



Master's degree thesis

LOG950 Logistics

Exploring Blockchain Applications in the Sports Industry: A Case Study of SL Benfica

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Acknowledgement

It all started a couple of years ago. I was sitting in my bed late at night wishing I was born 100 years ago. Thinking about all the “obvious” inventions we have today, that I probably would have invented; I would be a millionaire. As I kept playing with this chain of thoughts, I slowly began to realize that these “obvious” inventions would not be so obvious if I didn’t already know about them. I felt stupid, I felt funny, I felt curious. “What is going to be the next revolutionary invention?” I asked myself, before I could finish that thought I was already having the laptop in my lap, diving deep down on the internet, looking for answers. This is when I stumbled across “blockchain.” It was brilliant. I had heard about bitcoin, but never about blockchain. I quickly forgot everything about becoming a millionaire, I was obsessed by the concept. It baffled my mind, I had to learn more about it...I can’t remember falling asleep, I just passed out. When I woke up, just a couple of hours later, I did not feel tired... I felt ready. Ready to keep on with my investigation.

This experience taught me a very important life lesson. The purest form of motivation comes from feeling inspired. Therefore, I want to take this opportunity to thank some important and inspiring people in my life.

First and foremost, I want to thank my family for supporting me through this process and providing me with confidence in myself in times of doubt. I also want to thank my friends. I have a lot of different friends with different attributes and capabilities, and I don’t have a single friend I do not admire in some way.

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Abstract

In recent years blockchain has grabbed the attention of both researchers and industry professionals as it holds the capability to resolve complex issues and enhance processes across the entire supply chain. With time blockchain has proven to be very effective, and the effect is becoming well-documented across many industries. However, research on blockchain applications within the sports industry is scarce. Therefore, the aim of this thesis is to highlight possibilities of blockchain use-applications within the sport industry. Additionally, as there is a limited body of knowledge the thesis also aims towards helping others raising questions regarding future research. The thesis introduces and conceptualize blockchain in sports and explore opportunities, benefits, and challenges of incorporating blockchain in the sports supply chain. Furthermore, the thesis attempts to illuminate drivers, enablers, challenges, and desired outcomes of blockchain implementation.

The study is conducted as a case study with one of Europe's most decorated football clubs, Benfica. Research strategy and design is grounded in theoretical framework and the data collection were conducted in the form of interviews.

Main findings conclude that key drivers to blockchain implementation within the sports industry currently is to improve fan loyalty, increase revenue and promote innovation. Additionally, it explores the challenges presented by the interoperability across chains and implementation cost.

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1.0 Introduction

1.1 Chapter introduction

This chapter provides the reader with background information regarding blockchain technology as well as presenting advantages gained from the technology within different industries. Furthermore, the chapter highlights the research gap between blockchain technology and the sports industry. The chapter also states my problem definition and research questions and gives a clarification of how the rest of the thesis is structured.

1.2 Background for the thesis

The concept of blockchain was first introduced by Satoshi Nakamoto in 2008 as a peer-to-peer transaction platform. However, after discovering that the technology held a far greater potential, blockchain has gained considerable amount of attention both from various industries and academia in recent years (Gökalp et al., 2022). As a matter of fact, blockchain technology is progressing to be the most substantial technological revolution since the emerge of the Internet (Casino et al., 2021).

Moreover, a study containing more than thousand participants worldwide, suggests that blockchain is expected to be among the top five strategic priorities within the next two years (Gökalp et al., 2022). Blockchain technology presents promising solutions such as: decentralized management, immutable audit trail, privacy, security, data provenance, decreased total cost of ownership, and robustness (Gökalp et al., 2022). Thus, these attributes, together with blockchain technology, can be transferred into supply chain management and help companies enhance reliability, efficiency, transparency, and decrease their overall operation and logistics costs (Gökalp et al., 2022). Despite blockchains promising solutions, many aspects of blockchain innovation remain scarce in current literature (Laaraj et al., 2022).

Furthermore, industries are looking for innovative ways of staying ahead of the competition by utilizing blockchain technology (Pu & Lam, 2021). In the maritime

industry blockchain is expected to resolve industry specific challenges such as intensive paperwork, tedious processes, and data transparency. This will allow maritime companies to distinguish their services while simultaneously reducing cost; which is the most desirable hybrid business model for the maritime industry (Pu & Lam, 2021).

Within food supply chains, blockchain can provide reverse logistical control both upstream and downstream the supply chain; from the end-consumer all the way to the origin of the factory or farm (Casino et al., 2021). Moreover, it has the capability to bypass traditional authorities and ensure faster and secure transactions (Casino et al., 2021). The technology is expected to provide advantages in regards of supply chain traceability in the context of data interoperability, cost reduction, transparency, auditability, integrity and authenticity (Casino et al., 2021).

In the tourism sector there has been recognized significant use of blockchain technology within a range of domains, such as ticketing and reservations, tracking of baggage, inventory control, accreditation management, loyalty programs, and digital payments (Kwok & Koh, 2019). Regarding the sport industry, sport managers could apply similar blockchain strategies to ticketing (Naraine, 2019). However, blockchain has yet to be applied in other areas of the sport industry, particularly lacking research in the area of new digital payment and loyalty programs and data management (Naraine, 2019).

Since the beginning of the second decade of the current century, the sports industry has experienced a remarkable growth rate of 8.1% annually. And it is estimated that the industry will reach a total value of \$253.465 billion by 2024 (Lv et al., 2022). The introduction of blockchain technology has recently captured the attention of the industry, and its potential is being recognized by the industry's stakeholders (Lv et al., 2022). As a result, the integration of blockchain within the sports industry is expected to become a popular trend for innovation and development within the industry in the close future (Lv et al., 2022). However, from a theoretical perspective it is important to note that current research on sports blockchain is still in its emerging stages (Lv et al., 2022).

1.3 Problem Statement

As research on sports blockchain is still in an emerging stage, and the lack of research in particular areas, the problem statement addressed in this thesis is:

“How can sports companies strategically integrate blockchain technology to gain a competitive edge and improve overall supply chain performance.”

The thesis aims towards exploring both opportunities and challenges that may emerge when companies want to implement blockchain strategies. Furthermore, the thesis will attempt to enlighten the current body of research within the sports industry and blockchain by answering the following research questions:

RQ 1: Why should a sport company choose to implement blockchain technology?

RQ2: In what areas across the supply chain can a sport organization implement the use of blockchain technology?

RQ3: What challenges should a sport company expect in relation to the implementation of blockchain technology?

The study will be conducted as a single case study based on the sports company SL Benfica and further details about the company will be revealed in section “4.0 case description.”

1.4 Relevance and contribution of the study

This study contributes to the body of knowledge regarding blockchain in the sports industry, particularly regarding fan loyalty and fan engagement. Moreover, as this is a qualitative study it may be applied to futuristic quantitative studies as fundamental data. Furthermore, it helps raise important questions regarding blockchain in the sports industry and its use-cases. It may also contribute to improved knowledge towards blockchain and its implementation drivers, enablers, challenges and expected outcomes regarding the industry.

1.5 Structure of the study

Chapter two

Chapter two presents the reader with overview of the literature review and theoretical framework and concepts necessary to understand the findings, discussion, and conclusion. Furthermore, it presents viewpoints of other authors regarding relevant research.

Chapter three

Chapter three addresses methodology. This chapter provides the reader with an explanation of the research process. Furthermore, it provides information regarding research design, research strategies, and data collection.

Chapter four

Chapter four addresses the case company. The chapter equips the reader with information regarding the company's accomplishments and position within the market. Moreover, it presents the business supply chain, business model, and provides information regarding blockchain transition and utilization.

Chapter five

Chapter five presents the findings and analysis gathered by the process explained in chapter three. This chapter provides the reader with insight towards Benfica's blockchain journey and is grounded by direct quotes from the interview transcription.

Chapter six

Chapter six is a critical part of the thesis as it combines information from chapter two, four and five to illuminate the reader regarding blockchain implementation in the sports supply chain, and its challenges.

Chapter seven

Chapter seven concludes and summarizes the thesis, as well as presenting limitations and suggestions for future research.

2.0 Literature review

2.1 Chapter Introduction

This chapter provide the reader with literature regarding two main objectives. Firstly, it presents fundamental blockchain literature, to equip the reader with the necessary knowledge to understand the concepts and challenges presented later in the thesis. Secondly, the chapter provides an overview of blockchain in supply chain and presents pioneer cases within different industries.

2.2 Blockchain; a definition

The definition of blockchain

In literature there have been various forms of definition of a blockchain. However, from a technical perspective, blockchain can be defined as a peer-to-peer distributed digital ledger that utilizes cryptography to ensure its security, whilst simultaneously allowing for the addition of new data through a commonly agreed upon consensus mechanism, and ensuring that previous data records cannot be altered or deleted (Bashir, 2018).

It is important to note that a blockchain is a distributed system. A distributed system is a collection of nodes, where the nodes interact independently (van Steen & Tanenbaum, 2016). Nodes can be represented as hardware devices or software processes. Furthermore, the users of a distributed system have the experience of dealing with a single coherent system. Thus, the nodes are needed to collaborate. This collaboration is the core essence of developing a distributed system (van Steen & Tanenbaum, 2016). To understand blockchain technology it is therefore important to understand distributed systems (Bashir, 2018).

More specifically a blockchain is designed to work as a digitalized distributed ledger. Keep in mind that this ledger can be either centralized or decentralized. However, commonly, the intentions when utilizing blockchain technology are to utilize it as a decentralized form of governance (Bashir, 2018).

An elaboration of the definition

By examining the technical definition, it may come to mind that there are some technical expressions that might need further clarification. Firstly, the definition states that the blockchain is a “peer-to-peer network,” mainly this means that there is no central controller on the network, and transactions take place between users, without any third-party regulations. Secondly, the definition states that blockchain is a distributed ledger. Simply put, this only means that a blockchain is a ledger and all users on the network hold their own copy of the complete ledger. Continuously, blockchain utilizes cryptography to ensure its security. This allows the blockchain to keep its data integrity, data origin authentication, and non-repudiation (Bashir, 2018).

Furthermore, one of the most fundamental features of blockchain technology is that it is only updatable via the consensus-mechanism. Any update made to the blockchain is validated accordingly, and only after all peers (nodes) in the system have approved the current addition of a block will it be added to the chain (Bashir, 2018). This is how a blockchain achieves its power of decentralization. No central authority is in control of updating and/or approving the ledger. There is a vast variation of consensus algorithms. However, the consensus mechanism of choice is presented in the blockchain protocol (Bashir, 2018). The last feature to touch upon is the fact that a blockchain is append-only. This implies that the only way to add blocks (data) to the blockchain is a chronological arrangement of events in the order in which they occurred. Additionally, this implies that data added to the blockchain is immutable. Theoretically, it is possible to change the data within the blockchain, but this would require access (or control) of 51 percent of the chain or more, thus, leaving a blockchain practically unchangeable. However, keep in mind that there are scenarios where there might be legitimate reasons to change the data within a blockchain. For example, laws defined in the General Data Protection (Bashir, 2018).

2.3 The mechanics of blockchain technology

Blockchain in practice

As mentioned earlier a blockchain consists of nodes, these nodes have two different goals within a blockchain. They either mine (creating new blocks) and mint cryptocurrency - or function as block-signers which validate and confirm transactions. To decide which nodes

are going to be elected for validating the next block, blockchain technology utilizes different consensus mechanisms. The consensus applied by different blockchains are described in the blockchain protocol (Bashir, 2018).

This five-step process describes how blocks are generated:

1. Within the system a node will start a transactional process. This is done by the node creating a transaction and furthermore signing it with its own private key (As an assurance only the owner of the private key can authorize and execute transactions). Transactional data usually consists of information used for validation. Like, the transfer of value, relevant rules within the network (consensus), the source it is coming from and the destination address (Bashir, 2018).
2. Once a transaction is set up, it is spread among nodes (peers) within the network. This is done using a method called gossip protocol. More often than not it requires multiple nodes to get a successful validation, and this validation is executed according to pre-defined criteria within that particular chain (Bashir, 2018).
3. A transaction is considered completed once the validation process is finished and the transaction is put within a block, which is then distributed onto the entire network (Bashir, 2018).

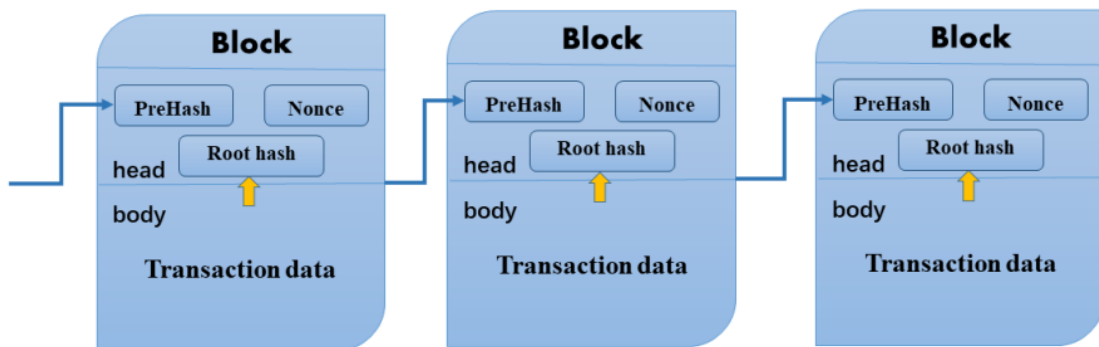
Take note of the fact that step 4 and 5 are considered non-compulsory steps. This is due to the transaction itself is completed in step 3. However, transactional reconfirmations and block confirmations are conducted in steps 4 and 5.

4. A freshly formed block is now part of the ledger, and connects itself with the earlier block, simultaneously, the next block will link itself cryptographically back to this block. This is also known as a hash pointer. This link adds a second layer of confirmation for the transaction. However, it is the first confirmation of the block itself.

5. Transactions are then reconfirmed every time a new block is created. Usually, within the bitcoin-network, six confirmations are needed to consider the transaction final.

How a block works; and how they link together

A block may be divided into two distinct parts; this is the block header and the block body. The block header includes attributes like the block version (indicates which set of block validation rules to follow), parent block hash (a 256-bit hash value that points to the previous block), Merkle tree root hash (the hash value of all the transactions in the block), timestamp (timestamp as seconds), nBits (current hashing target in a compact format), and Nonce (a 4-byte field) (Zheng et al., 2018) (See figure 1 for illustration purposes). Regarding the composition of the block body, it consists of a transaction counter and transactions. The number of transactions a block can contain depends on the size of the block and size of each transaction (Zheng et al., 2018).



(Figure 1 – Block illustration (Wang et al., 2019)).

As an example, here are three randomly generated hashes of imaginary blocks:

Block 1: 0x6b88c9f4c4d4e4f4c4f4d4e4c9f8b6

Block 2: 0x9c8b7a6d5c4b3a2d1c0b9a8d7c6b5a4

Block 3: 0x3e2d1c0f9e8d7c6b5a4f3e2d1c9b8a7.

A Block is generated and holds the first hash “0x6b88c9f4c4d4e4f4cf4d4e4c9f8b6.” When Block 2 is mined it links itself together with the first block by generating a parent block hash, which in this case would be equal to the first hash of:

“0x6b88c9f4c4d4e4f4c4f4d4e4c9f8b6.” Simultaneously, it also generates its own Merkle tree root hash of “0x9c8b7a6d5c4b3a2d1c0b9a8d7c6b5a4,” now the two blocks are linked

together. Block 3 generates a Merkle tree root hash of “0x3e2d1c0f9e8d7c6b5a4f3e2d1c9b8a7,” but has a parent block hash equal to the Merkle tree root hash of block 2, “0x9c8b7a6d5c4b3a2d1c0b9a8d7c6b5a4” - and so on, the chain keeps building by linking blocks together creating an immutable link of blocks, thus creating a blockchain.

Digital Signatures - private and public keys

Digital signatures is a big part of the blockchain. This is because every user within a blockchain owns a private and a public key; and these keys are utilized to sign transactions (Zheng et al., 2018). A digital signed transaction is distributed on the entire network, and the encryptions are accessible by public keys. A digital transaction is revolved around two different processes; signing and verification (Zheng et al., 2018). When a user wants to start a signing process, a hash is generated from a transaction, then the private key is utilized to encrypt the hash. Continuously, it is sent to another user. The receiving user verifies the transaction by comparing the decrypted hash (using the public key from the sending user) to a new hash generated from the received data (Zheng et al., 2018). Notably, the standard signature algorithms within blockchains applies an elliptic curve digital signature algorithm (ECDSA) (Zheng et al., 2018).

2.4 The history of blockchain development

The world was first introduced to blockchain in a paper called “Bitcoin: A Peer-to-Peer Electronic Cash System” written by a pseudonym known as Satoshi Nakamoto back in 2008, which primarily discussed implementation and concepts related to a well-known decentralized digital currency named Bitcoin. This paper was regarded as somewhat revolutionary because it introduced the world to a term named “chain of blocks” (Nakamoto, 2008), which later became what is known today as “blockchain.” Satoshi described how Bitcoin may maintain a secure, tamper-proof record of all transactions on the network regardless of having non central entity by applying blockchain technology (Nakamoto, 2008).

In 2014, a paper named “A Next-Generation Smart Contract and Decentralized Application Platform” was released by Vitalik Buterin, one of the co-founders of

Ethereum. Ethereum is a decentralized platform that allows developers to create and deploy smart contracts (Buterin, 2014). The platform paves the way for a wide range of applications within business areas as finance, gaming, and identity (Buterin, 2014). One year later, Buterin, created a blogpost where he shared his thoughts on public and private blockchains and argued that public blockchains have the potential to create a more decentralized and secure world, whilst private blockchains are better suited for scenarios where privacy and control are more important. An interesting observation made by Buterin is also that future blockchain applications will use hybrid models of public and private blockchains.

Continuously, in 2016 a crucial papers were released, named “The bitcoin lightning Network: Scalable Off-Chain Instant Payments” by Joseph Poon and Thaddeus Dryja, which discusses solutions to the scalability issues faced by the bitcoin blockchain whilst simultaneously, allowing for faster and cheaper transactions (Poon & Dryja, 2016). In 2018 Zheng & al published the paper “Blockchain challenges and opportunities: A survey” which gave a perspective of blockchain from both a technological and applicational perspectives. Furthermore, the paper addressed technical challenges and recent advances in tackling these challenges. Lastly, it highlighted future directions of blockchain technology (Zheng et al., 2018).

Today, blockchain technology is applied in real world use cases such as faster cross-border payments, identity management, smart contracts, cryptocurrencies, and blockchain technology from a supply chain perspective (Habib et al., 2022). The early history of blockchain were mainly revolving around cryptocurrency and transactions, however, the technology has moved past that stage and discovered implementations in different real-life applications. It is expected that it is within these real life applications blockchain technology will be simplified; instead of remaining a relatively complex concept (Habib et al., 2022).

2.5 Consensus mechanisms

Reaching an agreement (consensus) within a blockchain is not only complex, but also significant. Once a new transaction is completed and verified by all nodes on the network it is added to the blockchain (Bamakan et al., 2020). The consensus mechanism revolves around the preservation of three critical properties within a blockchain; ensuring the safety, liveness and fault tolerance of the network (Lashkari & Musilek, 2021). Safety is preserved if it ensures that all nodes will be contributing to an identical, consistent, and valid output. Liveness is a reference to the blockchains consensus mechanism's ability to guide the participation of non-faulty nodes in the creation of value. Lastly, to maintain a suitable level of fault tolerance, the consensus mechanism must have the ability to recover from potential failures of participating nodes (Lashkari & Musilek, 2021). Moreover, to reach consensus within a network multiple consensus algorithms have been designed and developed, and the number of these algorithms is constantly increasing (Bamakan et al., 2020).

