BLOCKCHAIN IN THE ART MARKET:

Opportunities and Challenges

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Abstract

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Abstract

Blockchain is usually associated with cryptocurrencies. However, as a distributed ledger technology, it can have many other applications. For example, blockchain can bring changes to how the art market operates. It can be utilised for many types of digital transactions, including collection, authentication, tracking of provenance, and sharing ownership of artworks.

This main purpose of this thesis is to provide perspectives on how and in what areas blockchain could be used to change the art market. It also examines how this technology may shift the balance of powers in the art market. The thesis further explores opportunities and challenges when using blockchain technology in the art market.

The thesis utilises a narrative thematic literature research methodology and includes a qualitative analysis of blockchain technology. Due to the nature and novelty of this technology, the reviewed literature covers a different range of disciplines, in which blockchain can be utilised. The findings were extrapolated to the use of blockchain technology in the art market.

The results demonstrate that blockchain can increase the speed, transparency, and volume of art sales worldwide and democratise the sector so that artists, collectors, and spectators can benefit from this technology. A blockchain platform can coexist with other traditional applications. However, before implementing this technology, we may need to overcome technological, governance, organisational, and societal barriers.

Keywords

art market, blockchain, challenges, cryptocurrency, digital art, opportunities, shared ownership, smart contract, tracking of provenance, work of art

CONTENTS

1 BLOCKCHAIN IN THE ART MARKET

Blockchain as a distributed ledger technology can have many applications. Its unique advantages over other technologies are widely covered in the media. Blockchain technology can change the balance of economic power in many areas and industries. It may evolve into a platform comparable to the Internet and support the flow of information.

Although the art market is often considered a niche sector, how blockchain is applied in this area can have far-reaching consequences for its adoption across the rest of the economy. Looking at the art market, blockchain has potential. Art is plagued by fraud, illicit transactions and tax evasion, all products of a fragmented physical market that is hard to trace. Blockchain could help to ensure the authenticity of a work of art, make the price and parties involved in a sale transparent. Moreover, it would allow the regulator to monitor the flow of art assets in and out of tax jurisdictions. However, considering the current state of the art market and blockchain technology, this will not be easy. (Macdonald-Korth Lehdonvirta and Meyer 2018, 5.)

1.1 OBJECTIVES

This main objective of this thesis is to provide perspectives on how and in what areas blockchain technology could be utilised to change the art market, including making various transactions, tracking of provenance, and making ownership of art transparent. It also examines how blockchain technologies may shift the balance of powers in the art market. The thesis further explores opportunities for using blockchain technology in the art market. Finally, it discusses the challenges that organisations might face when dealing with blockchain in the art market.

The thesis uses a narrative thematic literature research methodology and includes a qualitative analysis of blockchain technology. Due to the nature and novelty of the technology, the chosen literature sources were taken from a different range of disciplines, in which blockchain can be used. The preference was given to recently published articles in which authors discuss practical implications of blockchain technology on their respective industries. Authors were chosen based on the reputation in the field of blockchain in addition to having some experience in this area of study.

1.2 STRUCTURE OF THE REVIEW

The first part of the thesis outlines the basic principles and features of blockchain technology. The introduction also describes the use of smart contracts on a blockchain. It

further specifies the current economic state of the art market to put the application of blockchain into perspective.

The second part of the thesis examines blockchain adopters in general, and the phases of adoption of this technology. Building on the theoretical part, this section also describes an approach to blockchain uses in the art market. This part utilises articles and academic literature to specify the findings to understand how art market participants could use blockchain technology in the art market. The final part of the thesis is a comprehensive summary of conclusions with findings of the application of blockchain technology in the art market, future ideas, and suggestions for art market participants.

The data, examples and conclusion presented in the literature sources were analysed by applying logical reasoning and analogical thinking, extrapolating implications of blockchain from other disciplines to the art market. Another method that was used to find answers to the questions posed in the thesis was to identify if there are any patterns of the blockchain development in the art market by looking at how organisations currently use blockchain technology in this field.

1.3 THE PRINCIPLES OF BLOCKCHAIN TECHNOLOGY

The principles of blockchain technology are connected with the trust of information. In the digital age, it is often easy to manipulate a file on the computer. But how will we know what was true about the past without having to trust a central authority to keep the record? How do we address a growing concern of trust in information? The scientists, Stuart Haber and Scott Stornetta were thinking about this problem. In the 1990s, after some experimentation, they developed the time-stamping structure. We now call this structure blockchain. (Whitaker 2019, 25.)

A blockchain is a growing list of records on any kind of information, called blocks. These blocks are chained by the repetition of a unique 30-plus-character alphanumeric code. Each node, or user, has this code on a blockchain. Users can remain anonymous or provide their identity to others. A transaction takes places between blockchain addresses. (Iansiti & Lakhani 2017.)

Furthermore, on a blockchain, a hash function helps to protect each record cryptographically. This function can take any input and convert it into a fixed-length output, a string of characters. The hash of one block appears at the start of the next block. It is almost impossible to get the same output from two different inputs. Therefore, the parties cannot alter the data in any given block without changing all subsequent blocks. (Kafol

et al. 2018.) Moreover, only the hash is visible on the blockchain, the content of work is kept private (Whitaker 2019, 29).

In short, blockchain is an open, distributed ledger that can record transactions between two parties in a verifiable and permanent way (Iansiti & Lakhani 2017). Any information stored in the blockchain belongs to and is verified by the collective that has access to it (Styx 2018). Thus, all participants in the blockchain have access to the same version of the truth (Gopie 2018).

The basic features of blockchain technology are as follows:

1. Distributed database: each party on a blockchain can access the entire database and its history.
2. Peer-to-peer transmission: communication takes places between peers, not through a central node.
3. Transparency with pseudonymity: each transaction is visible to anyone on the system.
4. Irreversibility of records: once transaction appears in the database, the records cannot be altered since they are connected or chained with previous records.
5. Computational logic: transactions can be tied to computational logic, meaning that users can set up rules that trigger transactions between nodes. This principle allows users to deploy smart contracts on a blockchain, as described below. (Iansiti & Lakhani 2017.)

Typically, a peer-to-peer network manages a blockchain by adhering to a protocol for inter-node communication and validating new blocks. However, this does not mean that blockchain records are not unalterable. For example, bad actors could potentially corrupt the majority of blockchain's nodes. With advances in computing power, they could also find other's private keys and authorise transactions. (Whitaker 2019, 31.) The parties involved in the blockchain technology still consider the records secure by design. These records also represent a distributed computing system with high fault tolerance.

Blockchain can have many uses since keeping records of transactions is a core function of any business (Iansiti & Lakhani 2017). For example, the Bitcoin blockchain is a type of a distributed ledger but with a financial incentive for keeping the copies of the ledger. Nakamoto, the developer of bitcoin, introduced the concept of mining. By solving mathematical puzzles to verify each block, the computer wins an award in Bitcoin. (Whitaker 2019, 30.)

1.4 SMART CONTRACTS ON A BLOCKCHAIN

Smart contracts are lines of code that are stored on a blockchain platform. They automatically execute when predetermined conditions are met. Smart contracts can enforce an agreement so that all participants can be certain of the outcome without an intermediary's involvement. When several intermediaries participate in the transaction, there can be a lack of trust among participants. However, smart contracts streamline this multi-stage process. (Gopie, 2018.)

Smart contracts follow *"if …then…"* statements written into code on a blockchain. First, a network of computers executes the actions. For example, *if* certain conditions have been met, *then* release funds to the parties. When the transaction is completed, the blockchain is updated.

The benefits of smart contracts are:

- Speed and accuracy: there less paperwork, meaning more efficiency and speed.
- Trust: participants share records of the transactions, knowing that these records cannot be modified for personal benefit.
- Security: transactions are encrypted, and each record is connected to the subsequent records on a distributed ledger. To change a single record, the involved party needs to alter the whole chain.
- Savings: there is no need for intermediaries to verify the terms of the agreement because it is built into the code. (Gopie, 2018.)

Considering the mentioned benefits, smart contracts could be useful in several situations. For example, a typical stock transaction can be completed within microseconds. However, the parties have no access to each other's ledgers and cannot automatically verify that the parties own the assets and can transfer them. Therefore, the ownership transfer of the stock can take as long as a week. A series of intermediaries serve as guarantors of assets while the record of the transaction traverses organisations and the ledgers are individually updated. (Iansiti & Lakhani 2017.)

