



**UNIVERSITY OF BELGRADE
FACULTY OF ECONOMICS**



MASTER THESIS

**INFORMATION TECHNOLOGIES IN
FASHION: DECENTRALISED
AUTONOMOUS ORGANISATIONS AND
BLOCKCHAIN**

Teodora Pudar (2832/21)

Mentor: PhD Đorđe Stakić

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**Mentor: PhD Đorđe Stakić
Thesis Defence Committee:
PhD Jasna Soldić Aleksić
PhD Aleksandra Zečević**

**BELGRADE
MARCH 2024**

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Student ID number: 2832/21

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Apstrakt

Ova teza istražuje transformacioni potencijal blokčejn-baziranih Decentralizovanih Autonomnih Organizacija (DAO) unutar modne industrije, sa ciljem da se adresiraju ključna tehnološka, etička i upravljačka razmatranja vezana za informacione tehnologije neophodne za njihovu efikasnu implementaciju. Razvijen je sveobuhvatan teorijski okvir koji vodi upravljanje i rukovođenje specifičnim modnim DAO-ima. Metodologija koja je bila primenjena u ovom istraživanju obuhvata integrativni pregled literature predstavljen od strane Torraco (2005), studije slučaja i razvoj teorijskog okvira. Zaključci do kojih je ovaj rad došao pokazuju da DAO-ovi imaju kapacitet da revolucionarno reformišu strukturu upravljanja, poboljšaju transparentnost i omogućće kolektivno donošenje odluka unutar modne industrije kroz upotrebu blokčejn tehnologija. Predloženi okvir uključuje optimalne izbore za tehnološke karakteristike kao što su dokaz uloga (Proof of Stake - PoS) za konsenzus, asimetrična enkripcija za sigurnost, i on-chain skladištenje podataka i arhitektura bez dozvola. Okvir takođe nudi preporuke za upravljanje kao što su hibridni decentralizovani model i mehanizam glasanja bez težinskog vrednovanja. Teza takođe identifikuje faktore specifične za modnu industriju koji se trebaju razmotriti, kao što su ekonomska održivost, preferencije potrošača, i ulogu tehnologije u optimizaciji dizajna, saradnji i zaštiti potrošača. Uprkos velikom potencijalu koji nudi, teza navodi nekoliko izazova, uključujući regulatorna pitanja, rizike vezane za bezbednost podataka, kulturni otpor i etička razmatranja koja moraju biti rešena za uspešnu integraciju DAO-a. Ovi izazovi takođe sugerišu pravce za buduća istraživanja. Ukupno, teza pruža kako akademsku osnovu tako i praktične smernice za napredak DAO-ova u modnoj industriji.

Ključne reči: Blokčejn, DAO-ovi, Moda

Abstract

This thesis explores the transformative potential of blockchain-based Decentralised Autonomous Organisations (DAOs) within the fashion industry, aiming to address key technological, ethical and governance considerations related to information technology and essential for their effective implementation. A comprehensive theoretical framework was developed to guide the governance and management of fashion-specific DAOs. The methodology employed for this research comprises of an integrative literature review as outlined by Torraco (2005), case studies, and theoretical framework development. The findings reveal that DAOs have the capacity to revolutionise governance structures, enhance transparency, and facilitate collaborative decision-making within the fashion industry through the use of blockchain technologies. The proposed framework incorporates optimal choices for technological features such as Proof of Stake (PoS) for consensus, asymmetric encryption for security, and on-chain data storage, and permissionless architecture. Furthermore, the framework offers governance recommendations like a hybrid decentralised model and an unweighted voting mechanism. The study also identifies fashion-specific considerations, such as economic viability, consumer preferences, and the role of technology in design optimisation, collaboration and consumer protection. Despite revealing promising prospects, the thesis outlines several challenges, including regulatory issues, data security risks, cultural resistance, and ethical considerations that must be addressed for successful DAO integration. These challenges also suggest directions for future research. Overall, the thesis provides both an academic foundation and practical guidelines for the advancement of DAOs in the fashion industry.

Key Words: Blockchain, DAOs, Fashion

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Introduction

This thesis aims to explore and analyse the potential of implementing blockchain-based Decentralised Autonomous Organisations (DAOs) within the fashion industry. In order to achieve this, it will look into the technological background of the blockchain that enables them, as well as examine the governmental and managerial structures of DAOs. Additionally, it will explore the utility of smart contracts that enable their functioning and the particular opportunities and challenges associated with their implementation in the fashion industry.

The fashion industry has always been at the forefront of technological adoption. Be it the implementation of information technologies in the supply chain or the use of Artificial Intelligence (AI) in providing personalised customer recommendations, it has always presented inclinations towards technological progression. This, coupled with the industry's pressing need to improve on its ethical and sustainable practices, renders fashion a particularly fertile ground for the transformative potential of DAOs.

Decentralised Autonomous Organisations are blockchain-based entities that are governed by smart contracts and member consensus. Unlike traditional organisations, they are characterised by their decentralised nature, as well as their utilisation of token-based voting mechanisms that provide a basis for a transparent and democratic framework. This, in turn, allows for transparent governance and collective decision-making.

The objective of this thesis is to develop a comprehensive theoretical framework that proposes the integration of Decentralised Autonomous Organisations (DAOs) within the fashion industry. Drawing upon a facet of considerations, from technological architectures to governance structures, management styles and industry-specific challenges, the study strives to provide a roadmap for DAO adoption. It also aims to contribute to the limited body of academic research on DAOs within the fashion industry.

The foundational hypothesis of this study is that Decentralised Autonomous Organisations (DAOs) possess the ability to transform key aspects of the fashion industry, most notably its governance structures, operational transparency, and collaborative decision-making mechanisms. Drawing upon the technical nuances of

blockchain technology as well as the unique organisational tenets that are at the core of DAOs, this thesis aims to illustrate the way in which these emerging technologies can be implemented into the fashion industry's existing systems, thus changing the very core of its principles.

The structure of this thesis is designed to offer a comprehensive examination of Decentralised Autonomous Organisations (DAOs) and their applicability within the fashion industry. Moreover, it is structured to strategically align with the critical research questions, acting as a systematically coherent exposition. This exposition consists of three main sections that are designed to guide the reader through a logical progression of thought. The first section focuses on blockchain technology and the very introduction of the concept of a DAO. It lays the foundation with the discussion of the core technologies underpinning blockchain and DAOs, focusing on crucial components such as smart contracts, governance mechanisms and managerial aspects. Each component will be scrutinised through the lens of the information technologies that serve as their foundation. Additionally, this section will look into the applications and broader implications of DAOs, as well as the challenges they face. The second section of the paper will focus on the fashion industry in the technological context. It will examine the history of technology adoption as well as the specific implications and challenges associated with the integration of DAOs in the industry. Finally, the third section will gather all of the insights obtained from previous sections in order to develop a theoretical framework especially tailored for the fashion industry. This section will also contain two subsections that will delve further into the governance and management models of the presented hypothetical fashion DAO. This architectural design allows for an in-depth and multi-layer analysis, one that will act as a comprehensive guide for DAO implementation in the industry.

Methodologically, this thesis employs a facet of approaches to rigorously analyse the applicability and challenges that are associated with the adoption of DAOs within the fashion industry. An integrative literature review, as delineated by Torraco (2005), will serve as a basis for this study. This approach aggregates a wide spectrum of existing academic research in order to lay foundational knowledge on both blockchain and DAO technology. It will also assist in identifying gaps and opportunities in the existing literature, especially concerning DAO application in the fashion industry. In addition to the literature review, multiple case study analyses will be conducted, aimed at offering an array of real-world examples that will help inform the later parts of the study.

Following this, and based on the foundational elements gathered from the literature review and case study analyses, a comprehensive theoretical framework for the fashion industry will be formulated. This framework addresses the key research questions and objectives of the thesis. This multi-layered methodology provides us with a robust and nuanced lens through which the transformative possibilities of DAOs in the fashion industry are analysed, intending to offer actionable insights and recommendations. However, there are still some limitations related to the methodology used in this paper, such as the limited nature of the existing works on the topic. This is because DAOs are still considered to be in their infancy, especially considering their application in creative fields such as the fashion industry. This would limit the body of academic literature and case studies on the topic at hand. Finally, while the theoretical framework developed aims to be comprehensive, it may not be able to take into account all of the nuances or fully represent all of the possibilities and challenges that would come with implementing DAOs within the fashion industry.

1 Blockchain and Decentralised Autonomous Organisations

The idea of Decentralised Autonomous Organisations (DAOs) can be traced back to the 1990s, though the term itself had not been popularised until much later with the emergence of blockchain technology. Historical contexts of this emergence can offer us vital insights into the underlying principles and the potential application of DAOs, illustrating how they have evolved to fit the needs of various sectors, such as fashion.

In the 1990s, DAOs and related concepts were discussed within the framework of multi-agent systems and the Internet of Things (IoT) (Dilger, 1997). These multi-agent systems consist of a multitude of software agents that interact with each other and have been designed to offer solutions to problems that are either difficult or impossible for a single agent to solve. This process corresponds with the contemporary understanding of DAOs, more specifically, its model of decentralised governance, in which multiple agents or, in this case, stakeholders interact in order to come to a joint decision. This will be discussed in greater detail in the upcoming chapters of this paper.

Adding to the discussion of the history of the term itself, at a certain point in time, it had been employed to signify “decentralised nonviolent actions within the counter-globalisation social movement” (Gilson, 2014). Put more simply, it referred to collective actions aimed against globalisation that were both decentralised and non-violent. This shows us that, although the term nowadays denotes the system facilitated by blockchain technology, its current understanding is vastly different to what it was not long ago, making it a priority for researchers to clearly and articulately describe the term in its contemporary understanding.

This contemporary understanding of DAOs is closely related to the emergence of Decentralised Autonomous Corporation (DAC), which have emerged in the aftermath of Bitcoin's introduction (Nakamoto, 2008). In a DAC, the organisational rules are software encoded and, as such, function without being managed by a human. They still aim to generate profit for the stakeholders, much like any traditional organisation, but unlike traditionally operated companies, DAOs work anonymously based on pre-defined business logic. Based on these points, Bitcoin could be considered the first decentralised autonomous corporation, as it operates with no central authority and its rules are software encoded.

DAOs could be seen as an extension of DACs. DAOs could be described as digital communities operating on shared goals and lacking in formal managerial hierarchy, centralised control, or intervention by third parties (Santana & Albareda, 2022). Their goals are often broader than the ones of DACs and span beyond profit maximisation for stakeholders, at times including not-for-profit activities as well. Like DAC, DAO organisational models operate on blockchain technology. They are open-source and global, and their financial transactions, as well as the organisational rules, are blockchain-encoded, thus making them transparent and immutable (Liu et al., 2021).

Going further into the characteristics of DAO, Wang et al. (2019) have distilled the core of one such entity into the following key characteristics: distributed and decentralised, autonomous and automated, and organised and orderly. These will be analysed and discussed in great detail in section “1.2 Structure and Functioning of DAOs” of this paper. To be able to do this, blockchain technology will be looked at first in order to aid our understanding of the functioning of the basis of a DAO.

1.1 Blockchain Technology

The World Bank (2018) has defined blockchain as: “a novel and fast-evolving approach to recording and sharing data across multiple data stores or ledgers, with technology that allows for transactions and data to be recorded, shared and synchronised across a distributed network or a different network of participants”. To further our understanding of blockchain technology, a further look into each of the points of the definition provided by the World Bank should be looked into. “A novel and fast-evolving approach” relates to the fact that blockchain technology is relatively new, as well as being one of the fastest developing and constantly evolving technologies of the present time. “Recording and sharing data” pertains that, at its basis, blockchain records information, allowing it to track, store and send data that should be immutable. This data is shared across “multiple data stores or ledgers”, which means that unlike in traditional centralised databases, blockchain data is distributed across nodes (locations). This makes it decentralised, as each node contains a copy of the ledger. Furthermore, blockchain allowing for transactions and data to be “recorded, shared, and synchronised” means that, in addition to storing data, it enables it to be shared and synchronised across the whole network, thus enabling everyone on the network to have access to the up to date information. The “distributed network of different network participants” corresponds to the network of nodes, or different participants, that own a copy of the blockchain.

The way blockchain technology manages to record and transfer information is by containing multiple integrated components all working together and allowing for the creation of a unique and secure system. According to Wang et al. (2019), blockchain integrates data storage distribution, timestamps, asymmetric encryption and consensus algorithms while having the characteristics of decentralisation, immutability as well as audibility, thus achieving information transmission and safe and effective value transfer. Here, Wang et al. add key points and features to the previously looked into World Bank definition. The timestamp feature denotes that every transaction conducted on the blockchain is time-stamped, and as such, every transaction is chronological. This allows for transaction verification as well as aiding in data integrity. Secondly, the consensus algorithm is the method by which the network will agree on the transaction's validity. These can differ across different blockchains that use different algorithms, the three main ones being Byzantine Fault Tolerance (BFT),

Proof of Work (PoW) and Proof of Stake (PoS) (Mingxiao et al., 2017). BFT works based on distributed computing that allows for a network to come to a consensus even at times when some of the nodes (or participants) fail to communicate or choose to do so dishonestly. At its core, it allows for multiple parties to agree on a single version of the truth. PoW is the original consensus algorithm that was used by Bitcoin. Here, the transactions are validated by having nodes, which are called “miners”, solve complex mathematical problems, with the first one solving it being rewarded some cryptocurrency. Finally, PoS is seen as a lower-consumption alternative to PoW. Here, the “miner” is chosen based on the number of coins they have, or in other words, their “stake”. The reasoning behind this system is the higher the stake, the more incentive there is for maintaining a trust-worthy system.

When it comes to asymmetric encryption, blockchain operates by the use of two keys, one private and one public. These are mathematically linked algorithms that allow for secure transactions. The public key is one used to encrypt the data and is visible and accessible to the public. In contrast, the private key is held by a person and is used to decrypt it, ensuring the security of the transactions conducted on the blockchain. Finally, the three characteristics listed by Wang et al. (2019) relate to 1) Blockchain being governed by a network of nodes without a single one being in control of the blockchain, denoting its decentralised nature; 2) the unchangeable nature of the data on the blockchain, otherwise noted as immutability; 3) Ease of tracking and auditing the data due to each transaction being recorded on the blockchain or audibility.

Due to the above-mentioned characteristics, blockchain technology is proving to be particularly useful in areas where a 'trust' problem exists within a transaction system (Tan et al., 2023). Within a traditional system, this trust is established through centralised authorities such as government agencies and banks. However, these come with certain issues, such as cost, speed and vulnerability to corruption or fraud. Blockchain offers a way to mitigate these by obviating the need for intermediaries.

In addition to differentiating between blockchains based on the consensus algorithms they use, we can also divide blockchains based on whether or not the network is open for everyone to participate. As such, there exists a permissionless or public and permissioned or private blockchain, all leveraged in order to maintain network integrity (Mingxiao et al., 2017). Permissionless blockchain allows for a participant to take part in the submission and confirmation of the transaction. In contrast, in the permissioned

blockchain, participation is not permitted without an invitation or permission to join (Solat, 2020). While the first type was introduced with the release of the Bitcoin white paper in 2008, the second gained popularity with the advent of enterprise-focused blockchain solutions. Both of these serve different needs and have found applications based on specific requirements.

This chapter has provided an examination of blockchain technology, the foundational architecture enabling the functioning of Decentralised Autonomous Organisations. It has looked into the core features of blockchain, such as its decentralisation, immutability, and transparency, all of which make it an optimal platform for creating self-governing, decentralised entities. It has also directed different types of blockchain and different consensus algorithms employed that allow for its operation. The following chapter will build upon this discussion to specifically focus on the structure and functioning of DAOs.

1.2 Structure and Functioning of DAOs

Qin et al. (2023) suggest that in order to understand DAOs, we must not look at them just as decentralised autonomous organisations but also as decentralised autonomous operations. They have identified three basic principles, these corresponding to the acronym DAO and being the following:

1. Distributed and Decentralised (D);
2. Autonomous and Automated (A);
3. Organisational and Operational (O).

The first principle, (D), highlights the core feature of a DAO: its distributed and decentralised nature. Like with blockchain, contrary to the centralised systems where all the power is in possession of a single entity, in a DAO, the power and control are shared across a network of participants. This is enabled by the use of smart contracts on a blockchain that allows this by automating transactions as well as governance without the need for intermediaries. More on this feature in the following subsection of this chapter on smart contracts. Secondly, the (A) feature highlights the self-governing nature of a DAO. The code which allows for the use of smart contracts automates the operations as well as allows for the governance to be led by the network of participants, which, in this case, play the role of stakeholders. This means that the value creation process within a DAO is democratised, as everyone can participate in decision-making. The governing principles will be further explored in the “DAO Governance” subsection. The final principle (O) expands the scope of DAOs beyond merely its organisational structures to include the ways of operating. This essentially highlights the changed nature of management within a DAO as the traditional modes of operating have been redefined. More on this is the subchapter “DAO Management”.