A presentation of the most applied consensus mechanisms will follow, and further summarized in table 1 – Pros and cons of consensus.

Proof of Work (PoW)

The Proof of Work (PoW) algorithm has the nodes doing computations to solve a mathematics puzzle through the hash function (Bamakan et al., 2020). A miner (node) attempts to find a specific value as a nonce, so the hash value meets a pre-defined condition. As an example the miner may attempt to find the nonce that will make the 30-first bits of its hash value zero (Bamakan et al., 2020). This pre-defined condition can be changed. Thus, leaving the network very scalable and flexible to any conditions. Within such a network, each node is calculating the hash value of the block header. Hence, to reach consensus, miners try to locate a hash value equal to or smaller than a certain given value. Once a node finds the target value, the targeted block will be broadcasted to the entire network and all other nodes confirm the correctness of the hash value. This means, given that the block is validated, all nodes will attach this new block to their own blockchain (Bamakan et al., 2020).

Consensus mechanism has different advantages and disadvantages. The main advantages of a PoW system are high security and prominent level of decentralization. However, its

disadvantages lie within the function of mining and block-validation as this is a process that requires substantial amounts of energy. Additionally, both the speed and success-rate of hash validation is highly dependent on the hardware running the hash and its computational power (Bamakan et al., 2020). Even though proof of work presents a sense of scalability through its hash function, the complexity of solving the hash is time consuming. Thus, leaving the algorithm inappropriate for large and fast-growing networks that require a vast number of transactions per second (Bamakan et al., 2020).

Proof of Stake (PoS)

Another common consensus algorithm within blockchain technology is Proof of Stake (PoS). As it addresses significant issues within the proof of work algorithm, like energy inefficiency (Bamakan et al., 2020). In PoS the creator of the next block is chosen based on various combinations of random selections, like the nodes, stake-supply, and age. Thus, leaving the algorithm with good scalability. This works in a way where the selected node for the next block is chosen through a quasi-random process while the selected node is picked depending on its assets in the pool of shares relating to that node. However, unlike to PoW, this method does not require high computing power, hence, the miners receive no rewards, besides the transactional fees. Because the network is depending on nodes holding vast majority of stake, this leaves the blockchain somewhat centralized. Additionally, there is a frequent problem with this type of algorithm known as “nothing at stake.” Basically, what this means, is that a node that has nothing at stake has no incentive to act properly. Such node may for instance create two sets of new blocks to receive a double transaction fee reward (Bamakan et al., 2020).

Delegated Proof of Stake (DPoS)

The Delegated Proof of Stake (DPoS) is an improvement of the original PoS algorithm where the nodes select representatives through voting to validate blocks. It is possible to organize the network more efficiently as the numbers of representatives is limited, simultaneously each representative may specify the sufficient time to publish a new block (Bamakan et al., 2020). Moreover, the limitations of the numbers of representatives are still going to result in a more centralized network. Overall, DPoS presents features like scalability, energy efficiency, and low-cost transactions. However, it is semi-centralized and may be a better fit for private blockchains. Regardless of the fact that if a

representative makes an error of the required reports, the other nodes can vote to determine the replacement of said node (Bamakan et al., 2020).

Practical Byzantine Fault Tolerance (PBFT)

The Practical Byzantine Fault Tolerance (PBFT) algorithm is a consensus mechanism developed to combatant the Byzantine General Problem as a response to the increased malicious attacks and software errors as they often can be a result of arbitrary (Byzantine) behavior of faulty nodes (Bamakan et al., 2020). This consensus mechanism requires all nodes to take part in the voting process to confirm the next block. However, consensus is reached once two-thirds of the nodes agree upon the new block. Thus, allowing consensus to be achieved within the system faster than a system using Proof of Work. Nor does it require any sort of asset at stake of the consensus process like Proof of Stake. Leaving the system with good energy efficiency and high throughput. On the contrary, scalability and delays are noted as disadvantages for the system, as it has to wait for the majority of nodes to vote (Bamakan et al., 2020).

Algorithm	Pros	Cons
Proof of Work	<ul style="list-style-type: none"> - Decentralized - High level of Security - Acceptable level of scalability 	<ul style="list-style-type: none"> - Less throughput - high block creation time - energy inefficiency - special hardware dependency - High computational cost - Extensive bandwidth requirements
Proof of Stake	<ul style="list-style-type: none"> - Fast block creation time - High throughput - Energy efficient - Scalability (less than PoW) - Independency to the special hardware 	<ul style="list-style-type: none"> - Some sort of centralization - Susceptible to misbehaving of blocks within a blockchain networks
Delegated Proof of Stake	<ul style="list-style-type: none"> - Scalability - Energy-efficiency - Low-cost transactions 	<ul style="list-style-type: none"> - Semi-centralized
Practical Byzantine Fault Tolerance	<ul style="list-style-type: none"> - Energy efficient - High throughput 	<ul style="list-style-type: none"> - Little to no scalability - Possible delays may occur
Proof of Weight	<ul style="list-style-type: none"> - High level of customization - High level of scalability - Fast confirmation of transactions 	<ul style="list-style-type: none"> - No incentivization for miners (it is worth to note that this can be adjusted)

	- Power efficient	
Proof of Importance	<ul style="list-style-type: none"> - Fast - Power efficient - No mining required. - Decentralized - Scalable 	<ul style="list-style-type: none"> - Complex - Exploitable - Lack of security
Proof of Elapsed Time	<ul style="list-style-type: none"> - Energy efficient - Fair 	<ul style="list-style-type: none"> - Limited scalability - Lack of decentralization - Lack of security

(Table 1 - Pros and cons of consensus).

2.6 Smart Contracts

Even though the first implementation of smart contracts were introduced in 2009 with the bitcoin peer-to-peer article. The concept of smart contracts was theorized almost 20 years earlier, in the late 1990s. This was done in an article named Formalizing and Securing Relationships on Public Networks written by Nick Szabo in 1994, (Bashir, 2018; TİMÜÇİN & BİROĞUL, 2021). However, Szabo only got the opportunity to conclude the principles of smart contracts, before he had to terminate his business as a result of missing technological infrastructure (TİMÜÇİN & BİROĞUL, 2021). Nevertheless, the emerge of blockchain technology has presented new possibilities (TİMÜÇİN & BİROĞUL, 2021) Today, smart contracts propose a significant opportunity of cost-saving benefits by reducing the cost of transactions and simplifying complex contracts (Bashir, 2018). multiple sources, (Savelyev, 2017);(Bashir, 2018), states that there is no global agreement on the definition of smart contracts. Table 2 – Smart contract definitions will present various definitions gathered from literature.

Author	Definition	Source
Szabo	<i>“A smart contract is a computerized transaction protocol that fulfils the terms of a contract. The overall objectives are to meet common contract terms (such as payment terms, lien, confidentiality, and even enforcement) to minimize both malicious and accidental exceptions. Need for reliable intermediaries: Relevant economic goals include reducing the loss of fraud, arbitration and sanction costs, and other transaction costs.”</i>	(TİMÜÇİN & BİRÖĞÜL, 2021), – p. 6
Ante	<i>“A smart contract is a script that is anchored on a blockchain or similar distributed infrastructure. As soon as it is triggered by a blockchain transaction and validated across the network, predefined actions are executed. Since the conditions of a smart contract are transparently stored on the blockchain, it will always operate as all parties intend, which can reduce trust issues between the involved parties. Smart contracts are software scripts, just like scripts that run on non-blockchain applications.”</i>	(Ante, 2021), - p. 4
Savelyev	<i>“Smart contract is an agreement whose performance is automated.”</i>	(Savelyev, 2017), - p. 120

(Table 2 – Smart contract definitions).

As there is no global agreement on a smart contract definition, I will present my own definition as following:

“A smart contract is a digital contract written in code, defined by a set of binary parameters agreed upon by both parties, once the parameter(s) are fulfilled the contract self-executes regardless of human interaction.”

Moreover, the smart contract is not written in words as a normal contract, the smart contract is written as a code which automatically executes as the parameter(s) within the contract are fulfilled. Additionally, smart contracts should be unstoppable and follow the principle of coding, “code is law” (Bashir, 2018). This means that contractual execution will be completed even though the code is under malicious attacks or the interactions of third parties. Hence, the contract needs to be designed in such fashion that it can withstand malicious attacks (Bashir, 2018).

Furthermore, there have been some suggestions that smart contracts not necessarily need to be auto executed; they can be automatable since some scenarios may require manual human interaction. For instance, an educated professional may need to confirm or deny the authentication of a medical record manually – thus leaving a fully automated approach non-optimal. However, this interrupts with the definition of a smart contract to be auto-executable. This problem can be addressed by the use of “Oracles” (Bashir, 2018). Oracles propose an important attribution to the standard smart contract, which is the ability to access external data. By the help of IoT devices oracles may provide smart contracts with information such as stock market prices, real-world news, and weather reports (Bashir, 2018). Another feature of the Oracles is that they are capable of digitally signing the data, supplying validation for the smart contracts, validating the authentication of the data. Following, the smart contracts can either pull the data from Oracles, or the Oracles can push the data upon the smart contracts, depending on the coding. However, it is important that the Oracles does not possess the ability to change the data as they would be susceptible for data-manipulation (Bashir, 2018). Even though this do bring up the issue of trust. If a designer were to allow oracles to accept data from a large, reputable, and trusted third party, you still face the issue of centralization. Another possible solution is to make sure data is sourced from multiple sources, down to a public level. However, if the data can be collected from multiple sources that provides the exact same information, there is a high chance that the data is correct and can be trusted (Bashir, 2018).

2.7 Public vs private blockchain

Even though both public and private blockchain networks are decentralized peer-to-peer transactional networks that requires no third-party intermediary, there can be made some distinct differences in their features (Yang et al., 2020).

In public blockchains transparency and participation are key features. These features are pursued through decentralization by rewarding miners in crypto economics. However, the level of decentralization is based on the consensus mechanism utilized by the blockchain (Nabben, 2021). This makes public blockchains suitable to address macrosocial coordination problems, based on their unique ability to provide a decentralized consensus (Nabben, 2021).

On the contrary, in a private blockchain, the ability to take part in validation of transactions within the network is limited to include parties approved by a central administrator. Hence, private blockchains consist of a more centralized entities and operate closer to a traditional database compared to a public blockchain (Nabben, 2021).

Transaction data is most often kept private, leaving cases of private blockchains utilization mostly applied within internal, business-secure environments, within the fields of access, authentication and record keeping (Nabben, 2021).

Because private blockchains possess the ability to have very few authorized nodes they can generate a remarkably high transaction rate. This gives private blockchains the ability to process more transactions per second compared to a public blockchain (Yang et al., 2020). Furthermore, it is more time-consuming to mine a block within a public blockchain, since all nodes must agree to any changes made to the network, as they are recording the same information. Additionally, to ensure the integrity of the blockchain, all blocks are linked back to the genesis's block (Yang et al., 2020). However, on the other side, because a private blockchain consists of fewer nodes, it is more susceptible to malicious attacks such as hacking and data manipulation. (Yang et al., 2020). However, even though public blockchains may be redeemed more resilient towards malicious attacks, it is harder to control the information on the chain, as any user can enter the network and put sensitive information on the network as it relies on append-only data process leading to immutable data storage (Yang et al., 2020). In contrast to private blockchains, public blockchains do not require any infrastructural costs to establish the network. However, private blockchains requires wide scale adoption and operational expenses (Yang et al., 2020).

2.8 Layers in blockchain

As blockchain technology is gaining popularity, level one layers are facing performance issues. As a solution to this problem, blockchain developers have added additional layers to blockchains (Mint, 2022). Ultimately, blockchains can be divided into four layers, layer 0, layer 1, layer 2, and layer 3. The fundamentals of a blockchain are built on layer 0 and then utilized at the first layer, this consists of hardware and software components as described earlier, such as mining utilities and protocols (Mint, 2022). Blockchains that are built on layer 1 without any additional layers utilize the layer 0 fundamentals as consensus

mechanisms, ledger systems and coded language, most cases also contain some sort of token on the blockchain (Mint, 2022).

Core activities within the chain are run at layer 1, thus, leaving this as the most energy-consuming layer. Layer 2 presents options to handle the challenges faced on layer 1. However, note that this is not a requirement for a blockchain to operate and function properly (Mint, 2022). On layer 2 it is possible to enhance efficiency of system throughput or create scalability for layer 1 blockchains. This is done by “off-chaining” transactions. Simultaneously, it also presents the ability to centralize entities by bringing more nodes into the layer without challenging the decentralization of the original layer 1 chain. As an example, a company can bring nodes (servers) onto layer 2 to enhance its performance and obtain cheaper transactions. Layer 2 also provides solutions like nested blockchains and sidechains. The top layer, layer 3, introduces us to a visual user interface component, also known as Dapps. At this layer the blockchain is more user friendly for a typical end user (Mint, 2022).

2.9 The Blockchain Trilemma

As blockchain has gained increased popularity, public blockchain has seen some challenges as everybody is trying to create decentralized applications which will allow the technology to turn mainstream (Holotescu & VasIU, 2020). Challenges of public blockchains can be related to scalability, security, and decentralization, also known as the blockchain trilemma, addressed by Vitalik Buterin. To this date, there is not a fully working blockchain that has managed to address all three issues simultaneously. This is because addressing two of them, comes of the expense of the third (Holotescu & VasIU, 2020).

In a blockchain transactions can be time and energy consuming, this is because all the nodes are involved in creating blocks, then adding them to the ledger (Holotescu & VasIU, 2020). As an example, in PoW, the first node which calculates the first valid hash is going to mine the new block before the block can get broadcasted to the entire network, thus leaving the network with a relatively low transaction per second (tps) speed. In PoS there is a declared leader. However, to improve the speed of transactional process, such consensus pays the price of decentralization (Holotescu & VasIU, 2020). As an example,

the bitcoin blockchain, which utilizes PoW, can do about 7 transactions per second. The Ethereum blockchain, which utilizes the PoS consensus, can utilize around 20 tps (Holotescu & VasIU, 2020). There is made constant effort to address these issues. On the bitcoin network designers increased block size from 1MB to 4-8MB, thus, allowing blocks to hold an increased number of transactions (Holotescu & VasIU, 2020). Even though this allows for the blocks to hold more transactions, it presents the challenge of blocks taking more time to propagate within the network – thus slowing it down. Simultaneously, transactions with higher fees are validated faster, which are neglecting low fee transactions (Holotescu & VasIU, 2020). Other improvements are done by building layer 2 blockchains on top of layer 1 blockchains, creating new data structure such as Directed Acyclic Graphs (DAGs), or developing more efficient consensus algorithms (Holotescu & VasIU, 2020).

2.10 NFTs

A NFT, also known as a non-fungible token can be defined as a “ one-of-a-kind digital asset containing identifying information and codes deployed on a blockchain in a cryptographic manner” (Taherdoost, 2023). Originally it was CryptoKitties that attracted attention to NFT-goods as early as 2017. This was a game based on the Ethereum network. However, the rapid expansion of the NFT world can also relate to the emergence of Covid-19 (Taherdoost, 2023). As the WHO (World Health Organization) announced a global pandemic, the bitcoin market performance saw a substantial increase. Additionally, other cryptocurrency-marketplaces, such as NFTs gained an increase in popularity amongst investors. Most likely this came from a sharp decline of global market interest rates (Taherdoost, 2023). Furthermore, the lockdown resulted in increased online activities and helped push the expansion and curiosity around NFTs. Despite its rapid development, NFTs are still in an early stage of growth, holding great potential but also great uncertainty (Taherdoost, 2023).

According to (Taherdoost, 2023), NFTs are widely anticipated to have a significant impact on the financial and economic sectors based on the current trajectory of scientific inquiry. There are three main reasons for NFTs to have positive impact. The first one is that NFTs enables the potential uses of blockchain technology as it enhances digital scarcity, allowing digital assets to be redeemed more valuable because it ensures ownership (Taherdoost, 2023). Secondly, NFTs may reduce barriers to entering new markets where

content creators can monetize their work, such as images or music – allowing for optimalization of contractual work by eliminating third parties. This increase efficiency and reduce overhead costs (Taherdoost, 2023). Lastly, policymakers has witnessed an increase in speculation, fraud, and excessive volatility as a consequence of NFTs (Taherdoost, 2023).

There are multiple industries that have gained opportunities because of NFTs, such as arts, broadcasting, and sports (Alkhudary et al., 2022). Not only do they present opportunities to function as event tickets and decentralized applications built on top of public blockchains. They can also reduce paper waste, minimize fraud and tampering, and data-control (Alkhudary et al., 2022). From a purely theoretical perspective only the imagination can limit the potential of NFTs within decentralized finance, gaming, music royalties, real-world assets, and logistics. A stunning amount of over 230\$ million has been utilized in purchasing and trading digital assets of National Basketball Association (NBA) highlights (Alkhudary et al., 2022). Furthermore, Nike recently opted in on the NFT business, where the company had their patent for forging virtual sneakers accepted. As of now, buyers can store virtual sneakers in their crypto wallets as minted NFTs (Alkhudary et al., 2022). Moreover, in the NFT-world, there are now an emerging trend where you can produce new series of digital sneakers by crossing older series, which is also known as breeding (Alkhudary et al., 2022). A French professional rugby club distributed 18754 free NFTs for the season in 2021-2022, as part of a marketing strategy which had the goal of improving fan relations. Fans that own one of these NFTs gained the opportunity to purchase one of 1907 premium NFTs that granted access to exclusive products and experiences (Alkhudary et al., 2022).

Another crucial point that is important to understand about NFTs from a marketing perspective is that studies of NFTs are almost absent in current literature. As a matter of fact, until April 2022 only 13 articles have been published in indexed journals on the web of science and Science Direct; additionally, these articles focus mainly on asset pricing (Alkhudary et al., 2022).

From a historical perspective, digital goods have been redeemed less valuable than physical goods. This is due to the fact that it is hard to claim a strong psychological ownership towards digital goods (Hofstetter et al., 2022). However, with NFTs, their

immutability presents a solution to this exact problem as NFTs cannot be replicated due to their technological attributes. And this uniqueness should, theoretically, increase value as limited supply of a product presents the owner (customer) with a feeling of distinction and uniqueness (Hofstetter et al., 2022). Although this sounds great, there is a downside. Even though NFTs are unique, they are often remarkably similar, and have an almost identical look. Therefore, despite its exclusivity, they simultaneously present a level of conformity (Hofstetter et al., 2022).

Theory has yet to decide how NFTs can be designed to yield the best pricing strategies and generate maximum revenue. However, NFTs present consumers with new opportunities to exchange economic value as they are bought and sold on a blockchain with cryptocurrencies, or in some cases utilized as payment themselves (Hofstetter et al., 2022). Another important aspect of NFTs is the pain-point of payment and its effect on consumers. It is a well-documented phenomenon that consumers spend more money in lower-pain modes, such as credit cards compared to higher pain modes, like cash (Hofstetter et al., 2022). Moreover, consumers may act irrationally as they mentally may account for money differently when it takes the form of a liquid currency compared to being moved into securities (Hofstetter et al., 2022). Thus, paying for NFTs as its digital nature may give consumers the belief of a lower pain-point of payment. Although, as NFTs are a rather new phenomenon, and the confidence to the technology is low, it may also increase the pain-point of payment amongst certain users (Hofstetter et al., 2022). Pain of payment has such an impactful role in debt management and perceived transaction value. Thus, understanding this phenomenon may be crucial for anyone who wants to do business within the world of NFTs (Hofstetter et al., 2022).

