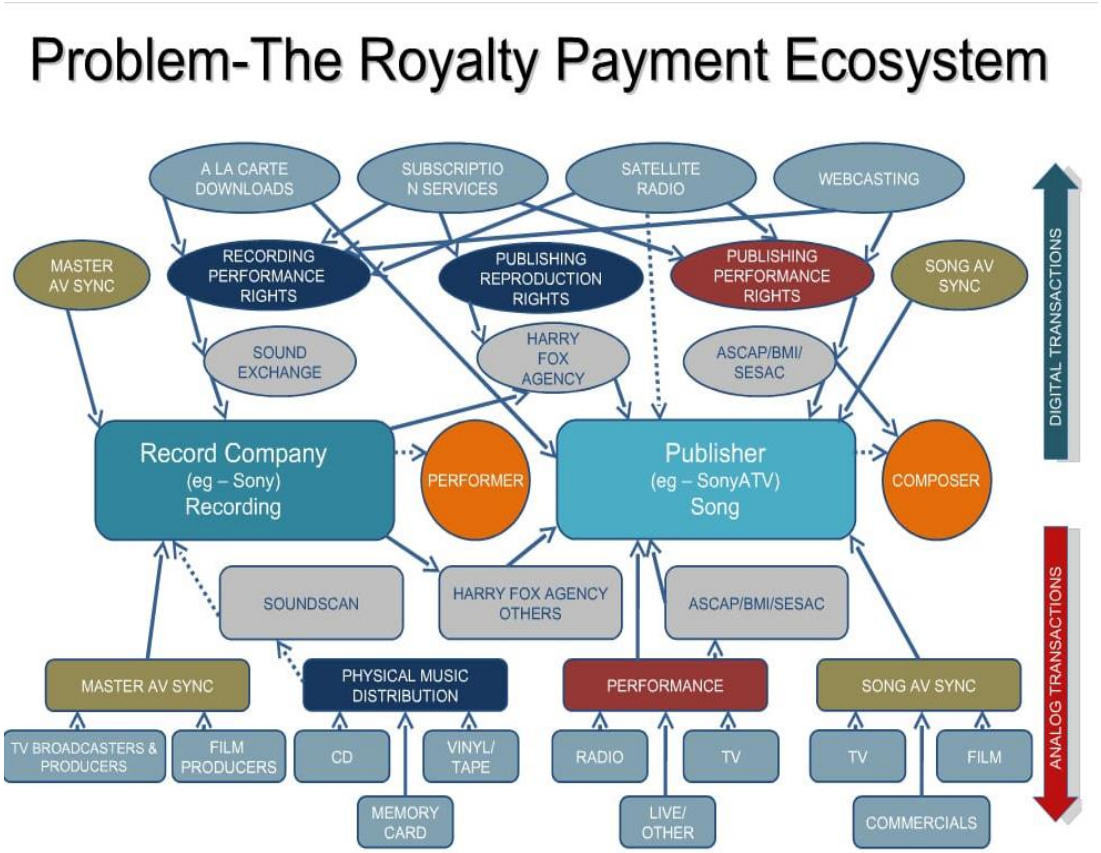

Figure 1 -The Royalty Payment Ecosystem (Music Reports Royalties Diagram, *2010)*

Figure 1 depicts the complexity of the royalty payment ecosystem and such complexity combined with the lack of transparency leads to the artist being clueless about where is the source of their royalty payments and how much should they be getting paid.

Using blockchain to add transparency throughout the ecosystem is a way to empower the artists and solve the major issue described.

The blockchain has the potential to simplify the royalty payment system, by creating agreements with automatic payments to the correct entities every time a song is played or used (Heap, 2017).

1.2. Motivation and Topic Relevance

Talking with Nuno Saraiva, president of Associação de Músicos Artistas e Editoras Independentes (AMAEI) and Lusitanian Music Publishing, it was revealed that despite recent developments in technology, the Music Industry inner workings, complex as they are, are still dependent on archaic methods such as paper records. Another problem is that each entity, such as Labels and Publisher keep their own private records making it harder to keep track and manage royalties. And more, it is an arduous task to keep track of copyright owners of more traditional songs.

A blockchain based system shared between the entities involved in the Music Industry would enable for a more transparent registry and facilitate the management and payment of royalties.

Musika Peripherika, a European Union co-funded project, has as some of its objectives the creation of a shared infrastructure for rights data to be declared and searched, a new standard for music data representation, digitisation of European traditional music and they also intend to setup web3 wallets for blockchain based remuneration. (*Musika Peripherika*, 2022; *Musika Peripherika - Presentation at Westway Lab*, 2022).

A better and more transparent management of music related rights management is a real need as told by Nuno Saraiva and as shown by the European Union which chose to invest in a project that aims to accomplish exactly this.

1.3.Main Concepts

1.3.1 Blockchain

Blockchain is a peer-to-peer, distributed ledger that is cryptographically secure, append-only, immutable, and updateable only via agreement among peers (Bashir, 2018).

Peer-to-peer means that all network participants talk directly to each other.

Distributed ledger means that a record of every transaction is spread across the network among every participant, and every participant holds a copy of the complete history of transactions. This is what grants the blockchain its transparency, which in turn will allow the artists to better keep track of the how, where and when their work was used.

Blockchain uses cryptography to assure data integrity, data origin authentication and ensures that no party can deny to being involved in a transaction.

Being append-only grants the blockchain immutability as when working as intended the only operation permitted by the blockchain is the addition of data in a time-ordered sequential order.

Updateable via agreement among peers means that no central authority is in control of updating the ledger (record of transactions). Any update made to the ledger must be validated by the participants on the network.

1.3.2 Smart Contracts

Smart contracts are automated, autonomous programs that reside on the blockchain network and encapsulate the business logic and code needed to execute a required function when certain conditions are met (Bashir, 2018).

The smart contract code can represent a multi-party transaction, typically in the context of a business process. In a multi-party scenario, the benefit is that this can provide attestable data and transparency, that can foster trust and provide insight, that can enable better business decisions, reduce costs from reconciliation that exists in traditional business to business applications, and reduce the time to complete a transaction (Yaga et al., 2018).

Smart contracts will be the key to automate royalty payment systems.

1.3.3 Blockchain Permission Types

Based on their permission model, blockchain systems are categorized into three types (Yaga et al., 2018) (Haddouti & Kettani, 2019) :

- Permissionless or Public Blockchains: open to anyone joining and submitting transactions without needing the permission of any authority;
- Permissioned or private Blockchains: closed ecosystems where only pre-verified users, can interact with the blockchain. These are preferred by centralized organizations to increase the control of their internal business operation;
- Consortium Blockchains: this type of blockchain is partly private, where the consensus process is controlled by a selected set of participants, while the right to read blockchain data is allowed to the public.

It is relevant to understand the different permission types and determine which would be the best for this use case. Being the first choice for an enterprise application either a private or a consortium blockchain.

1.3.4 Music Stakeholders

Throughout this document some parties involved in the music industry will be mentioned and this subsection serves to present and briefly explain each of them:

- Songwriter or composer (mentioned as songwriter on this document), the person who composes or writes the lyrics of a work (Scherer, 2016).
- Artist, the person who sings or plays an instrument during the recording or performance of a song.
- Publisher, she/he works with the songwriter and is responsible for licensing the songwriter work and ensure that royalties are collected.
- Record Label is responsible for finding music talent, record their work and promote the artist and the work.
- Performance Rights Organizations are responsible for dealing with the logistical issues concerning the licensing and royalties' collection concerning public performances.

1.3.5 Capability Maturity Model

Capability Maturity Model (CMM) is a methodology used to develop and refine a software development process. CMM establishes a framework for continuous process improvement, and it is divided in 5 levels (Lutkevich, 2022; Wang et al., 2016).

The first CMM level being Initial meaning that the processes are still disorganized, chaotic and it's not repeatable since at this stage the processes are not sufficiently defined and documented.

The second CMM level is repeatable and at this level the essential processes are established, defined and documented, also at this level some experience can be borrowed from similar products.

The third level defined is when there is a standard for the software development, and all the processes are documented.

Managed is the fourth level, and at this level the processes are monitored through data collection and analysis for qualitative evaluation.

At the final level optimizing, the processes are improved based on the qualitative evaluation and new innovative process and functionalities are introduced.

1.4.Questions and Research Goals

Although the use of blockchain technology has the potential to improve the transparency and payment system in the music industry, the following research questions arise:

- RQ1: Is the blockchain technology mature enough to handle the necessary operations for a blockchain based rights and royalty management system?
- RQ2 – How can blockchain facilitate royalty payments to the music stakeholders?

The answer to the previous questions will allow us to determine the feasibility of such system and in case such system is possible, and if the barrier of entry is low enough that non experts in technology fields can make full use of the system.

This research intends to analyze the music industry rights system, in order to understand how it would work in a blockchain based management system.

This research also intends to explore the current blockchain technologies and try to determine the best choices for this music royalty's management system.

The goal of this dissertation is to demonstrate a prototype capable of some operations related to royalty management and document the process of the protype conception.

1.5. Methodologic Approach

The chosen methodology for this dissertation is Design Science Research (DSR). DSR aims to solve organizational problems through the creation and evaluation of Information Technology (IT) artefact (Bisandu & Bala Bisandu, 2016) .

Hevner et al. (Hevner et al., 2004) provide seven guidelines to follow in DS research that are as follows:

- **Guideline 1** - Design as an Artefact: Design-science research must produce a viable artefact.
- **Guideline 2**: Problem Relevancy: The objective is to develop a technology-based solution to a business problem.
- **Guideline 3**: The Design Evaluation: The efficacy, utility and relevancy of the solution must be presented.
- **Guideline 4**: Research Contribution: The designed artefact must provide a clear contribution to the area in which it belongs.
- **Guideline 5**: Research Rigour: Rigorous methods must be applied in the construction and evaluation of the artefact.
- **Guideline 6**: Design as a Search Process: The production of the artefact depends on the search of the best available methods to reach our goal.
- **Guideline 7**: Communication of Research: The presentation of the design-research must be understandable to both technology and management-oriented consultation.

The most important of these are that the research must produce an artefact and the artefact is to solve important and relevant business problems (Bisandu & Bala Bisandu, 2016; Peffers et al., 2007). The quality and utility of the design artefact must be demonstrated. Usage of available methods and knowledge to come up with a solution to a defined problem. And finally, the research presentation must be effectively communicated to the proper audiences.

1.6. Structure and Organization of Dissertation

The present work is organized in six Chapters that intend to reflect the different phases until its conclusion.

The first Chapter introduces the subject of the investigation and its objectives, as well as the main concepts and a brief description of the structure of the work.

The second Chapter reflects the theoretical framework, called Literature review.

The third Chapter is dedicated to the application of DSR, and the design of the artefact.

The fourth Chapter presents the developed prototype and the development choices made, including the programming language and framework choices.

The fifth Chapter presents a use case of the prototype.

The sixth and last Chapter presents the conclusions of this study as well as an analysis of the document and current limitations.

Chapter 2 – Literature review

2.1. Search Criteria

To prepare the literature review process, the search of relevant publications was done through the EBSCO Discovery service (Vaughan, 2011) using the "Limit To Full Text" filter option, always using the Search Fields: TI Title, Su Subject Terms, AB Abstract. Different search terms were combined to find the best possible results, beginning at more specific terms and moving towards more general or broad ones.

As the dissertation is about music industry and royalty management, the following search terms were combined:

- blockchain, music
- DLT, music
- music, ontologies

Gathering a total of 27 results.

In both cases after the initial search there was a selection process based on the title and abstract of the documents to try and determine if the subjects of interest were a focal point of the document or they were simply mentioned.

At a final stage of the selection a quick glance over the remaining documents would reveal more of their content and the ones which contained implementations example or analysis were favored over more theoretical or mathematically focused ones.

Backward reference research was applied while reading through the articles in order to gain a better understanding of the topics.

Articles	Blockchain	Music Ontologies	Music Industry
(Sitonio & Nucciarelli, 2018)	▪		▪
(Owen & O'Dair, 2020)	▪		▪
(Kim & Kim, 2020)	▪		▪
(*Corda Overview*, 2021)	▪		
(Polge et al., 2021)	▪		

(*An Overview of Hyperledger Foundation*, 2021)	▪		
(Saraiva, 2022)			▪
(Saraiva & Silva, 2022)			▪
(*Musika Peripherika*, 2022)	▪		▪
(*Musika Peripherika - Presentation at Westway Lab*, 2022)	▪		▪
(Mary et al., 2019)		▪	
(Kudumakis et al., 2020)		▪	
(*What Is an Ontology and Why We Need It*, 2000)		▪	
(Yaga et al., 2018)	▪		
(Bashir, 2018)	▪		
(*Music Reports Royalties Diagram*, 2010)			▪
(Heap, 2017)	▪		▪
(Chalmers et al., 2021)	▪		▪
(Arcos, 2018)	▪		▪
(Haddouti & Kettani, 2019)	▪		

In the search for literature, it was clear that blockchain applied to the music industry is still a fresh concept as of 2022. There is some literature that explores the theoretical use of blockchain technology in order to improve the music industry but there was a lack of documentation pertaining to the blockchain music projects that already exist or those that have already failed.