If the parties used a blockchain system, the ledger would be replicated in a large number of identical databases, each hosted and maintained by an interested party. When changes occur in one copy, all the other copies are simultaneously updated. As transactions take place, records appear in all ledgers. There would be no need for intermediaries to verify or transfer ownership. This transaction could occur within seconds, not days or weeks. (Iansiti & Lakhani 2017.)

In the art market, smart contracts could also streamline and secure the process of buying and selling works of art, especially when it comes to royalties. For example, a party uses a smart contract to purchase an artwork. Because the smart contract is tied to the artwork, the transaction is automatic. As a result, smart contract removes the need for a third party to verify. This also ensures that records are continuous, and the buyer pays royalties in time so that everyone gets their fair share.

Nevertheless, smart contracts are currently lacking in scalability, auditability, manageability, and verifiability on a technical level. Moreover, the legal framework for their application does not currently exist. Smart contracts can evolve in the next years, however, IT professionals should carefully consider potential issues when developing smart contracts under a current blockchain and seek legal advice on their use. (Panetta, 2019.)

Blockchain technology can be used in many industries and disciplines. For instance, in the art market, companies can compile data on sales, track digital use, pay content creators and services. An art market is a place of buyers and sellers trading in the services and works of art. In a broader sense, art market participants include those who exchange monetary value for art objects or services. Thus, for example, museums and art galleries are among the interested parties in the art market. To implement the blockchain technology for transactions in art, one should consider the current economic state of the art market.

1.5 THE CURRENT ECONOMIC STATE OF THE ART MARKET

The current economic state of the art market is determined by several factors. First, the economic model of the art market is a hybrid type of prediction market. On this type of market, a work's perceived cultural value, its past monetary value and as its predicted future value all determine the price of an object of art. Economic agents of the market may affect this price uncertainty. For example, when making an artwork, creators may not intend it for sale. Buyers often have no idea of the value of the artwork they are buying. Dealers can also claim reimbursement for sales of things they have never seen to buyers they have never dealt with. (Plattner 1998, 482-493.)

Additionally, the art market is not fully transparent. While private sales represent about half of the market transactions, sales data is not systematically available. (Coslor 2016.) The art market's participants can include private collectors, museums, large corporate interests, and auction houses. Since artworks are not fungible like stocks, the art market's

participants are more limited in number than the securities or commodities markets. (Esterow 2008.)

Consequently, auction houses can be tempted to bid on behalf of the sellers whose items the houses are auctioning, leading to a conflict of interest. In another instance, although having no intention of buying, unidentified bidders can bid to drive prices up. (Pogrebin & Flynn 2013.) If, however, auction houses disclose sellers' reserve prices, illegal bidders could use this information to corrupt the final valuation of an artwork.

Before deciding to represent a new artist, economic agents also consider what types of works are currently in vogue. These market players are highly selective in the choices to maintain a level of quality that is saleable. Therefore, a smaller pool of artwork creators appears in auctions. In due course, this can result in the greater market predictability, and thus more reliable valuation. All these concerns are in play when gallerists set prices for emerging artists at a much lower level than for established artists.

Furthermore, valuation at the primary art market is more speculative because new art comes to the market for the first time. However, once an artwork is sold on the primary market, it enters the secondary market. The prices for which the artwork is traded in the primary market have a direct impact on the work's value in the secondary market. Thus, all these limitations dictate the size of the market and increase the risk that some items may be over or undervalued.

2 BLOCKCHAIN ADOPTION IN THE ART MARKET

Before blockchain is adopted by the art market, it has potential in other industries that can influence the course of blockchain development in other areas. For example, in the survey CIO Survey “Blockchain Status 2018: Market Adoption Reality”, Gartner examines how blockchain can be applied to industrial and business functions and explores the deeper facets of blockchain technology development. (De Meijer, 2018.) For companies, this means they can try out different blockchain projects to find out what the value of the blockchain is and what the best use case will be for it. However, to achieve this result, companies may have to wait until the technology becomes more robust and reliable.

2.1 BLOCKCHAIN ADOPTERS

In a review of 1,063 companies, Gartner found that the first blockchain adopters came mostly from regulated industries such as banking, finance, insurance, and financial services. Organisations carrying out blockchain projects represent only 4% of this group, and almost half of these companies (48%) said they had no interest in introducing blockchain, while the remaining 48% of companies had no plans to invest in blockchain over the next three years. (Torres, 2019.)

However, McKinsey’s main finding is that the financial industry must move concurrently to unlock the benefits of blockchain, a conclusion that supports the efforts of the large-bank-backed distributed ledger consortium R3. The report states that blockchain technology will transform the capital market industry, affecting not only financial services, but also insurance, investment banking, securities and asset management, and financial technology and finance. (Rizzo, 2015.)

McKinley argues that the adoption of blockchain technology can bring significant short-term benefits, as it stipulates faster settlement to the capital market by reducing the number of records that financial institutions need to maintain and ensuring that audit paths are more precise. (Rizzo, 2015.)

According to Gartner, blockchain is on the verge of generating more than $1.5 billion in new revenue for the financial services industry and has proven its worth in several business cases. Therefore, many bank managers have shown excessive enthusiasm, triggering heavy investment in many financial-services industries in the early months of blockchain deployment. (De Meijer, 2018.)

As for cryptocurrencies, we are currently seeing the introduction of Bitcoin, Ethereum, Litecoin and other new platforms on the market. These new additions will lead to a sharp

increase in the adoption of cryptocurrencies, as they will provide current cryptocurrency enthusiasts with a valuable experience. (Zaki, 2019.)

According to a report by the Blockchain Emerging Technologies Institute (BEEI), the number of jobs in blockchain increased 33-fold last year (Zaki, 2019). The solutions seem to address this problem, as more and more universities devote resources and focus on blockchain development.

2.2 THE PHASES OF BLOCKCHAIN ADOPTION

Blockchain is one of the foundational technologies. The adoption of a foundational technology typically happens in four phases. The novelty of the applications and the complexity of the coordination efforts needed to make them workable determine each phase. Novelty means the degree to which an application is new on the market. The more novel it is, the more effort will be required for users to understand what problems it solves.

Complexity is the level of coordination involved. It includes the parties that need to cooperate to produce value with the technology. Applications low in novelty and complexity gain acceptance first. Applications high in novelty and complexity take decades to progress. However, they can transform the economy. (Iansiti and Lakhani 2017.)

Blockchain applications are still in their early days. They can take a long time to evolve. For their adoption on a larger scale, other users must be taken on board to create value for all participants. As the scale and impact of those applications increase, their adoption will also require a change of legislation and regulatory efforts. (Iansiti and Lakhani 2017.)

The adoption of blockchain technology on the art market requires coordinating activities of many participants as well as gaining institutional agreement on standards and processes. Moreover, its adoption will demand major social, legal, and political change. (Iansiti and Lakhani 2017.)

2.3 APPROACH TO BLOCKCHAIN USES IN THE ART MARKET

The art market participants can use blockchain in the art market in several ways. First, the parties can add bitcoin as a payment mechanism. The market for bitcoin is already developed. However, adopting this currency will require the involvement of IT, finance, accounting, sales, and marketing functions to deploy blockchain. (Iansiti and Lakhani 2017.)

The art market participants can also utilise blockchain for managing physical and digital assets, or recording internal transactions, and verifying identities. Companies that manage multiple internal databases can find this solution especially useful. They can take advantage of cloud-based blockchain services from start-ups or large platforms. (Iansiti and Lakhani 2017.)

Localised applications are the next step for art market participants. These applications, set up on the private blockchain networks, can increase collaboration with trusted counterparties thus reducing transaction costs, for example, for tracking artworks. The technology for such experiments is now available off-the-shelf.

To develop substitute applications in the art market, the blockchain-based solution must have functionality as good as a traditional solution. It should be easy for adoption in the market and lower costs per transaction. (Iansiti and Lakhani 2017.) Moreover, it should enhance security to track the flows of information and currency between the art market participants via the common ledger.

Transformative applications will be most powerful when connected with a new business model in which the logic diverges from existing approaches. Although such business models are hard to adopt, they can mean future growth for the art market participants. These models will require new expertise in software and blockchain programming. (Iansiti and Lakhani 2017.)