Whilst looking into research regarding NFTs, a missing explanation is how said object attracts new segments, generates revenues, and transfer status to consumers. Thus, leading to increased content creation and sharing (Hofstetter et al., 2022). Lastly, NFTs has the ability to transform supply chains as they remove the need for intermediaries in the form of wholesalers, retailers or agents (Hofstetter et al., 2022).

NFT vs. Tokens

The main different between a NFT and a fungible token (like a Fan Token) is that fungible tokens are identical or uniform and can be traded with other fungible tokens of the same

type without anyone knowing. Compared to NFTs that are unique and cannot be swapped unnoticed with a similar NFT (Parham & Breitinger, 2022). Additionally, NFTs cannot be divided or merged (Parham & Breitinger, 2022).

Within the sport industry, there is now an appeal of Fan Token offerings. The Fan Tokens are offered to fans and comes with a variation of benefits. First, it functions like a stock of a club, where fans has the opportunity to hold a small share of it (Parham & Breitinger, 2022). The price of the token depend on a numerous of variables, such as value, profit, and or popularity of the club which changes depending on the results put up by the club (Parham & Breitinger, 2022). Secondly, the Token owners can be granted the right to vote on decisions within the club, in other words, owning a token gives you a small stakeholder action. And may lead to a deeper connection between fans and clubs (Parham & Breitinger, 2022). Thus a Fan Token offering may be seen as a win-win scenario for both the fans and clubs where both may experience benefits (Parham & Breitinger, 2022).

Challenges brought by NFTs.

Gas Fees

As most NFTs are minted on the Ethereum network, it is important to understand the term “Gas fee”, which is a dynamic fee that are paid on the Ethereum network to the miners who is validating transactions (Parham & Breitinger, 2022). Thus, there is a dynamic fee for generating NFTs. This is a well-known way of rewarding blockchain miners in any blockchain utilizing PoW. As Gas fees are dynamic, the price is dependent on congestion of the network and the price of Ethereum (Parham & Breitinger, 2022).

Extensibility issues

The extensibility feature, also mentioned as breeding earlier by Alkhudary et al. (2022), is one of the primary features of NFTs; combining multiple NFTs together to create another unique NFT (Parham & Breitinger, 2022). The extensibility of NFTs presents both opportunities and challenges. As far as challenges goes; first, there is the interoperability-issue also known as the cross-chain issue, which prevents the NFT ecosystems from crossing with each other leaving them locked in to their original ecosystem (Parham & Breitinger, 2022). Currently, most NFTs are minted on Ethereum. Hence, the extensibility

issue is not really an issue. However, as other ecosystems emerge; such as Polygon, Polkadot and Cardano, NFT-minters may face challenges in the future (Parham & Breitinger, 2022). Furthermore, blockchains often run with multiple “soft forks” which are minor modifications that have compatibility with existing or older protocols, thus these types of forks should not interfere with NFTs. However, the “hard forks”, more powerful modifications may cause trouble with previous protocols. And these types of updates during blockchain development may root conflicts for NFTs in the future (Parham & Breitinger, 2022).

2.11 The blockchains and NFTs

Ethereum

As already mentioned, the blockchain trilemma addresses the issues of scalability, security, and decentralization (Vitalik Buterin). Within the Ethereum network, scalability is the biggest issue. However, the community is working on a fix, and working towards what is currently known as “Ethereum 2.0” which are meant to address several issues, scalability being one of them (Parham & Breitinger, 2022).

At the Ethereum network the process speed is approximately 20 transactions per second (TPS) (Parham & Breitinger, 2022). Thus, ETH usually has a lower speed and higher transaction costs compared to other networks. However, ETH 2.0 presents the possibility of performing a thousand TPS, and this may help towards the scalability difficulties the network is facing (Parham & Breitinger, 2022). A part of this change involves transforming the consensus mechanism from PoW to PoS, which also makes the ETH network more environmentally friendly because of lower energy consumption per transaction.

Cardano

Cardano is a third-generation blockchain platform that is gaining popularity (Parham & Breitinger, 2022). This may be partially because it possesses edges in certain areas against other blockchains such as Bitcoin and Ethereum in form of higher TPS and lower transaction fees (gas fees). Furthermore, it supports smart contracts and “Dapps.” Thus, it may be a good network to mint NFTs on (Parham & Breitinger, 2022). An interesting

observation about Cardano is that it's one of the first blockchains to be developed by a scientific group of academics. The network runs a PoS protocol which may present advantages against a protocol ran by PoW. These advantages comes in the form of security, more decentralization, energy and cost efficiency (Parham & Breitinger, 2022). Now, Cardano is the most staked network in the world at around 73 percentage of all network coins. Furthermore, Cardano, Polkadot, and Ethereum all have the most potential capacities to become the future of blockchain technology as a regard of staked values (Parham & Breitinger, 2022).

Polkadot

Another next generation blockchain protocol, is the Polkadot network. This network connects parachains, a heterogenous network of blockchain shards. And this is done through the Polkadot Relay Chain (Parham & Breitinger, 2022). Like Cardano, Polkadot is also suitable to support NFTs in its ecosystem and brings the same advantages as Cardano; lower transaction fees and higher speed (Parham & Breitinger, 2022). And may function as an alternative option for NFTs as the network already has established a wide range of partners and chains which has integrated their technology.

Network	Transaction cost	Transaction per second	Consensus algorithms
Ethereum	~ 10-40 \$	15-20 Tps	PoW
Ethereum 2.0	~ 1-8 \$	100 000 Tps	PoS
Cardano	~ 0.3\$	1 000 000 Tps	PoS
Polkadot	~ 2\$	166 666 Tps	PoS
Polygon	Unknown	65 000 Tps	PoS

(Table 3 – Different blockchains and transaction attributes (Parham & Breitinger, 2022) and (Sarang et al., 2022)).

2.12 Blockchain in supply chain management

To be successful in supply chain management (SCM) it is required to effectively manage the flow of products, processes, information and cash in an integrated and synchronized manner (Chang et al., 2020). A supply chain may see significant change in their

competitiveness dependently on their business-strategy regarding product cost, working capital requirements, speed-to-market, service, ROI, stakeholder value and profitability (Chang et al., 2020). As supply chains grow more complex, and the world is becoming more interconnected managing supply chains across borders becomes more common (global supply chains), this brings opportunities, but also comes with greater uncertainties in the realms of geopolitics, technology and economy (Chang et al., 2020). According to (Chang et al., 2020), a recent study found that a total of more than 400 organizations and corporations across 64 countries as much as 69% has incomplete visibility into their supply chains, 65% report one or more supply chain disruptions, and 41% are still heavily reliant on Excel spreadsheets for tracking supply chain disruptions (Chang et al., 2020). Thus, in the following section existing challenges in current global SCM and the capabilities and opportunities for the technology will be presented. Mainly, there are six “pain-points” in supply chain; traceability, dispute resolution, cargo integrity and security, supply chain digitalisation, compliance, and, trust and stakeholder management (Chang et al., 2020). However, before talking about blockchain and all its endless opportunities, it is important to understand that the technology is still in an early stage and presents some challenges. Even though it can provide transparent and secure transactions, the transactions are irreversible and require a new transaction to be launched to address refunds (Dutta et al., 2020). Furthermore, the macro level nature of blockchain is yet to be decided, such as laws and regulations regarding the phenomenon. Lastly, even though the technology presents major cost-reduction opportunities from a theoretical perspective, the non-trivial operation cost and implementation cost of blockchain systems should not be taken lightly (Dutta et al., 2020).

Traceability

In supply chains, traceability allows decision makers the ability to manage and respond to risks swiftly and on record (Chang et al., 2020). Ordinarily, traceability was utilized mostly upstream in supply chain networks, to track the source and origin of raw material and components. However, traceability has expanded its reach to include downstream supply chain networks to trace goods throughout the entire supply chain all the way to the end consumer (Chang et al., 2020). Traceability and transparency are gaining attraction, yet customers and buyers still does not have a solid and efficient way to verify the origin and details of products and services (Chang et al., 2020).

As an example, in 2015, 55 people were infected during an E-coli outbreak at Chipotle Mexican Grill outlets in the United States. Even after several months of investigation by Chipotle and the Centres for Disease Control and Prevention they still were not able to clearly decide the source of contamination. Furthermore, as digital businesses and e-commerce see increased popularity, so does counterfeit products. Counterfeit products account for approximately 2.5% of global trade every year, and in 2018 the value of trade in these products is about \$461 billion (Chang et al., 2020). This does not only undermine brand integrity, but also may impact consumers' well-being. And consumers and other actors within the supply chain are constantly demanding more transparency from both brand-issuers and manufacturers throughout the entire supply chain (Chang et al., 2020). Blockchain presents the opportunity to trace a fully audited trail of transactional data for every touchpoint of a supply chain. Additionally, it can supply verified, transparent, and immutable records as digitalized certificates. Hence, blockchain possesses the ability to improve traceability of supply chain networks, allowing customers, decision makers, and whoever may be in need of information proof of provenance and product verification (Chang et al., 2020). Simultaneously, it can also be used in a reverse matter to trace outbreaks such as the ones seen in the e-coli example by Chipotle.

Dispute resolution

On a regular basis when a supplier is not successful of delivering as promised, either its on-time or in-full-delivery, supply chain stakeholders must decide the cause quickly. In these types of situations, the disputes are normally settled by fines or some form of compensation (Chang et al., 2020). Walmart is fining supplier who do not deliver at least 85% of their shipments on time. However, it is not always simple to resolve supply chain disputes as they may be expensive and prone to error as it requires to trace products and audit the streamline to identify and determine the cause of error (Chang et al., 2020). Thus, disputes may occur as disagreements in contract clauses and lack of accountability. If utilized correctly, blockchain may be an excellent tool to resolve disputes as it provides records regarding asset provenance, ownership transfers, legalities, and safety requirements in real-time (Chang et al., 2020). Furthermore, smart contracts can be predefined to automatically trigger compensations if certain parameter(s) are met. Concludingly, blockchain has the potential of minimising time spent on disputes (Chang et al., 2020).

Cargo integrity and security

To guarantee that buyers receive payment and sellers obtain genuine and un-compromised cargo documents such as bills of lading, invoices, and policies are commonly used. However, these documents are not tamper-proof and can be replicated by dishonest people to gain control of cargo that not originally belongs to them. Every year, an astonishing amount estimated between \$30-50 billion worth of cargo is stolen worldwide (Chang et al., 2020). Furthermore, as global trade is becoming more digitalized the risks of cyber-attacks is appearing. In 2013, the Belgian port of Antwerp reported crime syndicates utilizing cyber-attacks for drug-trafficking for more than two years, undetected (Chang et al., 2020). The breach of security allowed the drug-traffickers to manipulate the system, releasing containers to their own trucks and creating “ghost containers” to cover up their scheme (Chang et al., 2020).

By applying blockchain technology it is possible to strengthen the interrelationship between physical and digital transportation without compromising the integrity of the “chain-of-custody” process. Moreover, blockchain can trace the cargo at every point-of-transfer and requires a unique identifier for each authorised participant down the network. Thus, making it a lot harder to conduct cargo-theft (Chang et al., 2020). Additionally, as altering the blockchain requires control of more than 50% of the chain, it will be hard for people with malicious intent to disrupt the system (Chang et al., 2020). Lastly, blockchain technology may precisely identify the origin and display the reason behind a critical issue in a very effective manner (Chang et al., 2020).

Supply chain digitalization

Digitisation within supply chain has the possibility of evolving a new ecosystem, completely integrated for improved efficiencies and transparency and simultaneously developing new business models (Chang et al., 2020). The UN states that by removing outdated supply chain practices and eliminating administrative blockages it would enable more international trade, than deleting tariffs (Chang et al., 2020). In 2018, digitalization in supply chains was valued around \$12.4 billion, it is expected that supply chain investments in this area by 2025 has reached \$232 billion (Chang et al., 2020).

Not surprisingly, blockchain is gaining attention in this matter and is vastly emerging as the backbone of supply chain digitisation, alongside of artificial intelligence, workflow automation, and the internet of things (IoT) (Chang et al., 2020). Blockchain is believed to reduce bureaucracy, vastly diminish transaction time and administrative costs, and enhance cargo flow by automatically store data and cut lengthy paper trails. Together with smart contract blockchain can generate automatic business transactions and ensure a more direct relationship among fellow participants. This is enabled by allowing faster transactions, less transactional costs, and removing intermediaries (Chang et al., 2020).

Compliance

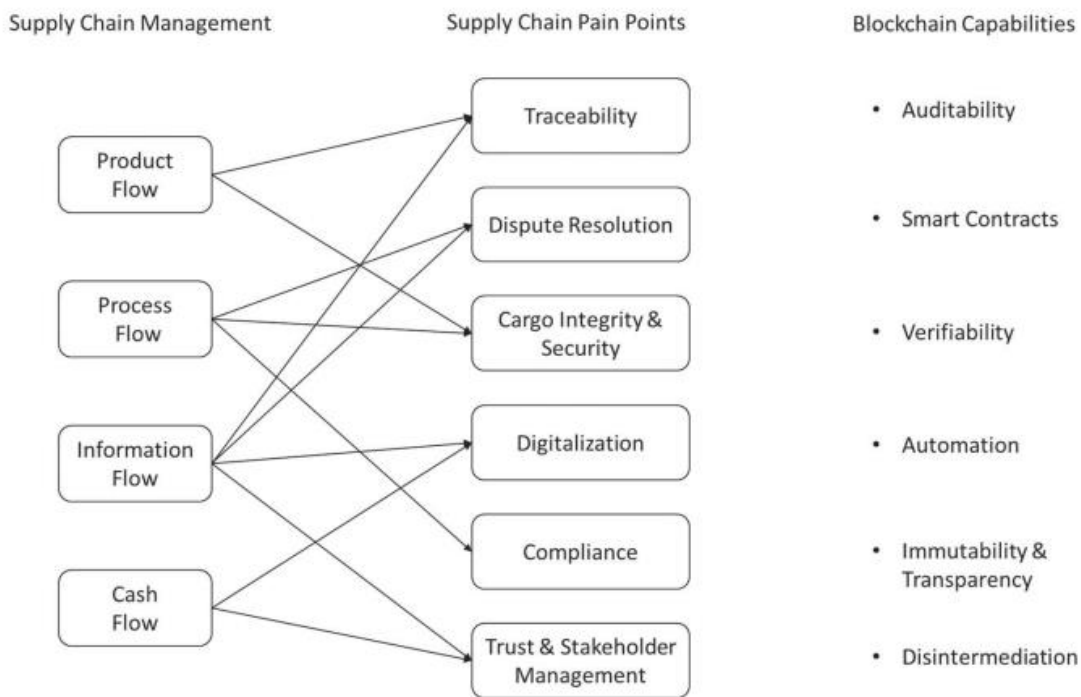
As today's market become more global, suppliers are gaining increased social and environmental responsibilities. Moreover, a major number of requirements are being monitored and cohered; such as product safety and integrity, technical regulations, ethical sourcing and so on (Chang et al., 2020). If organisations do not comply to these regulations, they will see negative impacts on both their bottom line and reputation. Due to inadequate cold transport technology abilities, 200 million tons of food are futile before making its way to the final market destination, every year (Chang et al., 2020). Furthermore, the UK's top supplier of chicken to supermarkets were caught tampering with food safety records to make customers buy expired chicken (Chang et al., 2020). However, blockchain technology can provide real-time visibility to the supply chain to confirm that all contract conditions are being reached. Thus, forcing organisations to coordinate and work according to the compliance requirements decided by the authored entity. Moreover, the stored data is constantly available for validation (Chang et al., 2020). The combination of IoT-sensors and smart contracts could automatically send a real-time warning for inspection if a sensor shows that the required environmental parameters are not met as agreed upon within the smart contract. Thus, this may help avoid product depreciation (Chang et al., 2020). Because a blockchain is immutable it serves both the customers, as well as the supply chain stakeholders by ensuring that the data has not been tampered with and provides a reliable source of information (Chang et al., 2020).

Trust and stakeholder management

Supply chain stakeholders names trust as one of the most crucial factors in a committed collaborative relation amongst each other. At the current moment, stakeholders are heavily

reliant on intermediaries such as bankers or legal entities to ensure the safety, verification, and coordination of transactions. However, these services are not free. Thus, they present a certain amount of cost and variability (Chang et al., 2020).

On the blockchain all parties can trust each other, because the trust is proven within the technology of the cryptographic distributed ledger, the underlying code, the consensus mechanism where consensus only is confirmed as all the participants on the blockchain agrees upon the same version of the ledger. Therefore, information such as transactional information, product information, credentials and reputation of parties, features of products or services, can all be validated and audited in real time at minimal cost (Chang et al., 2020). A summarisation will be presented below in figure 2.



(Figure 2 – Main pain points in global SCM and how blockchain can be utilised to adress these challenges (Chang et al., 2020)).

2.13 Examples of blockchain-pilot initiatives in different sectors

It may not come as a surprise that it is the private sector which is paving the way for blockchain technology (Chang et al., 2020). To further understand how blockchain can be utilized in supply chains, a presentation of different sectors and pilot-blockchain-initiatives

will follow. Drivers behind such initiatives is to develop early industry standards and identify sector-specific capabilities of the technology (Chang et al., 2020). Furthermore, table 4 will present different sectors and barriers to blockchain implementation.

Maritime Industry

The port of Antwerp is not only the second-largest seaport by total freight shipped in Europe, it is also the global leader of testing blockchain capabilities within its field as it is developing a “Smart Port” (Chang et al., 2020). This blockchain initiative is aiming towards strengthening some of the port’s container release operations. The “Smart Port” utilizes blockchain technology to distribute digital rights amongst parties; these rights are traded amongst the party members. Simultaneously, blockchain technology ensures that when the rights have been distributed from one party to another, the rights are revoked from the original holder (Chang et al., 2020). Therefore, no dishonest actor can show up at the port claiming the rights of any containers. Furthermore, all transactions are promptly and securely stored on the blockchain (Chang et al., 2020).

Moreover, the port of Antwerp identified that there was a vast exchange of paper-based certificates, and these certificates did require a lot of parties involved. Additionally, these parties are also usually from different countries. Thus, when receiving two versions of the same certificate it can be hard to identify which certificate authentically holds the origin and safety of the food (Chang et al., 2020). This process is both time and money consuming. By the application of smart contracts, the port of Antwerp managed to ensure that documents originally transferred from New Zealand to Belgium reached the correct authorities within the Antwerp port without duplicating any documents. This was done in real time, without any delay (Chang et al., 2020).

Transport Industry

The United Parcel Service (UPS) has applied for a patent of blockchain technology designed to route packages throughout entire supply chain networks (Chang et al., 2020). The system is designed to detect and choose service routes on the background of the services offered by networks of providers as soon as a package is registered at a docking-facility. As the package moves down the network, blockchain technology is constantly verifying its movements, and record all information about the shipment. If providers meet

the obligations, the system automatically ensure various payments by the use of smart contracts (Chang et al., 2020).

Food Industry

Within the food industry there are two significant pilot studies conducted by Walmart & IBM to progress and apply blockchain applications to enhance “farm-to-fork” supply chains (Chang et al., 2020). In the first study Walmart & IBM accomplished to trace a package of cut mangos from a US store back to its origin in a Mexican orchard in just 2.2 seconds. Before the application of this technology, the estimated tracking time was seven business days (Chang et al., 2020). Within the food industry, the mango study is one of the strongest proofs of concept. The second study was conducted by tracking several different pork products from one single supplier to different local stores in China. From these two studies Walmart concludes that a more transparent and precise transaction record on a blockchain holds benefits such as: safer food, enhanced flow resulting in fresher products to customers, and increased consumer trust (Chang et al., 2020).