The next subsections analyze the most relevant blockchain frameworks, the blockchain solutions focused on the music industry, and the music ontologies.

2.2. Blockchain Frameworks

Although the choice of framework depends sometimes on the preference of the developer, the developer can only choose between the frameworks whose features satisfy the needs of the client or the music stakeholders in our context. These needs where discussed with the AMAEI president. It is already established in section 1.3.3 that the blockchain framework needs to be permissioned, meaning either private or consortium.

Even considering a private blockchain, the transactions information would be available to every user that is a participant in the blockchain, that's why to ensure extra privacy and preserve negotiation power between different parties it is important that the blockchain framework is capable of restricting the transaction data to only the transaction participants. Ensuring that the transactions are fully transparent for all the transaction participants, but it is not accessible by other participants, e.g., when a master-synch license is requested and issued all the participants including the featured artists, the authors, label, publisher and the user who made the request get full access to all the transaction details, but a third party without any relation to that work or license doesn't get access to the transaction details.

Three blockchain frameworks will be analyzed as possible choices:

- Quorum is a Ethereum based blockchain developed by JP Morgan, for financial use-cases but can be used for any type of industry (Polge et al., 2021). Quorum aims to bring some enhancements over Ethereum, being the most important ones, for our use-case, privacy, permissioning and higher performance. The privacy enhancement means that is possible to create private contracts whose payload is only visible to the participants. Quorum smart contracts are programmed in Solidity, so if a developer has previous experience with Ethereum they may prefer Quorum over the next two.

- Hyperledger Fabric is a permissioned blockchain, that is designed to support various pluggable components, making it very flexible and adaptable to varying use-cases. (*An Overview of Hyperledger Foundation*, 2021). Fabric supports distributed applications (dapps) written in general purpose programming languages such as Java, Go or Node.Js (Polge et al., 2021), conferring more freedom of choice to the developers. As for privacy Fabric supports the creation of channels which allows for transactions in private channels, so that third parties can't have access to them. The following example is provided by the Hyperledger whitepaper: "This is especially important for networks where some participants might be competitors who don't want every transaction, such as a special price offered to all".
- R3 Corda is another permissioned blockchain, also with smart contracts and dapps capabilities same as the other two. In Corda each node must prove its identity in order to join the network (Polge et al., 2021). By default, every transactions data in Corda is shared between parties only on a need-to-know basis, ensuring a high level of privacy (*Corda Overview*, 2021). Smart contracts for the Corda framework are either written in Java or Kotlin and the dapps named CorDapps are written in Kotlin, so for any developer intending to work with R3 Corda familiarity with Java and Kotlin is a must.

Framework	**Data Visibility**	**Programming Language**
Quorum	Public and allows the creation of private channels	Solidity
HyperLedger Fabric	Authenticated members, allows the creation of private channels	Node.js, Java, Go
R3 Corda	Information shared only in a need-to-know basis	Java, Kotlin

2.3. Music Industry and Blockchain

The music industry suffers from a music licensing problem. Nowadays the ownership to the rights of a song is divided between different entities, and there is not a shared database containing the metadata related to songs ownership (Kim & Kim, 2020). The lack of a shared database makes it that paying the rights holder requires a search across different limited proprietary databases, causing payments to be delayed and sometimes even stagnate in funds that do not reach their rightful owners, called "black box" royalties.

In the pre-internet era, record labels added a great amount of value to the music industry supply chain (Sitonio & Nucciarelli, 2018). They would finance and supply the artists access to equipment, operational support to produce, record, promote their music and provide access to distribution and sales channels. Due to the value they added, record labels would retain 30% of the value generated with the final sales, the largest amount gained by any of the involved parties. The artists shares were unclear even to the artists themselves. The record labels were responsible for collecting and distributing royalty revenues and this allowed for the existence of the information asymmetry among artists, intermediates, and final consumers.

With the introduction of digital media market there were changes in the supply chain and a new party was introduced, the aggregator. This new change would mean that selling music would no longer depend on selling physical products. Artists would be able to use both the traditional and digital selling platforms. This also meant that new artists were no longer dependant on a record label to record and sell their music.

Even with the introduction of digital markets and the reduced costs to distribute music the record labels who are no longer the sole distribution method keep most of the shares related to the supply chain, sometimes over 50% of the share (Sitonio & Nucciarelli, 2018). The value captured by the artists did not increase with this change. Aggregators as a new intermediary made the information asymmetry in the industry even worse.

Blockchains could transform this landscape of centralized and potentially conflicting data into distributed transaction registries, providing a single source of truth as to who the rights owners are and who should receive the royalties (Owen & O'Dair, 2020). Every party can verify the records of its transaction's partners directly, without an intermediary (Heap, 2017).

The usage of smart contracts makes it so that payments go directly to the correct entity and not through any third parties. All the information needed to forward the payment to each shareholder will be in the blockchain and executed as specified on the agreement. The usage of blockchain in the music industry also helps in reducing the role of third parties and simplifying the royalty payment system.

Comparing Figures 2 and 3 it is possible to notice that with the introduction of blockchain platforms and networks, the supply chain would be simplified, and some parties would completely disappear e.g., Publisher and PROs, while others would take on a different role as seen with Record Label.

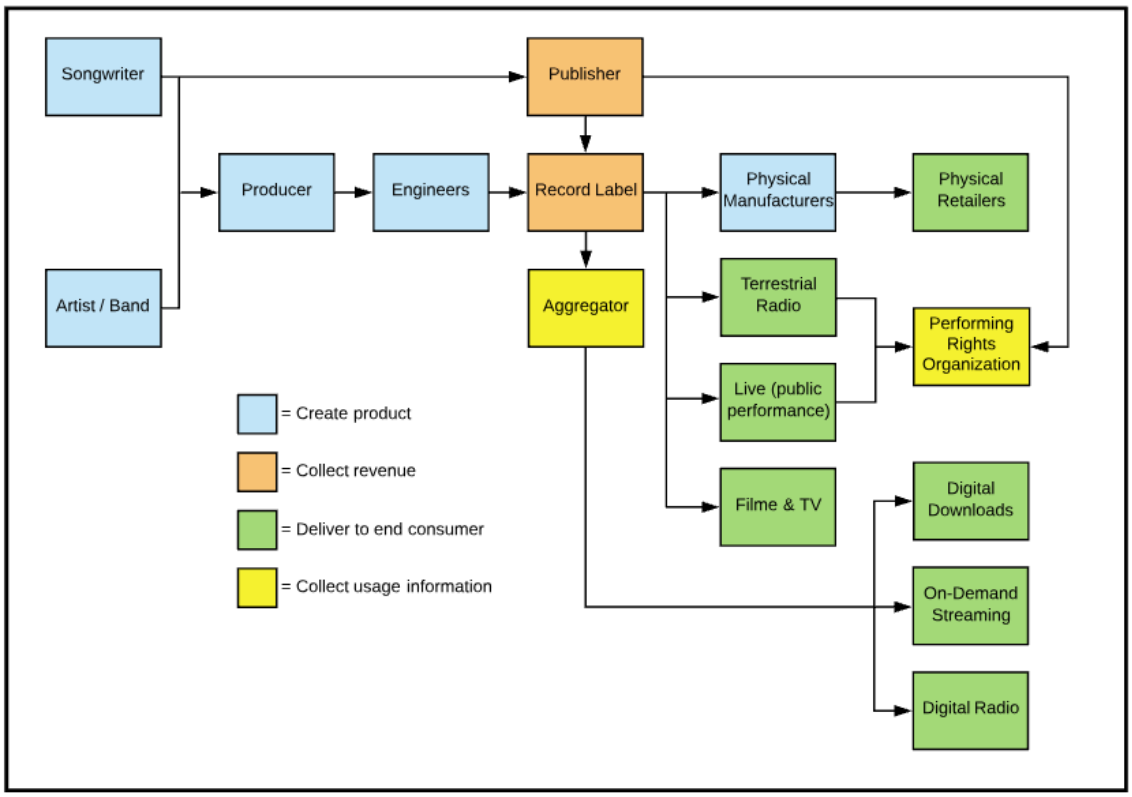

Figure 2 - Recorded music supply chain *(Sitonio & Nucciarelli, 2018)*

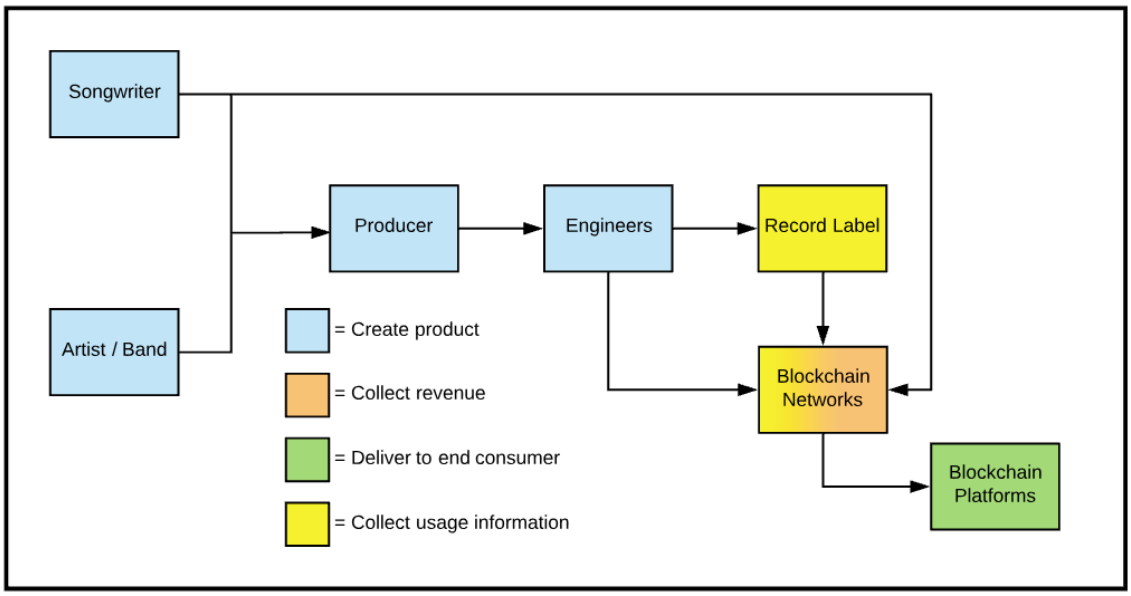

Figure 3- Recorded music supply chain with blockchain technology *(Sitonio & Nucciarelli, 2018)*

Figure 3 represents an ideal scenario, but one that is not easily achievable as most mainstream artists are under contract with one of the major labels and are unable to simply go from creation to the distribution in blockchain networks.

2.3.1. Blockchain Solutions

There are already some blockchain platforms that aim to solve the problem of transparency and artists monetization.

Musicoin, Resonate and Ujo Music are examples of blockchain platforms focused on music streaming(Sitonio & Nucciarelli, 2018).

Musicoin (musicoing.org) allows customers to stream music from their catalogue of independent artists. It promises fair compensation, transparent contracts and no intermediaries. They use a pay-per-play system that ensures that every artist is compensated for their contribution to the platform. The artists are paid automatically through smart contracts using the Musicoin cryptocurrency.

Resonate (resonate.coop) claims to be more affordable to listeners and pay artists over twice the rate of their competitors. Musicians are paid directly through smart contracts and the consumers pay to what they listen. Consumers add credits to their account that are discounted according to the amount of time they spend listening to music. And after listening to a song more than ten times, the consumer will no longer have to pay for it.

Other platforms such as Revelator (revelator.com) and Blòkur (blokur.com) focus on the royalty holders, offering metadata services to increase productivity and revenue through data analysis (Sitonio & Nucciarelli, 2018). Any given song might have multiple writers, each one of them being represented by different publishers, leading to a complex system where numerous low value payments are collected across the world making it hard to keep. Blòkur aims to keep track of all the information so that songwriters are properly credited and paid when their songs are used (Owen & O'Dair, 2020).