Companies will develop transformative applications after the widespread adoption of blockchain technology (Iansiti and Lakhani 2017). The areas where they could have an impact in the art market: authentication and provenance tracking of artworks, and algorithm-driven decision making in buying and selling of artworks, and in financial transactions that involve many parties.

These applications will also provide an advantage to new market players that will coordinate the new systems. These new players will build applications on top of the digital data, communication, and computation infrastructure. This will decrease the cost of experimentation and will allow new use cases to appear rapidly. (Iansiti and Lakhani 2017.)

3 BLOCKCHAIN USE CASES IN THE ART MARKET

Although the blockchain technology is relatively new, it has several use cases in the art market. The blockchain technology has potential in several areas including decentralising of information, managing collections and donors, creating new digital markets, managing insurance of a work of art, and tracking provenance. (Styx 2019.)

Trading in art digitally is in the interest of all parties involved in the transaction. Economically speaking, artists want to know how much their art is worth to be able to collect royalties from sales. An art market powered by a digital ledger would achieve this by providing a verified transaction record that shows the price and piece that was sold so that royalties can be easily collected. Legally, the host of the digital art platform may establish the trading exchange in a jurisdiction outside the scope of where royalties are paid. Technologically, a digital art market is much closer to the ideal state than today's world of physical trading. (Macdonald-Korth Lehdonvirta and Meyer 2018, 22.)

Next, the buyer's main concern is that they can trade at a fair market price and that the seller has a legal right to sell the work of art. Digital ledge-based transactions would make all of these a reality if prices are determined during bidding, while identification tags could ensure that the work of art is as described, and digital ownership records would prove the right to sell. (Macdonald-Korth Lehdonvirta and Meyer 2018, 22.)

This would be a major step forward from the current situation, where buyers are constantly suspicious of transactions due to widespread art market fixing and price manipulation. Moreover, a digital art market would connect many buyers into a single system as opposed to a highly fragmented physical art market. There would be more buyers and sellers in one place than in the current art market. Consequently, all parties would benefit from lower costs of shipping, auction fees, etc. (Macdonald-Korth Lehdonvirta and Meyer 2018, 22.)

Some blockchain companies have been already operating on the market. Usually, they specialise on a particular area of the art market. First, a blockchain company can act as an intermediary in the art market. For example, by using blockchain technology as an intermediary, AllPublicArt lets artists and art collectors do business with each other. This interaction not only reduces costs but also ensures the validity of each transaction between peers. To minimise art counterfeiting, AllPublicArt plans to use chains of blocks and to verify ownership of artworks. (ArtMarketGuru 2018.)

Furthermore, selling fractions of the ownership of works of art allows more people to easily invest in fine art. Fractionalised art sales, based on blockchain technology are

evolving into a new art transaction in various countries. They can support artists who respond to the need for greater transparency in the art market by using blockchain technology. (Chung 2019.)

Tokenising art on the blockchain and enabling the sale of works of art in the digital currency Bitcoin, as well as investing in paintings by top-selling artists over time, are redefining the way art is bought, sold, and authenticated worldwide. A platform for tokenising through blockchain enables a more transparent art market for the world's best artists. Specifically, Masterworks purchased the Andy Warhol's iconic work, "1 Colored Marilyn", for $1,815,000 in November 2017 at auction and then sold the joint ownership to more than 1,300 investors in May 2018. (Chung 2019.) There are other important blockchain use cases in the art market.

3.1 MANAGING INSURANCE OF AN ARTWORK

When it comes to an artwork related transaction, a major cost for museums is managing insurance. A work of art can be imported to or exported from a museum on loan or as part of a travelling exhibition, and insurance for that journey comes at an excessive cost. Despite the various levels of risk throughout an artwork's journey, insurance is often priced for a total loss. However, if the price of insurance changed throughout the journey of a work of art and correlates with the level of risk at any point, the cost of insurance would decrease. (Styx 2019.)

By updating the status of the work of art in real-time, blockchain has the potential to achieve this level of security and transparency. This could also eliminate the need for a member of a museum to accompany a work on its voyage, saving the organisation more money. This has become a reality after Maersk, a shipping company, revealed the creation of TradeLens, a blockchain-enabled shipping solution to endorse more efficient and secure global trade. (Styx 2019.)

3.2 AUTHENTICATING AND TRACKING OF PROVENANCE

Art market participants can use blockchain technology in the tracking of provenance. Blockchain players have been strong advocates of such solutions from the outset, and they are still in their infancy. This is evident in the number of companies and actors associated with the arts industry, such as the leading cryptocurrency and blockchain conferences and summits. (Sidorova 2019.)

Tracking of provenance is essential not only in setting the price but to be able to sell the works at all (Whitaker 2019, 32). Before making a transaction, art market participants

must confirm the authenticity and track the provenance of the artwork. Provenance refers to the chronology of the ownership or location of a historical object.

Storing any information about an artwork in the blockchain creates a decentralised ledger. This information can be permanently tied to the physical artwork through a smart tag, similar to a fingerprint. Not only could this measure prevent fraud, but also it can decrease the price of an artwork. (Styx 2019.)

Blockchain can counteract the lack of documentation because this technology offers an immutable and decentralised record. The record of legal ownership becomes the part of the blockchain provenance. While provenance describes the chain of ownership, authentication proves the authorship. Various methods, including personal expertise, scientific analysis can help to authenticate a work of art. (Styx 2019.)

For example, a scholarly expert concluded that Salvator Mundi was a real da Vinci. The National Gallery in London included this artwork in its exhibition on that recommendation. Subsequently, the painting was sold for millions of dollars at auction Christie's New York in November 2017. The authenticity of the painting has been later contested. (Whitaker 2019, 33.)

The parties use blockchain technology to determine the authenticity of the work of art, which can function not only as a seal of approval. Moreover, they can also use blockchain as a library of the source material. The blockchain record can certify that the experts assessed the information about the work of art. (Whitaker 2019, 33.)

Furthermore, to certify works of work, ArtChain uses blockchain technology to provide digital identification certificates for works of art. The art market is currently overloaded with counterfeit art and complicated procedures to verify the authenticity of a work of art, often involving third-party accreditation bodies. The company relies on the Bitcoin blockchain to authenticate works of art by certifying the chain of ownership, ensuring that digital certificates of authenticity cannot be forged. With smart contracts and digital tokens, ArtChain aims to make art trading more secure and efficient and reduce the potential risks associated with art investments. (ArtMarketGuru 2018.)

3.3 PREVENTING ILLICIT TRADE OF ART

Some objects of art are in high demand, while security in many parts of the world is low. Therefore, theft and forgery may exist on the black market. Although the art community condemns looting because it destroys archaeological sites, the trade of illicit antiquities acquired through looting can also occur. However, looted art remains omnipresent.

Auction houses, museums, galleries, and other market participants can use the blockchain technology to track the provenance of artworks. For example, blockchain companies can recreate title registries. Blockchain can also change the ownership structure of art by creating fractional ownership of artworks. (Thompson 2019.)

One of the companies, Thomas Crown Art, has already created a mechanism to utilise physical artwork as a store of value by 'walletising' each piece of art and then connecting it to a Certificate of Provenance stored on the blockchain in a 'smART contract'. This measure enables the possibility to use the physical artwork itself as a wallet making it capable of storing cryptocurrency. (Thompson 2019.)

The Ethereum protocol, a smart-contract structure, allowed tokenization. It generalised some of the scripting languages of Bitcoin to run many types of programs. While Bitcoin requires the user to have more understanding of the mechanics, Ethereum has a simpler interface and contributes to the structure of tokens. These tokens function financially in many regards the way that art investment does. Over time, smart contracts became standard. (Whitaker 2019, 28.)

3.4 INCREASING COLLABORATION IN THE ART MARKET

Blockchain can also increase the potential for collaboration in the art market. A decentralised ledger would help market participants to find pieces of artefacts owned by collectors. In due course, collectors could indicate on the blockchain whether they could loan their artwork to a museum or gallery.

Curators could easily turn to this information when planning an exhibition. This kind of collaboration could save everyone time and resources. This would also lessen the time spent on finding the artwork. Thus, museums and collectors would be aligned in managing collections, exchanges, and collaborations. (Styx 2019.)

