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A Blockchain based model for fashion Industry: The Halmanera case study

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Executive summary

It was 3 October 2008 when Satoshi Nakamoto, a well-known pseudonym published a white-paper entitled "Bitcoin: A Peer-to-Peer Electronic Cash System". With that paper, Nakamoto proposed a new transactional model completely decentralized and structured around a consensus mechanism capable of eliminating intermediaries. (Nakamoto, 2008).

Today, about 10 years later, even if no one has been able to reveal the identity of Satoshi Nakamoto, it can be argued that behind his projects was actually hidden the desire to create a real revolution that had the potential to disrupt impact on every aspect of human life. Based on this, there was a new technology: *the Blockchain.*

Recently, blockchain has been the subject of numerous attentions thanks to its ability to eliminate the centralized intermediary and therefore to substantially modify the models on which modern society is structured. The blockchain is in fact *trustless* in the sense that every user connected to the network does not need to trust the counterparty, or a central intermediary, in order to make a transaction. The trust of the user lies entirely in the technology and in particular within the software and protocol that regulate its operation.

This means that, blockchain is not simply a technological solution but a new decentralized approach to the concept of trust. The ability to digitally decline a new concept of trust makes this technology potentially suitable for assuming political

and social value as well. In this regard, the Economist stresses that: "The real innovation is not the cryptocurrencies, but the machine of trust that eliminates (the intermediaries) and promises much more"(i).
In this scenario, it can be argued that it can be considered a new paradigm, or a new way of interpreting the great theme of decentralization and participation.

In this regard, next to the vision that associate blockchain and cryptocurrencies, there are many other applications without setting any type of limitation. Within this context, companies and in wider terms *supply chains* have started to show interest in this new model.
In fact, the blockchain is a tool that enables to reach consensus in the execution of a collective activity that involves entities that do not necessarily trust each other, but which have a common goal.

This match perfectly with *supply chain*: in fact, within the supply networks there are a number of entities, which have a common interest, (to sell and serve a specific product satisfying the needs of the consumer) but which, at the same time, are separate and therefore do not necessarily trust each other.

More precisely, starting from this *matching* this research aim to analyse the impact of blockchain technology within the complex panorama of supply chains.
The choice of the object of analysis was motivated by the revision of a series of papers that involved both the scientific literature and a large number of qualitative and quantitative research on the topic. In fact, these allowed to clarify the real interest of supply chain managers and the scientific community in relation to the opportunities offered by this new technology within the supply chains. In support of these statements, data of Osservatorio Politecnico di Milano shows that on

average 25% of enterprise projects, which have developed around blockchain technology in recent years, relate to supply chain applications with a growth between 2016 and 2017 of over 550 percentage points (Valeria Portale, 2018). For this and other reasons, it was therefore considered interesting to investigate the impact of this new technology within the supply networks.
In this regard, the paper is structured around two lines of investigation. The first of a descriptive nature aimed at outlining the characteristics, challenges and opportunities of blockchain technology within *global supply chains*. The second, however, of a quantitative nature aimed at offering a clearer and more defined picture of the phenomenon under consideration within the footwear sector.

The research project therefore opens by proposing a detailed analysis of blockchain technology aimed at defining its assumptions and functionalities at a technical and theoretical level.
Chapter 2, on the other hand, presents a meticulous study on the challenges and problems that characterize the current supply chains and in wider terms the *Supply Chain Management*. An analysis of the scientific literature shows that technological innovation can be the key to overcoming, at least in part, many of the problems that currently characterize the supply networks. The key element shared by these new tools lies in their ability to provide solutions that encourage companies to re-shape their processes to better meet the demands of the final consumer. Obviously the blockchain falls within this panorama thanks to its ability to achieve cooperation and collaboration between the players in the supply chain.
Consequently, *Chapters 3 and 4* propose a possible use case in relation to the implementation of blockchain technology in the supply chain. For the purposes of the discussion, it was decided to describe the supply chain infrastructure by paying particular attention to the entity involved - Halmanera - and how this could interact

with the platform; the processes of authorization, verification, visualization and storage of data.