Manufacturing Industry

A key driver in the global economy, accounting for nearly 17% of total GDP, is manufacturing. In the UK an astonishing amount of \$2 billion yearly is estimated for insufficient supplier management, ineffective procurement, and poor freight administration. Furthermore, on a yearly basis almost \$300 billions of raw materials are lost in the form of fraud or leakage (Chang et al., 2020). Thus, a lack of trust may arise and a consequence of this may be a “trust tax” – this is a terminology that refers to the slow and costly process of vetting new business partners and building trust (Chang et al., 2020). Regarding manufacturing, blockchain sees the most popular use cases as of managing supplier contracts and enhanced payments using smart contracts. Furthermore, the industry is moving away from the classical “break-fix” models where equipment is replaced after it is broken, to a more analytical model that predicts maintenance before the product actually breaks (Chang et al., 2020).

One of the world’s largest smartphone manufacturers, the largest electronic supplier of Apple, built a platform named “Chained Finance” based on blockchain technology (Chang

et al., 2020). Loans worth a solid \$6.5 million was distributed successfully amongst several suppliers without any involvement of banks (Chang et al., 2020).

Table 4 showcases different sectors and barrier to blockchain implementation

<i>Type of Industry</i>	<i>General barriers to blockchain implementation</i>	<i>Industry specific barriers to blockchain implementation</i>
Maritime Industry	<ul style="list-style-type: none"> - Cost, initial development and further maintenance - High energy consumption 	<ul style="list-style-type: none"> - Low internet speed offshore - Low level of digitalization within the industry - Laws and regulation - Limited knowledge and expertise - Late adopter of modern technology

<p>Fashion Industry</p>	<ul style="list-style-type: none"> - BCT is perceived as an expensive technology. - Technological barriers appear more relevant and complicated to overcome. 	<ul style="list-style-type: none"> - Risk of increasing the cost of the final product - Low understanding of the new emerging technology in the industry - A perception that the fashion industry is not yet ready from either a technological or cultural point of view
<p>Manufacturing Industry</p>	<ul style="list-style-type: none"> - Legal uncertainties - Lack of trust - Setup complexities and costs 	<ul style="list-style-type: none"> - Missing standards - Missing infrastructure - Lack of management support and investment - Issues with collaboration and network establishment - competence deficiencies

Agricultural Industry	<ul style="list-style-type: none"> - Huge resource and initial capital requirement - lack of scalability & system speed 	<ul style="list-style-type: none"> - Lack of proper government regulation and regularity uncertainty - Lack of proper government regulation and regularity uncertainty
Food Industry	<ul style="list-style-type: none"> - Cost of investment - Lack of scalability and system speed - Low access of technology - Complexity of blockchain based system design 	<ul style="list-style-type: none"> - Research and development cost - Communication gap - Inadequate expertise
Sport Industry	<ul style="list-style-type: none"> - Missing theoretical framework 	<ul style="list-style-type: none"> - Missing theoretical framework

(Table 4 – Barrier to blockchain implementation (Sources respective to industries from top to bottom: (Zhou et al., 2020), (Moretto & Macchion, 2022), (Lohmer & Lasch, 2020), (Yadav et al., 2020), (Khan et al., 2023))).

2.14 Blockchain within the Sport Industry

Until this point the theory presented may seem dislocated from the sport industry. However, it is crucial to provide a solid theoretical foundation to understand blockchain in an easy way and putting emphasis on its capabilities, so the reader has the ability to judge the value of the technology (Naraine, 2019). Sport managers may however be more interested in how the technology could impact the industry from a more practical perspective.

Multiple use-cases of blockchain applications has been presented, but a much more similar industry to the sport industry is the tourism industry. The tourism industry identified major cases using blockchain technology, including ticketing and reservations, tracking of baggage, inventory control, accreditation management, loyalty programs, and digital payments (Kwok & Koh, 2019). According to Naraine (2019), sport managers can adopt concepts without difficulty. Incorporating ticketing with the use of blockchain technology, even though it may be resource intensive from a short-term perspective. However, as will be shown in later sections (6.0 Findings and 7.0 Discussion), the implementation of such a system is not only complex but has a lot of barriers. Furthermore, the advantages of the implementation may be outweighed by the complexity of making the implementation. Improved ticketing can also have user-enhancing effects and improve the consumer experience (Naraine, 2019). Moreover, blockchain has yet to be applied in other areas of the sport industry, particularly lacking research in the area of new digital payment and loyalty programs and data management (Naraine, 2019). Blockchain hold the capability to generate new revenues streams and increase fan loyalty at the same time (Naraine, 2019).

For sport organizations, as any other organisation, it is crucial to have access to financial resources. For sport organizations this provides opportunity to procure additional human resources and infrastructure. This can enhance on-field performance and athletic development and simultaneously expand business-operations (Naraine, 2019). However, within the sports industry financial resources mainly stems from traditional revenue-generating activities like ticket sales, sponsors or various forms of streamed content; such as television broadcast rights, and apparel (Naraine, 2019). This may be challenging for a lot of sports teams as revenue generating activities such as athlete-development is a time consuming process (Naraine, 2019).

Another important aspect of the sport industry is that central organization's intervention and control obstructs the effective connection between upstream and downstream resources within the industry (Lv et al., 2022). Additionally, the "influence" of the industry is often more significant than the profit, thus the current status quo is "only cheering but no money" (Lv et al., 2022). Furthermore, by applying a blockchain-based business model within the industry it is possible to enable mutual conductance between enterprises and operators regarding traffic, products and services, reduce transaction cost, and further stimulate consumers' willingness to pay (Lv et al., 2022).

Lastly, traffic has become an extremely important asset as the internet-age is becoming more and more popular and many sports companies have huge amount of traffic, such as forum communities and live chats during streams. However, how to monetize this traffic remains a difficult concept (Lv et al., 2022). But it is important to recognize its potential.

3.0 Research Methodology

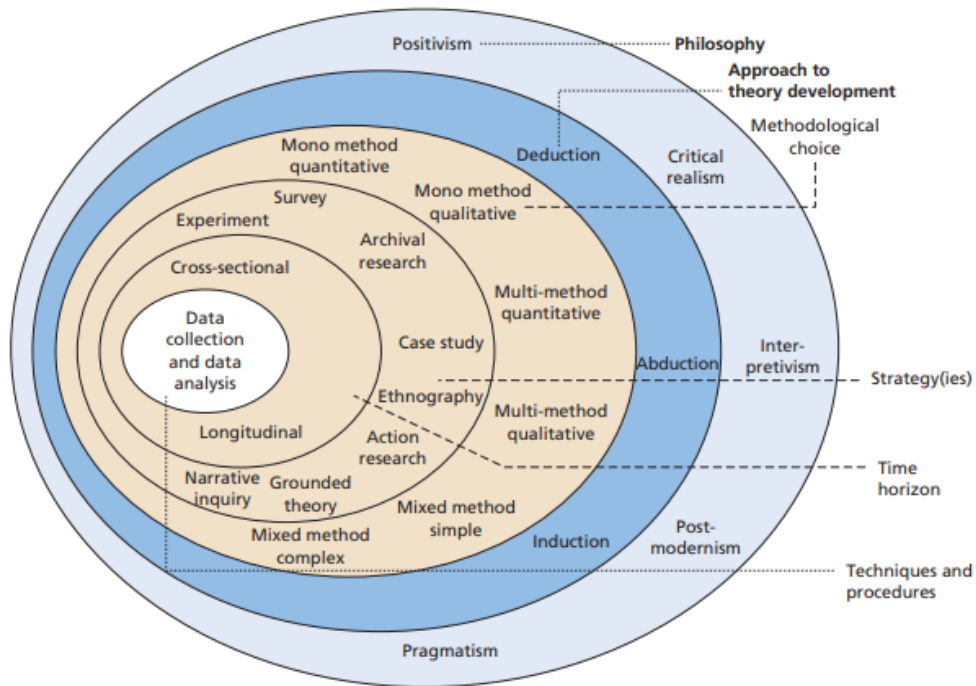
3.1 Chapter Introduction

This chapter aims to provide the reader with information about how the research were designed and conducted. It presents the research philosophy, approach, design, strategy, time-horizon, data collection, analysis, and data validity.

3.2 Introduction to research methodology

Many authors tend to label “research method” and “research methodology” equivalently, however, this is according to Saunders (2016) slightly inaccurate. Methods may be labelled as gathering-techniques of data and how to analyse it, such as questionnaires, observation and interviews, or quantitative vs qualitative strategies. Whereas the term methodology presents theory regarding how research should be initiated, both with a theoretical and philosophical assumption in regards of further implications for the chosen method(s) adopted (Saunders, 2016).

When doing research, it is important to explain the choices you have made and why you made them to outline why your research should be considered with importance (Saunders, 2016). To justify the way data is collected the “research onion” can be applied. The research onion is a diagram that illustrates the underlying issues of choice regarding data collection techniques and analysis (Saunders, 2016). The onion represents a set of layers regarding research philosophy, research approach, research design, research strategy, time horizon, and data collection and analysis as shown in Figure 3.



(Figure 3 – the research onion by (Saunders, 2016)).

3.3 Research Philosophy

Regarding philosophical positions there are according to Saunders (2016), mainly five different stances researchers can take, these are: positivism, critical realism, interpretivism, postmodernism, and pragmatism. For my thesis I have decided to take an interpretivism-stance as it highlights the difference between humans and physical phenomena as humans creates meanings; as people are unique and creates different opinions based on various cultural backgrounds, different circumstances, and interpreting experiences heterogeneously (Saunders, 2016). Thus, the purpose of this thesis is to generate new, enlightened understandings and interpretations of the blockchain concept in the eyes of the sports industry.

Moreover, it is important to be aware of the fact that the interpretation of research materials and data will reflect the researchers own values and beliefs, thus it will have a great impact on the research process (Saunders, 2016). Additionally, there has been made arguments in literature whereas the interpretivist perspective is highly relevant for business and management research as business cases usually are unique and complex in regards of context (Saunders, 2016).

3.4 Research approach

Mainly there is three different research approaches: a deductive approach, inductive approach, and an abductive approach. A deductive approach is often based upon reading academic literature and designing a strategy to test the theory. Furthermore, said approach builds on logic that if the premises are true, the conclusion must also be true. On the contrary, induction builds on data collection and an exploration of a phenomenon where one is generating (or building) theory (Saunders, 2016). The logic from this type of approach builds on known premises to generate untested conclusions. Thus, this method lines up well with the interpretivism-stance.

3.5 Research design

Generally, the research design can be interpreted as the plan for answering the research question(s). Thus, the importance of having a sound problem formulation and clear research questions should not be undermined. The research design will hold impactful purposes emerging from your research questions, give a clear direction of how data-collection will be executed, and how the data will be analysed (Saunders, 2016).

As an interpretive philosophy often is seen in connectivity with qualitative research (Saunders, 2016), a qualitative method has been selected for this thesis. These two goes hand in hand because the researcher(s) needs to interpret the data and make sense of the socially constructed meanings expressed about the researched phenomenon (Saunders, 2016). Furthermore, a qualitative research design may consist of a single data collection method; such as an interview, and hold an parallel qualitative analytical approach (Saunders, 2016).

Furthermore, research can be divided into two “main” categories; exploratory or descriptive (Saunders, 2016). As I am set to answer “how” or “what” questions I have chosen an exploratory design which will be further discussed in the following section.

3.6 Research strategy

Conducting a case study; case selection

I conducted a single case study analysis of the utilization of blockchain technology within the Portuguese sports club SL Benfica. Due to the limitation of practical theory on how blockchain applications are utilized within the sporting industry and missing data foundations combined with the fact that this is an emerging technology, conducting a quantitative study seems irrelevant. This situation generates an opportunity for a qualitative study. Furthermore, this may function as a foundation for future quantitative research. As a result, the case study approach may be a suitable methodology for this type of empirical investigation, if it is executed properly. Additionally, Yin (2018), states that utilizing a case study is appropriate when exploring a phenomenon that is poorly researched and the foundation of data required to generate a hypothesis has not yet been acquired. Typically, case studies with an exploratory agenda address how and why questions to develop preliminary insight by examining the interactions within a contextual setting (Yin, 2018).

Moreover, a single case study is redeemed acceptable if the case under investigation is critical, extreme, unique and or revelatory (Dube & Pare, 2003). Furthermore, a single case study allows for analytic generalization of a given phenomenon, which allows for theoretical development, thus, creating data-foundations that can be statistically analyzed in future studies (Yin, 2018). In addition to these factors, Yin (2018) highlights that a case study as a research method largely depends on your research question(s). The nature of your research questions and how or why they seek to explain the behavior of a modern social phenomenon strongly indicates whether a case study is appropriate (Yin, 2018).

Additionally, case studies gain increased relevance as your questions request an increased “in-depth” description of a given social phenomenon (Yin, 2018). Lastly, the single-case study utilization occurs when the case consists of some sort of extreme or unusual case, deviating from theoretical norms or everyday occurrences or practice. By doing so, a case study may be valuable in the sense that it can be applied to many other people or cases, beyond its original origin of research (Yin, 2018).

Conducting a single case study; an interview-approach

In a case study, the interview is considered one of the most significant sources of evidence. There are several reasons as to why, one of them being its ability to highlight crucial events and occurrences (Yin, 2018). Furthermore, a case study interview is likely to be more of a conversation rather than asking a set of pre-determined questions. However, the interviewer should have a set of pre-determined questions and a pre-determined direction for the interview, the conversation may flow naturally depending on the participants response and information (Yin, 2018). Keep in mind that this leaves you with two important tasks during a case study interview. Firstly, following your line of pre-determined questions and study protocol. Secondly, make sure that the conversation that occurs is unbiased (Yin, 2018). As an example, there may occur situations where you are wondering why a specific process had a certain outcome. Moreover, Yin (2018), states that in said situation, there is an important difference between posing a “why” question opposed to a “how” question. A “why” question may put an interviewee in a more defensive stance (Yin, 2018). Therefore, case study interviews challenge you to follow your original thought of inquiry whilst simultaneously presenting friendly, nonthreatening, but relevant questions in your open ended interviews (Yin, 2018).

Conducting a single case study; the four principles

Principle 1: use multiple sources of evidence:

Preferably, one is set out to use multiple sources of evidence. However, it is possible to utilize a single source of evidence as the basis for entire studies (Yin, 2018). As an example, some studies have relied solely on interviews but have not examined a single document, and the other way around. This may be a result of a researchers choice of choosing the single most appropriate source available (Yin, 2018). Even though doing so may be appropriate, it is important to take note of the fact that one of the major strengths of doing single case studies data collection is that it allows for the utilization of multiple sources of evidence (Yin, 2018).

Principle 2: Create a Case Study Database:

According to (Yin, 2018), Normally, the data collected from a single case study consists of two collections;

1. The data or evidentiary base, and
2. The researcher's report.

This is important, to allow a critical reader full insight to the raw data which has generated the baseline for the report and case (Yin, 2018).

Principle 3: Maintain a chain of Evidence:

The construct validity of the information in a case study is important, and to increase it, it is appropriate to create a chain of evidence. Thus, allowing the reader to follow the derivation of any evidence throughout the case from the research question to the results and case conclusion (Yin, 2018).

Principle 4: Exercise care when using data from social media sources.

3.7 Time Horizon

Time horizon refers to whether the research is going to be a “snapshot” or if it’s going to be a series of “snapshots.” Moreover, if the research has a snapshot approach it can also be named cross-sectional, while multiple-snapshot-approach goes under the name longitudinal (Saunders, 2016). Even though academic courses usually has a time constraint, it is still possible to execute a longitudinal study, if you start your research early enough, and plan well (Saunders, 2016). Cross-sectional studies revolve around the study of a specific phenomenon at a certain time. Thus, these types of studies usually utilize a survey-based strategy with the goal of exploring a given phenomenon (Saunders, 2016). However, said studies may also apply qualitative methos (or even mixed methods) such as case studies built upon interviews that were conducted during a short period of time (Saunders, 2016). Given my time constraints and the purpose of my research, I have opted to utilize a cross-sectional type of study. The following section will describe the data collection and how it was conducted.

3.8 Data collection, analysis, and validity

Data collection

The research process started out with a casual conversation between me and the sports director of SL Benfica [M1], where he revealed that they utilized blockchain technology within their business. Thus, raising the question within me how blockchain can be utilized to gain competitive advantages within the sports industry. This conversation functioned as a “pre-interview”, and together with a theory review on the matter this generated the foundation for the interview-guide. Moreover, we agreed to do a more in-depth interview later, where both parties would have the potential to prepare. Additionally, this allowed the sports director to locate the best possible interviewees for the following conversation. I proceeded by conducting a literature review on the matter. Take note of the fact that I have only utilized databases approved by “Molde University College – Specialized University in Logistics”, these databases consist mainly of Oria and ABI/INFORM Global. I have also been using Google scholar, but to a limited degree in contrast to the other databases. There may be arguments against limiting searches to a few databases whilst researching such a newly arising phenomenon. However, this also ensures that the theoretical findings are valid and trustworthy, leaving me with a decision to make as a researcher. I ended up choosing to utilize mostly Oria and ABI/INFORM Global (also recommended by the university). Nevertheless, to build the timeline I had to use some articles from Google scholar and whitepapers made on the Ethereum network for validation. Furthermore, all the papers I used outside of the recommended databases are cited frequently and to the best of my ability I redeem them valid sources of information regarding the matter they are dealing with.

The next step was to decide which method was most suitable for my research. The chosen method must be considered, not only in regards of the case under scrutiny, but also data-availability, time utilization, personal- skills and resources, as all the mentioned factors are somewhat limited in regards of my master-thesis. The first step was to decide whether to do a single case or a multiple case study. Initially, I wanted to generate a cross industry study, but data-availability and time seemed to be an issue. Furthermore, aligning statements both from Yin (2018) and Dube & Pare (2003), regarding the utilization of a single case study this method seem justified for my empirical study as the research on blockchain is very limited regarding the sports industry. Whilst I am writing this, it seems

to be little to none blockchain studies done regarding this industry, at least published within my preferred databases of search. Thus, this case seems to present an excellent opportunity to add data-material to the current theoretical foundation on the phenomenon.

Moreover, to generate a proper single case study I followed the four principles of (Yin, 2018), although for principle 1. I only utilized interviews as my method. This is because there is very limited data material from other sources as the company (and technology) is still in an early stage of utilization. However, I had two interviewees, this was the Sports Director [M1] and the head of blockchain development [M2], since the Sports Directors himself, felt like these were the two people who could answer my questions most precisely at the given time. Continuously, I set out to do the actual interview, this was recorded using an old school tape recorder and my mobile phone with the UiO-app connected to Nettskjema. After the interview, I started analyzing and coding the data. Precedingly, I went on and generated a database in correlation to principle two, as presented by Yin. This will be discussed more closely in the next section. Moreover, I followed principle three to the best of my ability and did not utilize any sources from social media.

Data analysis

The last step of the research process was to analyze the data. I started by listening to the interview one time to get a full overview. Continuously, I replayed it in bits to transcribe it. During this process I replayed the bits multiple times. Ultimately, I listened to it one more time whilst reading my transcription to make sure I did not commit any flaws.

To get a clearer insight into the actual findings, I started filling in my interview guide with the answers from the transcription. I then proceeded to generate a database in the form of a new word document where I listed key topics to my research like timeline, business-model, blockchain-strategy, challenges and so on. Later in the analysis process, after feedback from my supervisor I changed the titles to “Drivers, Enablers, Challenges, and Desired Outcomes,” for then again to re-arrange and re-analyze the findings according to the new database.