3.5 SHARING OWNERSHIP OF ARTWORKS

Art collectors can use the blockchain for sharing ownership of individual artworks. In this way, art investors diversify their art holdings that limited to the secondary art market. For example, the company Maecenas that purchased an Andy Warhol artwork, "*14 Electric Chairs"*, divided it up into shares sold as ART tokens. (Whitaker 2019, 35.)

This means that collectors can buy tokens through a company like and thus they can have a small investment in an artwork. As for artists, the blockchain would allow them to keep

fractional equity in works. Selling tokens would be similar to the reselling of royalties. In this case, blockchain records would originate with artists' studios. (Whitaker 2019, 36.)

3.6 CREATING AND SELLING DIGITAL ART

The market for digital art is more technologically demanding than for physical art. First, you attach a physical identification tag on a digital artwork to scan. Therefore, one has to develop some kind of digital watermark to track photographs, videos, or other digital objects. Second, digital artworks are used in millions of "transactions" every day through social media. As a result, tracking these images would require a very high-capacity information system that goes far beyond the capabilities of blockchain technology. (Macdonald-Korth Lehdonvirta and Meyer 2018, 19.)

To solve this problem, one needs to create a digital ledger scalable enough for often inexpensive digital works of art. In addition, social media companies are known as the biggest infringers of artists' copyrights. Their platforms host millions of copyrighted images every day, however, they do not pay the copyright holders for these assets. (Macdonald-Korth Lehdonvirta and Meyer 2018, 19.)

The parties can use blockchain technology for selling and creating digital art. One of the companies created "Cryptopunks", the rare digital art based on the Ethereum blockchain. Each 24×24-pixel image of the cryptopunk, generated by an algorithm, is unique and only one individual can own the image. The company created only 10,000 images. It stores each character's proof of ownership on the blockchain platform. The total value of all cryptopunks is equivalent to $117,482.85. (Styx 2018.)

With its meme generation engine, Archetype allows users to create their cryptographic tokens that present memes, art and other types of information. It is based on a decentralised network consisting of a series of smart contracts that allow users to trade blockchain-secured tokens. (ArtMarketGuru 2018.)

As a crowdfunding blockchain platform, the ArtByte Foundation was established to help artists of all media obtain recognition and financial support for their work through person-to-person digital currency technology. The tipping application allows art enthusiasts to give ArtBytes to their favourite artist. Both artists and fans can win ArtBytes by participating in community forums. In addition to its social media community, ArtByte also organises weekly talent shows and offers regular scholarships to promising artists. (ArtMarketGuru 2018.)

Cointemporary is an online platform for international contemporary artists. It exhibits a single work of art for ten days and sells it for a fixed Bitcoin price. Once the artwork is sold or the exhibition is over, and another artwork is introduced. Each artwork is uploaded as a digital file secured by a cryptographic certificate of authenticity with a unique entry in the blockchain. In addition to featuring artists using traditional media such as photography and painting, the company also displays installation art, video works and sculptures. (ArtMarketGuru 2018.)

Nevertheless, an artist does not always necessarily want to monetise his or her art. Sometimes, they want other people to have universal digital access as an important part of cultural history and should always available for free. (Macdonald-Korth Lehdonvirta and Meyer, 2018.) In this case, a blockchain-based platform as a decentralised distributed ledger with record-keeping capabilities might be a solution.

Most artists hope that the adoption of blockchain technology in this field will lead to a more balanced, transparent, and fair market for all. Blockchain can help artists better control the value of their art and earn money. In a broader sense, many expect blockchain to help young artists make a more sustainable living by providing them with a better platform to sell their art. However, these views can be considered utopian given the dominance of an elite group to which most of the rewards flow. Although artists fully understand how utopian their point of view is, they still cling to it because they deeply hope it will become a reality. Nevertheless, there is a competing, dystopian view. (Macdonald-Korth Lehdonvirta and Meyer 2018, 16.)

The dystopian point of view assumes that blockchain technology will be applied to the art market by a single entity, which will gain even higher economic rents from artists. In this case, this entity is a large social media company, which is believed to have developed a prominent art-oriented blockchain to monitor, sell and track physical and digital works of art. (Macdonald-Korth Lehdonvirta and Meyer 2018, 16.) This viewpoint can become a reality if we look at the development of the Internet, where information flow and consequently wealth accumulation is concentrated in the large technology companies.

Furthermore, if a company succeeds in patenting a new technology and then uses its scale and influence to promote its adoption, the market could be dominated by a single player before real competition emerges. In this case, the company would have strong pricing power and unprecedented oversight into the market, all of which would likely mean that it would obtain economic rent from the system. (Macdonald-Korth Lehdonvirta and Meyer 2018, 20.)

3.7 CREATING ART ON A BLOCKCHAIN PLATFORM

Dada is a network of visual conversation in which artists and non-artists communicate with each other through art, creating works together. Each work of art is assigned one of five levels of rarity, ranging from common to extremely rare art. Ethereum powered transactions are conducted through smart contracts to ensure intellectual property protection and digitally verifiable proof of ownership. In addition to creating a vibrant community in which artists can share their work, Dada also envisions a digital marketplace in which artists receive significant monetary value for their art. (ArtMarketGuru 2018.)

3.8 PROVIDING FINANCIAL SERVICE IN THE ART MARKET WITH BLOCKCHAIN

Artfintech is a technology company that provides integrated financial services to the art world. It is building a technological and social ecosystem for the management of digital art and for investing in art-based tokens via security tokens. It uses blockchain technology through an Open Source Smart Contract called Patron Protocol as well as several decentralised APPs (DAPPs) to control and manage access and ownership. Patron Protocol aims to manage ownership, access rights and authenticity. (ArtMarketGuru 2018.)

3.9 EXHIBITING DIGITAL ARTWORKS IN MUSEUMS

Anything we share on the Internet is a copy. With the advent of blockchain and blockchain-based games like Cryptokitties, digital art will be scare. For example, if one buys the digital artwork, they can own the code and thus the rights to the artwork.

Consequently, a blockchain platform can make digital art authentic, permanent, scarce, and tradeable. For this purpose, a company can use a blockchain platform to record ownership. One piece of artwork would go into one contract that mints tokens underneath it, and each token represents a digital print. (Styx 2019.)

For museums, this means they can give their visitors access to the digital artwork through ownership of a token or private key. Then, visitors can display artworks in the physical world via smart canvases after the proof of ownership. And, as museums incorporate more virtual reality into exhibitions and experiences, these environments can make works digital artworks more easily accessible to patrons. (Styx 2019.)

3.10 LINKING THE BLOCKCHAIN RECORD TO THE PHYSICAL WORK OF ART

A standard for linking the blockchain record to the physical work of art has not been yet developed. Companies have tried physical tagging, DNA analysis, and photographing the physical surface of a work of art in the manner of a fingerprint. (Whitaker 2019, 34.)

In another instance, Kevin Abosch, an artist, created 10 million pieces of digital art through a smart contract on the Ethereum blockchain. Then, he had his blood drawn and used that blood to stamp one hundred pieces of paper with the generated contract address those ten million digital works. This way, he created a link between the digital and the physical world. More importantly, those physical works would have no value without the digital pieces of art. (Styx 2018.)

3.11 CREATING A LIMITED EDITION OF A DIGITAL ARTWORK

In the case of selling digital art, the challenge is how to create a limited edition of a file that can be easily reproduced. The prototype of *Monegraph* or “monetized graphics” allows digital artists to record works on the blockchain. Creators specify sales conditions and sharing rights for their work. (Whitaker 2019, 35.)

3.12 ORGANISING BLOCKCHAIN-BASED ART AUCTIONS

Codex Protocol is a blockchain company that stores the authorship and provenance of a work of art while guaranteeing data protection. Codex is a decentralised title registry based on a blockchain for the art and collectables, supported by a consortium. It values the importance of provenance and authenticity, on which the entire value of a work of art is based. Its application, Biddable, allows owners of cryptocurrencies to bid on auctions through an intelligent escrow agreement. This also prevents auction houses from losing significant revenue to bidders who withdraw from the items they have won. (ArtMarketGuru 2018.)

3.13 MANAGING INTELLECTUAL PROPERTY RIGHTS

In this digital age, it is increasingly difficult for people to retain ownership of their data. Bitmark wants to address this problem. The Bitmark blockchain was developed to enable the creation of ownership from digital data. Its system uses a web-based application to give everyone access to data management. With the Bitmark toolkit, Bitmark’s goal is to enable people to extract their data from social media and other applications where people create and share information. In this way, users can easily mark each new creation with an accepted property right, which is then stored in the Bitmark’s standardised

cryptography system. The ultimate goal of the company is to treat data as an important asset from which creators can generate wealth and value. (ArtMarketGuru 2018.)