The .bc (dotblokchain) was introduced as a music file format designed to modernize rights management of this type of media (Sitonio & Nucciarelli, 2018). The idea behind this new format is that all the data required to identify the owner, payment rights, and other information is contained within the .bc file. The Verifi Media (2022), a Benefit Corporation, aims to provide the .bc format to all musicians, composers, and people in the music industry, through an open-source protocol and licenses.

Blockchain Solution	**Service Type**	**Objective**
Musicoin	Streaming	Disintermediation, Fair Compensation and Transparency
Resonate	Streaming	More affordable to listeners, Double the payment of competitors
Revelator	Metadata Services	One stop platform for music related business(e.g., financial reporting, rights management, business intelligence)
Blòkur	Metadata Services	Keep track of the licensing and royalty payments of music in digital products and services
.bc	File Type	Provide all the necessary information related to the rights directly in the song file.

2.4. Ontologies

An ontology defines a common vocabulary for researchers or other professionals who need to share information in a domain (*What Is an Ontology and Why We Need It*, 2000). It includes machine-interpretable definitions of basic concepts in the domain and relations among them. Using the same ontology across the network will allow different agents to more easily extract and aggregate information since they all communicate using the same underlying ontology. Developing an ontology is akin to defining a set of data and their structure for other programs to use.

Three music related ontologies will be analysed and further extended if necessary.

2.4.1. Media Contract Ontology (MCO)

MCO facilitates the conversion of narrative contracts to digital ones and permits the creation of new contracts in machine-readable code (Kudumakis et al., 2020; Mary et al., 2019). It consists of a core model and two extensions. The core model encompasses the concepts of permission, prohibition, and obligation by providing the elements for modelling the basic structure of media contracts. The two extensions are:

Exploitation of Intellectual Property Rights, which covers licensing for broadcasting or public performance.

Payment and Notifications, which covers royalties' splits between rights holders and currency conversions.

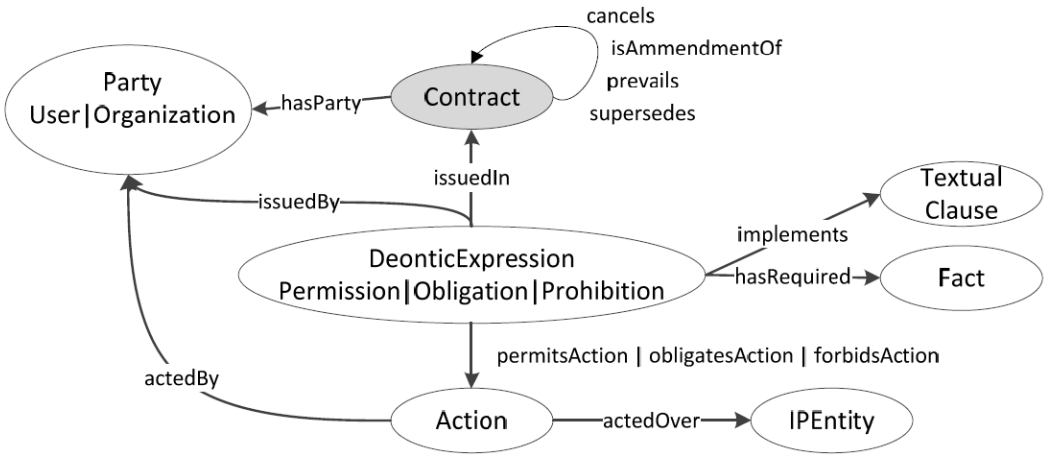

Figure 4- Main elements of MCO

Since MCO facilitates the conversion of narrative contracts to digital ones, the concepts which it explores can be used both in converting the existing contracts into smart contracts and in the creation of new contracts that would already in the form of smart contracts. Using MCO the type of service related to the rights can be represented as well textual clauses that might be present in the narrative contract.

2.4.2. Media Value Chain Ontology (MVCO)

Media Value Chain Ontology can represent in a machine processable way the life cycle of Intellectual Property (IP) entities (Mary et al., 2019). IP entities are objects in the value chain subjected to copyright laws. Users can be an individual or organization. Roles define the relation between a user and an IP (e.g., creator, producer, end-user) and grant rights over actions concerning that specific IP (e.g., create work, make adaptation, distribute). The roles are acknowledged by the copyright legislation.

MVCO also covers permissions, permissions are granted, invoked and revoked.

MVCO facilitates rights tracking for fair and transparent royalties' payments by keeping track of user roles and their permitted actions over an IP entity.

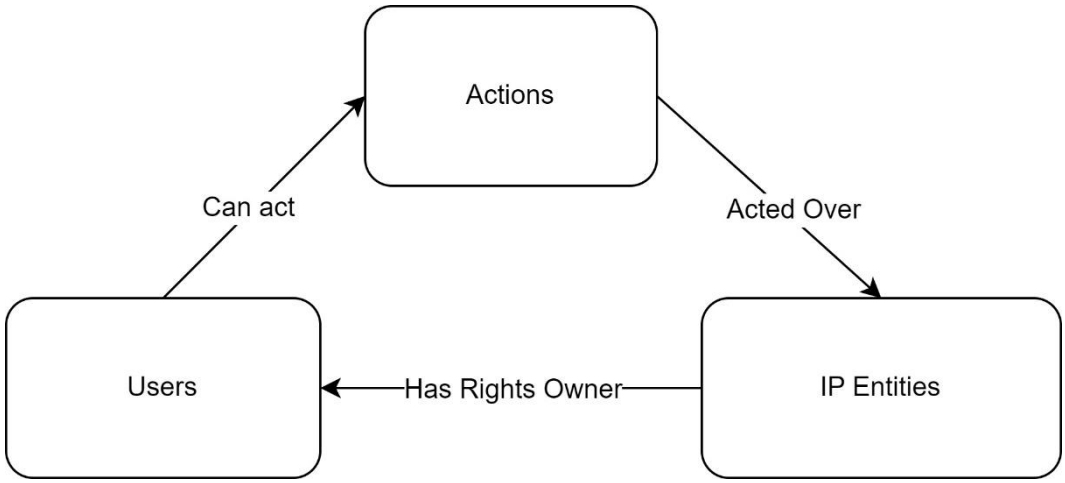

Figure 5 -Relations between Users, Actions and IP Entities

In MVCO permissions can also be granted conditionally. These conditions can be expressed as propositions with true or false values that can be combined with logical operators to create complex conditions (Kudumakis et al., 2020). These permissions can also be expressed as prohibitions and obligations. Permissions also relate a user and an action, and they define actions that an end-user can take over an IP or actions that an end-user could take over an IP (e.g., a user may have permission to play a song or a company had the permission to play a song in a commercial but they no longer can).

MVCO also supports to some extent the use of copyrighted material in cases of fair use.

2.4.3. Audio Value Chain Ontology (AVCO)

AVCO is an extension of MVCO which was created with the motivation to facilitate rights management of audio IP entities even when content reuse is involved (Kudumakis et al., 2020; Mary et al., 2019).

AVCO introduces the following concepts:

- Timeline: a linear piece of time in relation to time-based IP entities
- Interval: a temporal entity represented by the start and end points of a timeline
- Segment: a slice of an IP entity represented by its interval, represented in Figure 6
- Track: audio IP entity

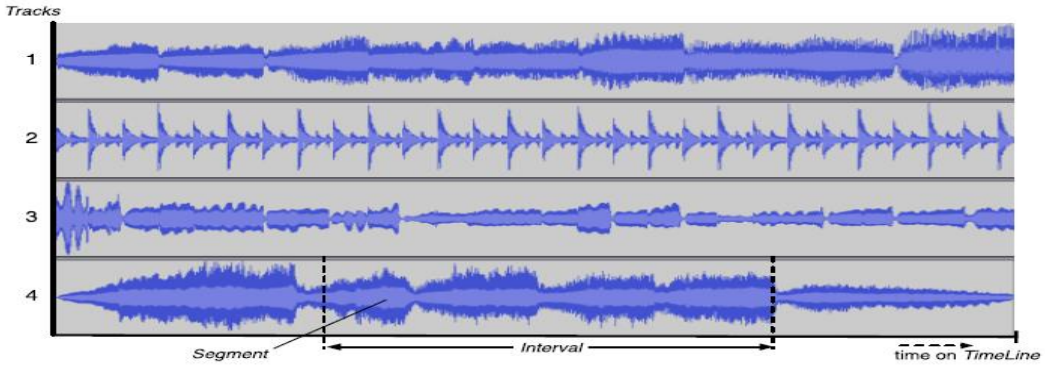

Figure 6- Representation of a multi-track audio. Segments are limited by an interval of time.

In the audio domain there are cases where a work is created by reusing existing IP entities, such as mixing existing songs or using samples from a song in the creation of a new one, and in the cases where the reuse of an IP occurs it gets harder to track the correct rights holders and the rights associated with each IP. As represented in Figure 7, AVCO tackles the problem allowing to represent that an IP contains a segment of an audio IP entity defined by the interval of time of the reused IP.

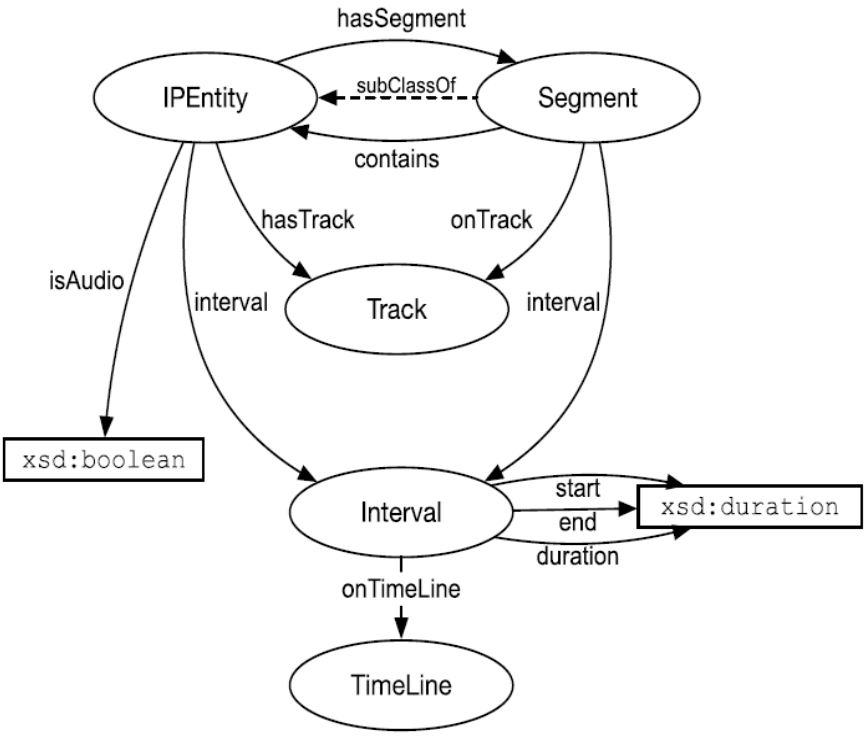

Figure 7- AVCO Representation

2.5. Literature Review Analysis

Through the literature review the main issues found are lack of transparency, unfair compensation to the artists and delayed payments or maybe even payments that were never made to the rightful party. During the literature review it was shown some platforms that already exist and that solve those issues by adding transparency automatic payments to their platforms. The limitation of such platforms is that they are aimed to independent artists only. While with the development of blockchain technologies and with the emergence of new artists that adopt such technologies and blockchain platforms the future of the music industry is sure to change to a fairer and more transparent one. But with the current industry being controlled by a handful of major players and most of the mainstream artists being under contract to one of the three major labels, the adoption of blockchain by the entire music industry could still take quite a long time.

A blockchain platform which instead of reducing the roles of the third parties would serve to migrate the current music industry system to a blockchain based one, utilizing the MCO represented in 2.4.1 to migrate paper based to contracts to computer-based ones that could be stored in the blockchain and with the third parties while maintaining their current roles would keep transaction records on the blockchain. This platform although would not tackle the problem of fairer compensation to the artists it would allow for a transparent music industry with automatic payments eliminating delays and non-payments.

Chapter 3 – Application of Design Science Research Method

The identification of the problem to be solved occurred as mentioned in the 1.2 section after a meeting with the field expert, the AMAEI president.

The problem being identified there is a search for the available methods to solve the problem, as well as a study of music related rights to guarantee that the resulting artefact would be accurate and relevant to the music industry.

During the development steps, blockchain based alternative to existing music industry business processes were designed utilizing Business Process Model Notation (BPMN) (Chinosi & Trombetta, 2012), processes that ended up being validated by the AMAEI president, and at a later step a Proof-of-Concept web interface was developed to interact with smart contracts based on the designed processes.