The paper continues by proposing in *Chapter 4* a taxonomy of a potential blockchain application in the supply chain. This methodological choice, although it may seem simplified, has made it possible to obtain a series of important results. The goal was to define how the blockchain could solve, even partially, the challenges that characterize the current supply chains through the creation of a model.

The model was then used in the last chapter to construct a blockchain applications within the footwear sector. The choice to investigate the implications of the *distributed ledger* within the *footwear industry* was dictated by a series of sectoral motivations.

In fact, this sector is characterized by a scarcity of use related. For this reason, the research also wants to demonstrate how blockchain technology could come toward feasible solutions that are statistically significant in relation to the phenomenon analysed. Furthermore, unlike other sectors, the footwear sector, has a certain heterogeneity in the applications developed. This made it possible to understand what the real use was but, above all, the progress of the individual solutions, offering a clearer picture of the state of the art of technology.

In fact, *footwear industry* is one of the sectors that could best incorporates benefits offered by the new technology. The reasons for this phenomenon should be found in the challenges it faces nowadys, namely: the request for greater transparency from consumers; the fight against fraud and counterfeiting; the increase in pressure imposed by regulatory authorities in terms of sustainability and the increase in visibility along the supply chain.

The methodology used in data analysis was structured around two different fields of investigation. Firstly, a review of the systematic literature was carried out on both technology and the footwear sector, thanks also to 9 months of work experience inside the company. After that, empirical research was conducted focusing on the analysis of case studies with the aim of comparing and possibly validating the results found from the literature review.

The paper ends with a conclusive section that attempts to summarize the essential elements examined in the various chapters, trying, on the one hand to offer a clear and defined picture of the opportunities arising from the implementation of the technology (primarily in the footwear sector). On the other hand, to delineate the limits and challenges that in a broad sense characterize distributed ledgers and which strongly limit their adoption.

Chapter 1 – Introduction to Blockchain technology

1.1 Blockchain as a distributed system for a new concept of *trust*

Historically, the digital transformation has been involved on several business applications where companies have lost opportunities or collapsed cause of the inability to deal with innovative solutions. At this purpose, it can be said that innovations have the potential to distrupt entire market, as Amazon has created a new business model in the in a B2C context, Uber has been given a new business concept where the idea of becoming a taxi driver is not attractive anymore.

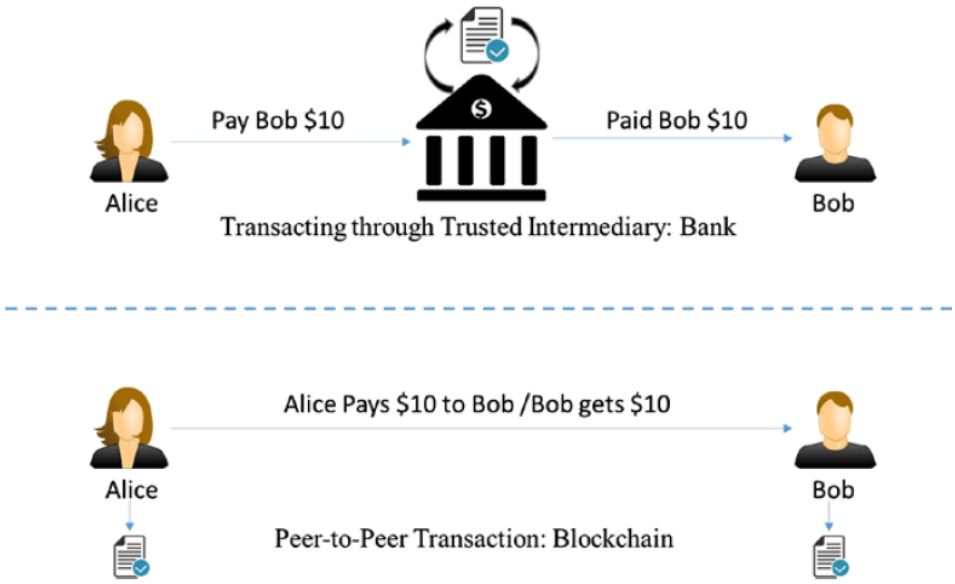
In this direction, Blockchain technology is bringing a new wave of innovation within the world economy. The innovative approach leveraged upon internet, is not limited on payment systems like Bitcoin, but its popularity has gone even further than the cryptocurrencies itself. Even if I am going to illustrate this new paradigm from a business perspective in the next chapters, an historic and technical overview is needed to better understand the basics.