Furthermore, *Binded* has created a private copyright vault for users who can upload their photos. The company allows creators to register their copyright by creating a unique fingerprint that is then stored permanently in the Bitcoin blockchain. Copyright certificates are issued to creators to protect them from possible copyright infringement. Thus, by allowing users to provide proof of creation in a public database, artists no longer have to go through the bureaucratic process of officially registering their works. (ArtMarketGuru 2018.)

4 OPPORTUNITIES

Blockchain's structure presents unique challenges and opportunities. Blockchain technology facilitates the exchange of information between multiple parties, such as financial institutions, and enables secure storage of records. Public and private entities in all sectors can benefit from the use of blockchain and establish a regulatory framework for its implementation.

Blockchain technology has created the backbone of a new kind of Internet by enabling digital information to be disseminated rather than copied. In recent years, the community has found many potential uses for the technology. For example, blockchain could be used for financial transactions in the art market. One way to use this technology is to work with a blockchain software vendor that is already developing use cases for such transactions. (Grewe 2020.)

Transparency and trust in blockchain can facilitate trade around the world. Many professionals believe that this technology can disrupt the financial sector by creating new and improved processes to help customers with their financial transactions. For blockchain to be widespread and adopted quickly, companies must look for ways to integrate it into their existing systems without having to replace them. (Naydenova 2020.)

4.1 FINANCIAL TRANSACTIONS ON THE BLOCKCHAIN NETWORK

With the invention of blockchain, traditional banking organisations took a long time to process and initiate transactions. Previously, the transaction process in the bank could take three days. However, with the advent of blockchain, that time could be reduced to a minute or even a second. Blockchain could offer companies to create new value by building a unique blockchain network. In developing a new solution, a good starting point is to explore the potential of blockchain as an alternative to traditional systems in managing transactions in the art market. (Naydenova 2020.)

The possibilities of using blockchain seem endless, as technology can be utilised in different industries. Blockchain is likely to change, triggering a new wave of financial automation, according to a recent World Bank report. Therefore, large technology companies are positioning themselves strongly to close this gap with their blockchain services (BaaS) and cloud-based storage. The key point is that blockchain has the potential to authenticate transactions without the need for an intermediary. As an example, blockchain can be used to solve many of the problems of today's financial services, such as cross-border payments and asset transfers. (Rao 2020.)

The key factor is the digitisation potential of assets, and an end-to-end solution requires the integration of other technologies. Assets and shares that are recorded digitally must be integrated into existing systems and managed. Asset types determine the ability to improve recording and process transactions via the blockchain, as well as the use of blockchain as a means of authentication. (Carson et al., 2018.) This means that blockchain can be used in the art market, such as financial transactions, insurance of works of art, digital asset management, and tracking of provenance. As providers understand blockchain and its impact on business, more innovative solutions can be created and brought to the art market.

4.2 DECENTRALISATION ON THE BLOCKCHAIN

Large companies such as Apple, Google, Microsoft, and many others have also begun to build on blockchain technology without jeopardizing decentralisation in favour of performance (Gharegozlou 2019). Moreover, the immutability and incorruptibility of the blockchain make it hard to counterfeit information and hack the system (Koksal 2019).

Over the next few years, companies are likely to experiment with new blockchain applications to find out where they bring the most benefit. One of the advantages of blockchain is that compared to traditional centralised databases, blockchains do not require increased storage capacity or the use of a centralised database system, such as a database server. (Binance Academy 2018.)

In contrast, many conventional databases rely on one or a few servers and depend on the availability and security of their servers. Because blockchain data is stored in a distributed network, there is no single failure point and no system data. Each network node can replicate and store a copy of the database so that a single node that goes offline does not affect the availability and security of a network. (Binance Academy 2018.)

In most traditional payment systems, a transaction takes place between two parties, such as a bank account. When using blockchain technology this is no longer necessary, as a distributed node network can verify the transaction in a process known as mining.

Thus, the blockchain system negates the risk of trusting a single organisation and reduces the total cost of transaction fees by eliminating intermediaries and third parties. The proof-of-work consensus algorithm that protects the Bitcoin blockchain has proven highly efficient over the years. Blockchain applications can be designed so that developers can earn their fair share of the ecosystem and reap the benefits of blockchain technology. (Binance Academy 2018.)

4.3 INVESTMENT OPPORTUNITIES IN BLOCKCHAIN

Blockchain consists of complex digital information blocks and can be used as a means of communication between individuals, companies, governments, and other entities. Blockchain Exchange – Traded Funds (ETFs) are companies that do business with blockchain technology. Although blockchain is a relatively new technology, many of the companies active in this area are well-established. As blockchain decentralises the information generated by transactions, many companies are beginning to consider how to integrate these new technologies into their business. (Johnston 2020.)

This means that investors do not have to get into a new technology early that has the potential to change the world in a similar way to the Internet. Blockchain technology and bitcoin get a lot of attention. However, this does not necessarily mean money for investors. If one wants to invest in cryptocurrencies, one must be aware that this type of currency will one day become a real currency used in the actual broad exchange of goods and services. (Peterson 2017.)

4.4 INVESTMENT IN CRYPTOCURRENCIES

According to a report by Goldman Sachs, the total market capitalization of Bitcoin and other cryptocurrencies in the US alone is $100 million. One of the top ten investments did not even come from venture capital but from a crowdsourcing financing technology called Initial Coin Offering. Blockchain technology and business are still a nascent industry when it comes to venture capital investment, and things are only just beginning. Currently, investors have multiple opportunities to invest in the blockchain industry. (Peterson 2017.)

Blockchain start-ups and technological giants, which already hold significant market share in their niche, are pushing into their niches. Listed blockchain technology stocks are another advance that could be used to build a portfolio. Blockchain companies issue cryptocurrencies and other tokens through initial coin offerings to raise capital. There are several avenues one can take to invest in cryptocurrencies. However, one should bear in mind that the more blockchain companies go public, the faster landscape changes. (Comben 2019.)

Blockchain exposure has been difficult to gain in the stock market, nevertheless, the Blockchain Exchange world has responded to this challenge. Exchange-Traded Funds such as Bitcoin, Ethereum and Ethereum Classic (ETH) have soared and are the best time for investors to start trading now. (Fitzpatrick 2019.) For example, there is a financial system around digital currencies, and since 2015 there have been more than one

thousand known cryptocurrencies and a growing range of services specifically facilitating the financial transactions of cryptocurrencies. Today, anyone can borrow, lend, save, exchange cryptocurrencies. However, the underlying technology that powers bitcoin and other cryptocurrencies, the blockchain, still offers investors plenty of promising investment opportunities. (Christou 2019.)

This is a major entrepreneurial experiment that will reveal whether the Bitcoin protocol, which has made important academic contributions to the world, can rationalize, innovate, and decentralise key areas related to digital assets, finance, payments, etc. Therefore, if one is considering investing in the blockchain, they should look beyond Bitcoin, or at least explore blockchain apart from digital currencies and look for ways to investigate it beyond the digital currency. Furthermore, one should seek advice from experts, not just from the financial industry, but also from other business sectors. (Christou 2019.)

4.5 FRACTIONAL ART INVESTMENT

We can consider art as an asset. Companies that build platforms for art can:

- Change the complex economic landscape of art investment.
- Link art investment with collecting luxury goods.

The shared investment can solve problems of liquidity in art investing. They can also potentially destabilize and burst bubbles in the art market. The forms of fractional art investment can also help artists if the equity shares originate with the artists' studio.

According to the "Wunder" museum website, its infrastructure lies at the intersection of digital art, patronage, and fractional ownership. Besides, a visitor does not need to go to a central location to view the works on exhibit. Owing to the blockchain, this decentralisation not only makes the museum more accessible but could also create a new level of competition in the digital museum space. (Styx 2019.)

Wunder's fractional ownership capabilities create opportunities for investors. In this way, blockchain offers more diversification and creativity in investment. Because of tokenization, more investors can have access to the work of art. They can secure fractional ownership through smart contracts on the blockchain. This can create new investment trends and opportunities. (Styx 2019.)