DAOs manifest themselves in two distinct forms of decentralised governance: algorithmic DAOs and participatory DAOs (Wright, 2021). Algorithmic DAOs are centred around the software. They facilitate social interactions much like decentralised blockchain-based protocols such as Bitcoin and Ethereum. In essence, they rely on automated smart contracts to allow for the decision-making process. As such, it allows for greater efficiency and predictability, as all of the actions conducted are based on predefined conditions within the smart contracts. On the other hand, participatory DAOs offer a potential for managing open-source technology through the

implementation of smart contracts, which will be explored in greater detail in the following section. Additionally, participatory DAOs offer solutions to some of the problems associated with fully automated smart contracts. They are more adaptable in the ever-changing circumstances, as well as being more flexible. These DAOs allow original developers to delegate ongoing decision-making to a community of users. These users then have the power to create the necessary parameters for the basis of the smart contract, as well as make updates to the contract itself (Wright, 2021). On the downside, the participatory model tends to be slower in decision-making and execution. This can be attributed to the inherent need for human participants to come to a consensus regarding the decisions within the DAO. Due to these factors, hybrid models have emerged as a way to avoid the inherent downfalls of both models, instead combining the efficacy of algorithmic models with the nuanced capabilities of decision-making of the participatory model.

Regarding technological features of DAOs, Santana & Albareda (2022) have identified key ones that make a DAO secure, transparent and reliable. These include reliability on machine consensus algorithms to validate transactions and make decisions. These have been discussed in the previous chapter in terms of blockchain technology and are similarly being utilised by DAOs for the needs of validating transactions or other data. Once again, these include Byzantine Fault Tolerance (BFT), Proof of Work (PoW) and Proof of Stake (PoS). In addition to consensus mechanisms, Santana & Albareda have identified a need for asymmetric encryption for security. Again, this comes back to the previously discussed blockchain technology encryption, a form of cryptography that uses two keys, private and public, to decrypt a message or conduct a transaction. Finally, they identify a third requirement, which is transparency and accountability, that is achieved through the use of smart contracts. While this blockchain-based technological layer forms the basis of a DAO, additional tools and algorithms are still necessary for its operational needs. Additionally, there are a number of emerging technologies supporting DAOs, such as Digital Twin, a technology referring to a digital replica of physical systems that provides a counterpart to physical objects; Metaverse, a virtual collective space created as a convergence of virtual and physical environment and interactive digital spaces; and Web3, a new internet paradigm integrating AI, blockchain technology and data analytics.

Cai et al. (2022) have also brought to the attention the question of where the data ought to be stored in the context of blockchain technology, namely between on-chain

or off-chain. On-chain storage of data would entail the data being stored directly on the blockchain, thus making it transparent and highly secure, but also making it more expensive and slower than the off-chain option, as the storage of most blockchains has a limited capacity. On the other hand, off-chain storage means that the data is stored outside the blockchain, which is often a traditional database. This is significantly cheaper and generally faster but comes with the issue of transparency and security, which is why on-chain tends to be the preferred option.

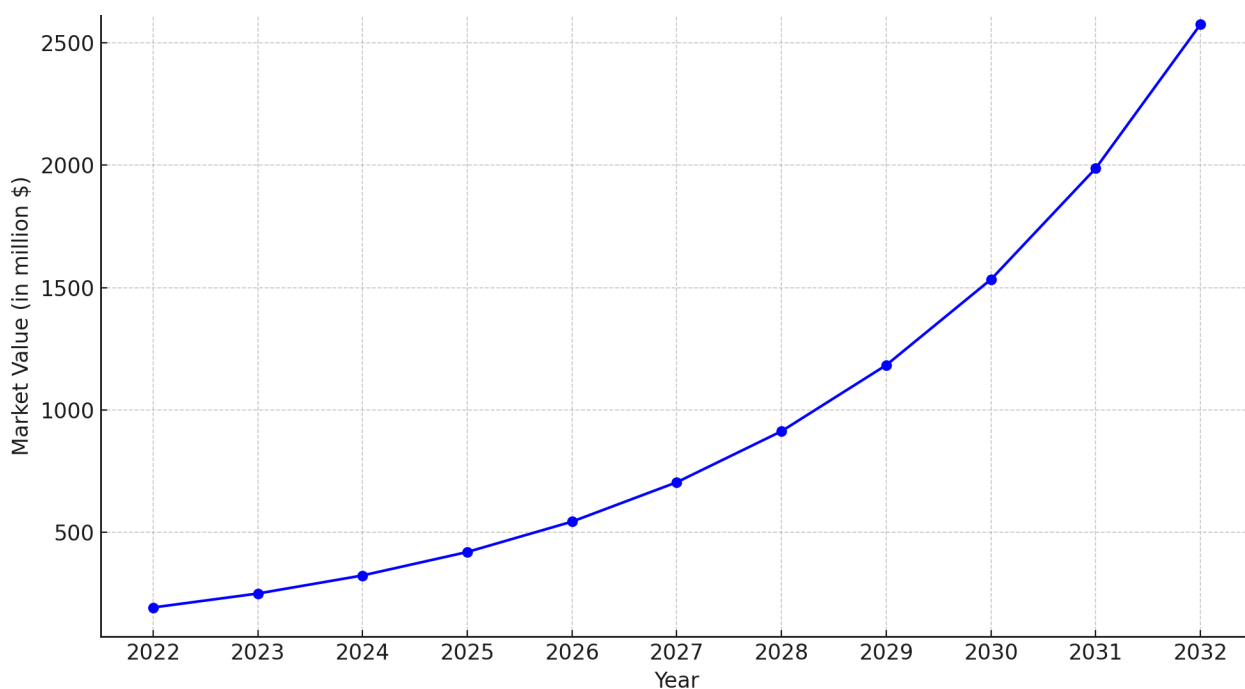
DAOs function based on three components: Smart Contracts, Governance Tokens, and Proposals and Voting (Santana & Albareda, 2022). While mentioned briefly in previous chapters of this paper, they will now be looked at in more detail in subchapters “Smart Contracts”; “DAO Governance”; and “DAO Management”, respectively.

1.2.1 Smart Contracts

Smart Contracts facilitate the requirement for organisation and order within a Decentralised Autonomous Organisation. They handle the rules, coordination, and execution layers of DAOs (Qin et al., 2023). The organisation and order is facilitated by having the rules, rewards, authorities and penalties transparent and available for access to all of the participating parties. This transparency is the essential feature that marks a departure from the traditional organisational models, thus reducing the management time, administrative overhead, and additional costs associated with such rule enforcement. More on the management benefits of DAOs in the “DAO Management” subchapter.

The smart contracts market has demonstrated remarkable growth and is projected to expand significantly in the coming decade. In 2022, the market has been valued at approximately \$192.7 million and is forecasted to reach around \$2.5 billion by 2032, showing a compound annual growth rate (CAGR) of 29.6% from 2023 to 2032 (Allied Market Research, 2023). The below line graph (Graph 1.) illustrates the projected market growth of smart contracts from 2022 to 2032.

Graph 1: Projected Market Growth of Smart Contracts (2022-2032)



Note. Author's own creation, based on projections from Allied Market Research, 2023. Smart Contracts Market Size, Share & Analysis 2032. Retrieved from www.alliedmarketresearch.com

This growth can be attributed to the rising adoption of blockchain technology and its applications across various sectors. The Decentralized Autonomous Organizations (DAOs) segment particularly dominated the market in 2022, accounting for a 37.0% revenue share. This dominance is due to DAOs' ability to distribute ownership and decision-making authority across a network, enhancing security and resistance to censorship (Grand View Research, 2023). The market is also seeing a notable rise in adoption by large enterprises, which accounted for 67.0% of the revenue in 2022. However, the small & medium enterprise segment is poised for considerable growth, thanks to the cost-effectiveness and efficiency improvements offered by smart contracts (Grand View Research, 2023).

Back to the smart contracts themselves, they can be seen as the building blocks of DAOs, allowing them to operate without human interactions (Singh et al., 2019). Essentially, they are seen as self-managing, handling all of the vital processes, including investment voting, as well as streamlining a number of processes, thus reducing the errors associated with manual work and saving time (Cai et al., 2022). Additionally, they benefit from their global nature, mitigating the need for country-specific intermediaries.

When it comes to DAO's mission, it is typically achieved through a “bottom-up” approach. As noted previously, it does not rely on centralised management to make decisions, rather relying on cooperation between individual nodes in the network. These nodes, representing members or participants of the DAO, interact, coordinate and cooperate with each other in order to come to a mutual decision. Smart contracts facilitate this by residing on the blockchain and governing a transparent voting system (Singh et al., 2019). They are essentially representing a self-executing digital agreement coded on a blockchain that allows for a DAO to function anonymously by executing actions automatically and based on predefined logic (Wang et al., 2019). This means that the underlying technology provides for a dependable and secure environment, as well as keeping an accurate record of all of its members and their actions, fulfilling the need for transparency and presenting a significant advantage of higher trust among stakeholders (Cai et al., 2022).

Smart contracts also play a vital role in allocating governance power through the use of tokens (Chod et al., 2022). This allocation does not differ much from how the governance (or control) is determined in more traditional types of organisations that

operate mainly on share prices. Whereas in traditional companies, the share prices give stakeholders a proportionate say in the decisions a company makes, in a DAO, this voting power is given through the use of tokens. Regardless, the goal is the same: a transparent and pre-determined distribution of authority and governance.

Ethereum is a blockchain platform that is specifically built to enable the running of smart contracts. Smart contracts reside in contract accounts, which are entities with four main characteristics, these being:

- 1) A “counter nonce” which makes sure that each transaction is processed only once, thus maintaining the integrity of transactions;
- 2) The “current ether balance” showing the amount of Ethereum’s cryptocurrency that the account holds at the moment;
- 3) “Contract code” pertaining to a smart contract code that could be linked to the account and that would be automatically executed given that certain conditions are met; and finally
- 4) The “storage state” which refers to the data stored within the account (Nisanth et al., 2022). These four attributes provide information on the transactions, balances and contracts associated with the smart contract.

Ethereum accounts can also be divided into external accounts and contract accounts. Private keys control external accounts and do not contain any code, while contract accounts are governed by contract code. Additionally, while the former is linked to an individual and generally represents someone’s personal account, the latter essentially governs how the account behaves, conducting automated actions such as fund transfers and token issuing. Essentially, external accounts are used by users to receive and send cryptocurrency, while contract accounts automate various tasks and actions on the blockchain, holding and executing smart contract code.

A “transaction” in Ethereum is considered a digitally signed data package that performs certain actions on the blockchain. In basic terms, it can be seen as a form of a command that is sent between accounts, ranging from a simple transfer to more complex smart contract interactions. The data package contains several elements: receiver of the message, digital signature from a sender, the amount of cryptocurrency that is to be transferred, optional data field, Startgas value (showing

the upper limit of computational steps necessary for the transaction to be executed); and Gasprice value (specifying the fee paid by the sender per computational step) (Wood, 2022).

With long-standing platforms such as Ethereum, DAOs have found use in a number of domains, including finance, social networks, and entertainment (Qin et al., 2023). Regarding the applicability of smart contracts in the industry, it primarily comes down to domain-specific requirements (Cai et al., 2022). This means that the efficacy of smart contracts is determined by how well they fit within the given industry, as it will not be appropriate for every solution. For instance, an industry based on a supply chain might benefit more from having higher transparency and real-time tracking than an industry more concerned with data privacy, such as a healthcare one. This makes research and understanding of the industry vital for effectively tailoring smart contracts suiting the industry's needs.

Despite the positive actions associated with them, smart contracts are still flawed. While they are able to automate tasks and enforce rules on the blockchain, smart contracts are not inherently intelligent algorithms. They lack the ability to learn and reason or otherwise make any decisions that they were not programmed to do in the first place. This is the reason for the emphasis on incorporating machine learning and AI, as these could be used to enhance the decision-making capabilities of smart contracts. This has been greatly supported by recent research in the field focused on finding a solution for increasing the flexibility of smart contracts in more complex situations. With technological advances, this interplay of smart contracts, machine learning and AI will be crucial in advancements in DAOs. Additionally, Sims (2019) has noted that smart contracts often contain errors and might not be able to anticipate all contingencies. This essentially means that in case the code is poorly written and thus unable to anticipate every possible scenario, the smart contract will act in unintended ways. Due to the immutable nature of smart contracts, this code cannot be altered easily, and it is, therefore, essential for the code to be thoroughly reviewed and tested prior to its deployment on the blockchain. Another issue we associate with the use of smart contracts is the high energy consumption needed for the execution of these contracts. To combat this, Ethereum has switched from a proof-of-work to a proof-of-stake consensus mechanism in September 2022, which has been estimated to reduce global energy consumption by 0.2% (Rennie & Holcombe-James, 2022).

1.2.2 DAO Governance

The research by Wang et al. in 2019 suggests that Decentralised Autonomous Organisations (DAOs) offer a revolutionary way of managing and governing organisations. At their basis, they operate entirely on the confines of a blockchain platform, a previously described decentralised network. Wang et al. (2019) have also noted that governance within Decentralised Autonomous Organisations (DAOs) often starts in a centralised manner, led by an initial project team that defines the rules and structures of the organisation. As the DAO evolves, the governance structure moves toward an increasingly decentralised model. This chapter will further explore this decentralised governance within a DAO.

According to Santana and Albareda (2022), Decentralised Autonomous Organisations are designed to enable autonomous peer-to-peer work through a dual system of governance, one that includes on-chain machine consensus and off-chain voting rights. On-chain machine consensus refers to decision-making processes that are automated and, as such, programmed directly on the blockchain and do not require human intervention. Off-chain voting rights refer to decision-making processes that are part of a DAO governance structure but are not conducted on the blockchain. This could include community discussions, votes or other participatory decision-making that is not automated and/or should not be automated due to the complex nature or ethical consideration. By employing these two types of governance methods, DAOs are able to balance the efficiency and security that are associated with machine-based decision-making with the flexible nature of human input.

When it comes to the power dynamic within a DAO, Santana & Albareda (2022) have noted a significant departure from the traditional power dynamics that are found in more traditional organisations is mainly due to the elimination of hierarchical structures. As such, the authority and responsibility get distributed among a number of stakeholders, allowing for a higher level of democracy as the level of influence is proportional to the investment, be it in the investment of time, expertise or funds. Additionally, this distribution of power allows for better decision-making as well as accountability for the decisions made. The individual stakeholder's incentives are more transparently aligned with the collective goal, seeing as every stakeholder holds a stake in the collective decisions made by the DAO.

In addition to the greater distribution of power between individuals in a DAO, individual stakeholders are also empowered to take full ownership of their actions and, as such, improve their decision-making skills. This is due to the fact that each stakeholder is individually fully invested in the outcome of the decision of the group since every member holds a stake in the organisation and all of the decisions it makes. This leads to higher accountability, which ultimately benefits the whole DAO.

Another notable feature of a DAO is anonymity. As noted by Laturus (2023), anonymity is one of the key differentiating elements of a DAO, seeing as the participants are not required to disclose their identity and are, as such, entitled to their privacy and free from any governmental interventions. This ensures a layer of protection that is not present in traditional settings and allows for a greater level of freedom within the decision-making process.

In the context of Decentralized Autonomous Organizations (DAO) governance, Qin et al. (2023) have identified two types: Group Governance and Social Governance. Group Governance can further be divided into two subtypes, these being fully decentralised and progressively decentralised. A fully decentralised model ensures all of the members have an equal say in all of the decisions made by the organisation, making it an ideal, fully democratic DAO. On the other hand, a progressively decentralised model looks more like an evolution of DAOs, as identified by Wang et al. (2019) and described in the beginning of this chapter. Once over, this model describes the opening up to greater community involvement from a more traditional central authority. When it comes to Social Governance, it more so comes down to aligning the goals of individual stakeholders with the collective goals within a DAO and among multiple DAOs (Qin et al., 2023). Laturus (2023) argues that there is still an ongoing issue of which type of ownership discussed would be optimal for a DAO. According to some classical economic theories, such as the one posed by Jensen and Mecklin in 1976, having more centralised ownership would be of benefit for monitoring and effective decision-making. However, it could be argued that, due to the unique nature of DAOs, this argument would be less applicable. This debate on the optimal type of governance is still ongoing, and the research on the topic is growing to include the more progressive modes of governance as well.