Soon after the financial crisis in 2008 a pseudonymous under the name of Satoshi Nakamoto published a public a white paper titled: ‘’ *Bitcoin: A Peer-to-Peer*

Electronic Cash System". It laid the foundation of a cash system *''based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party''*. During this time, many people discussed about huge oscillation and volatility of its price and criminal activities as a payment method. On the contrary, many people started to going through this phenomena by understanding how has been possible to make money transactions without involving a central institution. What it has been realized is something revolutionary where a new secure, open and transparent system enable transactions without any central institution: the Blockchain (Chiap, 2019).

Blockchain is a system of records to transact value (not just money!) in peer-to-peer fashion. What it means is that there is no need for a trusted intermediary such as banks, brokers, or other escrow services to serve as a trusted third party. Essentially, the new models proposed by this technology resides in the fact that transactions can be processed in a complete decentralized ecosystem. For example, if Alice pays to Bob $10, why would it go through a bank? Take a look at **Figure 1.**

Figure 1: Transaction through an intermediary vs. peer-to-peer transaction



Source: Sighal, 2018

Before 2009, it was no possible to transact value as showed in a peer-to-peer ecosystem. Clearly, blockchain protocol has brought a new wave of innovation by opening the doors to unexplored opportunities in our society.

In this regard, blockchain technology has been getting a rapid expansion from a strategic point of view upon businesses context, with the promise to minimize inefficiencies by building upon innovative solutions. In other words, the underline technology can radically change the way of doing businesses by providing new business models which security, decentralization, and transparency are enabled by a distributed ledger that records immutable transactions. Those characteristics are fundamental for the purpose of this paper that it will be mainly focused on how the Blockchain technology will impact the Supply Chain ecosystems and business processes.

One of the main driver of business processes is the concept of trust among actors. At this purpose, the Blockchain technology gives a completely different approach to a pillar of our society: the trust problem.

The ability of blockchain to record and keep transaction in a distributed ledger allows the community to re-think about the concept of trust. As it stands, most transactions between individuals (financial, education healthcare etc…) are centralized through trusted third-party organizations. For example, well known brand such as Amazon or E-bay have been acting as an intermediary between buyers and sellers. Why does not the buyer ask directly the seller to provide the product? One of the main reason is that of trust. In fact, we simply buy on these platforms because they provide to us the security and reliability that the transaction will take place. Blockchain do not either create or eliminate trust, instead it converts from one form to another. More specifically, the nature of blockchain of being transparent and immutable offers a decentralized environment where no intermediaries are needed to secure trust among the stakeholders. Our society is based on trust foundations built by different actors, from local traders to MNEs. If we lose confidence in only one link in the chain, no transaction is possible anymore (Chiap, 2019). In this way, (Singhal et.al, 2018) pointed out an interesting question: ‘’What if technology could enable trust and security without these intermediary and centralized systems?’’. The answer can be found within Blockchain technology. In fact, thanks to Blockchain the human tendency to trust in a system managed by actors is replaced by drastically changing the fundamentals of the system, enabling trust to be built upon the technology itself.