5 CHALLENGES

Blockchain has certain benefits over other systems, however, it also has its challenges. Blockchain became known as “Internet 2.0” and being studied by 80% of participating organisations in Deloitte’s 2019 Global Blockchain Survey. Transparency is inherent in public blockchains since everyone on the network has access to the register. (Zainuddin 2019.) Therefore, it is important to identify the challenges of this technology before calling it irreplaceable. Many professionals in the technology sector claim that blockchain is a technology that has certain limitations and is not yet efficient enough in many digital interactions. (Davis 2017.)

5.1 VULNERABILITY

Despite its secure design, blockchain is still vulnerable. Distributed ledgers are based on modern cryptographic techniques such as secure hashing algorithms. However, these mechanisms have weaknesses that can be exploited, especially with the advances in computing power. For example, quantum computers may be able to break encryption methods that the most powerful conventional computers cannot crack. If such vulnerabilities exist, they will be at least as applicable to existing online transaction systems, which depend on the same cryptography. Therefore, leading computer scientists are actively working to prevent such errors. Some platforms are already incorporating quantum resistance, even though workable quantum cryptographic computers are still a long way off. (Werbach 2018, 118.)

5.2 LACK OF INTEROPERABILITY

At this stage, most of the blockchain companies in the market cannot send or retrieve information from another blockchain. Based on a Deloitte report, the lack of interoperability gives blockchain developers freedom, however, it can complicate matters in IT departments since platforms cannot communicate with each other. (Modex 2019.)

There are many blockchain systems in operation, each designed for a specific purpose, by a community or a company building them for a specific purpose. However, an important part of the promise of blockchain technology has always been the way it connects multiple users and creates an added value. The current state of blockchain technology lacks that broader connectivity. Often, because of competitive reasons, companies are building ledgers to compete for certain market niches. (Werbach 2018, 61.)

The problem is that a blockchain can only be truly revolutionary if it is highly interconnected and widely used. The best example of this is a distributed system that many of us use every day by email. Although e-mail is now over forty years old, it has many similarities with blockchain, especially in the way parties are connected across time and space. Originally popular for its internal business communication, e-mail has expanded to allow communication between businesses and individuals from any location and any computer. However, before this could happen, concerted collaboration needed to develop a single e-mail protocol, which was adopted by all e-mail service providers we know today. It seems that blockchain is at the beginning of a similar process. Organisations are building internal digital ledger systems, but much work needs to be done on interoperability before the technology can deliver the promise that many envision. (Werbach 2018, 61.)

The report also states that on GitHub, over 6,500 projects are dealing with blockchain platforms. However, these projects have different protocols, coding languages, consensus mechanisms, and privacy measures. Therefore, standardisation could help companies to work on application development, and share blockchain solutions, making it easier to integrate blockchain with existing systems. (De Meijer 2020, Modex 2019.)

Furthermore, new technical vocabulary appeared with the emergence of blockchain technology. It is constantly evolving, and professionals have no choice but to introduce new vocabulary in this field. While the blockchain technology has made cryptography mainstream, it is still full of software jargon of this specialised field. Since blockchain is not yet a mainstream technology, companies have limited resources in this area. Most companies depend on specialised third parties and for assistance. However, since blockchain has developed in recent years, and if it continues to advance, its current limitations could remain in the past. (Davis 2017.)

5.3 INCREASING CENTRALISATION

Blockchain decentralisation power has its limits. The miners and core developers represent the biggest points of centralisation. Bitcoin works because the users have an economic interest in mining the bitcoin. Initially, the Bitcoin mining intended to be a low-intensity activity that could be carried out by ordinary users. Millions of miners around the world, all using their processing power, would be earning rewards. This was the case in the early years of Bitcoin's existence. (Werbach 2018, 120.)

However, as the price of bitcoins increased, competition among miners grew. As a result, mining companies began developing special hardware optimised for Bitcoin's hashing

puzzles. After some time, they began designing their custom chips, called application-specific integrated circuits (ASICs), to power a vast number of mining computers. The performance of these ASICs was so high that mining became a game of scale. Several miming companies gained an advantage through their mastery of ASIC design. (Werbach 2018, 120.)

Mining pools continued this trend. A Bitcoin miner was supposed to compete with others for rewards, miners realised that they could do better by pooling their revenues. Therefore, they divided their payments in proportion to the effort made. This made playouts more predictable, further accelerating the commercialisation of mining. (Werbach 2018, 120.)

The last step in the consolidation of the mining industry was the relocation of the mining industry with as processing power increased. Hardware costs and bandwidth represented a smaller percentage of the total expenditure than electricity to power computing and protect machines from overheating. (Werbach 2018, 120.)

Therefore, those who had access to cheap or free electricity were at an advantage, especially in areas where massive server farms were easy to operate. Relations with local or national authorities that control electricity supplies became a competitive factor for the miners. The mining companies are now generating several million dollars a day in revenue from their rewards. Mining pool operators want to maximize their profits, therefore there is no reason for them to promote the decentralisation of the Bitcoin network if it conflicts with their economic interests. (Werbach 2018, 120.)

The miners are not the only interest group in the blockchain. The developers working on the core of the software are quite small groups but with a lot of power. The original Bitcoin implementation has since been revised and significantly expanded. Implementing a scalable, reliable, and error-free network requires continuous effort. (Werbach 2018, 121.)

It is estimated that in the middle of 2017 that there were only about fifteen lead developers each for the Bitcoin and Ethereum platforms. For projects dealing with cryptocurrencies with asset values in the tens of billions of dollars, on which companies around the world have bet their future, those are very small numbers. The small number of core developers keeps these projects ongoing, but this raises the question of whether they can cope with the load. Both projects have much larger groups of dedicated developers but depend on the work of the core group. (Werbach 2018, 121.) However, the number of developers can increase if blockchain technology becomes more widely used and more job opportunities are created.

There is a Bitcoin Foundation with the task of promoting the protocol, but most of the key developers are paid by third parties, such as the MIT Digital Currency Initiative, the company-backed start-up Blockstream and the self-funded ChainCode Labs. Bitcoin's core developers are a very loosely connected group, often disagreeing with each other. (Werbach 2018, 121.)

5.4 THE COST OF USING BLOCKCHAIN TECHNOLOGY

The underlying cost of implementing blockchain technology can be extremely high. Although most of the blockchain solutions including Hyperledger are open source, they require a lot of investment in the infrastructure. For example, a company needs to hire a developer, manage a team that deals with various aspects of blockchain technology, including licensing of a paid solution. (Singh 2020.)

Besides, a company needs to train its existing professionals on how to utilise blockchain. In due course, the management team need to understand the complexities of the blockchain business. There are also maintenance costs associated with blockchain technology. (Singh 2020.)

5.4.1 The cost of a transaction

Blockchain, like all distributed systems, is not immune to attacks. It needs a large network of active users to counteracts these attacks. Nevertheless, widely distributed nodes can increase network congestion and transaction costs. For example, network speed and transaction costs were significant in Bitcoin after its first few years.

Right now, Bitcoin can process 4.6 transactions per second, and each transaction costs about $0.20. In comparison, VISA, a payment system, can perform 1700 transactions per second. Moreover, some professionals also believe that since bitcoin has a vast store of information, it forces blockchain participants to constantly reprocess and rerecord the information on the network. The size of the blockchain grows with more transactions and nodes. This situation is not ideal for commercial blockchains where the network needs to be fast and secure at the same time. (Davis 2017, Singh 2020.)

Besides, the information entered in the blockchain database must be of high quality. Therefore, because the data stored on a blockchain is not automatically trustworthy, the events must above all be registered with great accuracy. This is means that the storage mechanism of blockchain is not any different than that of the centralised database. (Davis 2017.)

5.4.2 The cost of energy consumption

On a Bitcoin platform, the miners are financially incentivised to solve complex mathematical puzzles. This mechanism requires considerable amounts of computation power to verify and process transactions. In addition, the energy required to cool down the computers can drive the costs exponentially. (Modex 2019.) The high energy consumption makes these complex mathematical problems not ideal for the real-world since mining means spending a lot of energy. However, private blockchain networks do not have this problem as the number of nodes within the network is limited. Besides, private networks often use more efficient consensus methods to reach consensus. Still, to remain operational, public networks can consume a lot of energy. (Singh 2020.)

In 2017, the World Economic Forum published a paper where it likened the bitcoin network's energy consumption to the power used by nearly seven hundred average American homes at the low end of the spectrum. (Modex 2019.)