Continuing the debate of an appropriate governance model, there is an issue of “governance paradox”. This concept was introduced by Tan, Mahula, and Cromptvoets

(2022) and points to the inherent contradictions that exist in blockchain governance. It posits that while blockchain systems are lauded for their decentralised nature that allows for a high level of transparency and trust, this decentralisation also leads to a number of governance issues, such as disputes and inefficient coordination among the involved parties. The paradox, therefore, lies in the fact that solving these governance issues associated with the DAO's decentralised nature would make the qualities it possesses less valuable and unique. The more one tries to fix the governance issues within a DAO, the more the same DAO comes closer to a traditional, centralised system, thus losing all of the advantages it had over that same system. It would mean that solving one problem would lead to the creation of more problems.

To combat these dilemmas, there is a potential for introducing novel governance models, such as “futarchy”, introduced by Singh & Kim (2019). This model emphasises the transformative potential DAOs hold in a number of areas, not just in business models but also in government ones. Futarchy proposes a decision-making process that operates through prediction markets, wherein participants would make bets on the expected outcomes of various decisions. The underlying idea is that the market would be the most accurate in predicting the best possible decision, thus being able to guide governance. This model illustrates the transformative potential DAOs possess. They are not only able to disrupt traditional centralised business models but also change the very basis on which decisions are made, potentially changing the modes of governance around us and affecting society as a whole.

As of now, this potential is still limited due to the legal bounds that we operate in. Currently, DAOs conflict with the existing corporate and securities laws. This is due to the inherently decentralised nature of DAOs, which does not neatly fit into the existing legal frameworks that have been designed for more traditional modes of operation. One example of this would be a problem with company registration. Seeing as a DAO does not have a director, it would be impossible to register it as a company under the current system. They also pose additional legal complications of an organisational nature, such as token transferability. While some guidelines and laws exist for unincorporated organisations, they are still not an appropriate match for the unique nature of DAOs. As such, there are a number of different legal wrappers that can be associated with different types of DAOs, and they are creating a risk of a mismatch between the DAO and traditional legal frameworks (Weinstein et al. 2022). To operate

within and collaborate with the existing system, DAO would need to be awarded a form of legal status, which is currently seen as a challenge of high complexity. There is also an issue of potential misuse of power and outcome manipulation, and to mitigate these, some DAOs have implemented membership restrictions along with other restricting mechanisms. However, as the technology advances and DAOs implement more and more of the upcoming technology, such as AI, in their governing processes, further challenges in this sphere are likely to arise, further complicating the legal status of DAOs.

1.2.3 DAO Management

An ideal DAO is managed by the principle of “code is law”. This essentially maintains that smart contracts guide the management of a DAO through automated rule enforcement, mitigating the need for a central authority or subjective interpretation of rules. Fundamentally, this means that the organisational structure has transformed from pyramidal to distributed, and the power is no longer with the individual but with the network of individuals within a DAO. It also implies that the management style has evolved from bureaucratic management procedures to a more community-driven autonomy enabled by the blockchain (Wang et al., 2019).

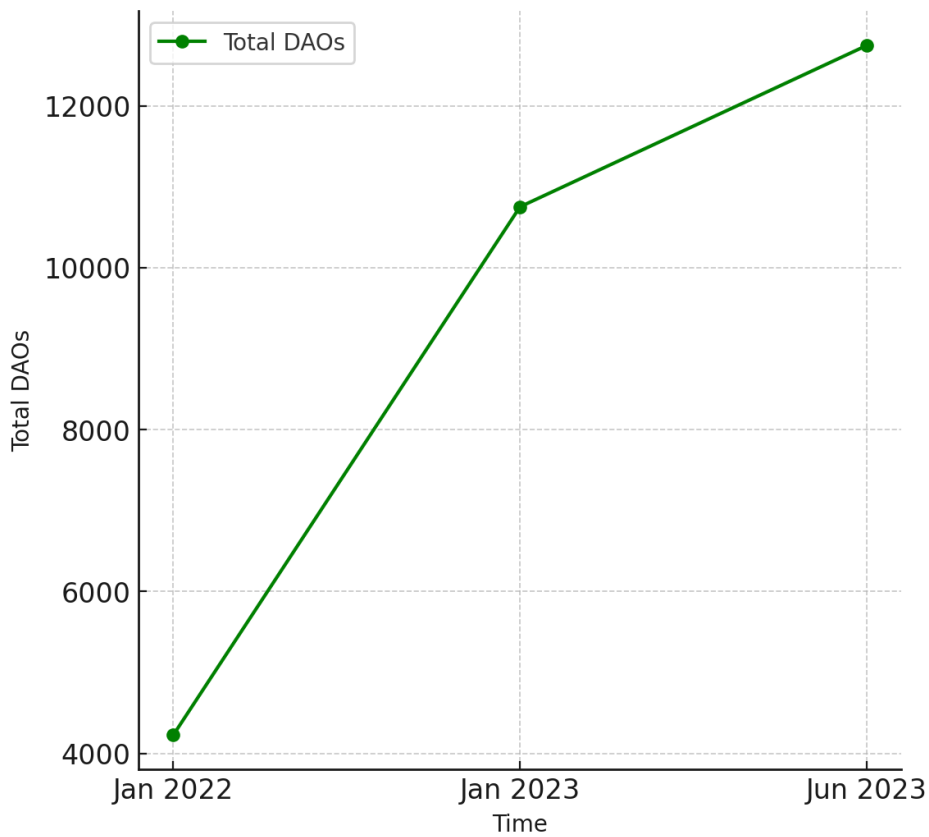
The principle described has brought about several shifts in how an organisation is managed. As mentioned above, traditional organisational structures have a pyramidal management style, meaning that only a small number of individuals are on the top, making all of the decisions concerning the downward operations. As we know by now, this is one of the significant departures from DAOs, as DAOs boast a highly distributed structure. Unlike in traditional organisations, decisions here are made by a network of individuals with proportional powers. Additionally, the principle of “code is law” marks a change in the power dynamics of an organisation, as the power is shifted from a centralised source to a stated decentralised network. Finally, it has allowed for an evolution in management practices, seeing as these are community-driven within a DAO and led through voting mechanisms often based on reward systems.

When it comes to voting mechanisms, many DAOs employ secure digital voting as a key feature of decision-making. As we have already established, this is conducted through the use of blockchain technology to record the evidence of voting. At the same time, the votes themselves are weighed based on previously determined factors. These might include the amount of capital an individual has contributed to the particular DAO, the balance of their ownership or, in other words, the amount of cryptocurrency they hold in their wallets at the time of voting, or even the specific type of tokens that they possess (Wright, 2021).

Decentralized Autonomous Organizations (DAOs) have experienced remarkable growth in recent years, with increases in treasury values, market capitalization, and participant engagement, as illustrated in the graphs provided below. As of March 31,

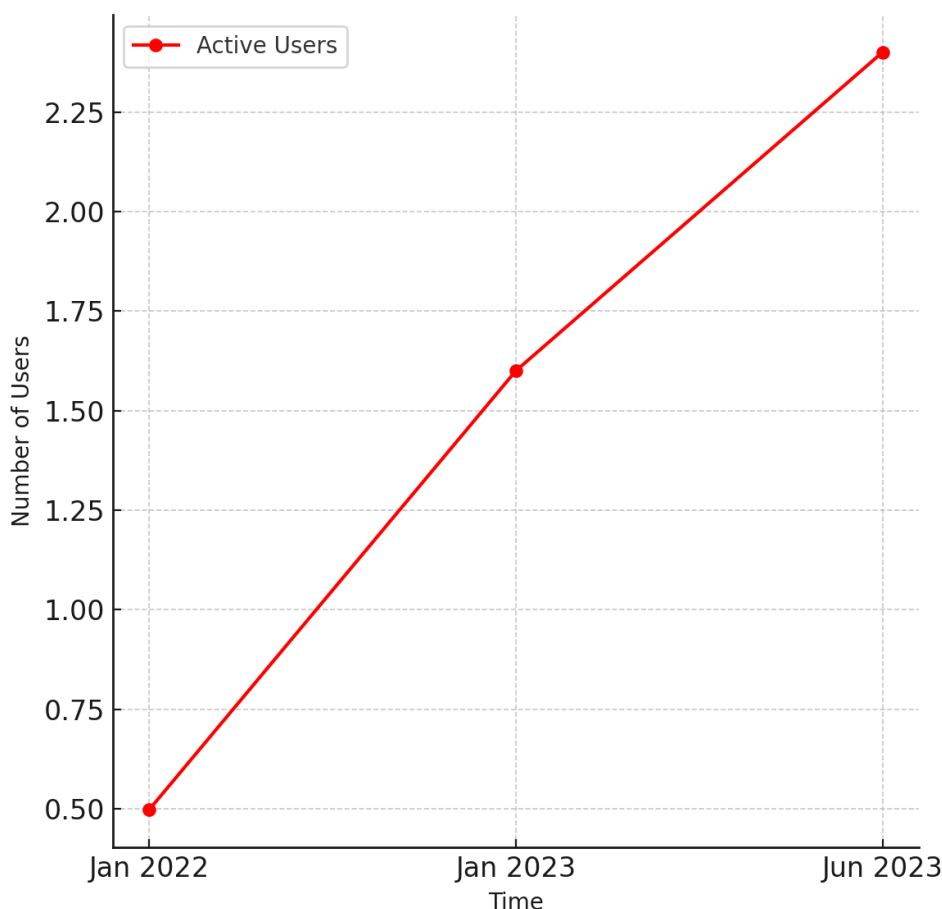
2023, DAOs' total assets had surged to a record high of \$25.1 billion, a notable escalation from the start of the year. The data from January 2022 shows the total market capitalization of DAOs at approximately \$21 billion, spread across 4,227 DAOs. However, by January 2023, this figure had declined to around \$8.8 billion, despite the number of DAOs increasing to 10,752, as clearly depicted in the first graph (Graph 2.).

Graph 2: Growth of Total Decentralised Autonomous Organisations (DAOs) from January 2022 to June 2023



Note. Author's own creation, based on data adapted from Naudts, E., 2023. The future of DAOs in finance - in need of legal status. ECB Occasional Paper No. 2023/331. SSRN. <https://doi.org/10.2139/ssrn.4605627>

Graph 3: Increase in Active Users from January 2022 to June 2023



Note. Author's own creation, based on data adapted from Naudts, E., 2023. The future of DAOs in finance - in need of legal status. ECB Occasional Paper No. 2023/331. SSRN. <https://doi.org/10.2139/ssrn.4605627>

The second graph (Graph 3.) demonstrates the substantial growth in the number of DAO token holders, which expanded from 1.7 million in early 2021 to 5.1 million by the end of 2022. Concurrently, the number of active participants—those involved in voting and making proposals—rose from a mere 13,000 to an impressive 1.6 million during the same timeframe. By June 13, 2023, the landscape of DAOs further evolved to encompass 12,745 DAOs with a total treasury of \$18.5 billion. Additionally, the number of token holders had grown to 6.8 million, with active voters and proposal makers reaching 2.4 million, as shown in the second graph (Naudts, 2023). These tokens can also be seen as serving purposes other than a mere medium of transactions. They can also be a valuable asset in reducing inequality between capital and labour (Sims, 2019). When payments within a DAO are made in tokens, the parties (or, in this case, labour) who contributed to this DAO are not compensated a wage for their part in a transaction, but rather, they receive a stake in the organisation

itself. As the amount of tokens they hold increases, so does their decision-making power within a DAO, which in turn helps reduce the gap between capital and labour that is ever so prevalent in traditional organisations. By aligning stake ownership with managerial power, DAOs help to tie the interest of all of the involved parties, and it is this transformative shift that can potentially lessen the inherent organisational inequality, as noted by Sims in 2019.

DAOs inherently streamline operational processes (Wang et al., 2019). This means that the costs related to trust, communication and transactions are minimised, and the DAOs are able to function smoothly by achieving a high level of trust and reducing the high amount of friction that is associated with more traditional organisational systems. To further understand this, we might look into the concept of the “Parallel Management Framework” that was introduced by Wang et al. (2023) and which has aimed to integrate technologies such as AI and social computing to add more layers to traditional managerial practices. This concept can be supplemented with the “Three Worlds” idea introduced in Wang et al. paper in 2023. This paper postulates the idea of three worlds, the physical world, the psychological world, and the artificial world, all essential for comprehension of knowledge work. These three worlds then come together in something essentially akin to a loop, providing a feedback-driven output of something called “Circular Causality”. Finally, the physical and cyber spaces then come together in what they labelled “Parallel Spaces”, which would include digital counterparts such as robots and digital humans, which would, in turn, enhance the management process (Wang et al., 2023).

However, there are still issues concerning DAOs in a managerial context, more specifically, the problem of DAOs becoming too deterministic and, as such, limiting their applicability (Tan et al., 2022). The term deterministic in this context relates to the idea that DAOs operate based on pre-determined principles, and so every action made by a Dao is already pre-made. This leads to issues of flexibility and potential stifling of innovation as the DAO finds it difficult to adapt to changing information quickly. Another potential issue is the possibility of a deterministic DAO inadvertently breaking some ethical standards or laws due to a lack of human guidance. Considering the benefits and the above-mentioned limitations, it is of great importance for the designers of DAOs to consider them and find an approach that is best suited for the purpose of the DAO.

1.3 Applications and Implications of DAOs

In 2016, the first DAO was launched, appropriately named “The DAO”. It was built on the Ethereum blockchain and aimed to function as an investor-directed venture capital fund. In a very short period of time, it was able to raise Ether worth approximately 150 million dollars, marking it the largest crowdfunding project at a time.

The immediate success of The DAO can be attributable to the benefits the organisational structure offers over more traditional, centralised structures. Whereas traditional organisations struggle with scalability, agility and stakeholder alignment, DAOs excel at them. An economist, Douglass North, has highlighted the potential of DAOs to eliminate the transaction costs associated with limited economic growth. DAOs are also associated with cost efficiency in terms of cutting the communication, management, and collaboration costs (Wang et al., 2019), in addition to reducing the cost of enforcing the rules that often pertain to legal proceedings (Sims, 2019). This emphasises the potential DAOs possess in fostering more transparent and efficient economic activities, which could, in turn, lead to economic growth. Additionally, economic systems are generally understood in terms of the win-lose game theory principle, one that sees the parties compete with each other rather than cooperate. This principle is usually represented by a non-cooperative Nash equilibrium. DAO, however, disrupts this paradigm by having incentives for all of the parties involved to cooperate. Moreover, as discussed in previous chapters, DAOs propose a radically different approach and thus offer a comprehensive range of solutions to the enduring issues faced by traditional organisations. This is why they have found applications in various fields, examples of which will now be discussed.

ConstitutionDAO and PleasrDAO are two examples of DAOs being able to combine individual contributions to exert a collective buying power. ConstitutionDAO was an initiative with the purpose of buying a copy of the United States Constitution at a Sotheby's auction and then making it publicly available. The participants came together in a DAO and essentially organised a crowdfunding campaign, one that was to eventually see them become co-owners of the copy of the Constitution. Their bid was ultimately not the winning one, but the initiative demonstrated the power and possibilities DAOs offer. Another example is PleasrDAO, which has gained attraction by purchasing many digital art and assets. PleasrDAO acts as a collective fund in

which the participants pool together their tokens and vote on which assets to purchase, demonstrating the ability of a DAO to democratise the art world.

DAOs have also found an intersection with metaverse and Cyber-Physical Social Systems (CPSS), making for intriguing possibilities (Wang et al., 2023). In this sense, DAOs could act as a bridge, bringing both real-world and virtual worlds together. In a metaverse, much like in an ideal DAO, all of the rules are encoded within the blockchain and are thus fully automated. The potential benefits DAO could offer here are vast, ranging from governing virtual lands to even entire economies of the metaverse. This could enable a fully democratised and decentralised, community-driven virtual world. Cyber-Physical Social Systems (CPSS), on the other hand, represent systems that include both computational elements as well as social ones. This means they consist of both servers and sensors, along with human elements and organisations. DAOs have the potential to act as a governing layer of these systems, providing a decentralised decision-making process that would be a better fit for the diverse stakeholders involved.

DAOs have also found applications in rent-sharing services. One example of this is Slock.it, a pay-as-a-service DAO. This idea fundamentally changes the traditional modes of rent sharing by decentralising the whole process, as it would essentially remove the middleman from all of the transactions and put blockchain governance in its place. Much like this example, the sphere of crowdfunding and Initial Coin Offerings has been drastically altered with the advent of DAOs. Whereas traditional crowdfunding consists of centralised entities deciding on which projects ought to be funded, a DAO-based ICO would have this responsibility and governance distributed among the participants. By investing in that DAO, a participant would receive tokens that would grant them voting rights within the DAO structure, thus letting them have a say in the direction of a project.

DAOs also have a high potential for addressing real-world challenges, such as waste management. Here, a DAO would be deployed in order to manage the entire waste management process automatically and in a decentralised manner. It could then be coded to offer rewards to individuals who effectively manage waste, such as recycling, thereby incentivising people to behave responsibly. This hypothetical example illustrates the wide real-world applicability of DAOs, which are usually associated with financial applications more than with anything else.