This dissertation and an article are planned to be published as part of communicating the research to the proper audience.

Communication with the domain expert was kept during the entirety of the process, so that every step could be validated.

In the beginning videocalls were made to identify and better understand the problem.

Ontologies were presented to the domain expert and later developed based on the feedback.

In a later stage the BPMNs were presented, and through multiple email exchanges feedback was provided and the processes kept getting improved until there was no incorrect information present.

After developing the prototype, a video demo was sent to the domain expert for validation.

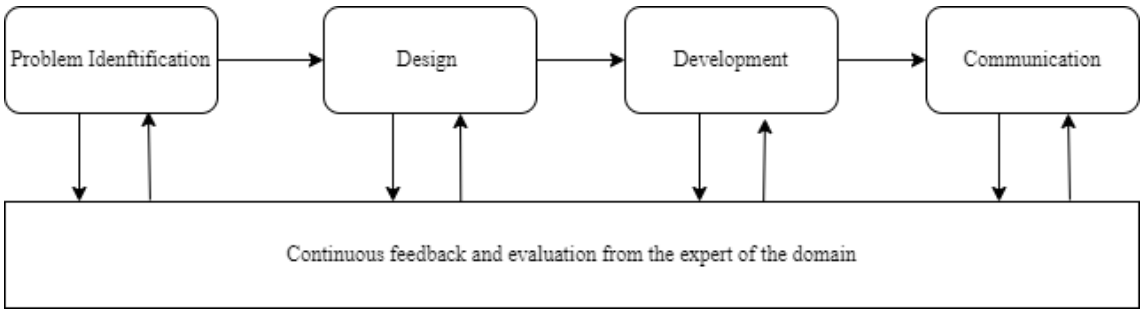

Figure 8 - Applied DSR Methodology in this dissertation work

3.1 Understanding Music Rights

Knowing that there is a problem with the current model of royalty payments doesn't make it so that a solution can be created. As seen in Figure 1 the royalty payment system is quite a complex one. Nuno Saraiva, besides personally explaining the different rights, also provided two very helpful documents that are written in Portuguese, (Saraiva, 2022; Saraiva & Silva, 2022) .

Before designing and developing any artefact, it is necessary to understand the author's rights and related rights.

3.1.1 Author's Rights

The entities associated with author's rights are the music publisher and the author(s) of the work. Author being the person responsible for the creation of the work, via composing the work or writing the lyrics.

Author's rights are based in the work itself meaning the composition and lyrics.

These Rights cover:

- Public performances: meaning that when a song is performed in public royalty payments are owed to the author(s) and publisher.
- Mechanical reproduction: this covers the licensing that is needed for an artist to record a song, giving it physical form through a cd, cassette, vinyl, etc. It also covers the recording to a computer file as it is done nowadays.
- Private copy: this is a fee paid by the manufacturers of blank CDs, DVDs, cassettes, and other electronic products with storage capacity to compensate for homemade private copies.

Author's rights are divided into "author side" and "publisher side", generally there is a 50/50 split on public performances but sometimes the split can go up to 100% to the publisher side on mechanical reproduction.

3.1.2 Related Rights

The entities associated with related rights are the featured artist, non-featured artist and record label. Related rights are based in the recording of the work, CDs, DVDs and digital files. Featured artists are the main performers in a record while non-featured artists are hired musicians. Traditionally non-featured artists are paid for the recording session and do not receiver further royalties.

Related rights cover the distribution of the song recording be it by radio, cable or any other methods of publicly playing the recording. It also covers the marketing of the recordings and private copy.

3.1.3 Master-Synch License

For the usage of a song recording in an audiovisual project as exemplified in section 2.4.3, it is necessary to license both the author's rights (synch) and the rights related to the recording ("master").

3.2 Music Processes

To develop a proof-of-concept artefact some processes were designed using BPMN. Due to the complexity of the music industry and legal side associated, the following processes are simplified focusing on the potential of smart contracts and are not a one-to-one representation of these same process as they are in real life.

3.2.1 Register Work in the Blockchain

In the process register work in the blockchain (Figure 9) it is defined that a Rights Holder registers a music work filling in the details and publishes it to the blockchain using a Proxy System, said system being a web application and not a third-party user or organization.

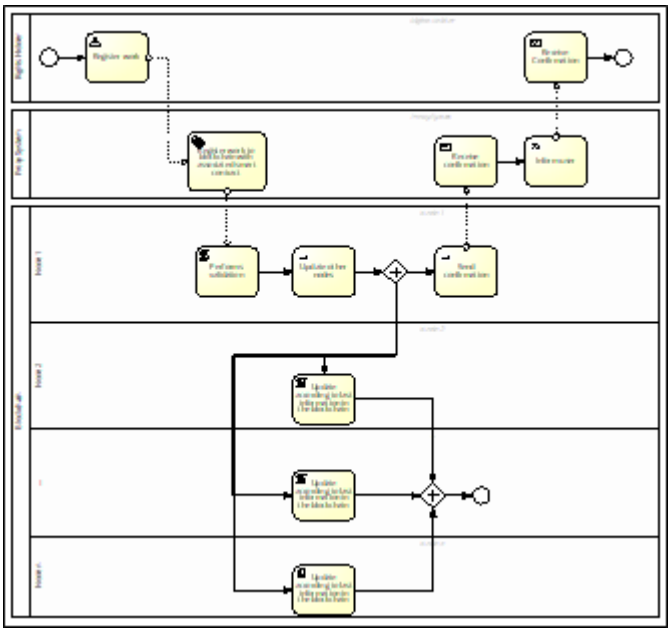

Figure 9 - Process of Register a work in the blockchain (click in the figure caption link to view a zoom of this figure in the Google drive).

The figures 10 to 12 show the details of each important step of the process represented in the figure 9. Concretely, the Figure 10 shows the detail of the task "Register work" by a Rights Holder, that implies this work is then registered in the blockchain by the Proxy System.

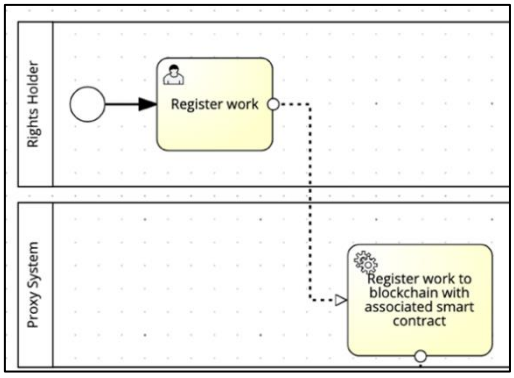

Figure 10- Register task by the Rights Holder user.

Through the defined consensus mechanism, the blockchain receiving node validates the transaction and all the other nodes are updated accordingly. For the sake of simplicity, we consider here that the receiving node has the permission to validate the transaction, i.e., to register the music work in a block.

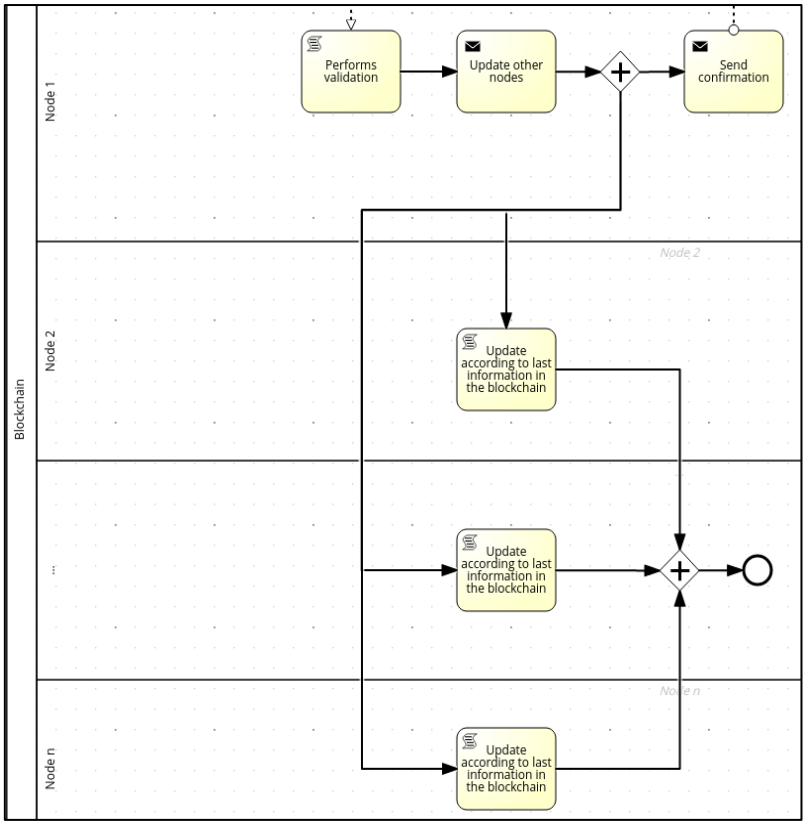

Figure 11- Blockchain is always updated according to the last transaction.

Lastly the Rights Holder user is informed through the Proxy System that the work was successfully registered on the blockchain.

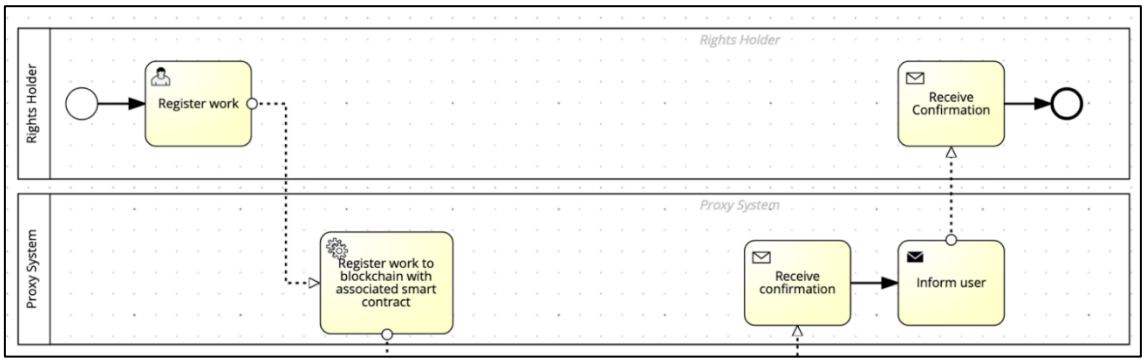

Figure 12 - The Rights Holder receives a confirmation of the registration of the work in the blockchain.

3.2.2 Synchronization Royalty Process

In the process *Synchronization Royalty Process* (Figure 13) it is defined that a Client requests a license so that they can use a musical work in an audio-visual production. The process depends on smart contracts which are contracts that automatically execute certain functions when certain conditions are met. In the following processes, smart contracts will be used to automatically split the royalties between the rights holder according to the pre-defined shares and automatically issue a license to the Client once full payment is confirmed. Every transaction is trackable so that full trust can be achieved.

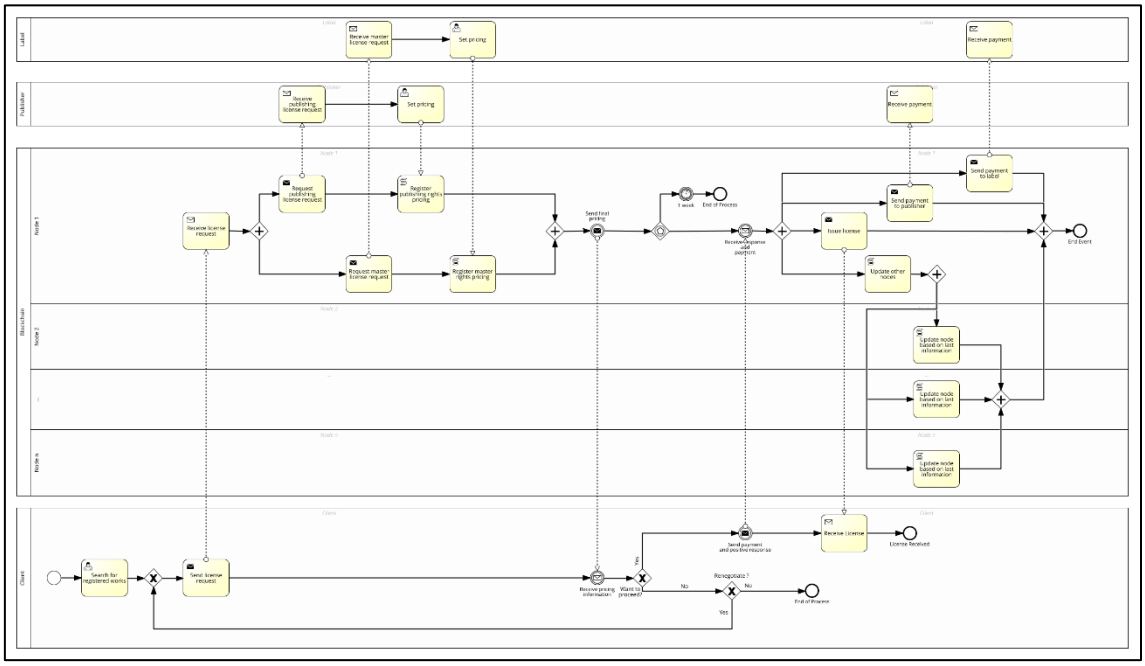

Figure 13 - Synchronization Royalty Process (click in the figure caption link to view a zoom of this figure in the Google drive).