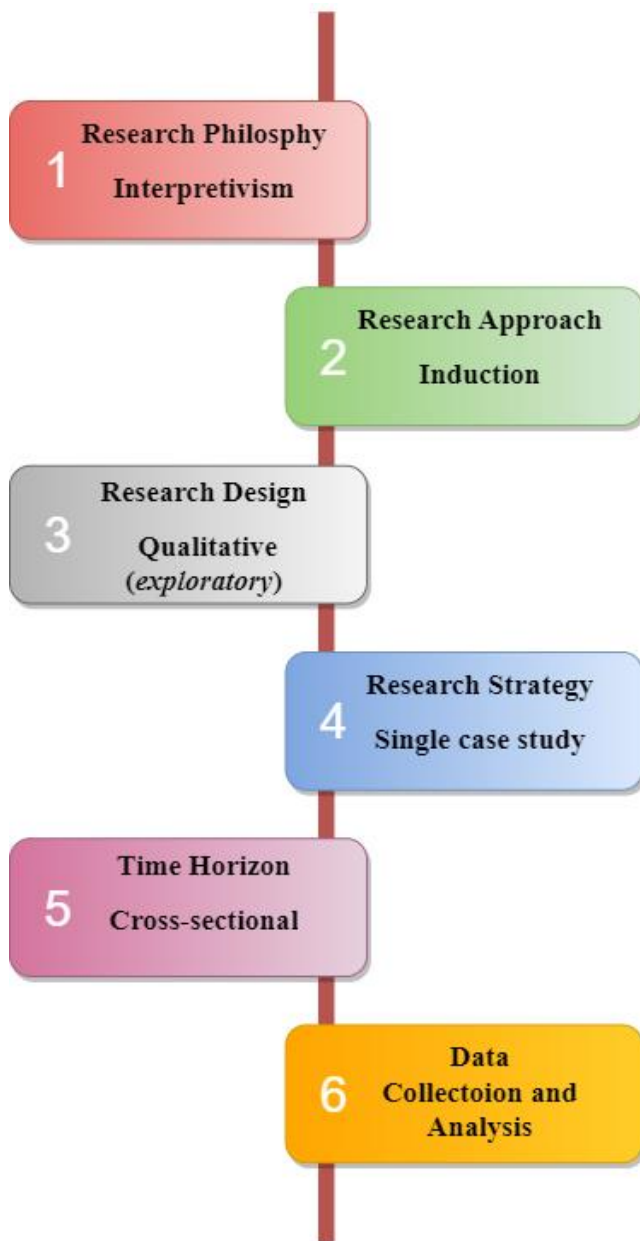
As this was a single case study, with a relatively small database, no computer programs were used to sort the data. However, I colored the titles as following: **Drivers**, **Enablers**, **Challenges**, and **Desired Outcomes**, and then proceeded to color the text from the transcription under the category with a particular color to make sure it got put in the

correct category. The coloring of sections could change multiple times as it was sometimes hard to decide what information belonged to what section.

Validity

The interviewees generate the basis for the material that is being analyzed. This proposes some degree of validity weakness. First off, it is important that the material gets as relevant and informative as possible. This can be strengthened by asking open and relevant questions. I have done so by following Yin's advice to the best of my ability, asking how questions instead of why. And trying to ask explorative questions not leading once. Furthermore, these are very busy individuals, thus, there were not generated a "test interview." However, the interview guide was revised multiple times, by both myself, my supervisor, and third parties such as family and friends with experience conducting interviews and research. The availability of the interview relies on the transcription and the recording. The interview was conducted online on Teams, and web cameras were utilized, thus, non-verbal communication was present as far as it is allowed by such terms.

Following a summarization of the research methodology is shown in figure 4 – Summarization of research methodology.



(Figure 4 – Summarization of research methodology).

4.0 Case Description

4.1 Chapter Introduction

This chapter presents the case company. It will provide information about the company, the companies supply chain, the companies business model, as well as utilization and transitions towards blockchain technology.

4.2 About the company

SL Benfica (Benfica) was founded in 1904 and is the most decorated club in Portugal. In fact, the club is one of the most decorated clubs in Europe (Benfica, 2023). Holding 81 official trophies, including 37 championships and two European-cups (Benfica, 2023). The fan-base of the club is massive, with more than 50 million fans worldwide (16 million in America, 14 million in Europe, 7 million in Africa, and 15 million in Asia). In communities of Portuguese speaking countries, Benfica is one of the most recognized brands. These communities have a combined population of 280 million people, and part of the strong representation of the Benfica brand is due to the robust trade links between countries and origin of players (Benfica, 2023).

As of 2022, Benfica is currently recognized as the 8th best club in the men's club ranking, worldwide. And is one of the most profitable clubs in terms of return on sales with an enterprise value of 349 million euros. The club is featured in the Deloitte's money league where it holds a ranking of 23rd place. For the past 10 years the club has invested 663 million euros in players, while generating over 1 billion euros in transfers. The biggest trade within the club came when João Felix was transferred from Benfica to Atletico Madrid for the stunning amount of 126 million euros. This is the fourth most expensive transfer in the world (Benfica, 2023).

The club has a massive supply chain network, of more than 500 companies, representing well-known actors such as: The Emirates, Heineken, Adidas, Betano, Repsol, Socios.com, EA sports, and many others (Benfica, 2023). Together these partnerships make each other

think and operate on a global level resulting in a bigger reach, all around the world (Benfica, 2023).

In a collaboration with the McKinsey Company, Benfica set out to innovate by increasing existing revenue sources such as membership fees, merchandising, season tickets, and ground-breaking match day sales. This have resulted in digital sales increasing by 70% in the B2C category. By deploying state of the art digital capabilities, the club has successfully engaged their extensive fan network across the globe (Benfica, 2023).

“The constant drive for innovation is what keeps our club on target to achieve our goals”
– Benfica (2023).

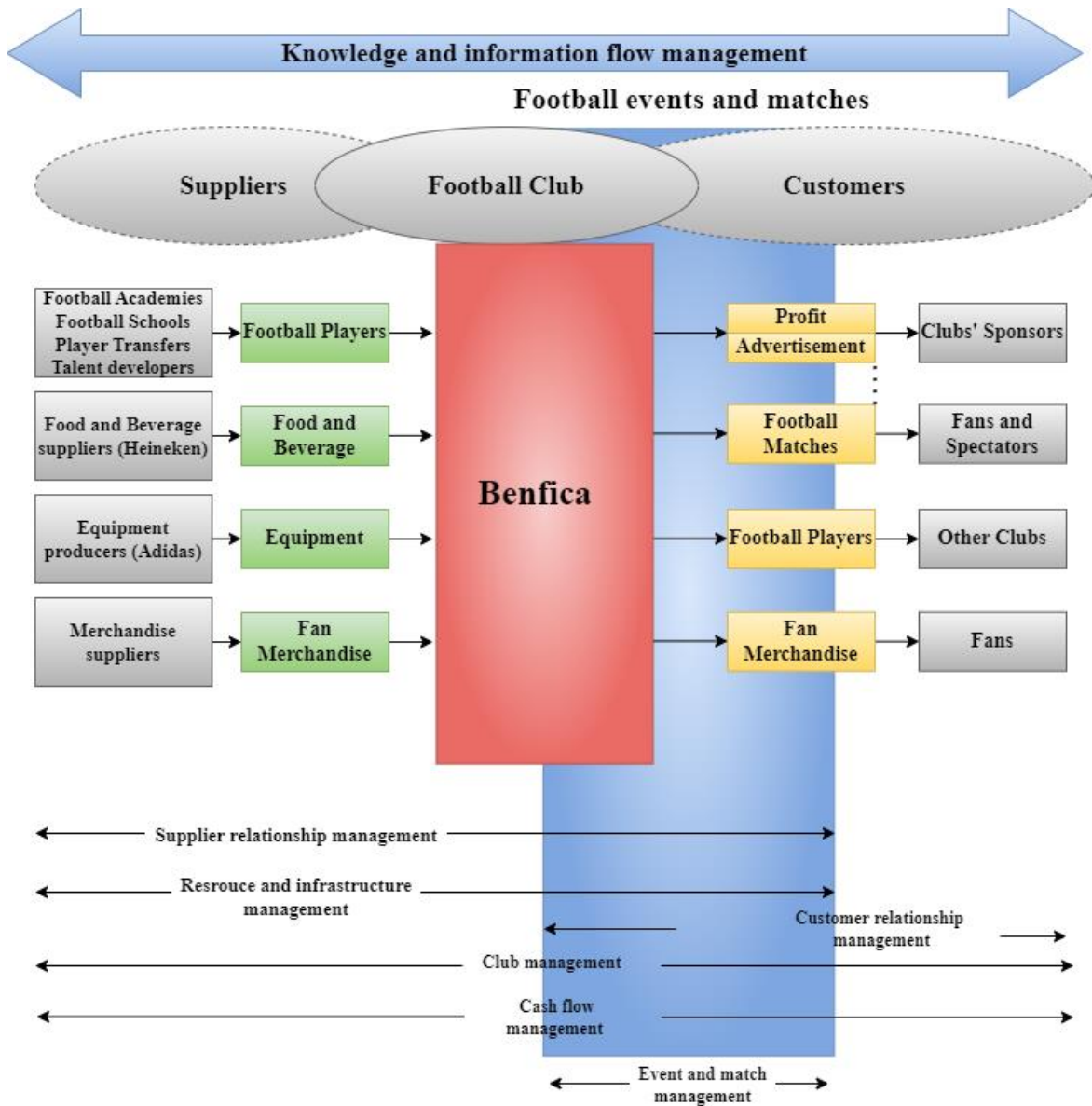
According to market studies done by the club, the Portuguese league and Champions league games are broadcasted in 130 countries and watched by 104 million people (on average per season). The club expects to reach two million registered fans around the world with their digital strategy (Benfica, 2023).

Benfica has over 50 football schools together with 5 strategically positioned training scenters. In the centre of all, lays the Benfica Campus *“where stars are made.”* A proof of this quote is Portuguese hero Bernardo Silva. Their two professional teams are training at the Benfica Campus every day together with the academy teams and the facility is composing of 9 youth teams, 57 technical staff members, 207 players and 27 coaches (Benfica, 2023). The Benfica Campus is currently holding the record of the world’s most profitable youth academies worldwide with a value of 379 million euros, grossing 457 millions of transfers (Real Madrid has the second largest, with 330 million euros. (Benfica, 2023).

Furthermore, the club is strategically implementing an international expansion program, this plan reflects the main pillars of the club: innovation, youth development, and eclecticism. Where the club intend to base its global expansion on its ability to produce and develop young talent (Benfica, 2023).

The Benfica supply chain

Illustrating a football clubs supply chain is a difficult and complex task as it involves a tremendous amount of unique flow, not only of goods but also of services. As can be seen in figure 5 presented below (the figure is inspired by Memari et al. (2021)).



(Figure 5 – Benfica’s supply chain; inspired by (Memari et al., 2021)).

If one were to categorize Benfica’s product to one item, theoretically, you might end up saying that Benfica delivers value to their customers. As this is a vast generalisation and goes for all companies (as it is the fundamental of running a business) it can once again be broken down to five main functions downstream the supply chain: Benfica generates football players, football games (entertainment), merchandise (social status, satisfaction,

and enjoyment), and profit/advertisement for their sponsors. Furthermore, this is presented with different forms of logistics; the football games are broadcasted and shared on TV and social media, the football players are sold to other clubs by agencies and contracts, and the merchandise is transported traditionally to stores and sold in stores or through e-commerce.

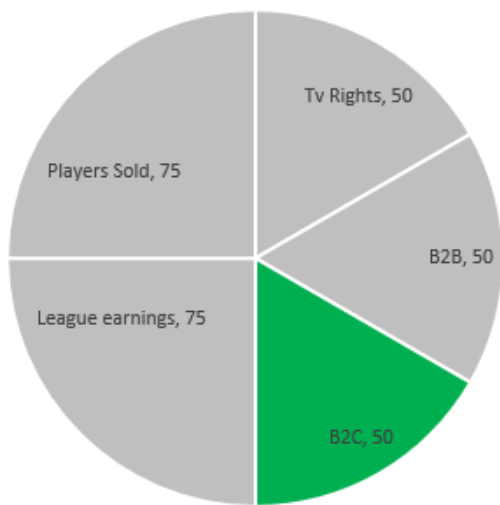
Upstream the supply chain you find actors that help Benfica generate these goods and services. These are found in the form of the Benfica academies, football schools, player transfers between clubs, “talent developers” (Talent developers referring to staff that helps “optimise” players, such as physiotherapists, coaches, personal trainers i.e.), food and beverage suppliers (providing sales on the stadium at home games), equipment producers, and merchandise suppliers,

4.3 Benfica’s business model

To understand how Benfica utilize blockchain technology to obtain competitive advantages, the potential challenges, and the futures of the technology with regards of the industry, first one must understand how the industry generates revenue.

The overall business of Benfica is worth around 300 million euros (see figure 6). However, this can be segregated into two separate segments that contains an equal share of value of 150 million. On one side, you have the actual sports related business, business related to football. Again, this segment can be divided with a 50/50 representation, where half the revenue generated comes from money earned in competitions, such as UEFA and Champions League, whereas the other half is related to sales of players. An interesting observation is that this part of the business takes a loss at the end of the year if there are no players sold. Furthermore, the first half can be divided into three segments. Tv rights in Portugal for the local championship, The Portuguese League generates around 50 million in euros from TV rights, B2B (business to business) generates another 50 million yearly, where about 30 million comes from sponsorship agreements. Regarding B2C (business to customer), there are three main ways of generating revenue: memberships and loyalty, ticketing, and merchandising. Currently, blockchain technology is relevant for the B2C area of the business.

Revenue Generation



(Figure 6 – SL Benfica revenue generation (pie chart)).

Furthermore, some clarification regarding members is needed. Benfica has around 300 000 members, and these are paying members. Members are differentiated by supporter/fans because even though supporter/fans are necessary to run a successful sporting business, paying members has a direct impact on the bottom line. Thus, members must be examined in a different way than supporters/fans regarding a business perspective. Members generate revenue by paying a membership fee to the club to keep their status as a member and the benefits this brings.

One of the benefits of being a Benfica member is access to the loyalty program. And a part of Benfica's overall success is because they are one of the top clubs (top 5) in regards of paying members around the world. And a big reason for this, is the loyalty program. Currently, the main parts of the loyalty program are revolved around web 2.0, but it is strongly believed that they can enhance their business performance regarding the matter with the utilization of web 3.0. Furthermore, they believe that they can do so better than their competitors. However, in this area of business, the utilization of blockchain is not magically going to transform it into profit. Thus, if you are not already good at loyalty programs, blockchain is not going to make you better. However, if you are doing well, blockchain may have performance enhancing effects.

As of today, Benfica fans consumes around 50 million euros in Benfica goods. These goods can be divided into ticketing, merchandising, and member fees. Moreover, they also spend more than 60 million in Partners allocated with Benfica. As an example, there is a group of retailers that are part of Benfica's partners, where fans generate discounts. Furthermore, there is a Spanish gas company where you generate currency in your Benfica wallet as you put gas on your car. Also, there are various restaurants that offer similar benefits. Totally, there is more than 1000 partners, represented in the form of over 3000 different stores located all over Portugal. All the money saved in different ways, goes to your virtual wallet within the Benfica company. This money can be spent on Benfica goods, such as tickets, merchandise, or it can be spent with other Benfica partners within the loyalty program.

4.4 Transition towards blockchain technology.

Benfica started their journey towards blockchain implementation and the Web 3.0 in 2018. Together with an engineering supplier they set out to develop two different products based on blockchain technology that aims towards improving their loyalty program. The first product was a Token for Benfica to manage the loyalty program, and a solution to receive crypto currency as payment for Benfica-merchandise, such as tickets for the games or jerseys. However, in 2018, Benfica decided not to launch the Fan Token because they identified different challenges and risks, not only for the company but also for the fans. Regarding fans, the main concern revolved around inviting Benfica fans into the crypto market, and the rippling effects this may cause, such as bad publicity. The concerns regarding the club were somewhat similar as the crypto market at this point, was very new, and the financial risks involved were both uncertain, undefined, and hard to predict. Thus, the club elected to defy such risks for both them and the fans and elected to wait for more information regarding the matter and for a better, more certain opportunity. However, despite not launching the Token the club still wanted to progress within the blockchain technology. And as a first step towards the technology, they opted in on accepting crypto currencies as payment. This were done by launching an agreement with another company working within cryptocurrency-transactions to accept different crypto currencies for certain products. At this point, they mainly accepted the most traded currencies, such as Bitcoin and Ethereum.

Moving on, in 2019 the company started looking into NFTs and the NFT-executive finalized and confirmed the first ever NFT-contract of Benfica later the same year. This was with a company called “SoRare.” At that current time, this was a small company with only two employees. Today it is, according to the NFT-executive of Benfica, the biggest company in NFT’s for sports. This information is hard to verify exactly, but it should be fairly accurate. Furthermore, this shows that there has been a demand in the market for this type of service. The company lets you utilize NFTs to build a fantasy team and compete in a fantasy league. This agreement was both important for “SoRare” and Benfica. For the developers, they got the benefits of showcasing the fact that they already had made a deal with a big company, that they are trusted by a big actor. For Benfica, this brings an advantage in the form of image. They get to showcase that they are a club who represents technological advancement and are willing to take an active role in the evolution. In January 2021, a more serious and intense blockchain focus occurred by the club, because of all the rumours and noise from another sports industry, the NBA. Naturally, Benfica wanted to see if they had potential to mimic what was going in with NFTs in the NBA, so they launched their own investigation on NFTs and how they can be utilized to generate revenue or value for the club.

4.5 Utilization of blockchain technology.

The first step towards the process of generating your own NFTs it to identify your assets. What type of content can you produce? As this is clarified, a second matter must be identified, and this is to whom and what do you have copy rights for? A competitive advantage was obtained by the club as they are very well organized internally, thus leaving an advantage over other clubs less organized. Allowing them to get on the market quicker and negotiate better deals. The second step is to organize assets into different categories, like video-assets, newspaper cover-assets, photo-assets and so on. Continuously, a table of content was generated and brought to the market to see which companies were interested in what types of assets. During 2021, there was a lot of investments going around within the NFT market, and this resulted in a sale of copy rights for millions of euros for Benfica. Additionally, it led to a total of ten contracts with different companies. Some of the products has already been launched for crypto-minting, others are still under further development.

A reason for the delayed development is because of a term called “crypto winter.” A crypto winter is usually caused by a decline in value or trading of cryptocurrencies. As the crypto market recently saw major downswings the further development has been paused, as developers are waiting for the market to recover.

Benfica does not only utilize NFTs to attract members towards their loyalty program, but they also utilize NFTs for their digital contracts. If contracts are digitalized, they are being identified by NFT’s to make sure that they are authentic and correct according to the agreement. Another option that are being investigated for NFTs is if the club decides to turn actual ticketing into NFT’s. These tickets would also represent images of the games and have some sort of additional value to the fans. But again, the research reveals that yet another blockchain project is put on hold. Part of this is because Benfica is mainly focusing on generating revenue through NFT conversions and licensing and have other business aspects to focus on. Additionally, there is not a dedicated team from the IT department to focus solely on blockchain developments.