As illustrated before, is fundamental to comprehend the concept of trust in order to keep going understanding following steps. At this point, the most curious may wonder how trust is enabled if any central authority can govern the system. Following up what is has been mentioned, the decentralization is one of the main

factors that lays the foundation of the concept of trust. If we talk about Blockchain technology, we're talking about an application of Distributed Ledger Technology (DLT) where a decentralized decision-making approach is made true. More clearly, instead of keeping data centralized in traditional ledgers, Blockchain enables the use of independent computers, often referred as a ''nodes'', to record, synchronize and share transactions in their respective electronic ledgers. (Treiblmaier, Beck, 2019, vol II). In this way, it is clearer that the opportunity to reduce intermediaries, transaction cost and increase the utilization of resources in business application can be realized where no centre exists, and where the logic of governance is built around a new concept of decentralized trust between all the subjects. At this purpose, a deeper illustration of concrete businesses benefit of Blockchain will be given in chapter 2.

1.1.2 From centralized systems to distributed ledger

The reason why is needed to focus primarily on centralization, decentralization and distribution is because blockchain is designed to be decentralized. For this reason, it is fundamental to understand the differences from centralized to distributed systems in order to have a clear image of what blockchain is. In fact, the key innovation in Blockchain technology is its ability to enable decentralized trustless

transactions removing all the middlemen, also known as Trusted Third Parties (TTP). This phenomenon, namely, the notion of disintermediation and decentralization paves the way to radically transform all types of activities where business is conducted on a global basis.

A centralized system is one in which there is a master node that has a centralized control with all administrative authority, for example Microsoft Passport is a centralized system, entirely controlled by Microsoft and closely tied to other Microsoft products . Such systems are easy to design, maintain, impose trust by a central point but suffer from many inherent limitations, as follows:

- They have a central point of failure
- Vulnerable to attack and less secure
- Centralization of power can lead to unethical operations
- Scalability is difficult

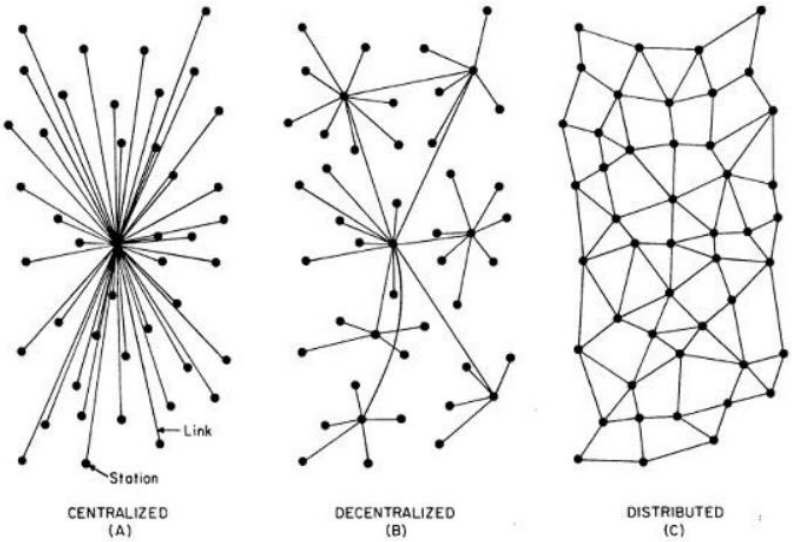
Decentralized means that there is no single point where the decision is made. Every node decides for its own behaviour and the resulting system behaviour is the aggregate response. Such system are difficult to maintain and guarantee trust but in our case Blockchain could represent a great innovation. However, they do not suffer from the limitations of conventional centralized systems, offering the following advantages:

- They don't have a central point of failure, that means more stability and fault tolerant
- Cyber Attack resistant, as no central point to easily attack
- Equal authority to all nodes, democratic in nature.

Taking into account that both centralized and decentralized system can be distributed, Blockchain technology can be defined as a decentralized distributed

system that operates in a peer-to-peer network. Distributed systems take concurrent applications a step further. The single components of an application not only run concurrently, they are also located in different places. In other words, distribution is the logical or physical spatial distance of objects in relation to each other, this is the case when they reside on different computers but also when they reside in different address. **Figure 2** shows differences and how the system works.