The figures 14 to 16 show the details of each important step of the process represented in the figure 13. Concretely, a Client user who aims to use a musical work in their project (e.g., a film), searches through the available published works in a webpage and then fills a form requesting a license. In the license request the Client specifies the type of project and whether they intend to use a snippet by providing the timestamps or the whole song. The Label and Publisher will define pricing for the different set of rights. The Client can then decide if they wish to proceed and pay, try to renegotiate the price, or end the process.

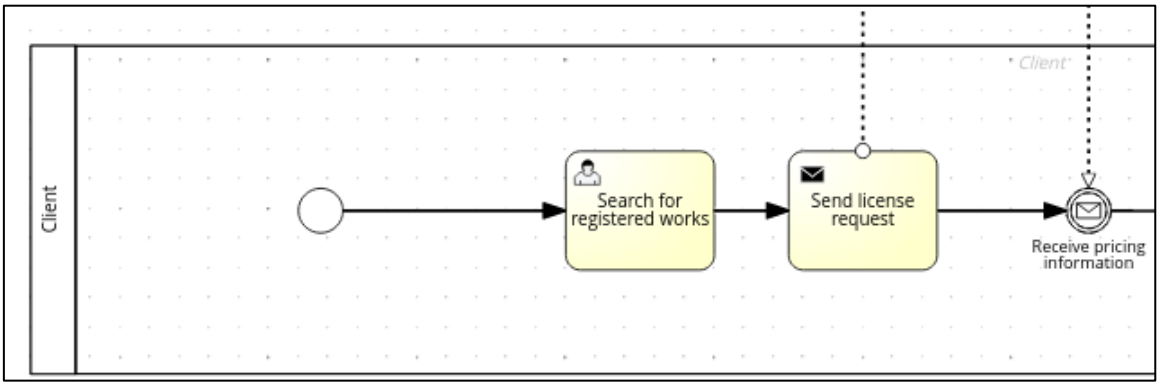

Figure 14 - The Client chooses and fills a license request.

The smart contract is automatically cancelled after some time of inactivity (defined as 1 week in the example). In case the Client agrees with the pricing and wishes to proceed, they send the payment to the smart contract (Figure 15).

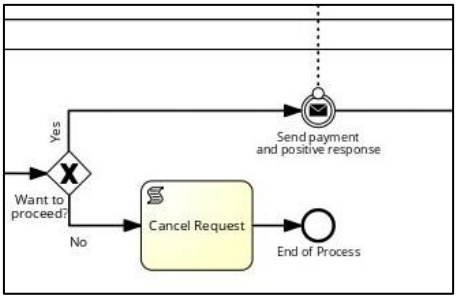

Figure 15 - The Client chooses whether he/she wishes to proceed or not.

Finally, the smart contract sends each of the pre-defined Rights Holder its share based on the percentages and issues the license to the Client. Every node of the blockchain is always updated after a transaction (Figure 16).

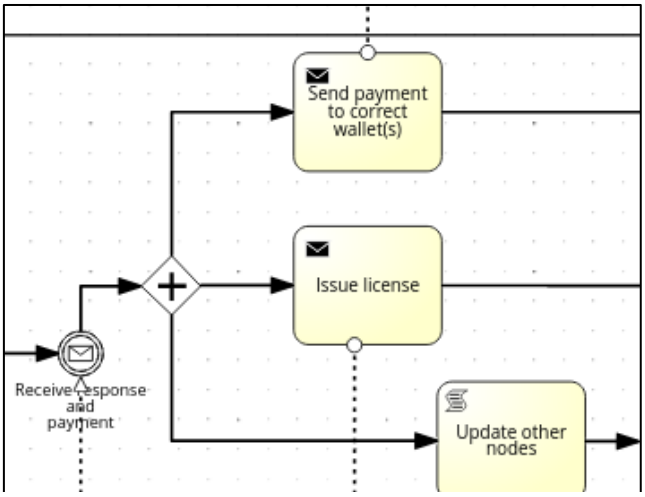

Figure 16 - Payment is sent to the Rights Holder and the License is issued to the Client.

3.2.3 Performance Rights Process

The representation of the *Performance Rights Process* (Figure 17) describes the process in which a Performance Rights Organization (PRO) manages a music work Performance Royalties. This process represents use cases such as those found in Licensing (passmusica.pt) .

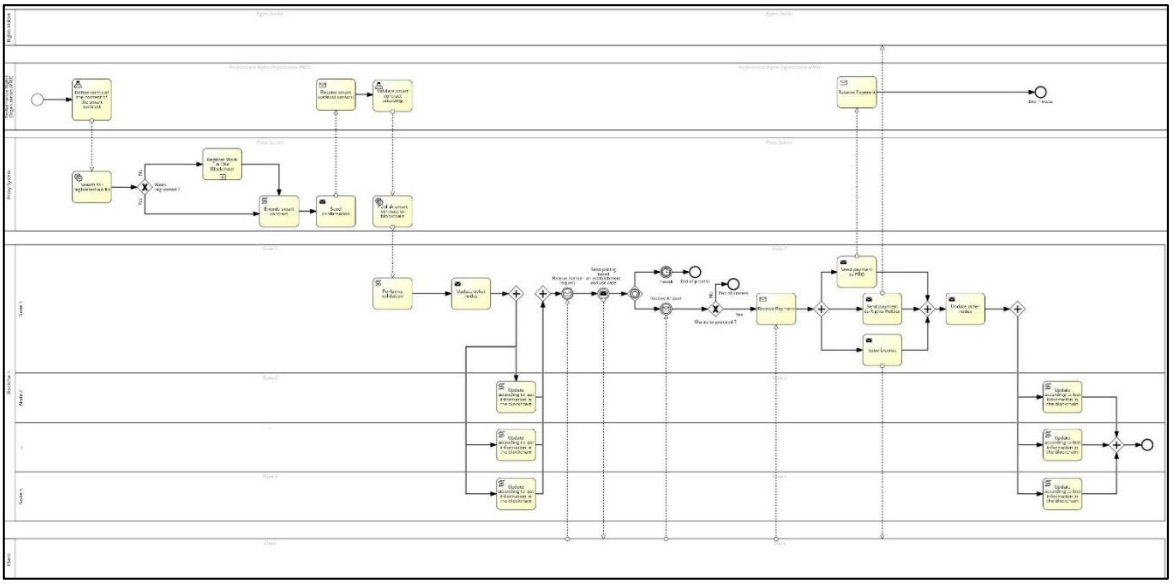

Figure 17 - Performance Royalty Process (click in the figure caption link to view a zoom of this figure in the Google drive).

The figures 18 to 20 show the details of each important step of the process represented in the figure 17. In this process the PRO defines the terms associated with a registered work. These terms are coded in a smart contract (Figure 18).

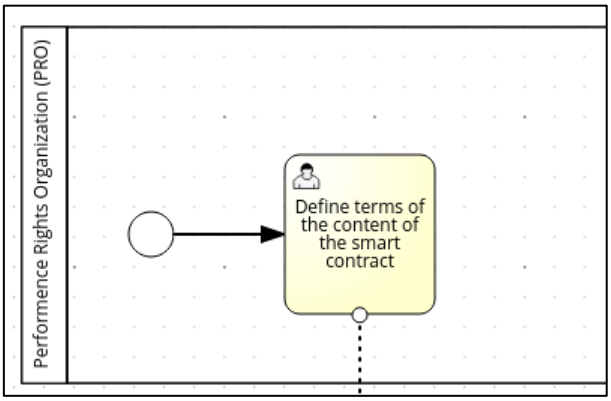

Figure 18 - The PRO defines the terms of the contract to be encoded in the smart contract

As represented in Figure 19, if the work in question happens to not be registered, we make use of the existing process “Register Work in the Blockchain” (Figure 9) and only then we encode a smart contract associated with said work.

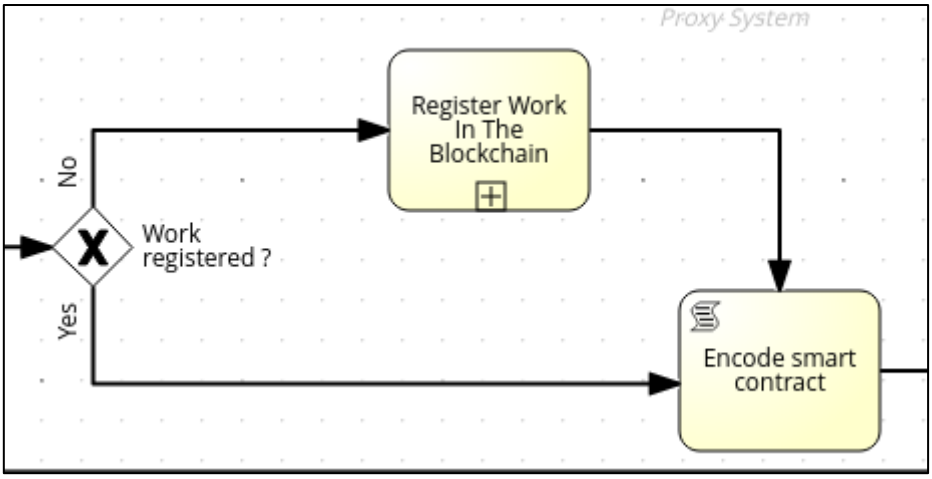

Figure 19 - The Proxy System encodes the smart contract.

Afterwards the PRO validates the content of the smart contract before it gets published to the Blockchain.

When a Client sends a license request, the pricing is automatically generated according to the terms defined by the PRO in the smart contract. If the Client agrees with the pricing, they proceed with the payment. When the payment is received, a License is issued to the Client, and each party automatically receives their share of the payment (Figure 20).

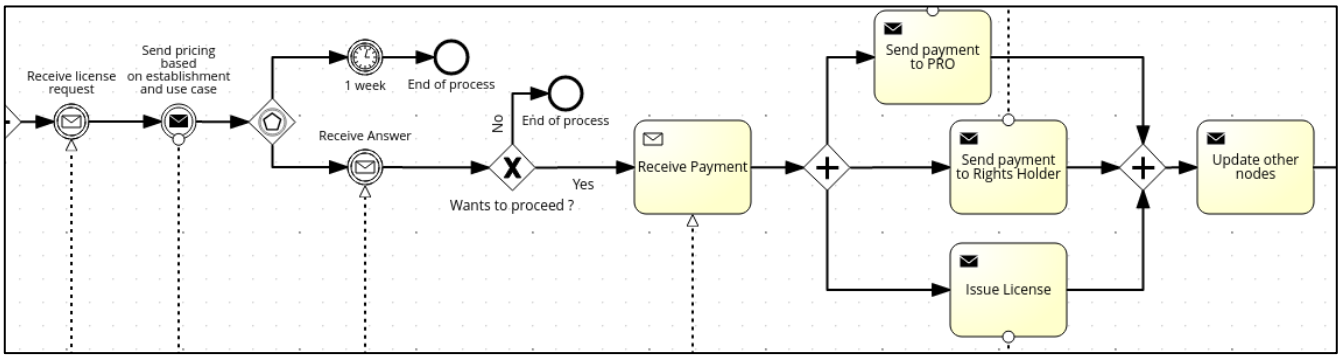

Figure 20 - Processing of the payment and Issuing of the License.

Chapter 4 – Development of the Artefact

4.1. Ontologies Development

When the ontologies were showcased to the domain expert, he pointed out that the User representation in the MVCO was lacking some important actors, so some additions were made in order to achieve a more accurate Ontology. As for the other two, it was the domain expert opinion that they were complete and accurate.

There was no representation for arranger, someone who works with the musicians to bring the most out of the composition be it by helping select the choice of instruments, the tempo, etc. The domain expert also noted that there was no representation for Publisher and that the differentiation between Featured representing the main artist and non-Featured representing the session musicians, the latter importance being that the main artists and session artists are treated differently in relation to royalties distribution.