Having said that, DAOs are redefining the ways organisations function, and they are finding applications significantly beyond their initial scope, which was largely limited to funding of individual software projects. They are now seen as a mechanism that allows for numerous actions based on decentralisation and automation and are sure to grow in scope and fields of applications.

Returning to the first DAO, The DAO, we are faced with an issue. After its successful crowdfunding project that raised over 150 million dollars at ICO, around a third of the funds was drained by an unknown hacker due to the vulnerability in the code. This is just one of the many challenges faced by DAOs and a topic that will be explored in the following chapter of this paper.

1.4 DAO Challenges

As illustrated in the example of The DAO, DAOs are vulnerable to security attacks due to possible flaws in their code (Singh & Kim, 2019). “The DAO” has served as a vital lesson illustrating the risks associated with blockchain and smart contracts and the need for rigorous code audits before the launch. It has also pushed for the development of improved security protocols concerning DAO governance models and sparked an important debate on the ethical implications of the immutability of the Blockchain, seeing as the hack in the initial DAO has led to a split in the blockchain, practically negating the events of the hack.

This split in the blockchain, otherwise known as a fork, presents another issue, that is, ideological differences within a DAO. In the event of the DAO, some participants have chosen to side with the new fork, while others have decided not to and that they would line up with the immutability characteristic of blockchain. These two sides with two opposing views demonstrate whether the code should be treated as “code as law” or that perhaps a more pragmatic approach is favoured. This issue only highlights the broader debate within the blockchain community, one that is the question of the role of code, governance, and social consensus in a decentralised system (Tapscott, 2016).

DAOs also present challenges in how capital returns are realised (Singh et al., 2019). This is due to the fact that, compared to traditional organisations, DAOs’ radically different mode of operation means that they lack standard financial metrics, making it challenging to perform traditional financial assessments. This means that DAOs come with a layer of economic and financial risk that the stakeholders, or in other words, participants, might struggle to comprehend. They might not be clear on how the profits are generated or the decisions made within the network. This poses the risk of asymmetric information within the DAO, an issue that might be overcome by educating all participants on all aspects of the DAO.

There is also a greater risk present in the blockchain space itself. One such risk is the issue of “rug pulls”. These, along with scam DAOs, can undermine the trust that is placed in these organisations (Ante et al., 2020). Rug pulls refer to situations where the founder or a major stakeholder essentially drains a project's funds without notice. These and other scams are especially prone in the current regulatory landscapes, which are still considered to be in their infancy when it comes to Decentralised

Autonomous Organisations. There is also a problem of centralisation within a decentralised organisation. This could happen in cases where one individual or a small number of individuals are able to acquire a disproportionate amount of power, be it through the number of tokens or computational power, thus undermining the benefit and the core principle of decentralisation that DAOs offer.

Although unique in their nature, DAOs still face some classical economic issues, such as the Free Rider Problem (Laturnus, 2023). In this sense, the people in the DAO who are not directly participating would be benefiting from the resource without contributing to the cost of it. This problem is avoided by traditional companies through the implementation of monitoring mechanisms, ensuring everyone is contributing fairly. In a DAO, however, this is more complex. Even though DAOs are more transparent and should thus make it simpler to see who is contributing what, this does not resolve the Free Rider Problem, as the decentralised nature of DAOs makes it significantly more difficult to enforce any penalty. The long-standing issue of the Free Rider Problem in DAOs goes back to seminal works in economics (Holmstrom, 1982; Huddart & Liang, 2005) that have discussed the issue in a number of organisational settings. DAOs must still address these economic concerns, potentially requiring new governance models.

Some other challenges include the complexity around the refund processes, as seen in the Constitution DAO case when they lost the auction. Whereas more traditional organisations may have predefined refund policies, DAOs might lack this flexibility to handle complex and sometimes unpredictable scenarios. Another concern is the issue of token transferability. This could lead to short-termism and instability in the governance itself. Due to the ease of token transfer in many DAOs, the participants might be motivated more by short-term goals and gains rather than long-term ones, leading to a high level of fluctuations and instability within a DAO. To mitigate this, reputational tokens have been introduced. These would not only represent a financial stake but also show the long-standing contributions of the individual that holds them and, as such, make it an incentive for participants to consider the long-term success of the DAO (Liu, 2022).

Moreover, DAOs are prone to manipulative practices, much like any organisation. This happens when an individual manages to obscure issues or manipulate voting outcomes. Some DAOs, including Friends With Benefits DAO and Flamingo DAO,

have implemented various forms of member restrictions to counter this issue. These member restrictions could be, for example, a requirement for a certain amount of tokens to be held as a prerequisite for voting. Another issue could be the high transaction fees associated with transactions in a DAO. These could deter potential stakeholders from participating in a DAO or make existing ones exit the DAO they are in.

One more issue is related to the managerial practices within a DAO. Due to their complex nature, DAOs present a great challenge in managing, supervising, and controlling them (Qin et al., 2023). This complexity is heightened once we consider the ability of a DAO to go around the traditional mechanism of authority, posing a significant risk to the regulatory frameworks (Santana & Albareda, 2022). Another challenge comes due to the irreversibility of smart contracts. Once they start running on a DAO, they can not be retracted, which could pose an issue for specific industries where sensitive intellectual property is of concern, such as pharmaceuticals or technology (Cai et al., 2022). This could lead to the exploitation of sensitive information due to the previously discussed vulnerability of the code.

Some scholars, such as Sims et al. (2019), also hold a belief that DAOs are not expected to significantly grow in scale in the foreseeable future. As of now, they seem to be in their infancy, and as such, the challenges explored above are more so considerations that should be taken into account when designing a DAO so as to avoid any of the issues discussed.

2 DAOs and the Fashion Industry

The fashion industry is an ever-evolving landscape. In this landscape, technological advancements are of crucial importance for the growth and progression of the industry. Though the sector itself is closely related to the physical world, with tangible products being at the forefront of the industry, recent years have seen a notable shift towards innovation and the adoption of more complex information technologies. This is why Decentralised Autonomous Organisations come into play, as they offer innovative approaches towards governance, management and overall operations in the fashion domain. This blockchain-based model offers an interesting, although so far unexplored, avenue for the industry that would be able to address certain issues pertaining to the current state of fashion.

Some of the issues the blockchain-based fashion industry would be able to address would be issues surrounding operational transparency, transparent governance, ethical design practices, as well as a number of other long-standing industry issues. It could change the very paradigm of the industry, one that would alter the very core of governance and management of fashion. With the Adoption of DAOs, the industry is able to revolutionise all of its internal operations, as well as the external interactions. It would also potentially come with positive externalities, with the positive impact associated with overcoming major sustainability issues within the current state of the fashion industry. These and many more will be explored further in the following sections of the paper.

In order to gain a better understanding of how the fashion industry could be integrated with DAOs, we ought to first look into the history of the fashion industry's adoption of technological innovation. We also ought to look into the major principles that would guide this adoption, in this case, the governance and management of this new system, both of which will have their own subchapters in this paper. Finally, before proposing a framework for DAO adoption in the fashion industry, the challenges associated with this potential application will be explored, addressing the possible solutions. But first, the next chapter will look into the historical aspect of technology in fashion.

2.1 Technology Adoption in the Fashion Industry

The fashion industry has long been considered a canvas for technological innovation, deeply influenced across all of its facets, from raw material sourcing to design and retail (Sun & Zhao, 2018). The adoption of these new technologies has significantly altered the fashion landscape in many ways and a multitude of times. This constant interplay of technology and fashion makes it an ideal sphere for adopting more complex blockchain technologies, such as DAOs.

As noted, the fashion industry has historically implemented various upcoming technologies, and starting from the realm of materials science, it has been able to implement significant advancements such as smart textiles, those being fabrics embedded with electronic components aimed at performing specific functions (Fernández-Caramés et al., 2018). These electronic components are able to perform a variety of functions, from colour changing all the way to monitoring physiological indicators such as heart rate. They provide designers with a number of new possibilities, stretching the boundaries of what fashion is able to achieve in terms of design. These are also able to collect and store data, which, while providing a number of opportunities for their usage, also opens them up to ethical concerns, such as the issue of data privacy and consumer rights.

Moving up the supply chain, the technological revolution has also impacted the production processes (Akram et al., 2022). The techniques used in production, ranging from automation, robotics and even additive manufacturing methods such as 3D printing, have not only reduced production costs but also improved the quality and enhanced sustainability. It has also aided in minimising human error, a problem that has been more prevalent prior to this adoption of technology within the fashion industry. In addition, technology is driving design optimisation (Thomassey and Zeng, 2018). The designers have been given a means of production that greatly increases their design possibilities, as they are able to convert their complex digital designs into real-life objects with relative ease compared to what it would've taken not that many years ago. These practices add to the sustainability of the industry, as well as align with the increasing demand for more ecologically friendly practices in the sector.

On the distribution side, the industry is similarly undertaking a significant technological change. One example of this is the possibility of Artificial Intelligence to offer accurate

sizing recommendations and optimise inventory management (McDowell, 2023). Additionally, blockchain technology is already revolutionising supply chain management, introducing never before achieved level of transparency (Sun and Zhao, 2018). The technology, as such, is able to track products from their starting point all the way to the final recipient, be it the customer or another entity. It can also help authenticate products, a feature of high applicability to the luxury fashion sector.

Other vital aspects of technology impacting the fashion industry are in the realm of ethical labour practices (Crane, 2016). Technologies like blockchain and the Internet of Things (IoT) are allowing brands to track and report on the working conditions of their employees in real time. This, in turn, essentially provides an audit trail that includes data on the product across all of its life stages, from raw material to the customer. This technology thus enables customers to make informed choices, closing the circle on ethical labour practices in the fashion industry.

Lastly, the adoption of Non-Fungible Tokens (NFTs) by the fashion industry presents a compelling intersection between fashion and the digital world (Periyasamy & Periyasamy, 2023). The NFT market, having experienced rapid growth from mid-2020, with Art NFTs contributing approximately 71% of the total transaction volume, is indicative of the growing interest in digital fashion items (Nadini et al., 2021). Fashion brands, following the lead of the art market, are now launching digital fashion items and offering limited-edition digital collections, mirroring the market trend where the average sale price of NFTs is less than \$15 for 75% of assets, but exceeds \$1594 for the top 1%, highlighting the diverse market value and exclusivity of these items (Nadini et al., 2021). Gucci's digital sneaker and The Fabricant's digital-only dress, which sold for \$9500 in an NFT auction, are prime examples of this trend. These items, which cannot be replicated, add a unique element of exclusivity that has captivated public attention (Hahn, 2021; Roberts-Islam, 2019).

Mekacher et al. (2022) add another dimension to our understanding of this market. The analysis of 3.7 million transactions reveals that rarity significantly influences NFT prices and investment returns. Specifically, the study found that rarer NFTs not only command higher prices but also show a lower tendency for negative returns. For instance, the median sale price for the 10% rarest NFTs saw a 195% increase, highlighting the premium placed on exclusivity in the digital realm (Mekacher et al., 2022). This trend dovetails with the luxury fashion industry's emphasis on exclusivity,

suggesting that the high valuation of rare NFTs mirrors the traditional appeal of unique, high-fashion items.

Several key factors influence the adoption of technology within the fashion industry. Firstly, economic viability is a primary consideration. This is due to the fact that the technologies that offer a high return on investment (ROI) are more likely to be adopted by fashion organisations. As such, the initial cost of adopting a new technology must be justifiable regarding long-term revenue and operational efficiencies (Porter, 2001).

Secondly, it is a competitive landscape that drives the adoption of technology, especially if other adopters of the technology gain a competitive advantage over their competitors with the use of that technology. In that sense, being the first adopter grants advantages regarding brand image, consumer loyalty, and market share (Christensen, 1997).

Thirdly, consumer expectations for a greater level of transparency within the supply chain, as well as with sustainability and personalisation, have pushed the industry to adopt more technology-driven solutions (Granskog et al., 2020). In a bid not to turn away customers from their brand, fashion brands have turned to technologies as a way of meeting these demands.

Fourthly, the regulatory backdrop can either foster or deter the adoption of technology in the fashion sector. This factor is of significant importance when it comes to blockchain technology, as the laws and regulations around data security and consumer privacy might significantly impact its adoption.

Fifthly, when considering the adoption of a certain technology, looking into the skill levels that the labourers possess is essential. Advanced technologies require a certain level of adaptability within the workforce, as well as the necessary knowledge and expertise in areas like data analytics and software development. The availability of these skills significantly eases the adoption process of these technologies (Zahra et al., 2021).

The final factor that is influencing technology adoption in the fashion industry that will be discussed in this paper is the internal organisational structure (Bonneti, 2018). This includes everything from the organisational culture, attitudes to leadership and risk-taking, value placed on innovation and many more. All these factors shape how

well the technological shifts will be adopted and whether or not it is a good idea in the first place to adopt these shifts.

Overall, we can see from this chapter how the Fashion industry has historically been adopting technological advances in order to improve or transform their practices. We have also seen the factors that impact this adoption and that determine the success or failure of the same. The next chapter will look at the implications of technological adoptions in the fashion industry in terms of DAOs.

2.2 Implications for DAO Adoption

The historical adoption of technology on the part of the fashion industry offers valuable implications for the integration of Decentralised Autonomous Organisations. One of the areas worth considering in this context is the area of distribution dynamics. Most notable in this area is the capacity of blockchain technologies to offer transparency through the use of smart contracts (Sun & Zhao, 2018). As mentioned in the previous chapter, the fashion industry has already incorporated some forms of blockchain technologies in its operations and, as such, appears to be open to further development in terms of technological integrations.

As Web3, a new evolutionary phase of the internet, comes about, DAOs present a potential for a significant change in how the fashion industry as a whole operates. The essence of Web3 aligns well with the founding principles of DAOs. This creates a perfect environment for the introduction of DAO into the fashion industry, as they offer a decentralised mode of governance that would disrupt the current hierarchical structures that govern the fashion sector (Zwieglinska, 2022). This highly centralised nature of traditional fashion organisations often leads to inefficiencies, bottlenecks and a lack of transparency, all of which have been noted in previous chapters of this paper. In the following chapters, we will look into how DAOs have the ability to combat these.

The fashion industry itself is characterised by its highly competitive nature and a very cost-sensitive environment. As such, it has historically been more apt to adopt new technologies that would enable a brand to gain a competitive advantage over other brands in the industry while remaining economically viable. This is where DAOs would come into play, as they are able to significantly reduce the need for intermediaries in various processes that a fashion brand conducts. More on this later.

Another previously discussed implication of technology adoption on DAOs in the fashion industry is consumer expectations. In the context of the fashion industry, consumers, more exposed and educated on sustainability and ethics of clothing production, demand greater transparency and ethical awareness from brands. DAOs, with their transparent and immutable technological base, align well with these expectations. Additionally, the study by Puiu (2020) underscores this trend, revealing a positive correlation between consumers' attitudes towards technology and their

knowledge of innovations like nanotechnology in fashion. This suggests that consumer education in technological advancements can play a crucial role in enhancing acceptance of these practices. In fact, the study indicates that more informed consumers tend to support brands that incorporate innovative technologies, aligning with their demands for ethical practices (Puiu, 2020). Harba's research further strengthens this point by showing how the integration of VR and AR in luxury fashion elevates customer experiences, meeting the growing demand for engaging and immersive brand interactions (Harba, 2019). Thus, informed consumers are not only supportive of ethical practices but also expect innovative technological experiences from fashion brands.

Another implication is the fast-paced nature of the fashion industry. The fashion industry is characterised by the quick pace at which trends come and go, with as little as two seasons presented by luxury brands yearly, all the way to a new collection dropping every week for a number of fast fashion brands. DAOs could offer a solution to the issues that may arise in the inability of traditional systems to keep pace with the climate, be it by providing a faster approach to decision-making or altering the entire system that is currently in place.

Regulatory climate is another important consideration when looking into the adoption of DAOs in the fashion sector, as it is profoundly influential in driving or inhibiting it. On the one hand, having highly defined regulations could provide potential companies looking to adopt DAO technology with the confidence to invest and participate in the particular fashion DAO. It can, therefore, foster innovation and provide a more stable environment. On the other hand, unclear or strict regulations could deter potential companies from adopting the said technology as they are afraid it could expose them to legal risks. As such, it could act as a barrier to entry.

We can also note the significant role the current technological structure of a company plays in the adoption of new technologies. Companies that have already made investments in certain blockchain technologies for various other purposes are more likely to adopt DAOs, as they already have the necessary technologies for their successful implementation. Alternatively, fashion companies that do not already have modern technology may find it challenging to try and integrate DAO, both financially and in terms of the knowledge necessary to do so.