Therefore, the large amount of energy required to run a blockchain network can deter companies. To overcome this issue, many blockchain companies are developing more efficient algorithms that require less energy. Thus, from a business perspective, private blockchains can be more suitable for making transactions since they are more energy-efficient and can provide an additional layer of privacy to protect information. (Modex 2019.)

5.5 SECURITY AND PRIVACY

Bitcoin and other blockchain-based systems do not pose an especially noticeable security vulnerability. However, for example, Bitcoin has a potential vulnerability or "51% attack". In this instance, an entity can control 51% or more of the network nodes, and therefore control the network. This means that if more than half of the computers act as nodes to make the network give the incorrect information, that information will become the truthful information. Consequently, the participants track Bitcoin mining pools closely to ensure that no one gains this kind of control over the network. (Davis 2017, Singh 2020.)

While cryptocurrencies offer pseudonymity, many potential applications of the blockchain involve smart transactions to be linked to known identities. This point raises concern about privacy and of the security of the data available on the shared ledger. Many technological companies deal with privacy rules governed by regulation. Their consumers share their sensitive information with these companies. (De Meijer 2020.)

However, if this information is stored in a public ledger, it will not be private anymore. Nevertheless, on a private blockchain, consumer's sensitive information could stay private. Furthermore, while blockchains are more secure than traditional systems, hackers can still acquire access to applications, systems, and businesses on blockchains. One of the solutions, self-sovereign identities can help users to control their data.
(De Meijer 2020.)

Another challenge is that although the record is verified on a decentralised ledger, the contents of the record are still in the hands of human experts. Many users equate "distributed ledger" with a framework for data replication or a distributed network for database management. In reality, blockchain implements a serial, append-only record of significant events. (Panetta 2019.)

Blockchain provides minimal data processing capabilities to avoid trusting a single central organisation. To ensure that blockchain is a workable business solution in its current form, IT professionals must be conscious of and weigh up the data management trade-off. (Panetta 2019.) For example, in June 2018, Terence Eden listed the Mona Lisa on the Verisart blockchain with himself as the artist and 1506 as the creation date. To overcome this issue, a partner organisation involved in provenance research can verify the work of art. (Whitaker 2019, 34.)

5.5.1 Building trust in private companies

In his book about blockchain technology, Werbach (2018, 150) points out that in an era of boundless enthusiasm about the potential of blockchain most discussions inevitably focus on the benefits rather than the risks of this technology. It is more exciting to describe how systems should work than to consider what would happen if they did not.

We should bear in mind that we rely on information technology infrastructures designed by other people. When art market participants use blockchain technology, they are putting the trust in private companies that usually built new blockchain platforms and standard taking on public registrarial activities. This dependency raises questions about the design and implementation of policies to oversight activities of these private companies.

5.5.2 Experiments with blockchain

Numerous commercial projects and experiments with blockchain are being carried out. There are some success stories in the field and validated use cases. However, there is not yet a blockbuster economy similar to a Google or Wikipedia. Perhaps that company is operating today, but not as efficiently. Even if the introduction of blockchain economics will

the scale of the Internet, there is no guarantee that the systems will maintain the openness and decentralisation that make projects like Bitcoin and Ethereum so exciting. (Werbach 2018, 13.)

Moreover, most blockchain is still under development and there is a lack of clear roadmaps for technology or business. Blockchain wallets fundamentally lack native fungibility, and ledgers themselves lack intrinsic integration capability. Critically, there are not adopted blockchain standards. This means that the technology has not matured to a point where interoperability can be guaranteed. (Panetta 2019.)

Therefore, participation in the blockchain universe, whether as a buyer or a system user, requires a leap of faith. Many of the technologies involved in blockchain are complicated and unproven. This means that both individuals and organisations must make investments based on incomplete information and rely on a world they do not fully understand. Appropriately, this leap of faith is exactly how blockbuster technology works. It creates truth on unreliable foundations. (Werbach 2018, 148.)

In areas such as financial services, data protection and surveillance, where trust in private and public authorities is essential and constantly undergoes trial, blockchain technology can make an effective contribution. Blockchain technology can be seen as a counterbalance to the progressive centralisation that has undermined the original vision of the Internet. (Werbach 2018, 148.)

Furthermore, the status of blockchain today reminded the Internet in its early days: an idea of decentralisation of power that could change the world. The Internet was also misunderstood as a technology of that is hard to govern, when in fact it was a technology of government. The comparison of blockchain to the Internet is valuable for two reasons. In retrospect, the study of the history of the Internet provides a model of how distributed ledger technology will develop. Looking ahead, systems based on the blockchain could revitalise the Internet as an open and decentralised platform. (Werbach 2018, 148.)

5.5.3 Blockchain and the Internet

Over the next forty years, the Internet spread around the world, creating many new forms of businesses and communities because it has a basic, open technological infrastructure. For example, Wikipedia created the largest collection of user-curated knowledge in the world. Netflix and Spotify helped to change the way people around the world interact and consume media. WhatsApp, Instagram, WeChat, and Snap changed the way billions of people communicate every day. All this happened because no one owns the Internet. (Werbach 2018, 149.)

However, despite its success, the Internet has not fulfilled many of the dreams and expectations it has raised. A handful of broadband and wireless network operators now control access in most parts of the world. Furthermore, a small subset of companies controls search, social media, advertising, e-commerce and many other important functions. They all keep users within their ecosystem as much as possible. (Werbach 2018, 149.)

The idea that network services become more valuable the more people have access to them strengthens this consolidation. Consequently, individuals have little control over their data that businesses collect to provide their services. Moreover, some governments have found ways to restrict the free flow of online information and use the network for surveillance purposes. User empowerment and innovation without permission are severely restricted. (Werbach 2018, 149.)

5.5.4 Hierarchical architecture of trust

The fundamental problem is that today's Internet security, identity and reputation infrastructures impose a hierarchical architecture of trust. For example, the Transport Level Security (TLS) is secure as long as the hierarchy of intermediaries successfully administers their digital certificates. Users are more likely to trust the Certificate Authority hierarchy than those with whom they do business directly. Since TLS is a point-to-point security protocol, it is not adjusted to end-to-end trust. Intermediaries and platforms similarly control identity and classification systems. (Werbach 2018, 150.)

The perception of the main Internet platforms has changed dramatically after they have gained a dominant position in the information ecosystem. At first, technology companies were seen as disruptive players, breaking the dominance of monopolistic companies in communications, media, financial services, and other sectors. They represented freedom of expression and user empowerment. Now, antitrust experts are openly concerned about the power of Amazon in retailing, while start-ups and content creators complain about the Google/Facebook duopoly on online advertising. Instead of making us smarter by providing us with access to the world's information, these platforms are accused of turning us into mindless automatons and opening the door to political manipulation and false messages. (Werbach 2018, 151.)

Nevertheless, power does not necessarily make market players untrustworthy. Market forces and internal rules can make dominant companies not to be evil. However, centralised control allows them to act in ways that may not be in the interests of those who trust them, or that may not promote justice, innovation and other values. It changes the

dynamics of language, creativity, and innovation. And it makes it easier for governments to extend surveillance or restrictions on digital freedom, as they only have to add new checkpoints. (Werbach 2018, 151.)

Moreover, the need to trust someone or something leads to an imbalance of power. The trusted actor becomes powerful and uses this situation to its advantage. For example, we trust Google as the most useful source of information and put trust in Facebook with our personal information, allowing both parties to eliminate potential competitors and generate additional revenue. (Werbach 2018, 151.)

Blockchain offers an opportunity to rethink the decisions of cyberlaw and this time create a more open environment. If blockchain becomes widely adopted as trustworthy technology, an opportunity for proprietary control would be removed. For example, the Ethereum is managed by a non-profit foundation, supported by a network of independent miners. The platform was made available as open-source software that allows anyone to fork both the code and the history of past transactions. With all these features, it is very different from the private information platforms that dominate the market. It would be much more difficult for the Ethereum Foundation to modify the platform so that some users benefit from it more than others. (Werbach 2018, 151.)