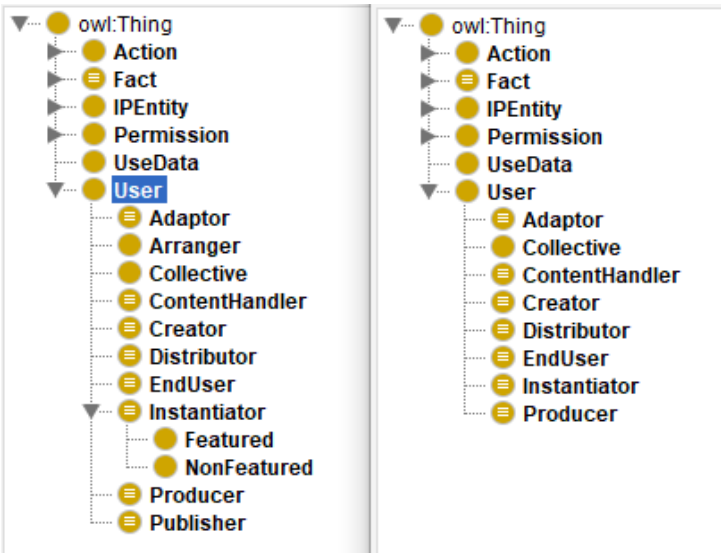

Figure 21- Additions made to the User represented on the left

The original idea was to use the knowledge represented in the three ontologies presented in the chapter 2.4, while developing the artefact, but due to the artefact limitation some of the concepts explored by the ontologies were not implemented and as such at the current state, the artefact only uses the concepts of User explored in MVCO to represent the different parties involved and the concept of time interval explored in the AVCO to represent a song segment in the smartcontracts.

4.2.Development Choices

To develop a solution for the established problem it is necessary to understand what the available development tools are and make the right choices to ensure the best product possible. That said due to time restrictions some choices were made based on the author's familiarity with some of the tools.

For the proof-of-concept, smart contracts were developed using Solidity which is the programming language used in smart contracts that run on Ethereum (as mentioned in 2.2.3). Solidity has a vast number of online resources geared towards helping in the development of smart contract, this accompanied by the fact that Solidity has been personally used in the past, made it the choice for this prototype development.

Ganache is a personal blockchain used in dapp development, it is where the contracts are deployed to during development, and it provides accounts for testing and interacting with the blockchain.

Only using Truffle and Ganache it is possible to interact and demonstrate the smart contracts, but for a better demonstration, it was decided to build a webpage that would serve as front-end for interaction with the smart contracts.

In order to build this webpage, the tools used were Node.Js to write some of the functions that would interact and get data from the smart contracts. And for the front-end the following frameworks were used React.Js, Next.Js and Chakra UI. It was the first-time using Node.Js and the three mentioned frameworks but once again due to the high volume of online resources it was a relatively painless experience to setup and use.

In order to interact with the web3 application a browser plugin Metamask is necessary. Metamask is a crypto e-wallet that allows us to manage accounts and interact with decentralized applications. It was necessary to configure the Metamask plugin in order for it to connect to our private blockchain provided by Ganache instead of Ethereum Mainnet.

4.3. The Dapp

The smart contracts used to demonstrate this prototype are RegisterWork, Sync, Pro. Each of them will be demonstrated and explained in this section. The source code for the dapp can be found at https://github.com/elsas-iscteiul/musicdapp.

4.3.1 RegisterWork Contract

This smart contract is used to register the data of a recorded song in the blockchain. And the information in it contained can later be used by other smart contracts (Figure 22).

```
contract RegisterWork{

  event Registered(uint identifier);

  struct Instance{
    string title;
    string artist;
    uint duration;
    address creator;
    address composer;
    address publisher;
    address label;
    //address engineer; Disabled for demonstration purposes
    //address producer;
    //address arranger;
    address[] featuredInstantiators;
    address[] nonFeaturedInstantiators;
    uint identifier; //change to string and use ISRC(?)
}
```

Figure 22- Recorded song associated data

In Figure 23 we can see the functions responsible for registering the song in the blockchain “initialRegistry” and the function that allows to add musicians to the song and define them as being classified as Featured or Non-Featured Instantiators. In further developments this contract would be separated into two contracts. RegisterWork where lyrics and compositions would be managed and RegisterInstance where recordings of a Work would be managed. Lyrics and compositions exist independently of song recordings.

The mapping is so one can retrieve the recorded songs by their identifier. In this prototype identifier is defined as being a number but in a real production scenario it would be best to replace it to a string and use something like International Standard Recording Code (ISRC) to identify the song.

```
mapping(uint ⇒ Instance) private instances; //used to get the a song by ID
uint[] private identifiers;



function initialRegistry(string memory _title, string memory _artist, uint _duration, uint
  if( !(instances[_identifier].creator == address(0)) ){
    revert("Instance is already registered");
  }
  instances[_identifier] = Instance({
    title: _title,
    artist: _artist,
    duration: _duration,
    identifier: _identifier,
    composer: _composer,
    creator: _creator,
    publisher: _publisher,
    label: _label,
    featuredInstantiators: new address[](0),
    nonFeaturedInstantiators: new address[](0)
  });
  identifiers.push(_identifier);
  emit Registered(_identifier);
}

function registerArtist(uint _identifier, address _artistAdress, bool _featured) public{
  if(_featured){
    instances[_identifier].featuredInstantiators.push(_artistAdress);
  }
  else{
    instances[_identifier].nonFeaturedInstantiators.push(_artistAdress);
  }
}
```

Figure 23- RegisterWork functions

4.3.2 Sync Contract

The Sync smart contract is used to represent a Synch-Master license request. In Figure 24 one can see the states variables of this smart contract.

```
contract Sync{

  address endUser;

  address payable publisher;
  address payable label;
  address payable[] songWriters;
  address payable[] featuredInstantiators;

  string projectType;
  uint songIdentifier;
  uint startInterval;
  uint endInterval;

  uint mastersPricing;
  uint publishingPricing;

  bool isSetPublisherPrice;
  bool isSetMastersPrice;
```

Figure 24- Sync Contract State Variables

With this contract it is possible to specify what type of project one is going to use the song for and the timestamps of the song one wants to use. The state variables are defined in the function *Create* represented in Figure 25. On the dapp the *Create* function gets his inputs for publisher and label by querying the RegisterWork instance of the selected song.

```
function create(address payable _publisher, address payable _label, address payable[]
            uint _songIdentifier, uint _startInterval, uint _endInterval) public{
              publisher = _publisher;
              label = _label;
              songWriters = _songWriters;
              featuredInstantiators = _featuredInstantiators;
              projectType = _projectType;
              songIdentifier = _songIdentifier;
              startInterval = _startInterval;
              endInterval = _endInterval;
              endUser = msg.sender;
            }


function setMastersPricing(uint _mastersPricing) public{
  require(msg.sender == label);
  mastersPricing = _mastersPricing;
  isSetMastersPrice = true;
}

function setPublishingPricing(uint _publishingPrice) public{
  require(msg.sender == publisher);
  publishingPricing = _publishingPrice;
  isSetPublisherPrice = true;
}
```

Figure 25- Functions to define the variables and set Prices

The setMastersPricing function can only be called by the address belonging to the label and the setPublishingPrice function can only be called by the address belonging to the publisher.

In Figure 26 we have yet another function of the Sync smart contract this one being responsible for the automatic payments belonging to each entity. Paying a percentage of the Publishing price to the publisher and splitting the rest between the songwriters. A similar situation occurs on the Master side, being a percentage paid to the label and the rest split between the featuredInstantiators.

```
function receivePayment() external payable{
  require(msg.sender == endUser && (msg.value == (mastersPricing + publishingPricing)) && isSetPublisherPrice && isSetMastersPrice);

  uint publisherShare = publishingPricing / 10;
  publisher.transfer(publisherShare);

  uint publishingShare = (publishingPricing - publisherShare) / songWriters.length;
  for(uint i=0; i < songWriters.length; i++){
    songWriters[i].transfer(publishingShare);
  }
  uint labelShare = mastersPricing / 20;
  label.transfer(labelShare);

  uint mastersShare = (mastersPricing - labelShare) / featuredInstantiators.length;
  for(uint i=0; i < featuredInstantiators.length; i++){
    featuredInstantiators[i].transfer(mastersShare);
  }

}
```

Figure 26- The payment method of the Sync Contract

4.3.3 Pro contract

The Pro contract was designed to interact with a webpage similar to Simulação de Pedido de Licenciamento (passmusica.pt), where a rate is given on the webpage based on the filled information, and in case the EndUser agrees they make the payment which is automatically transferred to the label (in the specific case represented by this contract).

There is a mapping on this contract that allows one to retrieve every licensing agreement made with a specific label identified by its address (Figure 27).

```
contract Pro{

    struct PerfContract{
        uint id;
        address business;
        uint capacity;
        address payable label;
    }

    event ContractCreated(
        uint id,
        address business,
        address label,
        uint ammountPayed
    );

    mapping(address => mapping(uint => PerfContract)) public contracts;
    mapping(address => uint) public contractsCount;

    function createContract(uint _capacity, address payable _label) external payable{
        uint contractCount = contractsCount[_label];
        contracts[_label][contractCount] = PerfContract(contractCount, msg.sender, _capacity, _label);
        uint ammount = address(this).balance;
        _label.transfer(ammount);
        emit ContractCreated(contractCount, msg.sender, _label, ammount);
        contractsCount[_label]++;

    }


}
```

Figure 27- The Pro Contract

4.3.4 Front-end

Through a webpage it is possible to interact with the smart contracts, and to interact with these three smart contracts, three pages were created. The first page (Figure 28) allows one to interact with the RegisterWork contract to register a new song to the blockchain and also register the recording musicians to those same songs.

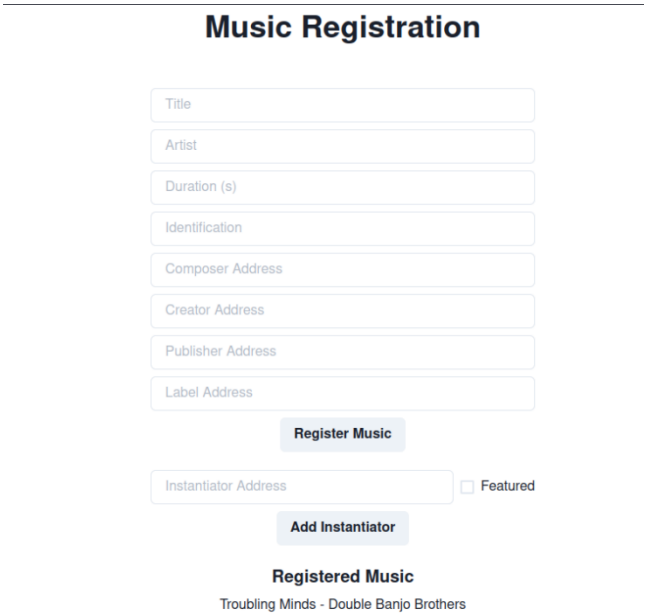

Figure 28- Page to interact with RegisterWork Contract

In the second page (Figure 29) it is possible to select between the registered songs and then interact with the Sync Contract to request a Synch-Master license. The publisher, label, creator, composer and featuredInstantiators addresses will be queried from RegisterWork Contract.

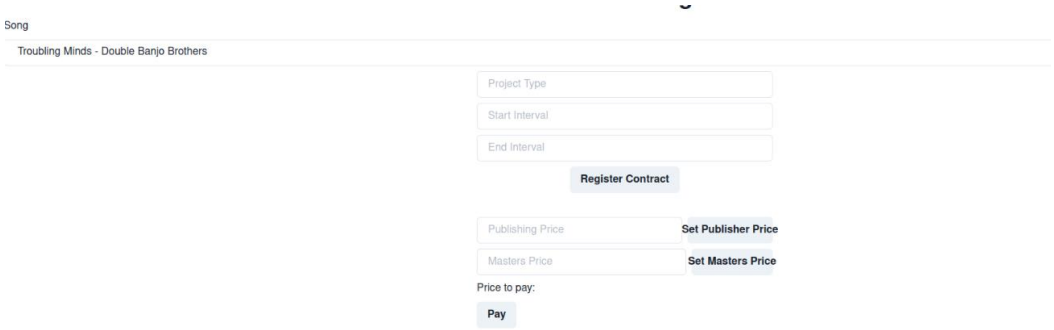

Figure 29- Page to Interact with Sync Contract

The third page is the page that is the clone of the passmusica webpage, and it serves to simulate a price, based on the establishment characteristics, and pay for the license in case the EndUser wishes to proceed (Figure 30).