Cultural readiness is another consideration for DAO adoption in the fashion industry. The culture within an individual fashion company determines its readiness to adopt disruptive technologies such as a DAO. While some companies might be more open and forward-thinking, others might prefer continuing to function in a traditional manner. As such, we can identify the willingness of the company to embrace change as one of the main factors that will influence the rate and extent of DAO adoption.

As we have seen by looking into the factors presented in this chapter, the fashion industry has a lot of unexplored potential with technologies such as DAOs, provided that the implications of doing so are fully understood. The next chapter will look into the challenges and limitations that DAOs present in the fashion industry, which will further support the building of an appropriate theoretical framework later in the paper.

2.3 Challenges of DAOs in the Fashion Industry

There are a number of challenges associated with the adoption of Decentralised Autonomous Organisations in the Fashion Industry. Along with the issues pointed out in the association with blockchain technology and DAOs in general, and in the section “1.4 DAO Challenges ” of this paper, there are other challenges strictly related to the fashion industry. This chapter will briefly explore those before moving on to the development of a theoretical framework for the most appropriate applications of DAOs in the said industry.

One of the most significant obstacles to adopting DAOs in the fashion industry is the question of creative direction (VanderPloeg, 2018). Clear creative direction is one of, if not the most important aspects of a fashion brand, which traditionally relies on a singular designer projecting their vision for the season. This is where the challenge with DAO adoption lies, as the underlying model of a DAO significantly conflicts with this very principle. In an industry where unique creative vision is vital, the lack of central authority could present a challenge. On the other hand, this very extreme departure from the traditional model could be the thing that marks a shift in the industry as a whole.

Another issue of this adoption in the fashion industry is the scepticism concerning their disruptive impact on traditional fashion structures. The public can misconstrue the aims of Decentralised Autonomous Organisations and equate them to multi-level marketing schemes, thus damaging the reputation of fashion brands that operate within a DAO framework. This is due to the focus of the critics on the token trading aspect of a DAO rather than its core missions and goals (Tong, 2022). This may affect the credibility and acceptability of DAOs, especially among the potential stakeholders who are uneducated and unfamiliar with blockchain technologies.

Another notable barrier to DAO adoption is regulatory challenges unique to the fashion industry. The industry itself is characteristic of the way its supply chain operates and the very globalised nature of it. This means that it is faced with unique issues of supply chain, labour laws, as well as environmental protection laws that vary across borders. The lack of formal regulations that are characteristic of DAOs can also make it difficult to enforce these rules, which could lead to problems in areas such as accounting, auditing and compliance, as well as making it practically

impossible to hold any one person responsible if the issues lead to legal troubles. Moreover, the globalised nature of the industry would make the adoption more difficult when it would have to deal with tariffs and other trade regulations.

The fashion industry also faces the issue of consumer protection, which relates to the laws that govern the safety, quality and labelling of products (Chan et al., 2012). A DAO fashion company might find it more challenging to comply with these regulations than a traditional company would. In the absence of a central authority, there may arise problems regarding recalls, quality controls, and such.

Having said that, it is vital to consider all of the limitations DAOs might face in the fashion industry prior to their adoption. The area of blockchain governance is still new, and many outside factors and institutions haven't had time to catch up with the evolving technologies, which is especially the case when it comes to the regulatory sphere. To be able to utilise their potential fully, the changes in the current law are required to allow for such new structures to function.

3 Potential of DAOs in the Fashion Industry

This chapter seeks to provide a comprehensive examination of the existing knowledge on DAOs in the fashion sector, with the aim of evaluating their relevance and contributing to the formation of the theoretical framework. To achieve this, the most recent research will be analysed, along with presenting some relevant case studies that will help ascertain the level of DAO integration in the fashion sector. After this part, the framework will be developed, followed by two subchapters focused on the governance and management aspects of the framework. Finally, a conclusion will be drawn on the potential that DAOs present in the fashion industry.

The growing trend of digitalisation within the fashion industry has allowed for new forms of business models to arise, one such being a Decentralised Autonomous Organisation. With the increasing demand on the side of customers for more transparent and ethical business practices, brands are starting to consider adopting new technological solutions that would combat these concerns. This could eventually bring a shift in the whole industry, allowing for a more decentralised and democratised system to replace the traditional hierarchical and centralised one.

In recent years, there have been a few examples of companies combining fashion with DAOs within their business practices. One such example is the case of Red DAO, an organisation that aimed at investing in digital fashion and that made significant investments in a collection of NFTs (Non-Fungible Tokens) released by the luxury fashion brand Dolce & Gabbana (Thomas, 2021). This company acted as a crowdfunding organisation that pooled together the funds from its investors in order to make these purchases. Another example is Tribute Labs, a supporter of Red DAO, which collaborated with a digital sneaker brand, RTFKT, to launch Neon DAO, a metaverse-focused organisation (Tong, 2022). These few early examples illustrate the interest in DAOs within the fashion sector and their applicability despite the obstacles they face.

As demonstrated with the example of Red DAO, DAOs are able to offer novel forms of governance for the fashion industry. This novel approach has the potential to reconfigure the traditional governance structures that are prevalent in the fashion industry. This would allow for all of the parties taking part in the industry, such as stakeholders, designers, suppliers, and retailers, to be able to collaborate

autonomously through on-chain and off-chain governance (Santana & Albareda, 2022). This potential for collaboration can be considered one of the most significant benefits that come from DAO implementation in the fashion industry. It offers a range of possibilities in all stages of the fashion lifecycle, from the design process to customer service.

DAOs in the fashion industry also offer a number of opportunities related to automation in the industry. Through a blend of previously discussed on-chain and off-chain rules, or in other words, rules that are enforced by the blockchain and the ones enforced outside of the blockchain, various processes that would otherwise require a high amount of effort or cost would be handled automatically by the blockchain. DAOs would also be able to provide a greater level of security that would be particularly valuable to such an industry that deals with issues of sensitive intellectual property (Santana & Albareda, 2022). These would offer an additional layer of security for the stakeholders looking to invest in the fashion DAO.

The concept of “code as law” that we have looked at in the context of blockchain technology has far-reaching implications for the fashion industry in the context of DAOs (Sims, 2019). This is especially true in copyright enforcement, supply chain management, and contract fulfilment. In copyright enforcement, the original designs could be tokenised on a blockchain and, as such, ensure that the designer's rights are automatically protected and any copyright infringement easily traced and flagged. When it comes to supply chain management, the verification of ethical and sustainable practices could be easily and automatically tracked and verified. As for contract fulfilment, DAOs can streamline the transactions between designers, manufacturers and retailers. At the same time, the payments would be automatically handled upon meeting pre-defined conditions, such as successful delivery of goods, thus minimising potential disputes.

When analysing the potential of DAOs in an industry, it is essential to look into its alternative models so as to gain a wider understanding of the issue. Singh & Kim (2019) have discussed alternative modes of governance such as “CarbonVote” and tools such as lightwallets (Spectrum). CarbonVote is an off-chain mechanism that allows stakeholders to vote on proposals by sending their tokens to designed addresses, thus offering a new approach to governance. On the other hand, lightwallets like Spectrum are beneficial in that they simplify the interactions of

participants with the blockchain by eliminating the need for them to download the blockchain in their entirety, thus making it simpler for stakeholders to participate in the particular DAO.

Another important consideration for adopting DAOs is the need for an educational reform that would educate the next generation of stakeholders on the background and landscape of the technology. This requirement has been highlighted by Wang et al. (2022) and is crucial in combating some of the issues that pertain to the adoption of DAOs in the fashion industry and that have been discussed in the previous chapter.

3.1 Developing the Theoretical Framework

This chapter of the paper aims to revisit the existing theories and concepts associated with blockchain technologies and Decentralised Autonomous Organisations (DAOs). The objective is to collect all of the relevant contemporary knowledge presented in the academic literature that will serve as a foundation for the formulation of a novel theoretical application of DAOs in the fashion industry. By once again bringing up the critical theories discussed in the previous chapters of the paper, such as the ones related to the concept of decentralisation, governance and management mechanisms, and operational transparency, the chapter will present an overview for a comprehensive analysis. Each theory and concept presented will be applied to the fashion industry context, with two subchapters specifically focused on the more prevalent ideas in the realm of blockchain, these being governance and management. Instead of having the challenges presented in a separate section of the framework, they will be incorporated and discussed seamlessly within each component of the framework. After the presentation of these developed theories and ideas, the concluding chapter of this paper will merge all of them while also thoughtfully addressing the limitations and challenges that were previously discussed. This holistic approach will help make an informed proposition on the potential applications of DAOs within the fashion industry.

What follows is a framework developed from the theories and concepts explored in previous chapters of this paper:

1. Fundamentals of Blockchain Technology and DAOs

1.1. Core Characteristics

- Immutability, Audibility, and Decentralised Nature (Wang et al. 2019).
- Transparency in transactions (Sun and Zhao 2018).

1.2. Security Features and Governance

- Machine Consensus Algorithms, Smart Contracts and Asymmetric Encryption (Santana and Albareda 2022).
- Different Types of Consensus Algorithms: BFT, PoW, PoS (Mingxiao et al. 2017).

- Asymmetric encryption: two keys, a private key and a public key (Santana and Alberada 2022).
- Algorithmic or Participatory (Wright 2021).
- Challenges: Ethical and Trust Concerns, including "rug pulls" (Ante et al. 2020); Advanced technologies like AI in refining models (Wang et al. 2023; Tan et al. 2022).

1.3. Data Storage and Network Types

- On-chain and Off-chain Data Storage (Cai et al., 2022).
- Permissionless (public) vs Permissioned (private) Networks (Mingxiao et al. ,2017).
- Challenge: vulnerability to security attacks (Singh and Kim 2019); Free Rider Problem (Holmstrom, 1982; Huddart and Liang, 2005).

2. Fashion Specific Considerations

- Technology as a Driver of Design Optimisation (Thomassey and Zeng, 2018).
- Potential for Collaboration (Santana and Albareda, 2022).
- Economic Viability Considerations (Porter, 2001).
- First Adopter Advantage (Christensen, 1997).
- Consumer Expectations including Sustainability and Personalisation (Granskog et al., 2020).
- Labour-specific Skill Levels (Zahra, 2021).
- Role of Technology in Ethical Labour Practices (Crane, 2016).
- Scepticism concerning DAO Adoption (Tong, 2022).
- Question of Creative Direction (VanderPloeg, 2018).
- Consumer Protection (Chan et al., 2012).

3. Fashion DAO Governance

- Overview of DAOs Functioning Based on Smart Contracts, Governance Tokens, and Proposals and Voting (Santana and Albareda, 2022).

- Forms of Decentralised Governance within DAOs: Algorithmic DAOs and Participatory DAOs; Hybrid Models (Wright, 2021).
- Dual System of Governance (Santana and Albareda, 2022).
- Governance Types in DAOs: Group and Social Governance (Qin et al., 2023).
- “Governance Paradox” (Tan et al., 2022).
- Ideological Splits: Role of Code, Governance, and Social Consensus (Tapscott, 2016).
- Optimal Type of Ownership (Laternus, 2023; Jensen and Mecklin, 1976).
- Voting Mechanisms: Weighed or Unweighed (Wright, 2021).
- Tokens and Inequality Reduction (Sims, 2019).
- Novel Forms of Governance like "Futarchy" (Singh and Kim, 2019).
- The Need for Educational Reforms for DAO Adoption (Wang et al., 2022).

The above framework presents all of the current and relevant academic literature that should be considered when considering the potential that DAOs have in the fashion industry. The remainder of this paper will focus on a hypothetical new model for the fashion industry, centring around the transformative potential of Decentralised Autonomous Organisations. This model will be predicated on the use of blockchain technologies, as explored in the previous chapters of the paper. By synthesising these key concepts presented, this paper aims to provide a comprehensive view of what this hypothetical, new, DAO-based fashion system would look like and on what technological basis it would operate.

Starting from the very basis of blockchain, a transformed fashion industry that is DAO based would embody blockchain’s core characteristics, these being immutability, usability, and decentralised nature (Wang et al., 2019). These characteristics form the basis of the transparent and community-driven DAO fashion model. The immutability feature would entail that every transaction on the supply chain would be recorded, ranging from the purchase of raw materials to the final purchase of the product by a customer. Immutability ensures that every supply chain transaction is permanent, adding a layer of accountability (Sun and Zhao, 2018). Audibility refers to the transparent and verifiable nature of transactions and decision-making processes that

occur in the fashion DAO. Finally, the decentralised nature of a fashion DAO offers perhaps the most transformative opportunities for the fashion industry, fundamentally disrupting its traditional business model. These attributes not only align with Wang et al.'s (2019) foundational characteristics but also fulfil the growing demand for transparency in fashion, as pointed out by Granskog et al. (2020).

Moreover, let's once again go over the key traits encapsulated in the acronym DAO: Distributed and Decentralised (D), Autonomous and Automated (A), and Organisational and Operational (O). The "D" represents the departure from the traditional centralised hierarchies in the fashion industry, as the hypothetical fashion DAO presented here is distributed across a network of participants, including designers, customers and others. This decentralised nature democratises the governance within the industry, an idea that will be further looked into in the following subchapter of this paper. The "A" in DAO is representative of the use of smart contracts associated with the blockchain, which allows for the organisation or in this case, a whole DAO-based industry of fashion, to carry out all of its transactions automatically. The transactions, in this case not, relate to not only the financial functions but also other interactions on the network that have the possibility to be minimally overseen through automatisisation. Finally, "O" emphasises the fact that, while decentralised and functioning on a network, our fashion DAO still maintains an organised structure, one that includes the governance of tokens, management protocols, as well as a voting system that aims to keep its distributed network coordinated and functioning properly. It also has its core functions that do not depart greatly from the traditional organisation, including designing, sourcing, producing, marketing and selling of products on our fashion network.

Security plays a crucial role in the efficacy of a Fashion DAO. Machine consensus algorithms, along with asymmetric encryption, are cornerstones for ensuring transactional and governance integrity (Santana and Albareda, 2022). These security features are indispensable in an industry where intellectual property, sensitive data, and rapid transactions are the norms. Together, these two offer a robust security infrastructure that not only preserves the integrity and credibility of our fashion DAO but also serves as a basis upon which the core premises of a DAO can flourish.

Regarding the choice of consensus mechanism that is most appropriate for the use in this hypothetical fashion DAO, it is of great importance as it has significant

implications for its performance, governance and sustainability. PoS (Proof of Stake) might be the most suitable option for this purpose. As a reminder, unlike Proof of Work (PoW), where miners solve complex mathematical puzzles to validate transactions and create new blocks, PoS works by allowing for the miner to be chosen in a deterministic manner based on the number of tokens they hold and that they are willing to “stake” as collateral. In the fashion context, this would mean that individuals within the system, such as stakeholders, suppliers, retailers or customers, could stake their tokens in order to become validators. Depending on the voting mechanism employed, their stakes could be weighed based on pre-determined factors such as their previous contribution to the DAO or their reputation in the community. The benefit this consensus mechanism provides over others is its energy efficiency. These factors are important not only for operational efficiency but also for aligning with consumer concerns about sustainability (Granskog et al., 2020). Considering the size of the fashion industry globally, this is a very important consideration because the wrong choice could lead to great issues of sustainability. Furthermore, this mechanism allows for a quicker validation of transactions, which is critical for such a fast-paced and transaction-heavy industry that is the fashion industry. This quickness of transactions also offers the benefit of potential streamlining of various aspects of the supply chain and retail operations. PoS could also be considered more secure compared to PoW in certain types of attacks, an essential consideration for an industry that deals with high-value transactions and intellectual property. It is also considered more cost-effective as running a PoS validator node is generally less expensive than the high computational and energy costs associated with PoW.

Despite these benefits, there are still limitations associated with the choice of PoS as a consensus mechanism over other mechanisms in a fashion DAO, as it carries the inherent risks of blockchain forks and faces the operational challenges of initial token distribution (Mingxiao et al. 2017). These would include the risk of attacks where validators would be able to create an alternative blockchain fork starting from a point far behind the current head of the blockchain. This issue has solutions like checkpointing. However, this is a concern associated with PoS that is not found in PoW. Additionally, unlike in PoW, in PoS, there is barely any cost to validating multiple blockchain forks. As such, validators might be tempted to bet on multiple forks, leading to security vulnerabilities. Another consideration is on the topic of initial distribution, which is necessary for the effective operation of PoS systems. Initial

distribution would require the fair distribution of tokens at the start of the fashion DAO operation among all of the participants, which might pose a challenge to do effectively. Finally, there might be a lack of initiative for participants to partake in stacking, and in a fashion industry where high returns are expected and achievable through other means, this might pose a challenge if staking doesn't offer competitive returns. Regardless of these challenges, Proof of Stake is the best option for use in industry-wide fashion DAOs compared to other mechanisms and is, as such, the first choice for the hypothetical fashion DAO proposed in this paper.