Continuously, the club is negotiating with one of the biggest CRM (Customer Relationship Management) companies in the industry, which will be referred to as Supplier 1 (because of confidentiality agreements). Supplier 1 is set to develop the characteristics and behaviours of the services that subscribers will get access to on a blockchain application. These subscribers will get access to something referred to as a “Red pass”. This functions as a season ticket and give users with said pass a limited access to buy various types of digital products. For Benfica, this comes with additional benefits besides from the obvious revenue profits, this will also allow the club to track the digital assets (products) a specific user is holding and may yield other advantages such as target-marketing. This application is being built on a blockchain. It is important to take note of the fact that Benfica is the first club to develop such application together with Supplier 1. At the current moment they are building their applications on two blockchain networks, Ethereum (ETH) and Polygon (Poly). However, they are faced by some challenges. Early in the crypto development, Bitcoin and Ethereum were the “concept leaders” However, ETH proposes some utilities that are not proposed on the bitcoin network, such as smart contracts, thus, Ethereum acted as the market leader for applications that requires such characteristics. Moreover, Ethereum were struggling with high gas fees (transactional fees), which resulted in a lot of developers changing to other networks, such as Polygon, or other similar networks. A lot

of businesses are simply motivated to gain access to the blockchain that provides the best possible financial conditions to run applications, as the goal is to pay as little as possible in gas fees. The reason behind the developers currently running two blockchains is because Ethereum is working on a solution to their commercial activities and may be able to provide better conditions for people who want to mint products on their blockchain. When Benfica entered NFT agreements, they had some sets of requirements. First, not be exclusive to a blockchain in the NFT world. Second, not having to depend on a specific cryptocurrency to be able to purchase NFTs. Third, offer the possibility to purchase the NFTs with regular FIAT currencies. And to have the ability to interact between blockchains.

Besides from NFT's and Web 3.0-ran applications, Benfica is also running a project with Supplier 2 of releasing a Fan Token, the Benfica Token. Even though the contract already has been signed several months ago, Supplier 2 decided to stop the launch as the crypto market started seeing a downswing. However, Supplier 2 is claiming the stop due a missing agreement with the financial authorities in Portugal. Since the agreement already is signed and settled, but the Token is yet to be launched, this is generating conflict amongst the two parties. Furthermore, this situation is building doubt and uncertainties towards future agreements.

It may be interesting to investigate how this Fan Token can enhance the business. Similarly, to the NFT's, the Token has a double objective. First, Benfica generates revenue through sponsorships, and revenue generated by licensing of the token. Secondly, the goal is to attract more people to the loyalty program and engage people in the environment of web 3.0 and the possibilities this environment presents. A big goal for the club is to offer a gate way from the regular web (web 2.0) to the world of blockchain (web 3.0). As of now, there are only 200 million people on web 3.0. The club aims towards making a user-friendly environment by creating an application that is gathering all the Benfica Tokens, all their NFTs, and their other digital assets in one place, and allowing it to be seen and modified to prevent the need of going to a specific blockchain network to interact with a certain technology.

For Benfica, blockchain technology is currently in an early phase, phase 1. In this phase the goal is to have all the specific NFTs the club can offer accessible in one marketplace, from one specific page. However, in the future the club aim towards having a fixed link

between physical products and digital assets. But this belongs to a phase 2 project. The reasoning behind this is simply because the technological development at this stage is not offering enough solutions regarding the aspect or is too expensive to execute. As an example, if you purchase a NFT of a Benfica shirt, you will not get a t-shirt in the mailbox. If you want a physical shirt, you will still have to go to the webpage and buy a real shirt in addition.

5.0 Analysis and Findings

5.1 Chapter Introduction

This chapter provides the reader with the findings from the interview. Additionally, it also provides the analysis of the findings grounded in direct quotes from the interview transcription. It showcases the drivers, enablers, challenges and desired outcomes of blockchain implementation within the company.

5.2 Drivers for blockchain technology

There are many drivers behind Benfica's blockchain implementation process. As mentioned by (Naraine, 2019), blockchain possesses the ability to generate new revenue streams and increase fan loyalty. And when Benfica started their journey towards blockchain implementation in 2018, the aim was to improve their loyalty program and allowing people to pay with cryptocurrency.

“Let me give you an environment of our beginning of the web 3.0. We were invited by an engineering company from Braga. Who had at that time they invite us to make two things a token, from Benfica to manage the loyalty, okey, and they also invite us to receive crypto currency if the people want to buy BTC-products, like merchandise and tickets for the games and other things, okey? At that time, we decided this, was in 2018.” – M1.

Despite the origin regarding blockchain implementation was related to improving loyalty programs, a more serious and intense blockchain focus occurred by the club in January 2021, because of all the rumours and noise from another sports industry, namely the NBA (National Basket Association). Naturally, Benfica wanted to see if they had potential to mimic what was going on with NFTs in the NBA, so they launched their own investigation on NFTs and how they could be utilized to generate revenue or value for the club.

“Today, our strategy with NFT is to sign the greatest number of contracts and the much more quantity we can produce in euros. It’s different where in the strategy, but M2 can talk about this.” – M1.

“As M1 was saying our focus when the boom regarding the NBA top shots in 2021 came around in January 2021, everyone was wowed and wow what is happening here, what is this NFT thing going on, and the business in football had this huge movement trying to understand what was happening.” – M2.

Furthermore, Benfica has a good reputation within the football industry. Not only in regards of football results and bringing up new talent, but they also have a good reputation for being a club that is trying to bring innovation. Thus, while seeing advantages to the business model by implementing blockchain technology they can also keep enhancing their image within the industry, as stated by M2.

“Benfica has a very good name in the industry of soccer. Not only what we represent in terms of the players we put in the market, but industry also recognize us as a club that is also trying to search and being in the frontpage of technological development.” – M2.

5.3 Enabling factors for blockchain technology

There are many conditions that has allowed Benfica to utilize blockchain technology effectively. The first step towards the process of generating your own NFTs it to identify your assets. What type of content can you produce? As this is clarified, a second matter must be identified, and this is to whom and what do you have copy rights for? A competitive advantage was obtained by the club as they are very well organized internally, thus leaving an advantage over other clubs less organized. This, as said here, allows them to get on the market quicker and negotiate better deals.

“What we have done was first identify what were our real assets in terms of copy rights, this was the first move we had organized internally, fortunately for us we are very well organized in terms of what our copy rights are, and very clear, and it’s much more clear than other big clubs around universe of the soccer industry.” – M2.

The last step is to organize assets into different categories, like video-assets, newspaper cover-assets, photo-assets and so on. Continuously, a table of content was generated and brought to the market to see which companies were interested in what types of assets, as illustrated in this quote:

“What we have done categorize we have this type of asset, asset, asset, videos, newspaper covers, photos, and so on... And so, we got this in a huge table and said okey we can do this this this.” – M2.

During 2021, there was a lot of investments going around within the NFT market, and this resulted in a sale of copy rights for millions of euros for Benfica. Additionally, it led to a total of ten contracts with different companies. Some of the products has already been launched for crypto-minting, others are still under further development:

“We went to the market and let’s see who is moving on the market first, and all this is appearing new companies with new things with new investors coming around from the web 3.0 from the crypto industry saying I put you here some millions of millions of dollars. What we had to identify was a lot of companies in this department. And this turned out to be what M1 was saying: 10 contracts.” – M2.

Another condition that allows Benfica to implement blockchain technology, despite not investing heavily into the technology in the form of money and finances; is that they have the capacity to spend a lot of working hours. Research generate the right ideas on how to further develop this part of the business, but as of now, the amount of money invested is relatively low compared to other investments. Regardless of this, Benfica has been able to generate money equal of their main sponsor. This number is not revealed, however, assumingly, this is a significant amount. The club reveals that with further emerge of the technology the club will go to the next phase of their blockchain development, and at this point they will be willing to invest more money into the industry and take more risks.

“We invest a lot of hours, to do research on this industry to have the right idea to develop the business, but today we did not put money on that, the only money we put on that is our hours. But its only hours of our work, and today at the end of this season the money we produce on that industry is little less than the main sponsor of Benfica, its huge money, but

we only invest hours we don't put money on that, probably the next level will be to put some money and take some risks, if we are successful if we are successful on some particular things like NFTs for the guys who renew their season tickets and where is the right way to make money with that. This is the question.” – M1.

Nevertheless, there is a lot of money going around within the industry, thus, it is unlikely it is going to collapse. However, such a new industry involving a lot of money will always bring certain financial risk and it has a lot of volatility to it. Therefore, some developers may go bankrupt which brings additional risk for Benfica and the industry. The industry needs to be willing to take some risk and pay for the technology and product, as explained here:

“...the explosion of this industry as I will say occurred in 2021, and the value came only from 2021, 2022, we are in 2023, we are talking about a recent industry I will say, with a lot of money going around, so that is the risk, we are not expecting that the industry will collapse because there are so much money put in it, by a lot of companies, including the bank, banks are going through there, that it is going to have a future, but between this and the stable future it's not going to be stable because the digital is going to flare up, between today and tomorrow some companies are going to collapse for sure.” – M2.

This situation seems to be the case as not only clubs, but also UEFA and FIFA are looking into becoming part of the blockchain environment and looking for sponsors within Web 3.0.:

“Including as u can see from UEFA and FIFA, they have launched a specific part of being a sponsored for specific areas of web 3.0, they are looking for crypto partners, NFT-partner, Fan Token partner! They have it, but they stopped a little bit. For sure in the future the competitions when the club is in the champions league competitions one of the things is to have the possibility to is to make a special collection of moments of that competition with NFT combining them with crypto if they have a specific digital coin that has best condition to get the other NFT, I think that will combine the easy part for some leagues and some national leagues will go into that point also.” – M2.

To determine exactly which part of the supply chain that is going to see the most advancement by utilizing blockchain technology is yet to be determined. Because the club is still in an early phase, and it all depends on the next phase and what strategies to implement. Currently, the overall strategy is to utilize the NFTs, Fan Tokens, and the Benfica brand to generate as much revenue as possible in the form of sponsorships and copy right agreements, and simultaneously invite fans into the world of Web 3.0.

“What part of Benfica is going to have the biggest effect of the implementation of blockchain? This depends on the strategy we have on the next level, today we work with a team that is involved in the business, the idea is now, like M2 said in the right way, we are to keep most of the money that we can. We have tremendous potential to provide our brand on that environment, on the next step where we try to find most of the money.” – M1.

“Benfica probably invest some other ways to attract more people.” – M1.

A key factor to Benfica’s success within the blockchain environment, besides their good internal structure, is their possession of copy righted content. The club has been a top club for a long time and have 190 years of content to their disposal. Only the imagination limits your capabilities of generating content in such a case. The history, the stadium, the fans, an avatar of yourself with a Benfica shirt. Furthermore, the next step is to be able to realise how to generate equity. And one of the best ways for the club to do so is by investing money to attract more people into the environment:

“...our inventory are so strong because we have 190 years it’s so rich you can make everything on the environment , you can put the history of Benfica in NFTs, you can have the metaverse in life of Benfica, you can have the stadium, you can have the fans, Benfica in the other ways, only if you have the avatar with the Benfica shirt, and outside the sports environment.” – M1.

5.4 Challenges for implementation of blockchain technology

Currently, a big challenge regarding blockchain technology is the conversion between “Blockchain A” and “Blockchain B.” At this current time, there is no possibilities to transfer assets across blockchains. However, this may be possible in the future. Another

important challenge is the volatility of cost on the different blockchains and choosing the blockchain with the lowest cost presents some additional challenges. The challenge here lays with identifying which blockchain is going to be the market leader and give the best financial conditions, not only right now, but in the future. Thus, presenting companies with the dilemma to predict the right blockchain, or wait for technological advancement.

Benfica is working with several companies on different blockchains. However, an important factor here is that the club does not decide what blockchains to utilize, this is done by the companies they cooperate with. From Benfica's perspective, it is important to guarantee that the possibilities to go from "Blockchain A" to "Blockchain B" is going to be an option. And the companies they work with has all agreed upon this in the contract if the technology will allow to do so. Thus, for Benfica, the most important factor for Blockchain will be cost:

"The biggest challenge is to have the right choose at the moment, we work with several blockchains, one is bigger than the other, but at the end we don't decide the blockchain of the licensees, they decide their blockchain, what we would have to guarantee in the future, is the possibility, that is already guaranteed in the contract, when possible have this conversion from blockchain A to blockchain B, and at that time the cost between blockchain A and blockchain B will be the most important obstacles." – M2.

This advancement may be presented in the form of blockchains either being willing to merge or allow feeless transactions across chains. Allowing NFTs to be in the same environment without being overly complicated or expensive. As of now, Benfica is left with the impression that bigger blockchains are gatekeeping smaller blockchains to entire their blockchains:

"And why? because the biggest chain will not permit a smaller chain to enter quicker in there, so it is going to be a little bit more because they block the data ofc, and the community, instead of opening the door to permit to other blockchains." – M2.

This makes sense from a business-perspective. However, Benfica's blockchain executive believes to resolve this issue, someone would have to oblige them to comply in form of a macro factor decision (like the Portuguese government) or being pressured from other

industries, like the telecommunication industry or data control to get blockchains to convert or find some technical way(s) to go along side each other.

“And I will say this will be, it is not from our part but it will be much easier to have to do so, but it will depend on somebody that will oblige them to do so by other industries in telecommunications or data in data profile, data control , and they will oblige this blockchain to convert to each other we told them AGDP assets and so on compliant, but I will say this is the most challenge we have at the moment.” – M2.

The implementation costs of blockchain are treated equally to all other financial decisions within the company. However, regarding this matter, the main issue lays within the negotiation with other companies whether to utilize “Blockchain A” or “Blockchain B.” Because at the end of the day, every blockchains represent different levels of cost in terms of fees, and this transactional fee is going to be significant for the club. The financial department is constantly analysing the market because the end-margin has an impact, and this is differing from the commercial market. In the commercial market you are buying a product, then re-selling it. This is not exactly true with NFTs and other blockchain related services. Because after you have sold the product, you need to pay a specific company a specific amount of money for them to generate (mint) the product you are selling. For the time being, this process, and the costs related to it presents a certain amount of variation and uncertainty.

“My opinion: is the same as you see in all the financial tools that you have, when we analyze the cost on the gateway of payments on here or banks earn on our sales it is impressive the value. It is important for you to negotiate with them either on blockchain A or blockchain B. because at the bottom the amount of value in the end is going to be big in the future. The limitations or the conditions for the negotiation is going to be important for us but for our financial department to analyze the market because at the end margin is what we are talking about but at the end and as u know in the primary market when we have, I’m not talking about service I’m talking about commercial, because commerce is easy, but when we have service we are paying a specific company a specific amount, for them to generate a specific item, okey, at the moment we don’t have that cost but in the future we will have it, you earn service, you earn other type of valid, but it’s totally

different from a commercial point of view you have a product, you have a trade, and from that trade you will pay a specific commission of that trade.” – M2.

There is one strategy to increase the value of buying tickets. This strategy implies that by buying a ticket you also acquire an NFT along sides of your ticket. However, today, producing a ticket cost nothing. The challenges here lay within the minting of that NFT. Minting an NFT costs money, and if you do not manage to sell that NFT you take an instant loss. Furthermore, the NFT is only connected to that specific game, thus, turning it completely useless if not being utilized. Additionally, minting is an energy consuming activity, which will produce a CO2-footprint, and on a large scale, proven in-effective, this may result in a negative reputation for generating tickets with this method, as explained here:

“Imagine, if you buy a ticket for a game and I give you NFT today this cost nothing, what is the challenge, what is the NFT connected to the next game? Next game Benfica will receive, X at home, the production of NFT cost money, and you don’t sell this is automatic loss, but could be too expensive to buy this, having ideas is easy, you need to produce, with ideas, more money” – M1.

The challenge regarding NFTs is not within the production, but rather how to convert these ideas into revenue, as each idea come with increased expenses. As an example, it would be possible to give each user of the red pass a possibility to buy a NFT of the last season which would be exclusive for these members. This NFT could contain all the season victories, draws, defence, speeches of the coaches, speeches of the captain:

“It’s easier if we reach the championship when you renew the 45 000 seats of the season ticket you give NFT with the last season when Benfica reach the title in Portugal, and this have value, because you renew the season ticket and I give you a chance to buy the NFT only for this fans, only 45 000 fans could have this packet or this collection of NFT were you have all the season the victories, the draws, the defense, all the moments, with some speech of the coach, with some speech of the captain, this will be some really good content, I buy my season ticket, with 10 more euros I can have a NFT of the 38th title, this will produce money, the idea is such tremendous potential.” – M1.

Although the club has access to all this content, they are still facing the real issue of how to generate revenue from NFTs directly. Thus, per now the NFT strategy is utilized to attract fans, with an intent of generating more revenue at other aspects of the business. It is sort of an investment to have more attraction from fans, but there needs to be other ideas of how to generate revenue, because NFTs has a production cost, and the profit function as per now, is negative.

“That strategy, the content, would make sense to develop in our business, to give more value at the end for Benfica. You go for NFT for all the fans when we have one million registrations to our digital eco systems I can give NFT, but to have more attractions to people to Benfica, but after that I would make money with other business. Not with NFT, NFT could be an investment to have more attraction of fans, but after that work on this to make more connections other than NFT where we need to spend money.” – M1.

Regarding fans, the main concern is revolved around inviting Benfica fans into the crypto market, and the rippling effects this may cause, such as bad publicity. The concerns regarding the business of the club were somewhat similar as the crypto market at this point, was very new, and the financial risks involved were both uncertain, undefined, and hard to predict.

“At that time, we decided this, was in 2018, we decide don’t launch the token because we saw that some dangerous to invite Benfica fans to put money in crypto. The market at that time is so new and the financial risks and we don’t want to involve the Benfica fans with financial risk at that time we decide not launch the token, but we will start our first step towards new business with the engineering company from Braga.” – M1.

Early in the crypto development, Bitcoin and Ethereum were the “concept leaders” However, ETH proposes some utilities that are not proposed on the bitcoin network, such as smart contracts, thus, Ethereum acted as the market leader for applications that requires such characteristics. Moreover, Ethereum were struggling with high gas fees (transactional fees), which resulted in a lot of developers changing to other networks, such as Polygon, or other similar networks. A lot of businesses are simply motivated to gain access to the blockchain that provides the best possible financial conditions to run applications, as the goal is to pay as little as possible in gas fees.

“In this phase we are in the beginning, we are developing with the first club with Supplier X, now they are focused in the blockchain of ETH and Polygon only, as u know ETH was a movement in the beginning, that was very interesting and very nice, but were very expensive regarding the commission and a lot of people went to others like polygon and a lot of them trying to get best conditions and best financial results to not pay as much money as ETH.” – M2.

During negotiations Benfica faced a challenge with their supplier. Supplier 2 decided to stop the launch as the crypto market started seeing a downswing. However, Supplier 2 is claiming the stop due to a missing agreement with the financial authorities in Portugal. Since the agreement already is signed and settled, but the Token is yet to be launched, this is generating conflict amongst the two parties. Furthermore, this situation may be building doubt and uncertainties towards future agreements.

“Supplier 2, is a huge company in the FanTokens and we already signed this contract several months ago, but the problem was crypto industry came down, so they stopped to launch, they argued to have an authorization of the financial authorities in Portugal to launch a FanToken a Benfica token, and we already have this prepared and signed but in fact we didn't have yet the FanToken launched and this will increase our problem of loyalty with some special offers for these kind of people.” – M2.

Another challenge is regarding cryptocurrency and its extreme volatility, and as of now the market is seeing a huge downswing that is causing Benfica to put some developments on hold because of a term called the “crypto winter”, where the cryptocurrency is dropping extreme amounts:

“The contract is done so and some of the amounts has been paid and some are going to, but we have stopped a little bit because of the crypto winter.” – M1

5.5 Desired/Expected outcomes of blockchain implementation

As naturally occurring, the desired/expected outcomes are going to be aligned with the drivers behind the blockchain innovation. The original intent in 2018 was to increase the fan base by improving loyalty programs as explained in section 5.1.