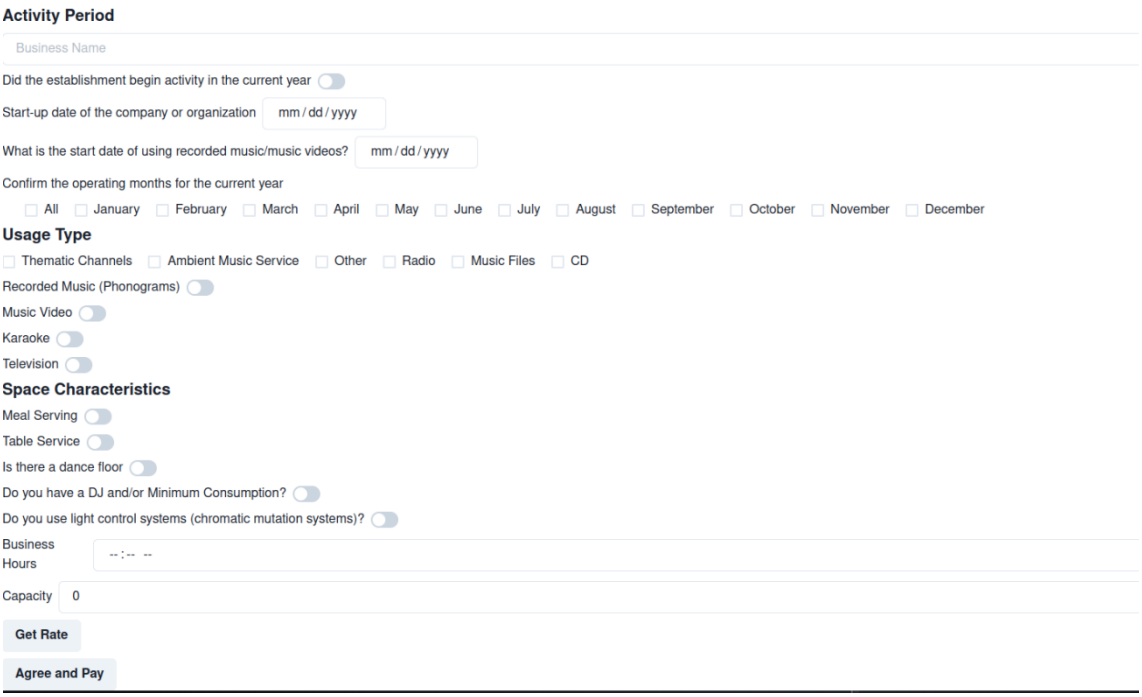

Figure 30- Page to interact with Pro Contract

Every transaction is recorded in the blockchain, and Figure 31 is the transaction of a song being registered in the blockchain.

CONTRACT

CONTRACT
RegisterWork

ADDRESS
0×7208b53406e214b3BE47235c934F650892EB873C

FUNCTION
initialRegistry(_title: string, _artist: string, _duration: uint256, _identifier: uint256, _arranger: address, _creator: address, _publisher: address, _label: address)

INPUTS
Troubling Minds, Double Banjo Brothers, 180, 732623, 0×80b1121964aad634af96d02cd5344b81a8e7db67, 0×ffc9a49a31a8bb815c6936dae64065980d66f9cd, 0×641e0272732c917320e9083f15d6a650e2f6ef91, 0×dbbc593b7d667836488a4f7d67c5557f26aaa300

Figure 31- RegisterWork initialRegistry transaction

Chapter 5 – Artefact Demonstration

To validate the automatic payments a new work will be registered, and a sync contract will be used to test the payments.

For this validation the accounts at indexes 0 and 1 are featuredInstantiators. Account at 2 will be a nonFeaturedInstantiator. Accounts 5 and 6 will the songwriters. Lastly account 7 will be the publisher and account 8 the label (Figure 32).

With further development it would be possible to define shares, but as of now the shares are hardcoded for demonstration purposes as follows:

- Authors Rights: 10% for the publisher and the rest equally divided between songwriters. In the example we will use 0.5eth as the price, so it would mean 0.05 for the publisher and 0.225 for each songwriter.
- Related Rights: 5% for the label and the rest equally divided between all the featuredInstantiators. Using 1eth as the masters price, the label would be paid 0.05eth and each featuredInstantiator 0.475.

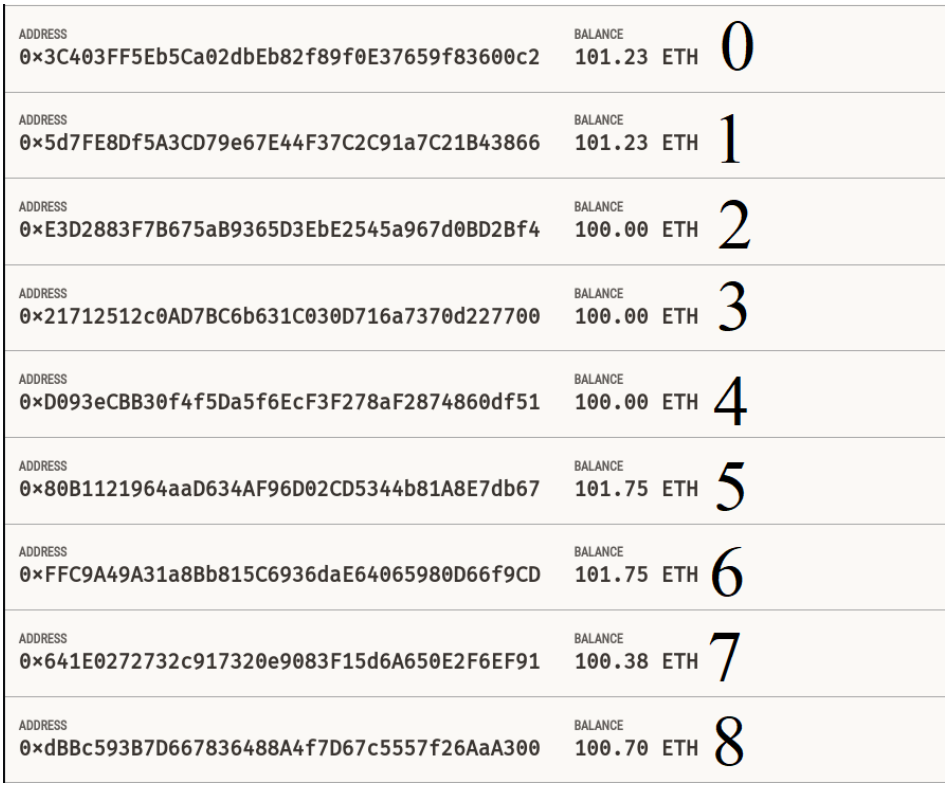

Figure 32- Accounts Balance Before Validation

In the register work page (Figure 33), we will register a made-up song with the participants mentioned above.

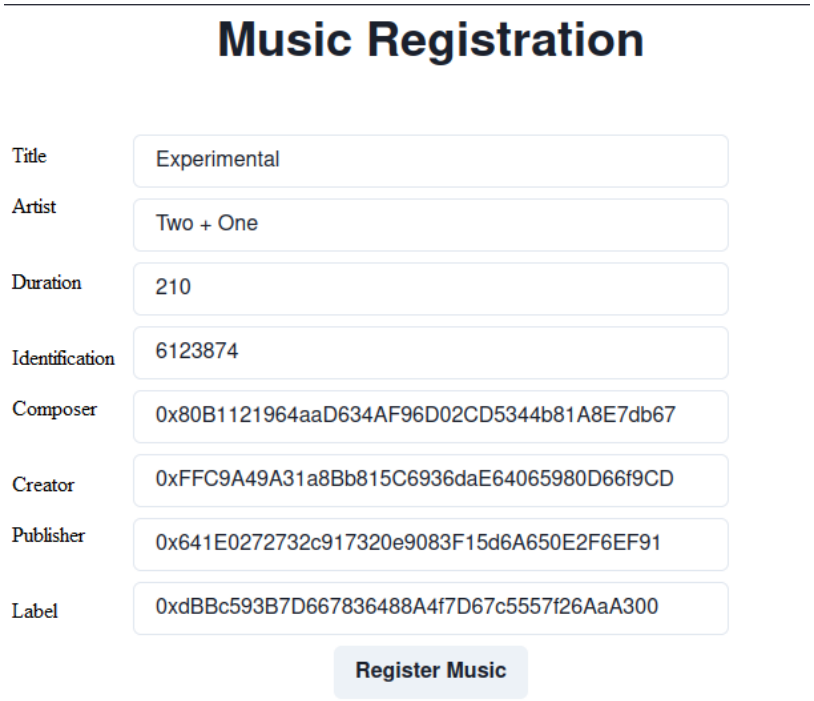

Figure 33 - Register the work

And we add the Instantiators (Figure 34 to Figure 36).

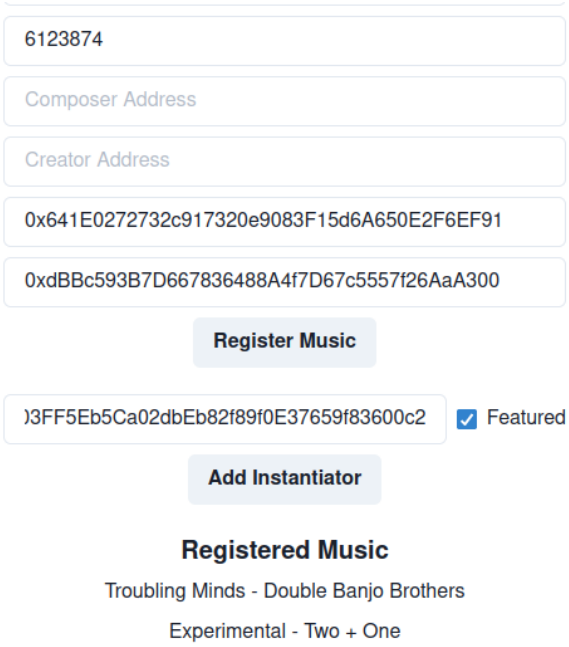

Figure 34 - Add first instantiator

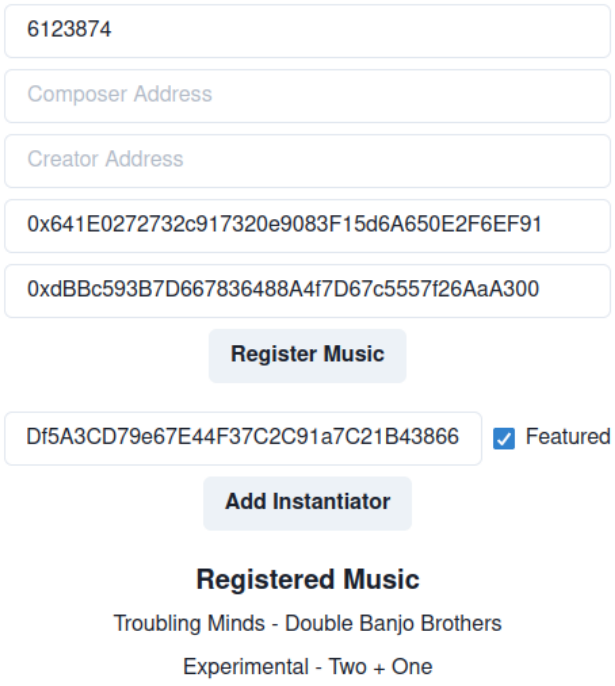

Figure 35 - Add second instantiator

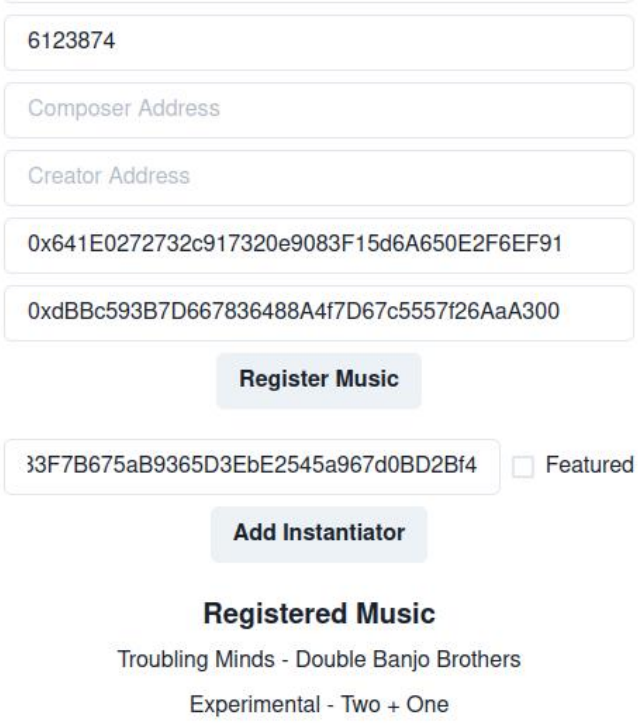

Figure 36- Add third instantiator (non-featured)

The work being registered one can now test the developed sync contract (Figure 37).