When making a proposal on the implementation of DAOs within the fashion industry, we ought also to look at the encryption method that is to be employed. In the context of fashion DAOs, asymmetric encryption provides security measures that ensure data integrity, confidentiality and secure transactions. Asymmetric encryption offers robust security essential for protecting proprietary designs in the fashion industry (Santana and Albareda, 2022). As noted in earlier chapters, asymmetric encryption would mean the use of two keys, a public key for encryption and a private key for decryption, a system that would significantly enhance the security architecture of the fashion DAO.

This would cover a range of operations within the DAO, one such being the example of design submission over a DAO fashion platform. The designer would be able to submit their original design to the platform, encrypted, and only other participants with the corresponding private key would be able to access the design, ensuring confidentiality and security. In this sense, the DAO would act as a platform where designers and customers would meet and interact, independent of the third parties. This is the transformative potential DAOs offer to the fashion industry. In traditional fashion structures, there are a number of intermediaries between the designer and the customer. First, there is the fashion company under which the designer operates, and depending on their role in the company, they may or may not be creatively restricted by the company's overheads. Then, there comes the production aspect, which may be constricted by factors such as the geographical location of the brand or the skilfulness of the labour that is employed by the company. The transportation of goods might also pose an issue and further widen the gap between the designer and the customer. Upon finally reaching the customer, they might still face issues such as improper sizing and fit, all the while having the presence of multiple intermediaries in the supply chain, inflating the end cost for the consumer.

The existence of a blockchain-based decentralised model for fashion would be able to offer a more cost-effective, streamlined solution, as well as allow for much greater creative freedom for the designer. This will be further discussed later on, for now, back to the concept of asymmetric encryption. Additionally, given the growing consumer demands for transparency and ethical business conduct, including labour conditions and sustainability, the industry needs to balance the opaqueness that comes with encryption against the need for transparency in certain aspects of the supply chain (Granskog et al., 2020). With all the transformative benefits and possibilities it offers, there are still some issues that need to be considered and worked on in order for asymmetric encryption to be a viable solution. Some of these pertain to the computational power needed to execute them being much higher than that of their symmetric counterpart, as well as the more robust encryption adding to the higher costs. Moreover, there is an issue with scalability, as the resource-intensive nature of asymmetric encryption might pose a challenge to maintain as the network grows.

Another consideration is the mode of data storage in fashion DAOs, the choice being between on-chain and off-chain. On-chain data storage aligns well with DAOs' principles of decentralisation and trust, making it ideal for Fashion DAOs. It supports transparency and ethical practices but faces scalability and privacy concerns (Cai et al., 2022). Off-chain storage, while efficient, undermines the DAO ethos by compromising on data integrity. This paper argues for the choice of on-chain storage of data and for the following reasons. While off-chain mode is generally cheaper and faster, it comes with the issues of trust and data consistency, as well as going against the very core DAO principle, which is decentralisation. For this reason, the on-chain mode of storage is more appropriate as the data is stored across the network of nodes and is, as such, immune to the issues of trust that may arise when data is stored with a third-party provider. Moreover, Data stored on-chain is immutable, meaning it can not be altered, thus ensuring data integrity. It is also transparent and available to all participants in a fashion DAO, fostering trust within the network. However, it still comes with some disadvantages, such as the issue of scalability, seeing as most public blockchains operate within a limited block size, making it more difficult to store a large amount of data. There is also a consideration for the privacy aspect of the blockchain, as all of the data is transparent, and some sensitive business information that would otherwise be kept secret would be exposed to the network. While the transparency of on-chain data storage could raise concerns about

intellectual property within the fashion industry, it presents a highly compelling opportunity for fostering more transparent business practices related to ethical sourcing and labour practices. Ultimately, this shift holds the potential to completely revolutionise existing business models in the fashion sector, making it a crucial aspect to carefully weigh in the industry's blockchain transition. As such,

When it comes to the choice of which blockchain infrastructure our Fashion DAO uses, we've opted for a permissionless or public architecture as opposed to a permissioned one. This is an obvious choice due to the very essence of DAOs, which is characterised by its decentralised nature and inclusivity. A public, permissionless blockchain architecture is best suited for the proposed Fashion DAOs as it democratises participation and promotes innovation (Mingxiao et al., 2017). In a permissionless architecture, everyone is able to join the network with no barriers and no prior authorisation needed. This is especially valuable in the context of the fashion industry, which is traditionally characterised by very high barriers to entry, be it for designers, manufacturers or even customers.

With the public, permissionless blockchain, this fashion DAO would be able to democratise the entire industry across all of the stages of the supply chain, creating a transparent environment that can be audited by anyone in the network. This approach would foster innovation within the community, as well as contribute to ethical practices in the supply chain. However, there should still be consideration for the complexity of the technology. Some participants in the network might be less familiar with the technology and, as such, might be at a disadvantage if they do not find a way to navigate the said fashion DAO. Another consideration is quality control. Whereas in the traditional fashion models, there are certain institutions, as well as market mechanisms, that help facilitate the quality control process, in the blockchain environment, where anyone can participate, the quality of the participants is not guaranteed. Therefore, a solution needs to be found that will address the quality control requirement within the fashion DAO. It could be argued that, in a fashion industry-wide DAO, the free market would naturally evolve to facilitate quality control mechanisms. This organic regulatory framework, as such, would serve as an essentially self-correcting ecosystem, one in which market forces, including consumer preferences and reviews, would shape and maintain the quality of products and services.

We ought also to look into the fashion-specific considerations when making our proposal on the fashion DAO. In our hypothetical fashion DAO, technology would act as a catalyst for design innovation as well as optimisation (Thomassey & Zeng, 2018). The smart contracts component would allow for the automatisisation of the supply chain, while Artificial Intelligence (AI) would be able to predict fashion trends, thus reducing inventory waste and enhancing design quality.

Additionally, collaboration can be seen as the cornerstone of our fashion DAO (Santana & Albareda, 2022). Designers, suppliers, and consumers would hereby have the platform on which to interact and co-create value through voting mechanisms, contributing to a more democratic and inclusive fashion ecosystem.

There is also consideration for the economic viability within the model. The hypothetical DAO model described in this paper takes into account economic viability, integrating features that both generate revenue and cut costs (Porter, 2001). The very core of the blockchain, being its decentralised nature, allows for reduced managerial costs. At the same time, smart contracts offer the possibility of automation of many functions, saving both time and money.

Early adopter advantage is another factor worth considering when developing a fashion DAO model. Brands, designers, or suppliers that would join the fashion DAO in its early stages would benefit from first-adopter advantages, setting industry standards as well as earning a larger share of community influence (Christensen, 1997). They could also benefit from the network effect as more members join, seeing as their early presence would make them a go-to for newcomers, making it advantageous both socially and economically. Additionally, early membership or token acquisition would be more cost-effective during the early stages of a DAO. As demand increases, the cost of tokens and participation would also rise, giving early adopters a financial advantage.

Another consideration is consumer expectations, as today's consumers are more aware and more demanding of transparency, ethical manufacturing, and sustainability (Granskog et al., 2020). The fashion DAO proposed in this paper will aim to take these expectations into account, offering transparent and sustainable supply chains and ethical practices.

Skill diversity can be considered a key contributing factor in the fashion industry, requiring both specialised craftsmanship and innovative and creative designers (Zahra, 2021). The fashion DAO would operate as a free market, one in which the community would guide all of the stages in the design processes, and by community votes, more capable craftsmen and more creative designers would gain prominence in the network.

Scepticism towards new technologies is a given in any industry, including fashion (Tong, 2022). As such, this apprehension would also pose a challenge to the wide acceptance of the new paradigm of the fashion industry, that is, our fashion DAO. To best combat this, a phased implementation strategy would have to be used while also integrating educational campaigns that would bring the technology to public awareness.

Another consideration is presented in the question of creative direction (VanderPloeg, 2018). While the proposed fashion DAO would lack a central authority that would lead the creative process, the role of the creative director will go to the community as a whole. In other words, the DAO network would act as a filter that would, through their votes, act as a democratic crucible where designs are subjected to collective scrutiny. As such, only the best and most widely accepted designs would come through, while the others would be filtered out.

A final fashion-specific consideration here would be the concept of consumer protection. Consumer protection is an important aspect of the fashion industry, and within our fashion DAO, the data interests of the customer would be insured by the inclusion of specific measures encoded within the blockchain. The quality assurance of the product, on the other hand, could be handled through a decentralised verification system. Products would be tracked throughout their lifecycle, from raw material to finished product, via the blockchain and with the inclusion of AI. This would ensure full traceability and enable the consumer to verify the quality and authenticity of the products they are purchasing.

The subsequent two chapters will delve into the governance and management of the proposed fashion DAO, respectively. Guided by the critical key points listed and outlined in the framework, they will offer an exhaustive exploration of the mechanics and functionalities that constitute the said DAO. This meticulous examination will aim

to paint a holistic picture of the ways in which the envisioned fashion DAO could operate in practice.

3.1.1 Fashion DAO Governance

The following subchapter will look more closely into the underpinning governance structures of our proposed fashion DAO, focusing on core components like Smart Contracts, Governance Tokens and Voting. It will explore various modes of decentralised governance, such as algorithmic and participatory DAOs, as well as novel modes like “futarchy”. The chapter is aimed at analysing the most suitable governance structures for the optimal functioning of our proposed fashion DAO.

As argued by Wang et al. (2019), governance in a DAO typically starts in a fully centralised manner, evolving towards a fully decentralised one once all of the members have an equal say in organisational decisions. This would also be the case for our fashion DAO, seeing as an immediate and full transition from the traditional model towards a fully decentralised DAO would not be possible. Rather, there would be a gradual transition that could take years or even decades. This is due to the very nature and size of the fashion industry, and the fact of just how big of a role fashion plays in economies of many countries around the world. Regardless, we will work on a hypothesis that such a shift would be immediate and formulate the theory around governance in fashion DAO based on the idea of a complete and industry-wide transition to such an operational model.

Two main forms of decentralised governance have been identified by Wright (2021): algorithmic DAOs and participatory DAOs. The choice between these two forms comes down to the goals of a DAO, the type of decisions it is supposed to make and the type of community it will foster. This paper suggests the use of both a participatory DAO and an algorithmic DAO in our proposed fashion network due to the opportunities both offer for different operations within the industry. As such, a hybrid model is most appropriate. As a reminder, algorithmic DAOs function based on the code written in the software, while participatory DAOs rely on the votes of their participants for decision-making. Therefore, both are crucial for different operations in the governance and execution of operations within the fashion industry network.

The concept of the hybrid model of decentralised governance also resonates with the dual system of governance in a DAO, as identified by Santana and Albareda (2022). This framework highlights the fusion of both on-chain machine consensus mechanisms as well as off-chain participatory voting rights. On the one hand, on-chain machine consensus, as has been looked into in the previous chapter in the

context of the fashion industry, allows for the execution of pre-defined rules of the network. The decisions are carried out quickly and transparently, thus minimising the possibilities of conflicts or manual errors and making the whole DAO fashion system more secure and trustworthy. On the other hand, the off-chain voting mechanism offers the dynamics and flexibilities that are often required in more complex organisational situations. Due to their nature, they allow for human judgement to play a part in the process by grouping the collective judgement of all of the participants into a unanimous decision that is to be carried out. These voting rights allow for the fashion DAO to be responsive in terms of potential challenges that arrive, which have not been anticipated by the initial code. Together, these two governance models form a comprehensive governance framework, offering a balanced approach to governing in a decentralised fashion network.

Regarding the choice between Group Governance and Social Governance, as identified by Qin et al. (2023), our hypothetical fashion DAO leans toward Social Governance for the following reasons. The reason is due to the nature of the fashion industry, which is characterised by its interconnectivity with other industries as well as its very collaborative nature. As a reminder, Group Governance is focused on the internal structures of a DAO, primarily revolving around the decisions made within the specific organisation. On the other hand, Social Governance goes beyond the boundaries of a specific organisation and concerns itself with how it interacts with other external entities. This is of vital importance to a fashion industry based DAO, seeing as the fashion market relies on collaboration with external organisations for its functioning. For instance, it provides flexibility to align the objectives of our fashion DAO with broader goals that we identified in previous chapters, such as ethical considerations and sustainable sourcing and labour practices, and as such, shape the industry standards.

When developing our proposal for governance models for our fashion DAO, it is imperative to look into the intricacies of potential challenges, such as the “governance paradox” outlined by Tan, Mahula, and Cromptvoets (2022). This paradox comes from the inherent contradictions in the blockchain, seeing as the very cornerstone of transparency and decentralisation can bring about inefficiencies and disputes in governance. This “governance paradox” could also pose a challenge in the hypothetical fashion DAO this paper is proposing, as the decisions surrounding the design process, supply chain, management and partnerships could become impaired

due to the democratic processes in the network, thus causing inefficiencies. The paradox could also manifest in trying to resolve conflicts within the network. For example, if the network cannot agree on the design direction, some sort of centralisation would have to occur in order to make a decision, thus undermining the foundational principle of decentralised governance. Our use of both on-chain and off-chain governance models within our fashion DAO will help combat this paradox, as minor decisions would be automated. In contrast, larger ones would be voted on by the community. Another way to reconcile this paradox is through the use of novel modes of governance, such as “futarchy”, as proposed by Singh & Kim (2019). Futarchy would use prediction mechanisms that would predict some of the market-based decisions within the industry and could also help in trend analysis. It could also help in leveraging collective intelligence through predictive mechanisms, which could offer a transformative advantage for our fashion DAO, allowing the network to anticipate the outcomes of group decisions better. This foresight would be able to inform stakeholders and refine the decision-making processes, improving the collective knowledge for future governance activities within the network.

3.1.2 Fashion DAO Management

In the transformative landscape of Decentralised Autonomous Organisations (DAOs), our hypothetical Fashion DAO stands as an exemplary model of modern management principles adapted for the blockchain era. The management style differs greatly from the management styles of traditional fashion organisations. One of the most notable differences is in power dynamics within the system. Whereas the traditional fashion brand is centralised and characterised by a pyramidal organisational structure where a small number of individuals dictate the operations of the entire company, the blockchain-based fashion industry would have a distributed network where decision-making powers are proportionate among the participants, be it designers, producers, customers, etc. This system would not only make all of the operations on the network democratic but also add a layer of accountability for all the participants, incentivising them to partake in the decision-making processes (Wang et al., 2019).

Another important consideration for our fashion DAO is the voting mechanism it would employ. The question here is the choice between weighed and unweighed votes. Both options have their own set of advantages and disadvantages, which will hereby be evaluated. When it comes to the weighted voting mechanism, and in the context of our topic, the participants in the network would have different weightages based on predetermined factors, anything from the level of investment in a project to even tenure with the DAO. Therefore, the participants who have more at stake would have more influence on decision-making, reflecting a form of democratic governance that also incorporates elements of stakeholder capitalism. Strategically, this might encourage greater investment on the part of the stakeholders, who would want to see their increased stakes grant them power within the organisation. This closely aligns with the current condition of the fashion market, one where large amounts of capital are in circulation.

However, this very system would defeat the purpose of having a DAO-based fashion network in the first place. If the weighted mechanism were in place, the power balance of the participants within the network would be skewed, making it more similar to the traditional model than to the ideal decentralised DAO. This accumulation of decision-making power would lead to risk-averse behaviours within the network, stifling the creativity the same network has the potential to foster. On the other hand, an unweighted voting mechanism offers the benefit of a fully democratised network,

one that offers a sense of equality and inclusion for all of the participants. It is for these reasons that we have opted for the use of this particular voting mechanism in our hypothetical Fashion DAO.

The next point for consideration is the use of tokens that could potentially help in reducing the inequality between capital and labour, a point raised by Sims (2019). In this sense, tokens act not only as a unit of currency but also as a medium in democratising organisational power dynamics. This means that the individuals participating in the DAO, who could be designers, supply chain workers, or even consumers, would acquire tokens as a reward for their labour or investment in the DAO. This mechanism is particularly valuable for the labour force, which, in the traditional model of organisation, has a very limited input on governance matters. In a DAO-based fashion system, these workers would get a right to vote for all of the matters concerning the DAO they participate in. This would not only bridge the gap between capital and labour but also change the whole mode of management within the system, providing a more inclusive, equitable environment.