Werbach (2018, 152) states that the reason that dominant Internet platforms absorb so much of the value of online activities is both economic and technical. For example, Facebook stands between users who want to interact and advertisers who want to market them. By 2017, it will generate more than $30 billion in revenue from these interactions. Users provide the data and attention that fuel this revenue engine; however, they receive none of the financial benefits. Furthermore, network effects help ensure control of Facebook. A competitor, even if it offers a much better service, cannot offer the same promise of benefits, because what people want is access to their friends. And Facebook maintains strict control over its users' identity information.

In his regard, distributed ledger networks are different. The ownership value can be monetised with a cryptocurrency. For example, one of the platforms provides a distributed cloud storage technology based on blockchain. Instead of storing files in a specific location that can be accessed through a uniform resource locator (URL) address, the platform stores multiple copies of files on many hard drives on the network. (Werbach 2018, 152.)

The token serves as the intermediation by creating incentives on both sides, in a similar way Google brings advertisers and viewers together. Uploaders contribute tokens, which they can purchase in other currencies, and storage providers earn tokens. The company

that provides the technology has no control over the content stored on the network. And the value of the tokens depends on supply and demand. Blockchain-based start-ups offer users the opportunity to derive value directly from the success of their protocols. This could help overcome the network effects trap which makes it hard for a new platform to get the scale.

However, such contribution can require resources, which in due course, incentivises the users that already have such power to participate in this economy, as we have seen with cryptocurrencies. In the case of Bitcoin-based platforms, a mathematical puzzle must be solved for monetary reward. This work is energy-intensive, and users who already have these resources have a chance to earn a bitcoin. In the future, this kind of situation might lead to centralisation of 'power' in the hands of giant blockchain-based companies.

5.5.5 Overcoming security issues on blockchain

In terms of blockchain, overcoming security issues is one of the most important challenges. When there is an opportunity for financial gain, hackers will try to exploit the loopholes of the system. This is especially true of any bitcoin platform. To date, there are many examples of attempted and successful hacks of bitcoin platforms. For example, in 2004 one of the bitcoin exchanges collapsed. Most recently, another bitcoin exchange has been hacked. According to Iansiti and Lakhani (2017), these hacks revealed weaknesses not in the blockchain itself but in separate systems linked to parties using the blockchain. Irrespective of the area of use, a blockchain platform has a wealth of information that too can be converted into profit.

Blockchain technology provides the opportunity to digitise models of governance. As miners make another type of model, there have been some major public disputes between different sectors of society. Such disputes are a characteristic of blockchain technology and are centred around the question of "forking" the blockchain. It is a process that involves upgrading the blockchain protocol until most network users agree to it. (Davis 2017.)

5.6 LACK OF REGULATORY OVERSIGHT IN BLOCKCHAIN TECHNOLOGY

There is a lack of regulatory oversight regarding the blockchain technology, which becomes is a significant roadblock for mass adoption. Countries have not yet fully developed systems of taxation and regulation of blockchain technology. Therefore, art market participants must be cautious to engage with blockchain-based platforms and technologies, considering that private companies are still experimenting with this

technology. In the case of blockchain and other technologies, regulations struggle to keep up with advances in the field. One of the challenges is that organisations are utilizing blockchain technology for transactions. However, the blockchain market is still not appropriately regulated. Thus, when it comes to transactions, there is a lack of security. (De Meijer 2020.)

Nevertheless, blockchain could still fit into the existing regulatory structures. To overcome the challenges, the government needs to create policies for blockchain transactions. However, this means that regulators in all industries must understand the technology and its influence on the businesses and consumers in their area. (De Meijer 2020.)

6 CONCLUSIONS

In this part, the key findings of the thesis and suggestions for further research on this topic are identified and discussed.

6.1 KEY FINDINGS AND ANALYSIS

While some industries have already begun to introduce blockchain into their business, many are still exploring the best way to get started. Apart from a few examples, blockchain's revolutionary technology has the potential for a wide range of applications across a wide range of industries and industries. Blockchain was first launched as a technology for bitcoin exchanges, however, its practical use in the business world goes far beyond cryptocurrency transactions. In finance, for example, blockchain networks allow securities to be traded within minutes, not days. In the supply chain, they make it possible to track and log the flow of goods and payments in real time.

The uses and examples provided in this thesis illustrate how blockchain, although in its early stages, has entered the art market and museum and could be there to stay. The key findings and analysis based on the literature review are the following:

- Despite optimistic views, blockchain has not yet made as much progress in its development as many would expect, and its current state can be compared to the state of the Internet in 1993.
- Blockchain raises questions about trust in technology. It is not an alternative to trust. However, blockchain can help to eliminate dependencies in complex transactional workflows. Therefore, we may need to better understand in what areas blockchain can be advantageous in comparison with traditional systems. Having outlined the prospective applications of blockchain, we may need to solve blockchain-related technological and legislative issues before its wider adoption.
- Nevertheless, many believe that blockchain could reduce the cost of transactions in the art market. Blockchain can also provide an infrastructure that facilitates transactions in the art market. Currently, the focus is on the sale of high-quality objects such as paintings and sculptures. However, this is changing as blockchain can increase the speed, transparency, and volume of art sales worldwide and can democratise the sector so that artists, collectors, and spectators can benefit from its wealth. Whether art valuation, provenance, or digital collectables: blockchain can make the industry more sustainable. This sounds promising, however, blockchain does not have to be the solution to every use case in the art market.

- Art market value is likely to increase dramatically if blockchain is successfully adopted, creating new ancillary industries, such as in art-based lending, fractional ownership, managing intellectual property rights, etc.
- Blockchain encourages organisations and individuals to compete and collaborate to design a new digital future.
- Therefore, this technology would be a real game-changer in the art market. Recording and storing all transactions that take place on the network eliminates the need for trusted third parties such as banks, credit card companies and other intermediaries. Many art companies have already begun to use the system, such as Verisart, which certifies works of art and collectables with the Bitcoin blockchain. Whether it can succeed in the art world is another matter, as many leading figures in the art world have much to lose if such a scenario occurs.
- Moreover, digital ledgers could help not only in making transactions but also in the tracking of provenance and tax collection concerning art transactions.
- Blockchain can further democratise access to art and revaluate the role of art in society. It can broaden investment opportunities in work, labour, and compensation.
- One of the advantages of blockchain technology lies in its decentralisation. However, the economic interests involved in bringing this technology into the art market are extremely high. If central authorities, such as banks, social platforms, or companies try to have most “shares” in the technology, blockchain can lose its appeal of “decentralisation”. Therefore, if blockchain technology becomes more widespread, a likely scenario is that a single player or several large players will dominate the art market.
- Since blockchain is a decentralised technology, the governance mechanisms of blockchain are vital to ensure that it benefits the art market in the long run. These mechanisms can determine who has the power in changes to the code or solutions to problems or errors.
- The wider adoption of blockchain technology in the art market can help the artist to find a new niche or audience. However, this technology comes with risks especially if it becomes more centralised.
- While blockchain presents endless opportunities for shifts toward a more secure, accessible, and transparent art market, there are still plenty of challenges that need to be considered. Before implementing blockchain, we need to overcome technological, governance, organisational, and societal barriers.

- Despite its secure design, blockchain can still have vulnerabilities and exploits. Although distributed ledgers are based on modern cryptographic techniques such as secure hashing algorithms, these mechanisms have weaknesses that can be exploited, especially with the advances in computing power. Moreover, currently, there is also a lack of privacy as blockchain consumers share their sensitive information with the companies.
- Another issue at this stage is the lack of interoperability, meaning that most of the blockchain companies in the market cannot send or retrieve information from another blockchain.
- Moreover, the cost of transaction on a blockchain-based platform is relatively high and can slow the adoption of blockchain technology across industries and in the art market.
- Bitcoin can facilitate transactions in the art market if many issues, such as vulnerability, lack of interoperability, security and privacy, cost of the transaction, increasing centralisation, and lack of regulatory oversight, are resolved.

Therefore, substantial changes need to take place before blockchain is widely adopted. Nevertheless, it has already been implemented in various industries, and the landscape is changing as adoption increases. Blockchain players have been strong advocates of finding solutions to the above-mentioned issues, however, it seems that there is a long way ahead as far as wider blockchain is concerned.

Overall, blockchain technology helps us to think about questions of novelty, authenticity, and public participation in the art market. It has led to its use in many areas linked to the art world, such as the sale and distribution of art, art sales and art holdings. Blockchain has become a fixture in art because it can guarantee the authenticity of work and the right to pay. Thus, blockchain can help us to create a transparent platform that unites two parties without interference.

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