“We already earned the money because of sponsorship, but there is a double objective, one is to receive money with the sponsorship, but also with the money they pay us to licensing the token, the other thing is to give more reaches to our loyalty program.” – M1.

The managers believe that a reason for Benfica being one of the top clubs in the world regarding paying members is because of their loyalty program. Furthermore, they expect blockchain technology to extend their fan base, and do so better than other clubs around the world.

“One of the reasons is that Benfica is one of the most clubs in the world because it’s the second or the third with most members around the world this is because our program of member of loyalty to, and we believe if we can do this in 2.0 and the reality without digital environment, we believe with 3.0 we can be much better than the majority of the world.” – M2.

However, as the blockchain technology developed, Benfica implemented additional strategies in regards of NFTs. Today one of the expected outcomes is also to increase the total revenue generated by the company.

“Today, our strategy with NFT is to sign the greatest number of contracts and the much more quantity we can produce in euros. It’s different where in the strategy, but M2 can talk about this.” – M1.

The club aims towards making a user-friendly environment by creating an application that is gathering all the Benfica Tokens, all their NFTs, and their other digital assets in one place, and allowing it to be seen and modified to prevent the need of going to a specific blockchain network to interact with a certain technology. Additionally, in the future the

club aim towards having a fixed link between physical products and digital assets. But this belongs to a phase 2 of their blockchain project.

Thus, if you wanted to buy a NFT of a shirt combined with a physical shirt you could do so with one simple click. You do not have to utilize third-party applications to access NFTs and a traditional Benfica ecommerce store (or physical) to buy the shirt. However, currently, with the current state of technology, this is not possible or too expensive. This comes with additional benefits; besides the obvious revenue profits, this will also allow the club to track the digital assets (products) a specific user is holding and may yield other advantages such as target marketing, as illustrated in these two quotes:

“And the idea is to finish on that in our system, and this is the way we see the next level, next level is to put on that crypto wallet our environment in 3.0, is the way that I told you we need to have conditions to launch on the 2.0 the web 3.0 because it’s the way to give much more knowing about our project to our fans.” – M1.

“The potential to have now the same NFTs that we have contractually in the same umbrellas in one market place only and we are going to have a specific page in phase 1 where people can achieve all the agreements we have in the terms of NFTS, in the future also to mix and to link the physical product and the digital asset or the digital property, ownership, in the same environment, but that will be a phase 2, because technological there are not so many solution that you can utilize in your webpage, like you are going to your site and buying a shirt then you are going to buy a shirt, at this moment these technological tools are not mixed together and at this moment it is expensive to link it together.” – M2.

Moreover, Benfica is currently identifying digitalized contracts by utilizing NFTs. However, another stage of the project is to turn ticketing into NFTs. However, this part has not yet been explored as it comes with some challenges, and Benfica has opted to focus on money conversion in the first stage.

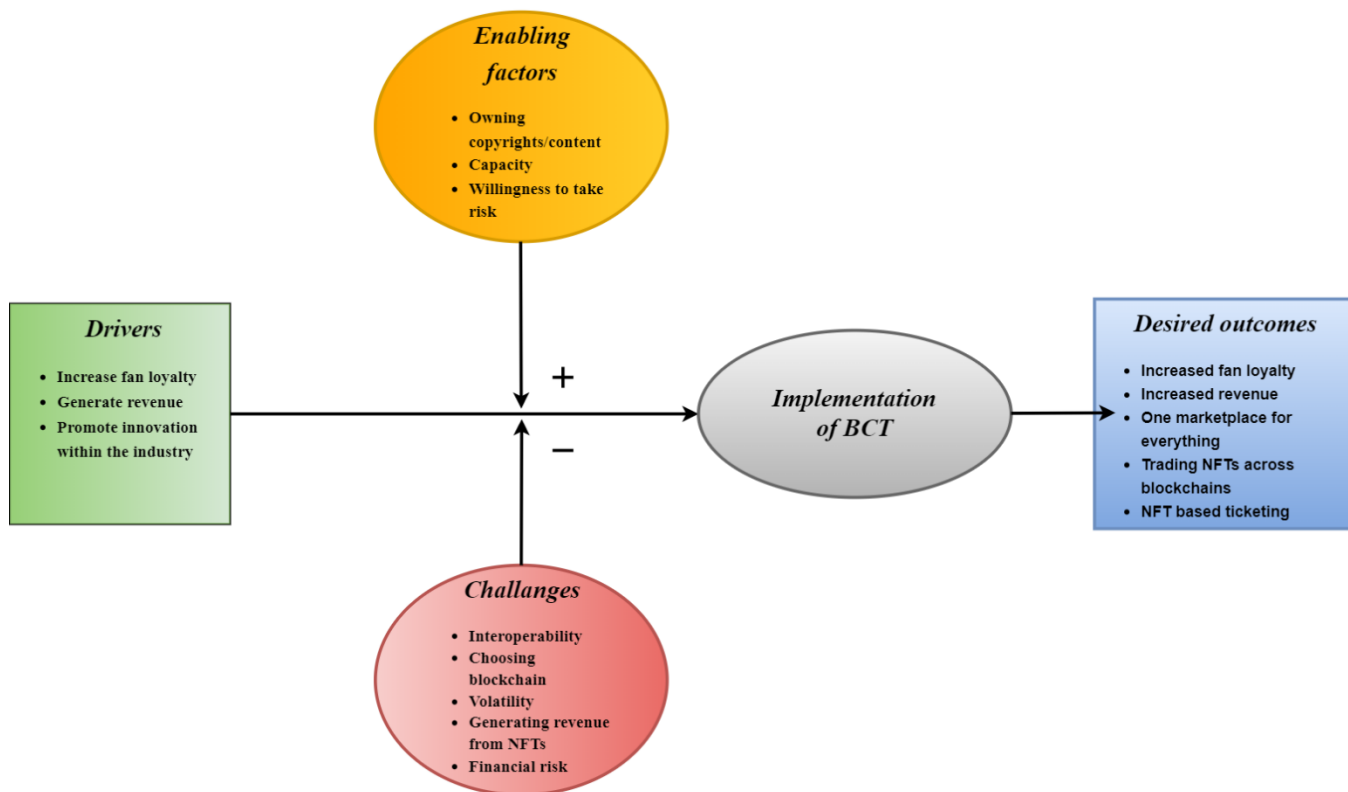
“The part that you were asking Miguel, the services. If we digitalize contracts, we identify them with NFTs if we turn actual ticketing into NFT that you can also have the imagery of the game. Some examples are appearing in the developing part, we didn’t go to that part

yet, because we had focus on the business, so getting money conversion in licensing and business.” – M2.

Lastly, the interoperability issue needs to be dealt with as the industry would greatly benefit from the ability to interact with NFTs across chains to be able to obtain the best possible financial solutions.

“What we would have to guarantee in the future, is the possibility, that is already guaranteed in the contract, when possible, have this conversion from blockchain A to blockchain B” – M2.

Figure 7 summarizes the findings.



(Figure 7 – Summarization of analysis and findings).

6.0 Discussion

6.1 Chapter Introduction

The objective of this thesis has been to discover why a sport company should implement blockchain technology, in what areas of the supply chain a sport company can implement it, and what challenges a sport company may expect to encounter during a blockchain implementation process. In this section an elaboration on the findings combined with existing theory from different domains will be presented.

6.2 Reasons for blockchain implementation in the sports industry

Benfica started out their blockchain journey in 2018 by focusing on launching a Fan Token and offering the option to pay by cryptocurrencies. However, these are not the only ways the club is utilizing blockchain technology to gain competitive advantages. Since 2019, the club has been working with developing NFT strategies. Moverover, the real transition started in 2021 because of what was going on in the NBA industry. According to (Alkhudary et al., 2022), there are multiple industries that gained opportunities because of NFTs, and the NBA was one of them, where an amount of over 230\$ million dollar has been circulating in the ecosystem regarding purchasing and trading of digital assets such as NFTs. Naturally, when such ridiculous amounts of money start circulating in an industry close to yours, this is prone to grasp your attention (There can be made arguments for whether Benfica is in the same industry as the NBA or not, regardless the business models is similar enough to grasp attention and to further distinguish both industries is outside the scope of this thesis). And Benfica launched their own investigation to discover how NFTs can be utilized to generate value for the club (M2).

The first form of value came in early 2021. This outcome was not directly linked to the blockchain technology but rather a side effect of it. When the club sold copy rights of NFTs for millions of euros (M2). Even though it's not directly connected to the blockchain, a competitive advantage may be obtained in this area by being better internally organized than your competitors. This allows for a faster market transition and increased leverage whilst negotiating deals (M2).

An interesting question to ask is how Benfica can generate revenue or value from NFTs? Taherdoost (2023), claims that NFTs are expected to have a major impact on financial and economic sectors, leaving the club with the challenge of finding the optimal strategy for NFTs. Mainly there are two options. Benfica can mint a high volume of similar NFTs – thus making this NFT far less valuable than a low-minted edition. As a result of this the revenue will not come directly from sales, but from an increase in activity, fan-engagement, and loyalty programs. The second option could be to mint a very limited amount, to make them more valuable to the market, leaving them more expensive, and try to make direct revenue from sales. From other similar sport industries, as for instance the rugby industry, NFTs were utilized as part of a marketing strategy with the goal of improving fan relations (Alkhudary et al., 2022). This may be an indication that other similar industries are opting to go that route. Additionally, while considering these two options it is important to weigh long-term strategies against short-term benefits. Since the B2C consumer area mainly generates revenue in loyalty, ticketing, and merchandising, finding a way to engage the greatest number of fans may be the optimal strategy. Simultaneously, having a higher number of people investing less amount of money also lowers the risk of social backlash as NFTs are in early stage of growth, by holding great potential it also has great uncertainty (Taherdoost, 2023).

Furthermore, from a marketing strategy perspective, it is important to note the fact that studies regarding NFTs are meager in today's literature (Alkhudary et al., 2022). And the existing articles focus mainly on asset pricing, which has been left out of the scope of this thesis. Therefore, it is extremely hard to make any arguments of which strategic decision to make with NFTs based on literature. This claim is further confirmed by Hofstetter et al. (2022) whom states that theory has yet to determine how NFTs can be designed to yield optimal pricing strategies and generate maximum revenue. Regardless of this claim, the latter also claims that NFTs presents consumers with new opportunities to exchange economic value as they are bought and sold on a blockchain with cryptocurrencies.

Continuously, it is important to distinguish between NFTs and Fan Tokens as Benfica offers both. Moreover, their main strategy, for now, is revolving around NFTs. A NFT is a non-fungible token, thus redeeming it unique (Parham & Breitinger, 2022). Hence, Benfica is offering their consumers a unique product; the concept should be enough to create value for anyone that is a fan of the club and wants to boost social status. However, even though

NFTs presents you with the ability of being unique, a lot of them (depending on how many you mint) have almost identical looks and features (Hofstetter et al., 2022). Thus, defying the concept of being unique as they present a level of conformity (Hofstetter et al., 2022). Hence, if the club wants to utilize NFTs to improve fan-engagement, they need to find a way of making their NFTs unique in their features as well.

The strategy applied by the rugby team mentioned earlier in this section was based on selling NFTs (about 19 000) during one season, the owners of these NFTs were given the opportunity to purchase one of approximately 1900 premium NFTs whom furthermore granted access to exclusive products and experiences (Alkhudary et al., 2022). This has a couple of effects. First and foremost, it results in increased fan engagement. Secondly, it improves sales, and thirdly, it creates a bridge between fans and Web 3.0, which is an important aspect if blockchain technology is going to succeed; to bring everyday people on to the blockchain (figuratively speaking).

Regardless of these effects, the NFTs in this project are no different from normal VIP tickets. If you replaced the NFTs with some sort of special tickets the functionality of the strategy would be the same on a long-term basis. Since NFTs are gaining attention because of the buzz within the NBA industry and all the money circulating around in the ecosystem, NFTs are “hot”. But what happens when the attention fades and NFTs are not seen as attractive anymore? Then the functionality is just as functional as a normal ticket and by addressing the gas fees and energy consumption of NFT generation arguments may be made that some form of tickets would be both cheaper and more sustainable. Thus, to utilize NFTs as a fan-engagement strategy on a long-term basis the NFTs need to have a bigger function than just functioning as an access key to further content. Because, if that’s the only functionality, arguments can be made that there are more sufficient ways of doing so. But the main idea is viable, because NFTs add a layer of safety. As history has shown, physical goods tend to be valued higher than digital goods because it is difficult to obtain a strong psychological ownership towards digital goods (Hofstetter et al., 2022). What if NFTs could lead to ownership of physical goods?

This idea is evolving based on Nike’s feature, where consumers now, according to Alkhudary et al. (2022), can store virtual sneakers in their crypto wallets in the form of minted NFTs. Furthermore, this feature could be combined with another digital feature that

is gaining popularity in the NFT ecosystem, “breeding” (Alkhudary et al., 2022). This attribute allows the crossing of new series with old series to create a hybrid NFT of the series (Alkhudary et al., 2022). So how is Benfica going to utilize this to generate value?

This is the interesting part. Keep in mind that research revolving NFTs are still having a lack of empirical evidence regarding how they attract new segments, generates revenues, and transfer status to consumers (Hofstetter et al., 2022). So, when Benfica generates their NFT strategy, they would have to make sure that it transfers status to the consumer, most likely leading to increased revenue and attracting new segments. And the following idea may have the opportunity to provide all that. Furthermore, an important aspect of this is that the change of payment method stays familiar towards the end-user to keep the pain-point as low as possible. Hofstetter et al. (2022) states that the relatively new phenomenon of NFTs may increase the pain-point of consumer purchase. However, he also states that its digital nature may give consumers perception of a lower pain-point. Thus, it is very important that no matter what, the pain-point must be kept at the lowest possible.

Starting off, a consumer buys a physical shirt, either online or physical. Here the consumer gets the option of adding an NFT with their purchase for an additional fee. If they decide to do so, they will automatically get an NFT in their digital Benfica wallet. It goes without saying that there also must be an option to just buy the NFT without the physical goods. Continuously, the NFT represents the product you have physically bought; as an example, let us say this season’s home kit. Now, in your digital wallet you have an NFT of this season’s home kit, next season you buy another shirt and an NFT of the next season’s home kit. Now you are presented with the possibility to merge your NFTs into one new NFT; a combination of your two NFTs (breeding). Furthermore, this NFT can now be traded into a physical shirt with a combination of the two home kits. Let us say making the front side the color of season X and the backside the color of season Y. Thus, the NFT grants you the opportunity to generate something completely unique and designed by yourself! Additionally, you do not have to merge season X and Y, you can merge season X and Z. Thus, the NFT enables some unique options for you in the future.

Moreover, you may build on this idea. Say you want your name on the shirt, you must buy a ticket for a game, whilst buying a ticket for a game, you get the opportunity to buy an NFT with your signature (or a player’s signature). Owning this NFT may also be breded

into the combination of your shirt, allowing you to design your totally unique shirt, collecting signatures, home (and away) kits, players numbers and so on. The essential details and how to best carry such a project out from a marketing perspective are best left to the marketing professionals. However, as determined earlier a more quantity-like pricing strategy would be less risky and enable more people. Furthermore, it would be possible to design a smart contract which would allow the breaded NFT to be exchanged directly with the producers ERP-system so no intermediary would be necessary for production, as stated by Hofstetter et al., (2022).

This strategy does a couple of things. Firstly, it allows their consumers to generate something unique for themselves, which adds value to the NFT as it can be used to obtain a unique physical product, designed by themselves. Secondly, it may inspire consumers to make purchases they otherwise would not do, as say buying multiple home kits from a season (in the form of NFTs) because they want to use these NFTs to breed with kits for upcoming seasons. Thirdly, it enables a new market segment, as this may attract people who want to invest in these NFTs to re-sell them at a later point if Benfica launches a home kit that would breed particularly well with a home kit from an earlier season this NFT may gain a higher demand and the supply is limited, thus leaving us with the principles of supply and demand. If successful, this would most definitely lead to increased revenue and transfer status to consumers. Furthermore, Benfica may use the holding of digital assets to track which items users are buying, thus giving the opportunity to utilize target-marketing ads more accurately. Lastly, the NFT strategy may be used to get rid of physical stores and make most sales online if this is more desirable.

6.3 Areas of sports supply chain and blockchain utilization

To answer the research question “*RQ2: In what areas across the supply chain can a sport organization implement the use of blockchain technology?*” it is important to understand why this question is being asked in the first place. As there is not a lot of research for blockchain technology and the sport industry, it is necessary to find the initial point of development; not only to better understand the process of implementation, but also to further understand the utilization of blockchain strategies and sports supply chains; and what they are trying to accomplish by implementing the technology. As shown in section 4.3, Benfica is utilizing blockchain technology in the business to consumer (B2C) area

which belongs to the downstream part of the supply chain. And it is in this part the club projects its value to fans in form of merchandise and status. This area accounts for around twenty percentage of the company's revenue and regards three main ways of revenue generation: memberships and loyalty, ticketing, and merchandising.

Moreover, blockchain technology presents opportunities within all three of these areas. For Benfica, there are three main drivers for blockchain utilization: Improve fan loyalty, generate revenue, and promoting innovation (M1;M2). However, to do so, Benfica decided to utilize the technology to improve their loyalty program in the form of a Fan Token. A Token like this functions as holding a stock in the club (Parham & Breitinger, 2022). However, it also comes with numerous risks regarding its price, such as value, profit, and or popularity of the club (Parham & Breitinger, 2022). Therefore, Benfica decided not to launch the token in 2018; because they identified different challenges and risks not only for the company, but for the fans (M1). Simultaneously the club tries to lower the barriers to the technology by enabling cryptocurrency as payments. Although this tactic is sufficient to invite consumers into the world of Web 3.0, arguments could be made that the club should have given the consumers incentives to pay with crypto such as discounts for further incentivisation.

Furthermore, Benfica is also utilizing NFTs for their digital contracts. Digitalized contracts are being identified through NFTs to make sure the contracts are authentic and correct according to the agreement (M2). It is not stated clearly whether this is utilized for player transfers downstream or upstream (or both) in the supply chain as B2B transactions. However, this still shows that NFTs can be utilized within sport supply chains not only regarding the B2C section, but as a B2B tool as well. However, the latter requires more research to determine how big of an impact this is currently having on the sport supply chains. Therefore, this will not be further discussed in this section.

Additionally, the club is currently looking into turning NFTs into ticketing. These tickets would have characteristic NFT features such as representing images of the games (M1). This may also give fans additional value, as it would be much harder to buy tickets and re-sell them on the black-market leaving fans with a reassurance of pricing. However, this project is currently put on hold, and will be discussed in the next section (section 6.4). It may be worth noting that this project will also take place in the downstream of the supply

chain and improve supply chain areas affecting the events and match areas of the supply chain as presented in figure 6.

6.4 Blockchain implementation and the challenges

Despite the massive opportunities presented by blockchain technology, the technology is facing resistance regarding implementation. The challenges presented by the technology is vast, complex, costly and time consuming.