In the context of this paper, the "Parallel Management Framework", as proposed by Wang et al. in 2023, represents a shift in the way management functions within decentralised organisations. The framework proposes that, for the effective management of a DAO, there must be consideration for three distinct "worlds": the physical one, where tangible actions and interactions occur; the psychological world, which consists of human emotions, judgments, and motivations; and the artificial world, characterised by algorithms, data analytics, as well as other technological interventions. In the context of our proposed DAO, this would entail leveraging AI technology for data-driven decision-making, as well as automating certain governance protocols and enhancing operational efficiency. AI technology could be used in other ways as well, from having AI customer service assistants to AI bots assisting in supply chain management, and as such, creating a seamless loop of feedback-driven outcomes, which Li et al. refer to as "Circular Causality." The psychological world would be embodied by the voting rights participants in a DAO have, and the physical world would represent the final product of the fashion industry, this being tangible clothing a customer would receive.

Despite the number of benefits to managerial practices of the fashion DAO, there are still some drawbacks to consider. An especially significant one to take into account is

the possibility of determinism within the system. Determinism, in this sense, means that the DAO operates based on pre-defined rules, which could stifle innovation or even lead to legal issues in case of coded rules clashing with the norms or laws in which it operates (Tan et al., 2022). In our hypothetical fashion DAO, taking into account these challenges is vital given the very dynamic nature of the industry itself. An important factor in minimising the problems associated with determinism is the choice of the form of decentralised governance. As we have noted previously, this hypothetical fashion DAO would employ a hybrid model, which would mean that there is still human input into the operations of the organisation, and thus, the problem of determinism is lesser than it would've been had the model of governance been an algorithmic rather than a hybrid one. Regardless, the issue of legal challenges pertains, and the legal system will have to evolve to be able to facilitate the broader adoption of DAOs across industries, including the fashion one.

3.2 DAOs in the Fashion Industry

In this section, we simplify the complex idea of Decentralised Autonomous Organisations (DAOs) in fashion. We use a clear, practical example to explain how blockchain technology could transform the fashion industry. Despite growing interest in this area, there's still a big knowledge gap in applying these new technologies in fields like fashion, both in academic studies and industry practice. To address this, we introduce a hypothetical but realistic example of a fashion DAO, explaining its structure, operations, and possible effects on the industry, building on the concepts discussed earlier in the paper. Through this example, the chapter intends to provide a clear, accessible insight into the application of DAOs in fashion, addressing both theoretical and practical aspects.

In the upcoming section, we'll focus on our example fashion DAO, called "PFFDAO" (Proposed Fashion Framework DAO). This part builds on what we've already discussed about PFFDAO, going into more detail on how it would work in the real world of fashion. We'll revisit PFFDAO's key features, not just to deepen our theoretical understanding, but also to show how these ideas could be practically applied in the ever-changing world of fashion. This comprehensive analysis will include both the operational mechanics of PFFDAO and as well as their strategic implications. As such, it will be presenting a holistic view of its potential efficacy and impact.

When it comes to the operational structure of the Proposed Fashion Framework Decentralised Autonomous Organisation (PFFDAO), its governance model operates on a decentralised platform, similar to a digital community council. Here, the collective decision-making is central. This model democratises the fashion industry, allowing all members, from designers and suppliers to customers and investors, to actively participate in and influence organisational decisions.

As made clear before, the decision-making within PFFDAO is conducted through a transparent voting process. Each member, be it a designer, supplier, customer, or investor, is granted voting rights. This enables them to influence decisions ranging from design selections to ethical practice implementations. This process is based on blockchain technology, which ensures that every decision that is made is being recorded and traceable, crucial for upholding transparency and accountability.

The Proposed Fashion Framework Decentralised Autonomous Organisation (PFFDAO) features a number of key roles, all of which play a vital part in its ecosystem. Designers in PFFDAO are at the forefront of creativity, proposing innovative fashion designs. Their role is pivotal, similar to the artists in an interactive gallery, where their creations are showcased to the whole DAO community for evaluation and feedback. This process democratises fashion design and also encourages a wide range of styles and trends, making the fashion landscape more inclusive.

Suppliers within PFFDAO are fundamental to the integrity of the supply chain. Suppliers have the responsibility of sourcing materials as well as overseeing production. In addition to this, there is also a strong emphasis on sustainability and ethical practices. Their role goes beyond mere procurement. It involves ensuring that the entire production process is in line with the environmental and social values of PFFDAO. This dedication to ethical practices is not only a moral obligation but also a strategic asset in a market that is increasingly aware of environmental concerns.

Customers in PFFDAO play a dynamic and interactive role. They are not mere consumers, rather, they actively participate in shaping the fashion narrative. This participation can extend to proposing the designs they've made themselves for community voting, and as such blurring the lines between consumer and creator. Their feedback and choices directly influence the brand direction. This makes PFFDAO a truly customer-driven entity, something not quite accomplished ever before in the fashion industry. This innovative model not only enhances customer engagement, it also ensures that the products resonate more deeply with the market.

Investors and stakeholders are crucial to PFFDAO's financial stability, akin to shareholders in traditional firms but more actively involved in decisions. Their investment not only funds PFFDAO's operations but also gives them influence over its strategic choices. This approach aligns PFFDAO's financial goals with its wider objectives, fostering a sustainable and progressive entity that prioritises both profit and ethical, creative values.

A fundamental characteristic of PFFDAO is its dynamic, inclusive environment, where roles are flexible, allowing members to assume various positions or shift between them. This structure enables individuals to participate in different capacities, such as designer, supplier, or customer, enriching the ecosystem with diverse skills and

viewpoints. Each decision, from design to supply chain, is made democratically, fostering a collaborative, member-led operation. This approach transforms the fashion industry into a more inclusive and adaptable sector, encouraging collective input and innovation, and marks a significant shift towards a more responsive and community-focused industry.

When it comes to the technological background of our PFFDAO framework, it plays an essential role in its effective functioning. This base primarily consists of blockchain technology and smart contracts, each playing a vital role in maintaining transparency, efficiency, and security in the operations of the DAO.

An innovative feature of PFFDAO's operations is the use of token-based rewards. These digital tokens or cryptocurrencies act as a means of exchange within the DAO. They facilitate transactions and reward contributions throughout the network, encouraging active participation and helping to maintain a self-sustaining economic framework within the DAO.

In PFFDAO, agreements and transactions are governed using smart contracts. These digital contracts streamline processes like managing royalties and payments, ensuring compliance with the set terms. This not only boosts efficiency but also reduces the likelihood of disputes and non-compliance, thereby strengthening PFFDAO's operational integrity.

At the heart of PFFDAO's technology is blockchain, acting as a decentralised record system that accurately logs every transaction and interaction within the DAO. This ledger resembles a transparent, permanent digital logbook where each entry is time-stamped and open for verification by DAO members. This level of transparency is vital in the fashion industry, ensuring the permanence and immutability of records, from design submissions to sales. This feature of the blockchain fosters trust and dependability among PFFDAO members.

Smart contracts complement blockchain in PFFDAO. They are digital protocols that automatically carry out agreement terms when specific conditions are met. These contracts, encoded on the blockchain, function like self-executing legal agreements. They handle various DAO processes, from automating voting and decision-making to managing payments and royalties. By reducing the need for intermediaries, smart contracts streamline operations, significantly boosting the DAO's efficiency.

PFFDAO's security is enhanced by blockchain's decentralised structure, which spreads data across numerous nodes, reducing risks of tampering and fraud. Additionally, smart contracts boost this security by ensuring the precise execution of agreements and transactions within PFFDAO, creating a trustless operational environment.

In PFFDAO, the workflow covers a fashion product's entire life cycle, from initial design to final purchase. This cycle is marked by its democratic and transparent approach at every stage, ensuring the product's journey is in line with the values and standards of the DAO community.

The lifecycle commences with the design conception stage. Anyone is able to adopt the role of the designer, making this one of the most novel aspects of our PFFDAO. Here, designers, who are integral members of the PFFDAO, submit their creative works to the DAO. In PFFDAO, design submissions are open to all members, not just a select few, reflecting the organisation's democratic nature. This process exemplifies the inclusive nature of PFFDAO, ensuring that the designs selected truly represent the collective preferences of the community. The voting, enabled by the DAO's tech infrastructure, plays a crucial role in this inclusive decision-making process. This inclusive approach enriches the industry's creative output.

Once a design is chosen in PFFDAO, the next step is creating a prototype. This stage involves collaboration among designers, suppliers, and manufacturers within PFFDAO. This stage is crucial for evaluating the design's viability and practicality. The participation of diverse stakeholders brings various perspectives, leading to a prototype that is both refined and functional.

After the prototype is approved in PFFDAO, the product moves to the production stage. This phase is characterised by its commitment to transparency and ethical practices. The PFFDAO ensures that every step of the supply chain, from material sourcing to manufacturing, is transparent and open to all members. Another key advantage is in reducing waste and the industry's environmental impact. This system optimizes resource allocation and curbs overproduction, contributing to a more sustainable fashion landscape. Such openness guarantees that production aligns with the ethical standards and sustainability objectives of the community, highlighting PFFDAO's dedication to responsible fashion.

Quality control and logistics are subsequent stages managed by the DAO. Here, the PFFDAO oversees the entire process, ensuring that the products not only meet the established quality standards but are also delivered efficiently to the market. This oversight is critical in maintaining the reputation for quality and reliability.

After meeting the required standards, the products are sold through a PFFDAO-managed platform. Every transaction within the system is logged on the blockchain, enhancing transparency and security. This process ensures that consumers are not only purchasing a product but are also engaging with an ethical and transparent ecosystem.

The final stage in the product lifecycle is the feedback and improvement phase. Here, post-purchase, customers are encouraged to provide feedback on the products. This feedback is crucial as it forms the basis for continuous improvement and evolution of products and practices within the PFFDAO. It ensures that the DAO remains dynamic and responsive to consumer needs and preferences. In essence, the process flow within PFFDAO exemplifies a model where each stage of a product's life is democratised and transparent.

In order to more clearly demonstrate the said lifecycle, we will present a step-by-step illustration of how the Proposed Fashion Framework Decentralised Autonomous Organisation (PFFDAO) functions in real-world scenarios, highlighting the interactions between designers, suppliers, and customers:

1. **Design Submission:** Initially, designers, who could be anyone from the DAO community, submit their fashion designs to the PFFDAO platform. This open submission policy encourages diversity and inclusivity in design creation.
2. **Community Voting:** Once designs are submitted, they are presented to the entire DAO community. Members such as designers, customers, and investors are involved in a voting system enabled by blockchain technology. This setup ensures that the selection of designs is transparent and fair, reflecting the preferences of the community.
3. **Design Selection:** The designs that garner the most votes move to the next phase. This democratic approach ensures that the most popular and community-backed designs are chosen for production.

4. **Supplier Engagement:** After a design is selected, suppliers are brought into the process. These suppliers are part of the PFFDAO network and are committed to ethical and sustainable practices. They source materials and begin the manufacturing process, adhering to the standards set by the community.
5. **Production Oversight:** Throughout the production phase, the blockchain-based system of PFFDAO allows for continuous monitoring and transparency. Members can track the production progress and ensure that all practices align with the DAO's ethical guidelines.
6. **Product Availability:** Once manufactured, the products are listed on a platform managed by PFFDAO. All of the members as well as the public can access the platform, where they can purchase the products.
7. **Customer Feedback:** After purchase, customers are encouraged to provide feedback on the products. This feedback is then being recorded on the blockchain, thus ensuring transparency and authenticity. It is then used for continuous improvement and influences future design and production decisions.
8. **Continuous Evolution:** The PFFDAO analyses feedback and data, leading to improvements in various areas like design and manufacturing. This iterative process ensures that PFFDAO stays adaptable, responsive, and continually evolves based on actual interactions and feedback.

This process can be made even more clear by imagining it through a hypothetical scenario such as the following one. Imagine someone joins PFFDAO with a unique insight or creative vision and develops a fashion design. This design is then uploaded to the PFFDAO platform. This submission process is supported by a user-friendly interface that guides the designer through uploading designs, including detailed descriptions and visuals, ensuring clarity and comprehensiveness for voters. When this someone submits a design to the PFFDAO platform, blockchain's cryptographic security ensures the design's authenticity and originality are preserved, protecting the designer's intellectual property.

During community voting, blockchain records each vote in a secure, unchangeable manner, preventing tampering and ensuring transparency. Following this, after a design receives community approval, the next step is to select a supplier. Suppliers

interested in producing the approved design submit bids, including details such as material costs, production timelines, and sustainability practices. The community reviews these bids and votes for the supplier that best matches PFFDAO's values and the project's requirements. For supplier selection, smart contracts automatically enforce the community's decision based on voting outcomes, streamlining the process.

Stakeholders, including investors and partners, play a crucial role in the ecosystem by providing funding and strategic guidance. They participate in key decision-making processes through a voting system, influencing the selection of designs, supplier partnerships, and the direction of production strategies. Their practical involvement ensures that the DAO's operations not only stay true to its ethical and sustainable ethos but also remain financially viable and competitive. Their investments in PFFDAO designs are rewarded proportionally to the profits generated from sales. This mechanism encourages stakeholders to invest in designs they believe in, aligning their financial contributions with PFFDAO's success. The more successful a design becomes in the market, the greater the return on investment for those who backed it, fostering a financially motivated community committed to the organisation's innovative and ethical fashion initiatives. Stakeholders' investments are tracked on the blockchain, with smart contracts automatically distributing profits based on predefined rules, aligning financial incentives.

With a supplier chosen, the production process begins. Throughout this stage, the chosen supplier updates the PFFDAO platform with progress reports, material sourcing information, and any challenges encountered. This ongoing transparency allows PFFDAO members to monitor production in real-time, ensuring adherence to ethical standards and production quality. Blockchain technology plays a crucial role here, creating an immutable ledger of updates and changes. Throughout production, blockchain provides a real-time, immutable record of progress, materials, and any issues, ensuring accountability.

Upon completion, the product is listed for sale on the PFFDAO platform. This platform, accessible to both DAO members and the public, features blockchain-based transaction systems for secure purchases. Sales transactions are securely processed via blockchain, with customer feedback collected for continuous improvement, completing a cycle of innovation and community engagement. After buying a product,

customers are encouraged to leave feedback, which is then collected on the blockchain. This feedback is crucial for iterative improvement, influencing future design and production decisions.

PFFDAO's value in the fashion industry is diverse, emphasising ethical manufacturing, reducing waste, boosting creativity, and ensuring supply chain clarity. These advantages are practically achievable with PFFDAO's operational framework, establishing a new standard for ethical and sustainable fashion practices.

Adopting PFFDAO faces a potential obstacle in the complexity of blockchain technology. To tackle this, PFFDAO will introduce educational initiatives, like comprehensive guides, to demystify blockchain for all parties involved. Equally important is creating user-friendly interfaces for DAO interaction. PFFDAO strives to make participation accessible to all, regardless of their tech skills, by simplifying the user experience.

Addressing scepticism from traditional fashion entities is also a challenge for PFFDAO. Established brands might be wary of adopting new operational models., or see PFFDAO as a competitor. In order to overcome this, PFFDAO's strategy includes partnering with influential industry figures, demonstrating the practical advantages of DAOs. Success stories, improved efficiencies, ethical practices, and enhanced consumer trust will be highlighted to persuade the fashion industry of the benefits of adopting PFFDAO structures. Forming alliances with progressive industry members is key to overcoming doubts and resistance.

DAOs' innovative nature poses regulatory challenges due to differing global laws on blockchain and cryptocurrencies. PFFDAO plans to work with legal experts to navigate these complexities and comply with international regulations. This approach aims to foster legal frameworks that support DAOs in fashion, ensuring compliance and promoting the growth of blockchain in the industry.

Finally, as PFFDAO grows, scalability will become a critical issue. The infrastructure needs to be able to handle an increasing number of transactions, users, as well as data without compromising on either performance or security. To address this, PFFDAO will invest in robust technological infrastructure. This investment will focus on scalable blockchain solutions capable of supporting a growing ecosystem. In addition, continuous technological upgrades and the adoption of emerging blockchain

innovations would have to be essential. This is in order to ensure that PFFDAO remains efficient and effective while it expands.

In summary, PFFDAO leads in applying blockchain technology within the fashion industry. It revolutionises the traditional fashion product lifecycle, from design to sale, by incorporating blockchain technology in all its operations. PFFDAO is a model of democracy and transparency, reshaping how fashion operates and is experienced. The design conception stage leverages technology to enable any member to assume the role of designer, fostering a truly inclusive and innovative environment. This is followed by a technologically driven prototype development and production phase, where blockchain ensures transparency and ethical adherence in the supply chain. The quality control and logistics stages are meticulously overseen through smart contract protocols, ensuring efficiency and high standards. Consumer interaction with the DAO is revolutionised through blockchain-based transactions, providing unparalleled transparency and security. The feedback loop is also technologically mediated, allowing for real-time consumer insights and agile responses to market demands. However, PFFDAO navigates challenges such as technological complexities and resistance from traditional industry players. To mitigate these, the organisation is committed to developing educational resources and intuitive interfaces, making blockchain technology accessible to a broader audience. Strategic collaborations and advocacy for favourable regulations will further entrench PFFDAO's position as a leader in the intersection of technology and fashion. PFFDAO's value in the fashion industry is diverse, emphasising ethical manufacturing, reducing waste, boosting creativity, and ensuring supply chain clarity. These advantages are practically achievable with PFFDAO's operational framework, establishing a new standard for ethical and sustainable fashion practices.