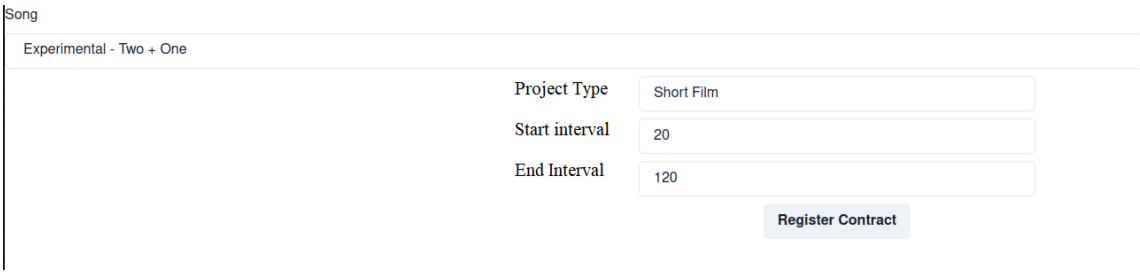

Figure 37- Registration of the sync contract

After the endUser has submitted the sync contract the publisher and label must set the license prices (Figure 38), the price is set in wei the base unit used in Ethereum; 1eth is the same as 10^{18} wei. This will later be changed so that ether is used in the webpage, and it will be converted to wei when calling the contract.

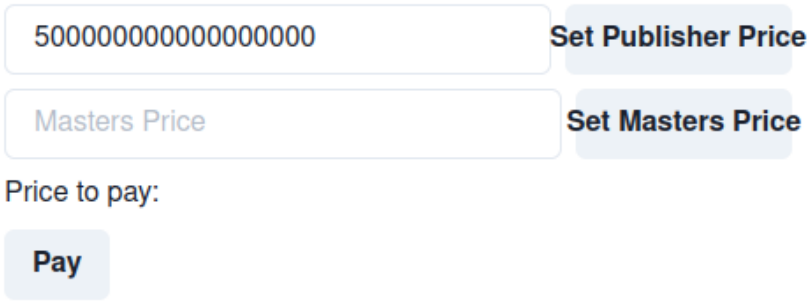

Figure 38 - Publisher sets price in wei, equivalent to 0.5eth

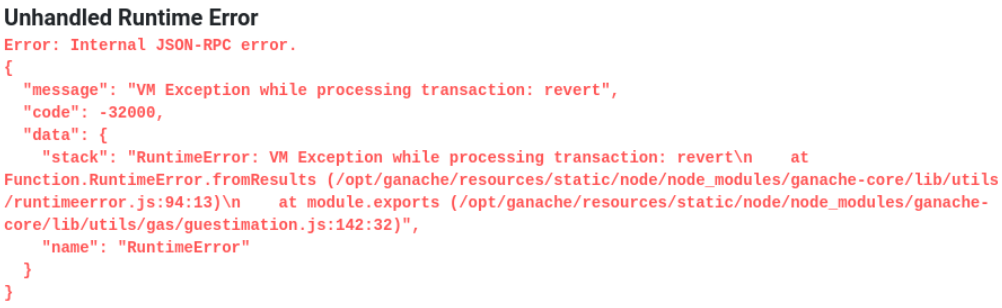

Figure 39 - Unhandled error that occurs when an unauthorized party tries to set the price

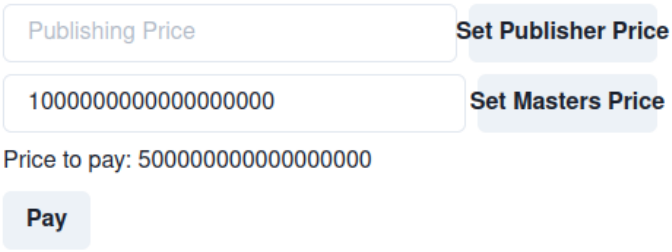

Figure 40 - Label sets the price in wei equivalent to 1eth

The endUser can only pay after both prices are set or else an unhandled error popup shows like in the Figure 39.

After both prices (

Figure 40 and

Figure 41) are set the endUser can pay (Figure 42).

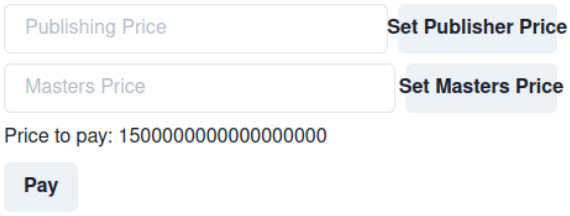

Figure 41 - Final price set based in both publisher and masters price

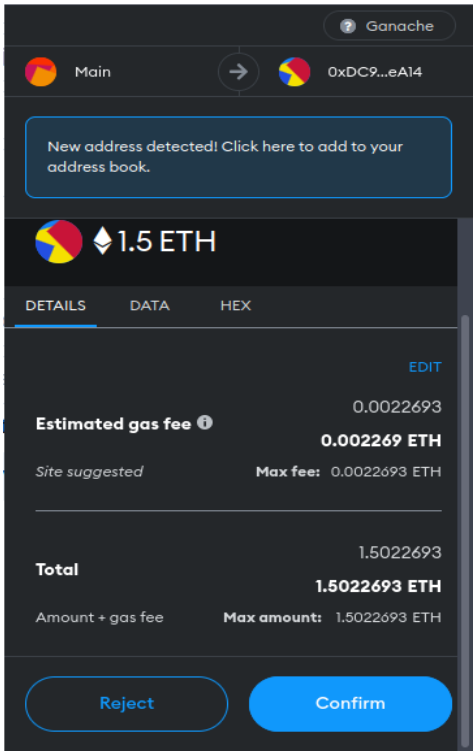

Figure 42 - Popup for the endUser to confirm payment

ADDRESS	BALANCE
0×3C403FF5Eb5Ca02dbEb82f89f0E37659f83600c2	101.71 ETH
0×5d7FE8Df5A3CD79e67E44F37C2C91a7C21B43866	101.71 ETH
0×E3D2883F7B675aB9365D3EbE2545a967d0BD2Bf4	100.00 ETH
0×21712512c0AD7BC6b631C030D716a7370d227700	100.00 ETH
0×D093eCBB30f4f5Da5f6EcF3F278aF2874860df51	100.00 ETH
0×80B1121964aaD634AF96D02CD5344b81A8E7db67	101.98 ETH
0×FFC9A49A31a8Bb815C6936daE64065980D66f9CD	101.98 ETH
0×641E0272732c917320e9083F15d6A650E2F6EF91	100.43 ETH
0×dBBc593B7D667836488A4f7D67c5557f26AaA300	100.75 ETH

Figure 43 - Account Balances after the endUser payment

Comparing the balances from before (Figure 32) and after endUser payment (Figure 43) one can see that the featuredInstantiators balance has gone from 101.23 eth to 101.71 eth (from 101.235 to 101.71, but ganache only represents up to two decimal places) meaning the 0.475 expected eth were added to the accounts.

The songwriter balance went from 101.75 to 101.98 eth (same occurrence as featuredInstantiators) in accordance with the expected addition of 0.225 eth.

Lastly the publisher went from 100.38eth to 100.43 eth meaning that the publisher also received their payment of 0.05 eth and the label went from 100.70 to 100.75 eth also proving they also received their expected payment of 0.05 eth.

Chapter 6 – Conclusions

6.1. Work Analysis

At the beginning this dissertation set out to answer two research questions:

- RQ1 - Is the blockchain technology mature enough to handle the necessary operations for a blockchain based rights and royalty management system?
- RQ2 – How can blockchain facilitate royalty payments to the music stakeholders?

As for the first question RQ1, the current state of blockchain technologies already allow for the development of blockchain based royalty management system and several solutions already exist or are being developed, but most of them in their early stages. Sixty of them are mentioned in the article (Chalmers et al., 2021), and the focus of these venture ideas seems to be the disintermediation of the music industry, getting the music directly from the artist to the fan. Some projects try to bank out of the hype that revolved around Non-Fungible Tokens and make it a selling point. As an example, here are some direct quotes out of the tune.fm website "We enable artists to monetize their creations directly from their fans like never before to earn a living and control their destiny" and "Mint Music NFTs with multiple songs, albums, art, video, royalties, and experiences; then sell them directly to your fans in our auction marketplace. Drop multi-tiered NFTs with different levels of unlockable perks and exclusive experiences.".

Music related blockchain projects are still very experimental and as seen in the table below from the 60 venture ideas mentioned in the article only 26 of them are currently active.

Also analysing the maturity level using the Capability Maturity Model, we consider that the maximum level achieved by blockchain based royalty management systems is the level two which is Repeatable, since a small number of them provided documentation in the form of white papers, but the vast majority still are at the first level.

As for the second research question RQ2, blockchain facilitates royalty payments to music stakeholders by providing a distributed registry of transactions between the different involved parties avoiding conflicting information present in different centralized databases and the added transparency will allow for a better understanding of the transactions assuring each payment goes to the correct party.

Despite its advantages, Blockchain is still a new technology, and its usage may seem to be a little difficult for non-tech experts. There is the need to setup an e-wallet to interact with a dapp, and for transactions the user would need to have balance their e-wallets. The most popular browsers today (Chrome, Firefox, Safari, Edge), need a plugin so that they can interact with dapps through e-wallets, and this acts as barrier of entry. Although more technically gifted or younger users, may already have experienced some interactions with dapps, most of the population hasn't, making it harder to see a widespread adoption of a blockchain royalty payment ecosystem, till more user-friendly features will be developed.

Besides answering those two questions, further analysis of this work can be done. Although the domain expert had positive feedback in relation to the BPMNs, he emphasized that those where too simple to be used in real life, as they do not cover most use cases, which can be more complex.

As for the ontologies, the additions suggested by the domain expert were used when representing the different parties involved in the prototype smart contracts, not much more where used. The prototype would be more complete if the MCO and the concepts from the ontology MVCO concerning to Permission and Action were used.

The prototype lacks user registration and the fact that the different parties are represented by their e-wallet string address makes it a little more difficult to use the dapp. A better way would be a mapping of registered users to their wallet, so the different parties could be represented by their name or another method of identification that not the long e-wallet string address. Also, currently the prototype was developed only to the point where it was possible to test the developed smart contracts and as such it only allows for the registry of recorded songs, when a more accurate approach would be to allow for the registry of the composition and lyrics in separate from the recorded song, as those exist in separate and are managed by different entities.

6.2. Main Conclusions

The music industry as it stands suffers from a lack of transparency and slow payments, not only between the entities such as labels and the artist but also between the entities themselves. The usage of blockchain technologies could very well be a solution to those problems. The music industry is slow to adapt to new technologies and as such the creation of new tools that fit well in the current system can help the transition to a blockchain more equitable and just system.

The labels and publishers are a big part of the music industry and trying to cut them out entirely does not benefit the adoption of the blockchain technology in the industry.

It is possible to develop blockchain based tools that can be used by the artists, labels, publishers, PROs to migrate processes that are used today to blockchain based solutions in order to solve the lack of transparency and slow payments without trying to shake the whole industry, by focusing on the migration of the existing contracts into smart contracts and focusing on new roles for the existing stakeholders instead of trying to cut them off.

The prototype presented in this dissertation although only a proof of concept and would need a lot more development until it can be a product that is suited for use in real case scenarios, shows the general direction that the music industry entities expect the adoption of blockchain technology to take, as the basis for the prototype design and development was from inputs directly taken from a professional of the area, the AMAEI president Nuno Saraiva.

6.3.Current Limitations

This work as an attempt to create a platform that can ease the transition of the current music industry into a blockchain based one still has some major flaws. This proof-of-concept is way too simplified to be adopted by the music industry. This work to be used would need to cover way more use cases. Also, the simplified nature means that the permissions seen in the ontology MCO were not implemented in the smart contracts. It also lacks a way to register and validate user information on the platform, a contract management tab where all the participant users could analyse all the contracts they participate in, and it does not address the mechanical royalty payment systems. For actual use of this work in real world contracts, this platform would need to be further developed accompanied by tests performed by music industry professionals and at least a lawyer to make sure the smart contracts would be in accordance with the legal world.

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