Benfica identify a major obstacle regarding NFTs and their content creation. The challenge lays not necessarily within what content to generate, but what strategy to apply to maximize return on investment (M1;M2). To defy this challenge the technique of breeding was discussed in the previous chapter. However, this technique also brings challenges that needs to be addressed. NFTs suffer from the “interoperability-issue” or “cross-chain” issue, which locks NFTs into their primary ecosystem; as presented by Parham & Breitinger (2022). This theoretical statement is further confirmed by Benfica as they identify this as one of the biggest challenges with blockchains, because there are no possibilities to transfer assets across chains (M2). As of now, most NFTs are minted on Ethereum (Parham & Breitinger, 2022). And the interoperability issue does not really present that big of a challenge. However, this is something all companies within every industry, not only the sporting industry, need to keep in mind when strategizing for the long-term utilization of NFTs. This is because if you mint an NFT on for instance Ethereum, and three years later blockchain X has a lot better conditions, and you decide to start minting there, these NFTs will not be able to breed together. Hence, it is important to not make promises one cannot keep. This also set drawbacks to the breeding-strategy as one of the reasons it may be valuable is to hold on to old NFTs to breed them with newer ones. Furthermore, blockchains are constantly modified; by both “soft” and “hard” -forks (Parham & Breitinger, 2022). The “soft forks” does not represent any real difficulties for the blockchains, however, the “hard forks” may cause new technical updates to interfere with older-protocols, resulting in conflicts for NFTs that is not yet discovered (Parham & Breitinger, 2022). Thus, the constant updates of blockchain brings a certain constant risk for NFTs (and other applications) building on the chains.

A strength of blockchain technology is its immutability. However, combined with the interoperability-issue, this also presents another obstacle for blockchain implementation and NFT-generation, which is choosing the right blockchain. Firstly, M2 states, that they do not directly choose what blockchain they are working on. This is done by their blockchain-partners. Hence, negotiating what blockchain to utilize or choosing a partner that is willing to accept your demands regarding blockchains is an important step of this process. And this brings certain risk into any kind of blockchain related process already at this stage. Such a new industry, with all this money circulating within the biome, will always bring a certain financial risk as there is always the possibility of a developer going bankrupt (M2). And choosing the right one is of great importance. However, the risk can be mitigated by looking at former projects, company size, liquidity, and tenders.

Furthermore, after choosing a business-partner the issue of choosing the right blockchain still remains and may even be more complicated than finding the right business associate. The reasoning behind this is that because of the immutability and interoperability companies are going to be locked onto the blockchains they choose; and the conditions they present, such as transaction speed, transaction cost, scalability, security and so on. This leaves companies with the conundrum of either predicting which blockchain will be the market leader, trusting their business associates to do so, or waiting for technological advancement that will allow for blockchains to either merge or offer feeless transactions across chains. As this would allow NFTs to be in the same environment without being overly complicated or expensive (M2).

Choosing the right blockchain is important, not only because of their attributes but also because of its cost and the volatility that comes with this. As presented in section 3.12, most industries identify cost as a general barrier to blockchain implementations (Zhou et al., 2020), (Moretto & Macchion, 2022), (Lohmer & Lasch, 2020), (Yadav et al., 2020), (Khan et al., 2023)), and this is an issue that needs to be further discussed because NFTs come with additional implications regarding cost. First, both M1 and M2 recognizes that every blockchain represents different levels of cost in terms of fees (also known as gas fees) and these fees are going to be significant for the club. The challenge here lies in identifying the future market leader, hence, providing the best futuristic financial conditions. As of now, Benfica and their blockchain-partners are currently building their blockchain applications on both Ethereum and Polygon (M2).

Ethereum is currently working on, going from Ethereum to Ethereum 2.0. This is a process that involves several soft-and-hard- forks, thus it is hard to pinpoint exactly when the complete transformation is going to be completed and what their current state is at this exact moment. However, assumingly, at the completion of the transformation of Ethereum 2.0 the network will have a transaction fee ranging from 1-8\$ and a transaction speed of about 100 000 transactions per second. As polygon's whitepaper is unavailable at this moment it is hard to find information about their transaction fee, however, polygon has the possibility to do 65 000 transactions per second (Parham & Breitinger, 2022); (Sarang et al., 2022). The challenge regarding transactional fees lays within the gas fees; as they are dynamic (Parham & Breitinger, 2022).

Dynamic fees are regulated by different networks in diverse ways. The gas fees on the Ethereum network are determined by supply and demand. As most NFTs are minted on the Ethereum network (Parham & Breitinger, 2022), this platform is most likely to see the highest demand, giving room for other networks to gain competitive edges on price. Simultaneously, if all actors in the NFT space are looking for the platform that is going to give the best conditions regarding price, this is going to be extremely volatile on the networks as everyone assumingly will move to the network which at the current moment has the best prices. As for now, Ethereum is utilizing the PoW-consensus mechanism, this mechanism is always going to present more expensive prices as they must reward miners for completing transactions. Combined with a supply and demand dynamic pricing model this network is set to be expensive. Even though there is little information to discover regarding Polygon, it is currently having a far better transaction speed than Ethereum. Partly because they utilize the PoS consensus mechanism. This mechanism allows the network to choose the next miner of the block on various attributes like node supply and age (Bamakan et al., 2020). This makes this network far more energy efficient compared to a network utilizing PoW. In this network the miners gain no reward beside the transactional fees so networks utilizing these types of consensus mechanisms may be far better suited for minting NFTs regarding cost. However, the 2.0 version of Ethereum is also going to utilize this consensus mechanism, thus it is not possible to rule it out of the equation just yet. Also, Ethereum presents a much bigger user surface, making it a far more secure network.

Polygon's gas fees are determined by both the network and the users, the network determines prices by demand and the gas limit is decided by the user. Hence, on polygon you can control your willing-ness to pay, your maximum investment. However, this may also cause your transaction to be de-prioritised. Whilst minting tickets and NFTs for sales having your transactions prioritised may not be so important if you strategize and sell a pre-fixed amount. However, if multiple companies within the same industry utilize the same plan but are willing to pay slightly more than your company, you are going to have delayed minting towards the season, which may be a huge problem and cause loss in revenue. Furthermore, this caps your potential sale to the amount you decided to mint, thus, may also lead to a loss in revenue and the money you saved on minting may be de-valued compared to the money you could have made on additional sales – leaving strategizing with NFTs even more complex than presented in the previous section. An interesting consensus mechanism for NFT-minting to combatant this problem, could be the Proof of Importance, as it is power efficient, requires no mining, and is scalable. However, this consensus presents us with the blockchain trilemma, as it has lack of security. Thus, it may expose owners of NFTs to being hacked and losing their assets.

Moreover, within the Cardano network, the transaction fees are determined by the network and based on factors such as transactional size and complexity. In Cardano you get a transaction fee around 0.3\$ per transaction, which is 33% cheaper than the lowest transactional value in Ethereum 2.0. Additionally, Cardano presents a transaction speed of 1 000 000 transactions per second, which is a major difference from both Ethereum, Ethereum 2.0, and Polygon. As stated by M2, a lot of businesses are simply motivated to gain access to the blockchain that provides the best possible financial conditions to run applications, as the goal is to pay as little as possible in gas fees. Cardano may present good options for minting of NFTs, as the network has higher TPS and lower transaction fees (Parham & Breitingner, 2022). Additionally, the network supports smart contracts and distributed applications. Running on a PoS protocol. And as M2 stated, the transactional fee on the blockchains is going to be significant for the club in the long run.

Another challenge represented by blockchain technology and NFT-minting can be found in Benfica's project of ticketing in the form of NFTs. As of now the club is in phase 1 of blockchain development, and some of the reasons they are not going to phase 2 has been discussed in this chapter, such as, technological development and cost. The challenges

with turning tickets into NFTs is rooted in the minting process. Tickets have been around as long as one can remember. And one must assume that companies have found a way of generating tickets, both cost effective and sustainable. So why change to NFTs? Well, NFTs present an opportunity of not being re-sold for a higher price on the black market, which can be attractive to both fans and the industry. This would be a good benefit of NFTs as tickets. However, minting a NFT comes with a cost, a cost higher than generating a normal ticket. And if you do not manage to sell the ticket (NFT) you take an instant loss (M1). Additionally, the NFT is only connected to a certain game, what are you going to do with the NFT after the game? At this point its rendered useless, and even though the fans may gain tickets at cheaper prices as they are guaranteed they do not have to go to the black-market, the overall prices of tickets will increase because of increased production costs. Furthermore, if tickets are not increased maybe goods will increase, or beverage at the games, ultimately, the consumer will pay the price of increased production prices of tickets, alternatively the company will take a loss, which is less likely.

Moreover, another challenge faced by the blockchain technology is that minting is also dependent on the precede value of the crypto market. Thus, as the crypto market took a big down swing in regards of the USA's correlation of inflation (the crypto market has a strong correlation with the New York Stock Exchange), developers wanted to pause development to wait for the market-recovery. Hence, crypto prices influence development of NFTs and their projects. However, even though it is a volatile market, the market is expected to increase over time; long-term (M2). This may raise questions such as, do the developers profit heavily from increase in the market? If crypto prices skyrockets, is minting of NFTs going to be more profitable? Are prices going to be re-negotiated steadily to match market volatility?

Despite these questions, Benfica has been able to utilize blockchain technology to generate a revenue equal to their main sponsor (M1). Even though this number is not disclosed, it is assumed to be of significant value. However, because of these technological difficulties the club is waiting for further technological development before entering the next phase of blockchain projects. When the technology emerges, the club has stated that they are willing to invest more money and take more risk (M1). Although Benfica has not invested a lot of money into the development of blockchain technology compared to other investments, they have spent a lot of working hours, conducting research, and trying to

generate the right strategies on how to further develop this part of the business (M1). These kind of doubts may be a part of why the technology is moving slow, as similar observations can be made from other industries ((Zhou et al., 2020);(Moretto & Macchion, 2022);(Lohmer & Lasch, 2020);(Yadav et al., 2020);(Khan et al., 2023)), where the willingness to invest into the technology is low, and every one seem to wait for the technology to present more optimal and robust solutions.

6.5 Possible opportunities for the future

As presented in this chapter, blockchain technology has the potential of bringing great opportunities to the sports industry, but it also comes with some big challenges in the areas of strategy and cost. From Benfica's perspective, it is important to guarantee the possibility of cross-chaining NFTs (M1;M2). Thus, a solution to the "interoperability-issue" needs to be resolved in some way. Developers has all agreed that as soon as the technological advancement is there, companies will be allowed to do so (M2). Furthermore, M2, believes to resolve this issue, the blockchains must be obliged to comply or pressured form other bigger industries to make advancements in this area. This somewhat makes sense. First, this seems to be a very complex technological process that would need to be developed. Secondly, why would competing blockchains allowing trades amongst each other? Well, this may be the starts towards the solution regarding the blockchain trilemma. To this date there is no blockchain that has managed to address all three issues simultaneously, because addressing two of them, comes of the expense of the third (Holotescu & VasIU, 2020).

However, if cross-chaining were possible, it could be an opportunity to set up smart contracts to "rent" scalability with other blockchains for a smaller fee. Thus, when your capacity is maxed out, other chains would simply give you computing power to complete transactions on their chain and transfer the assets to your chain for a small, automatic fee. Whether this will be sustainable or not is hard to determine at this stage of technology. But by utilizing smart contracts there definitely would be no negotiating problems or need of intermediaries (Bashir, 2018). Thus, the networks could focus on building secure and decentralized consensus mechanisms and protocols.

Moreover, Benfica is not the only club looking into blockchain applications and strategies. According to M2, there are a lot of clubs trying to figure out how to most effectively

utilize a blockchain strategy. Even UEFA and FIFA are looking into becoming a part of the blockchain ecosystem and looking for sponsors within Web 3.0 (M1). Thus, as such massive forces are eager to get into the technology the entire industry could merge and build a private blockchain as a layer on top of a public blockchain. By building a layer 2 on top of layer 1 it is possible to gain efficiency enhancing abilities of system throughput or generate scalability at layer 1 blockchains (Mint, 2022). This is done by “off-chaining” transactions. Additionally, this is a way to bring more nodes into the layer without challenging the original decentralization of layer 1 (Mint, 2022), keeping the blockchain safe against attackers. This allows companies to bring nodes (servers) onto layer 2 to enhance its performance and obtain cheaper transactions (Mint, 2022).

Moreover, private blockchains present some obstacles. Generally, private blockchains are mostly utilized within internal, business secure environments within the field of access, authentication and record keeping (Nabben, 2021). Furthermore, a private blockchain consist of fewer nodes, thus making it more susceptible to malicious attacks and hacking (Yang et al., 2020), which could leave the blockchain vulnerable. Lastly, the use of private blockchains requires wide scale adoption and comes at large operational expenses (Yang et al., 2020). Therefore, if the industry could assemble, together with FIFA and UEFA, to generate a massive private blockchain, there is the possibility of reducing volatility of gas fees and ensuring capacity. As a final example, if sports industries across sectors decided to all mint NFTs and utilize a breeding strategy so you could mint a fan jersey of your favorite football club combined with the signature of your all-time favorite players within other sports you have the possibility to design some unique assets. Additionally, this allows individuals within different sporting industries to monetize their names, bringing more incentive towards the industry. However, this is going to be a massive investment made by industry and will be very difficult to implement. Although, if successful this may present great opportunities for all actors involved.

7.0 Conclusion and limitation

7.1 Chapter Introduction

In this chapter a conclusion of the conducted study will be presented. Furthermore, the chapter recognizes the limitations of the study and suggests avenues for future research

7.2 Conclusion

In conclusion, blockchain technology presents unique opportunities for the sports industry, not just within the NBA, but also for football clubs. Actors within the sports industry have the possibility to enhance their operations by generating new revenue stream, increase fan loyalty, and prevail as a market leader regarding innovation as explained in the previous chapter(s). This is allowed by blockchain utilization and benefits such as: transparency, security, and immutability. In recent years the utilization of non-fungible tokens (NFTs) is one such application that has gained increased attention. NFTs allows actors within the sports industry to monetize their brand, players, and history; by utilizing techniques such as breeding. This can be done by generating unique and limited digital assets that fans can acquire. Either as economical investments, personal affection, or with trading purposes. Nevertheless, the sports industry is still in an early process of blockchain technology adoption, and even though there are recognized many benefits, there are yet plenty of challenges to overcome.

Within the sports industry blockchain technology is currently most seen applied downstream the supply chain in sections regarding various B2C activities such as fan-engagement and loyalty programs. However, there is possibilities to apply it in certain B2B segments both upstream and downstream the supply chain in the form of digital contract management. This may yield beneficial opportunities in the future. Moreover, this area still requires further research.

Despite these promising rewards, blockchain still faces major challenges, such as the “interoperability-issue”; which prevents blockchain-assets to be traded across blockchains.

This may present vast difficulties, and clubs need the insurance that NFTs can be cross-chained in the future to enable seamless trading. However, there is no one who can determine when this feature will be available, or if blockchains ever will have the capabilities to do so. This is grounded in the technical complexities in cross-chain transactions and requires a substantial technological advancement.

Moreover, there is a possibility of a more immediate solution. This is presented in the form of the creation of a private blockchain, and including all the actors of the industry, including FIFA and UEFA. By enabling so many actors even a private blockchain may provide a secure and scalable infrastructure to enable further advancement of blockchain technology within the sports industry.

Furthermore, another challenge that has been encountered by blockchain technology and its development within the industry is the challenge of cost. Blockchain development and implementation requires crucial investments, not only in the terms of money, but in time and resources. For Benfica, this is a significant barrier to take their blockchain development to the next phase. However, potential benefits such as new revenue streams, increased fan engagement, and more secure options may outweigh the initial costs. Additionally, the use of smart contracts and side-chain transactions may provide reduced costs and enhanced efficiency.

The sport industry is not the only industry encountering these challenges. Many other industries are also struggling to implement blockchain technology due to similar issues. However, the potential benefits cannot be ignored. Thus, it is crucial for football clubs and other actors within the industry to invest in blockchain technology and work together to overcome these challenges, driving innovation and growth within the industry.

7.3 Limitations

This study, as many others, have boundaries and I am going to present them as openly and clearly as possible.

First, the biggest limitation is my experience, I have little to no experience as a researcher, other than a bachelor's degree. Even though the actual process can be quite similar, it

presents a vastly difference in time-consumption, scale, requirements, and skills. Thus, rendering me with suboptimal time utilization. Which brings me to the second limitation, time. As this is a master's degree the time frame of the completion of this study is limited to about 6 months. Moreover, a third limitation was my access to certain articles as "blockchain+sports+nfts" is not necessarily the main domain of HiMolde, there were certain articles and books I could not access. Therefore, there is possibilities of theoretical points missing, especially regarding NFTs as tickets. However, this is not a main point of the thesis, thus, this should not present a huge issue.

Another limitation to this study is the fact that it has a supply chain perspective and even though it provides quiet thorough explanations of blockchain in general. The study is missing theoretical groundwork such as marketing strategies regarding NFTs, pricing strategies regarding NFTs, human behaviour and social status, as well as historical theory regarding the concept of NFTs and why it most likely will be successful as a strategy. The addition of this theory would most likely strengthen the arguments of the thesis and implementation of blockchain technology within the sports industry. Acquired

7.4 Future research

For the future there is undoubtedly, potential for substantial academic exploration of blockchain applications in the sports industry. According to Naraine (2019), organizations are resistant to change. Especially in the context of technological changes. Therefore, it is necessary to provide evidence and report how organisations can obtain competitive advantages by embracing blockchain implementation in regards of discarding it because of its challenges. Furthermore, as the discovery of tactical knowledge is likely, researching the un-explored phenomenon of blockchain technology within the sports industry has a profound value (Naraine, 2019). This may lead to industry acceptance in the future.

Moreover, this thesis opens for research regarding industry-specific private blockchains as there may be potential of value generation by successfully implementing industry-specific blockchains, not only within the industry of sports, but in other industries. Will blockchain ever be able to deal with the interoperability-issue, or will the best way to tackle this challenge be to build one huge ecosystem? Lastly, the thesis highlights missing research

on NFTs as digital contract management both upstream and downstream the supply chain and recognizes the fact that this area needs further research.

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APPENDIX:

INTERVIEW GUIDE:

General Questions:

1. What is your position (title) within the company?
2. What are your daily tasks within the company?
3. For how long you have been working at SL Benfica?
4. Could you describe what your department are trying to accomplish for SL Benfica?

Blockchain related Questions:

1. When did you implement blockchain?
2. How long did the implementation process take?
3. How has the implementation of blockchain developed in Benfica?
4. Do you see a clear difference in the process operations before and after the implementation of blockchain?
5. In what areas of your business do you utilize blockchain?
6. Do you think you are gaining a competitive advantage by utilizing blockchain in “said areas”
7. Do you think utilizing blockchain in these areas gives certain advantages to the club supporters?
8. How do you utilize blockchain technology to gain competitive advantages?
9. Will cost ever affect the level of implementation of new digital tools in Benfica?
10. Does the implementation of blockchain affect the decision-making time within the organization?
11. What part of Benfica had the most impact of the implementation of blockchain?

12. Are there any negative consequences of the implementation of blockchain from your perspective? If yes: what are these?
13. Do you think blockchain can be utilized to improve player management, transfers and contracts within your industry?
14. What are the benefits of utilizing blockchain technology within your industry?
15. How can blockchain technology enhance transparency and trust in Benfica?
16. Are there any ongoing or further planned blockchain initiatives in Benfica? If so, can you describe them?
17. Do you think blockchain technology help prevent fraud and corruption in football?
18. How does the football club ensure data privacy and security when using blockchain technology?
19. Do you think there is any potential drawback or limitations of using blockchain technology within your industry?
20. What skills and expertise are required to successfully implement and maintain blockchain technology within the sporting industry?
21. Does Benfica plan to collaborate with other stakeholders in the industry to promote and develop blockchain initiatives in football? If yes: what advantages do you see in doing so?
22. What are the current industry standards and regulations for blockchain technology in football?
23. From your perspective, what are the most significant challenges that Benfica faced when implementing blockchain technology?
24. What are the KPI(s) that Benfica uses to measure the success of its blockchain initiatives?
25. How does Benfica plan to stay up to date with the latest developments and trends in blockchain technology?
26. What do you see as the future of blockchain technology in football, and how do you think it will evolve over the next 5-10 years?