Conclusion

In conclusion, this thesis has demonstrated the transformative potential of blockchain-based Decentralised Autonomous Organisations within the fashion industry. The research addressed key questions regarding the technological requirements, ethical considerations and governmental structures pertinent to implementing DAOs within the said sector. Based on the findings, DAOs possess the capacity to revolutionise governance structures, enhance transparency, and foster collaborative decision-making in the fashion industry.

The developed theoretical framework has highlighted the optimal structural choices that would serve as a guideline for the governance and management of DAOs specifically tailored to the fashion industry. The framework has incorporated the theories that were explored in the literature review of the paper and integrated them within the context of fashion-specific, industry-wide DAO. The discussion of the framework in this thesis offered a strictly chosen selection of the optimal technological and governance features tailored specifically for the effective deployment of DAOs in the fashion industry. On the technological side, the framework suggests the use of Proof of Stake (PoS) for consensus building, asymmetric encryption for enhanced security, on-chain data storage for operational integrity, and a permissionless architecture as a way to foster inclusivity and innovation. In the governance and management domain, the framework recommends a hybrid model of decentralised governance, favouring social governance over group-based alternatives and advocating for an unweighted voting mechanism as opposed to a weighted one. The framework has also identified fashion-specific factors that should be considered when conceptualising a fashion DAO. These have included the role of technology in enhancing design capabilities, avenues for industry collaboration, considerations for economic viability, advantages for early adopters, consumer preferences and expectations, specialised skill requirements in labour, scepticism surrounding the adoption of DAOs, challenges related to maintaining creative direction, and the importance of consumer protection measures. All of these elements have helped to form a robust, holistic model designed to navigate the complexities inherent to both decentralised technologies and the fashion industry.

In our Proposed Fashion Framework DAO (PFFDAO) chapter, we explored the practical application of DAOs in the fashion industry, providing a detailed walkthrough

of the entire product lifecycle. We illustrated how PFFDAO could revolutionise each stage, from design conception to consumer purchase, in a real-world setting. This comprehensive overview highlighted how the integration of cutting-edge blockchain technology and smart contracts would facilitate these processes. We delved into the operational intricacies, showcasing how PFFDAO's unique structure would empower transparent and ethical practices throughout the industry, thereby setting a new standard for innovation and sustainability in fashion.

Several challenges and limitations to the integration of DAOs in the fashion industry have been identified in this study. These challenges encompass regulatory hurdles, particularly concerning blockchain technology and smart contracts; data security risks, given that blockchain, is still a maturing technology; cultural resistance within the industry, which is often rooted in traditional ways of operating; and scalability issues, especially when dealing with complex supply chains and various stakeholders. Furthermore, ethical considerations, such as equitable distribution of decision-making power and ensuring environmental sustainability, also emerged as significant challenges in the study. Overcoming these challenges would require multi-stakeholder collaboration, continuous technological innovation, as well as regulatory clarity. Furthermore, due to the fast-evolving nature of blockchain technology that forms the basis of this study, it should be viewed as a starting point, subject to iterative improvements and adaptability to the latest advancements and understanding in the field.

The aforementioned challenges could serve as a guiding point for the direction of further research. Further exploration of these challenges might offer more nuanced solutions and strategies for industry adoption. In-depth case studies would also be useful in evaluating DAOs in the context of fashion, as the current research on the topic is non-existent. Overall, each challenge identified offers an opportunity for further academic research that would help in the formation of a comprehensive overview and evaluation of the potential of DAOs in the fashion industry. The great possibilities of research would not only deepen the understanding of the hypothetical concept but also drive practical advancements in the field.

Bibliography

1. Allied Market Research. (2023). Smart Contracts Market Size, Share & Analysis 2032. Retrieved from [www.alliedmarketresearch.com]
2. Akram, S.V., Malik, P.K., Singh, R., Gehlot, A., Juyal, A., Ghafoor, K.Z., & Shrestha, S. (2022). Implementation of Digitalised Technologies for Fashion Industry 4.0: Opportunities and Challenges. *Scientific Programming*, 2022. DOI:10.1155/2022/7523246
3. Ante, L., Fiedler, I., & Sandner, P. (2020). The state of adoption and existing applications in the field of blockchain and decentralised technologies—A systematic literature review. *Business Research*, 1-50. DOI:10.4067/S0718-27242021000300089
4. Cai, T., Chen, W., Psannis, K. E., Goudos, S. K., Yu, Y., Zheng, Z., & Wan, S. (2022). Scalable on-chain and off-chain blockchain for sharing economy in large-scale wireless networks. *IEEE Wireless Communications*, 29(3), 32-38. DOI: <https://doi.org/10.1109/MWC.004.2100616>
5. Chan, T.Y. & Wong, C.W. (2012). The consumption side of sustainable fashion supply chain: Understanding fashion consumer eco-fashion consumption decision. *Journal of Fashion Marketing and Management: An International Journal*, 16(2), 193-215. DOI: <https://doi.org/10.1108/13612021211222824>
6. Chod, J., Trichakis, N., & Yang, S. A. (2022). Platform tokenization: Financing, governance, and moral hazard. *Management Science*, 68(9), 6411-6433. DOI: <https://doi.org/10.1287/mnsc.2021.4225>
7. Christensen, C. M. (1997). Marketing strategy: Learning by doing. *Harvard Business Review*, 75(6), 141-151.
8. Crane, D. (2016). The puzzle of the ethical fashion consumer: Implications for the future of the fashion system. *International Journal of Fashion Studies*, 3(2), 249-265. DOI: https://doi.org/10.1386/inf.3.2.249_1
9. Dilger, W. (1997). Decentralised autonomous organisation of the intelligent home according to the principle of the immune system. *1997 IEEE International Conference on Systems, Man, and Cybernetics*, Vol. 1, pp. 351-356.

10. Fernández-Caramés, T.M. & Fraga-Lamas, P. (2018). A Review on the Use of Blockchain for the Internet of Things. *IEEE Access*, 6, pp. 32979-33001. DOI: <https://doi.org/10.1109/ACCESS.2018.2842685>
11. Grand View Research. (2023). Smart Contracts Market Size, Share & Analysis Report, 2030. Retrieved from [www.grandviewresearch.com]
12. Granskog, A., Lee, L., Magnus, K. H., & Sawers, C. (2020). Survey: Consumer sentiment on sustainability in fashion. McKinsey & Company, 17. URL: <https://www.mckinsey.com/industries/retail/our-insights/survey-consumer-sentiment-on-sustainability-in-fashion>
13. Hahn, J. (2021). Virtual Gucci Wanna digital sneaker. (2021). Dezeen. Retrieved from <https://www.dezeen.com/2021/03/19/virtual-25-gucci-wanna-digital-sneaker/#:~:text=Gucci%20creative%20director%20Alessandro%20Michele.in%20photographs%20for%20social%20media>
14. Harba, J. (2019). New approaches to customer experience: where disruptive technological innovation meets luxury fashion. *Proceedings of the International Conference on Business Excellence*, 13(1) 740-758. DOI: <https://doi.org/10.2478/picbe-2019-0066>
15. Holmstrom, B. (1982). Moral hazard in teams. *The Bell journal of economics*, 324-340.
16. Huddart, S., & Liang, P. J. (2005). Profit sharing and monitoring in partnerships. *Journal of Accounting and Economics*, 40(1-3), 153-187. DOI: <https://doi.org/10.1016/j.jacceco.2005.04.008>
17. Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs, and ownership structure. *Journal of Financial Economics*, 3(4), 305-360. DOI: [https://doi.org/10.1016/0304-405X\(76\)90026-X](https://doi.org/10.1016/0304-405X(76)90026-X)
18. Latus, V. (2023). The Economics of Decentralised Autonomous Organizations. DOI: 10.2139/ssrn.4320196.
19. Liu, Z., Li, Y., Min, Q., & Chang, M. (2022). User incentive mechanism in blockchain-based online community: An empirical study of Steemit. *Information & Management*, 59(7), Article 103596. DOI: <https://doi.org/10.1016/j.im.2022.103596>

20. Liu, L., Zhou, S., Huang, H., & Zheng, Z. (2021). From technology to society: An overview of blockchain-based DAO. *IEEE Open Journal of the Computer Society*, 2, 204-215. DOI: <https://doi.org/10.1109/ojcs.2021.3072661>
21. McDowell, M. (2023). Place an order, get a promo: Why brands are investing in post-purchase tech. *Vogue Business*. <https://www.voguebusiness.com/technology/place-an-order-get-a-promo-why-brands-are-investing-in-post-purchase-tech>
22. Mingxiao, D., Xiaofeng, M., Zhe, Z., Xiangwei, W., & Qijun, C. (2017). A review on consensus algorithm of blockchain. In *Proceedings of the 2017 IEEE International Conference on Systems, Man, and Cybernetics (SMC)*, pp. 2567-2572. DOI: <https://doi.org/10.1109/SMC.2017.8123011>
23. Mekacher, A., Bracci, A., Nadini, M., et al. (2022). Heterogeneous rarity patterns drive price dynamics in NFT collections. *Scientific Reports*, 12(13890). DOI: <https://doi.org/10.1038/s41598-022-17922-5>
24. Nadini, M., Alessandretti, L., Di Giacinto, F., et al. (2021). Mapping the NFT revolution: market trends, trade networks, and visual features. *Scientific Reports*, 11(20902). DOI: <https://doi.org/10.1038/s41598-021-00053-8>
25. Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system.
26. Nisanth Reddy Kasi, Ramani S, Marimuthu Karuppiah. (2022). Chapter 1 - Blockchain architecture, taxonomy, challenges, and applications. *Hybrid Computational Intelligence for Pattern Analysis, Blockchain Technology for Emerging Applications*. DOI: <https://doi.org/10.1016/B978-0-323-90193-2.00001-6>
27. Naudts, E. (2023, October). *The future of DAOs in finance - in need of legal status*. *ECB Occasional Paper No. 2023/331*. SSRN. DOI: <https://doi.org/10.2139/ssrn.4605627>
28. Periyasamy, A. P., & Periyasami, S. (2023). Rise of digital fashion and metaverse: Influence on sustainability. *DESD*, 1, 16. DOI:10.1007/s44265-023-00016-z
29. Porter, M. E., & Michael; ilustraciones Gibbs. (2001). *Strategy and the Internet*.
30. Puiu,A.(2019).Analysis of the Consumer Knowledge and Attitude toward Innovations in the Fashion Industry. *Proceedings of the International Conference on Applied Statistics*,1(1) 407-418. DOI: <https://doi.org/10.2478/icas-2019-0035>

31. Qin, R., Wang, G., Li, J., Wang, F. Y., Gan, Y., & Yan, L. (2023). A Novel DAO-Based Parallel Enterprise Management Framework in Web3 Era. *IEEE Transactions on Computational Social Systems*. DOI: <https://doi.org/10.1109/TCSS.2023.3239059>
32. Rennie, E., & Holcombe-James, I. (2022). Developments in Web3 for the Creative Industries. *Australia Council for the Arts*. https://creative.gov.au/wp-content/uploads/2022/11/Rennie-et-al_2022_Developments-in-Web3-for-the-creative-industries_Front-matter.pdf
33. Roberts-Islam, B. (2019). World's first digital-only blockchain clothing sells for \$9,500. *Forbes*. Retrieved from <https://www.forbes.com/sites/brookerobertsislam/2019/05/14/worlds-first-digital-only-blockchain-clothing-sells-for-9500/?sh=5a678435179c>
34. Santana, C., & Albareda, L. (2022). Blockchain and the emergence of Decentralized Autonomous Organizations (DAOs): An integrative model and research agenda. *Technological Forecasting and Social Change*, 182, 121806. DOI: <https://doi.org/10.1016/j.techfore.2022.121806>.
35. Sims, A. (2019). Blockchain and Decentralised Autonomous Organisations (DAOs): the evolution of companies? DOI: <http://dx.doi.org/10.2139/ssrn.3524674>
36. Singh, M., & Kim, S. (2019). Blockchain technology for decentralized autonomous organizations. *In Advances in computers*, Vol. 115, pp. 115-140. DOI: <https://doi.org/10.1016/bs.adcom.2019.06.001>
37. Solat, S., Calvez, P., & Naït-Abdesselam, F. (2020). Permissioned vs. Permissionless Blockchain: How and why there is only one right choice. *Journal of Software*, 16, 95-106. DOI: <https://doi.org/10.17706/jsw.16.3.95-106>.
38. Sun, L., & Zhao, L. (2018). Technology disruptions: Exploring the changing roles of designers, makers, and users in the fashion industry. *International Journal of Fashion Design, Technology and Education*, 11(3), 362-374. DOI: <https://doi.org/10.1080/17543266.2018.1448462>.
39. Tan, T. M., & Saraniemi, S. (2023). Trust in blockchain-enabled exchanges: Future directions in blockchain marketing. *Journal of the Academy of Marketing Science*, 51(4), 914-939. DOI: <https://doi.org/10.1007/s11747-022-00889-0>.
40. Tapscott, D., & Tapscott, A. (2016). *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World*.

41. Thomas, D. (2021). Dolce & Gabbana Just Set a \$6 Million Record for Fashion NFTs. The New York Times. <https://www.nytimes.com/2021/10/04/style/dolce-gabbana-nft.html>
42. Tong, A. (2022). Non-fungible token, market development, trading models, and impact in China. *Asian Business Review*, 12(1), 7-16. DOI: <https://doi.org/10.18034/abr.v12i1.607>.
43. Torraco, R. J. (2005). Writing integrative literature reviews: Guidelines and examples. *Human Resource Development Review*, 4(3), 356-367. DOI: <https://doi.org/10.1177/1534484305278283>.
44. Thomassey, S. & Zeng, X. (2018). Introduction: artificial intelligence for fashion industry in the big data era (pp. 1-6). *Springer Singapore*. DOI: https://doi.org/10.1007/978-981-13-0080-6_1
45. VanderPloeg, A.J. & Lee, S.E. (2018). The role of the creative director in sustaining the luxury brand. *Fashion, Style & Popular Culture*, 5(3), 343-358. DOI: https://doi.org/10.1386/fspc.5.3.343_1.
46. Wang, S., Ding, W., Li, J., Yuan, Y., Ouyang, L., & Wang, F.Y. (2019). Decentralized autonomous organizations: Concept, model, and applications. *IEEE Transactions on Computational Social Systems*, 6(5), 870-878. DOI: <https://doi.org/10.1109/tcss.2019.2938190>.
47. Wang, S., Ding, W., Li, J., Yuan, Y., Ouyang, L., & Wang, F.Y. (2019). Decentralized autonomous organizations: Concept, model, and applications. *IEEE Transactions on Computational Social Systems*, 6(5), pp. 870-878. DOI:10.1109/TCSS.2019.2938190
48. Wang, G., Qin, R., Li, J., Wang, F. Y., Gan, Y., & Yan, L. (2023). A Novel DAO-Based Parallel Enterprise Management Framework in Web3 Era. *IEEE Transactions on Computational Social Systems*. DOI: <https://doi.org/10.1109/TCSS.2023.3239059>..
49. Wang, F. (2022). The DAO to MetaControl for MetaSystems in Metaverses: The system of parallel control systems for knowledge automation and control intelligence in CPSS. *IEEE*. DOI:10.1109/JAS.2022.106022
50. Wood, G. (2022). ETHEREUM: A secure decentralised generalised transaction ledger. Berlin Version beacfbf.

51. World Bank. (2018). Blockchain & Distributed Ledger Technology (DLT). Retrieved from <https://www.worldbank.org/en/topic/financialsector/brief/blockchain-dlt>
52. Weinstein, G., Lofchie, S., & Schwartz, J. (2022). A primer on DAOs. Harvard Law School Forum on Corporate Governance. Available at: <https://corpgov.law.harvard.edu/2022/09/17/a-primer-on-daos/>
53. Wright, A. (2021). The rise of decentralized autonomous organizations: Opportunities and challenges. *Stanford Journal of Blockchain Law & Policy*, 4(2), pp. 152-176.
54. Zahra, A. M., Dhewanto, W., & Utama, A. A. (2021). Boosting emerging technology adoption in SMEs: A case study of the fashion industry. *International Journal of Applied Business Research*, 169-185. DOI: <https://doi.org/10.35313/ijabr.v3i2.155>.
55. Zwięglinska, Z. (2022). How DAOs could change the fashion industry. Glossy. Retrieved from <https://www.glossy.co/fashion/how-daos-could-change-the-fashion-industry/>

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