Figure 2: centralized, decentralized and distributed systems



Source: Blockchain4innovation

Once understood the meaning of centralization and decentralization, it is possible to introduce the concept of Distributed Ledgers . To better understand how DL works such as Blockchain, a clear image about differences from centralized to distributed concept is needed.

Government, banks and companies have based on Ledgers that record and storage data concerning any kind of information. This system implicated a modify upon Ledgers by a central authority every time there was a change in the statement. In this way, Trust of people had to do on Central authority to which guaranteed correct transaction.

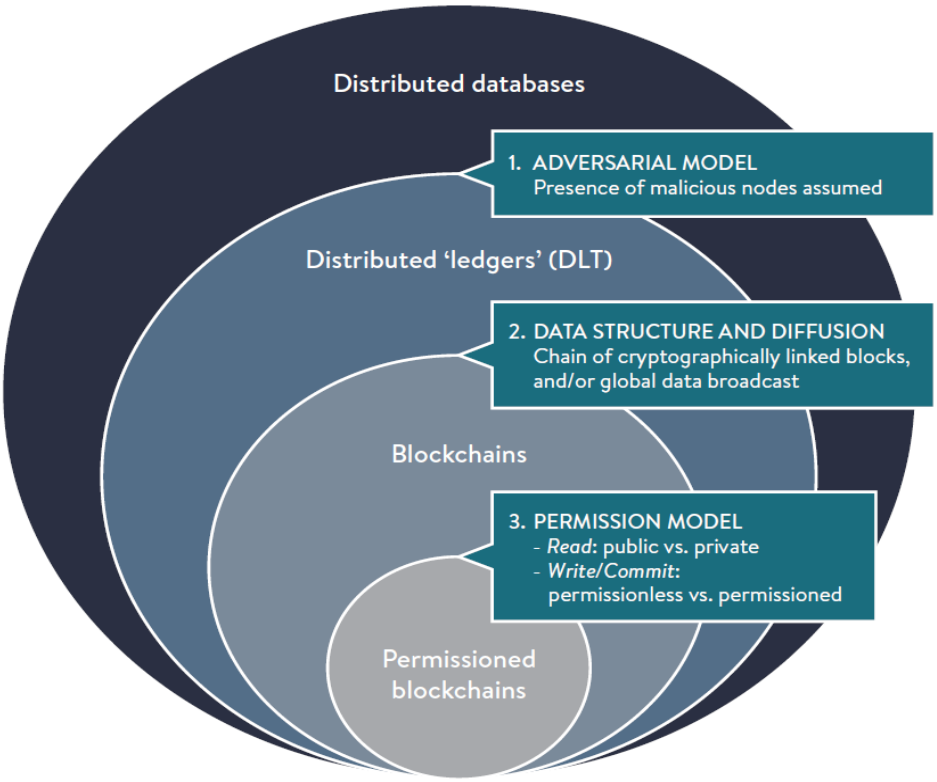
With digitalization instead, Central ledger evolved making them faster with several other functionality. The logic behind remained the same: the access and management rules remained with Ledger's central manager but, due digital opportunities ceased to be personal and physical and became virtual by switching to the Internet.

The big change comes with the Blockchain, the novel consisted in having no longer a central authority needed to verify, check and authorize the legitimacy of a transaction. Now the question is: how can the legitimacy of a transaction be verified if there is no central authority that has the possibility to carry out the necessary checks? The answer resides on Blockchain that rely on decentralization and distribution of ledgers. Now the Ledger is for everyone, all users have a copy and everyone can check it, view it and, in the face of rules that compose the Governance of the blockchain based on consensus mechanism, they can modify it. The logic behind Blockchain is called Distributed Ledger Technology (DLT).

In general, the term ‘distributed ledger technology’ refers to all initiatives and projects that are building systems to enable the shared control over the evolution of

data without a central party, with individual systems referred to as ‘distributed ledgers’. If one wants to describe a system that has global data diffusion and/or uses a data structure of chained blocks, one should call it a ‘blockchain’. Again, it can be observed that in practice, both terms - Blockchain and DL – are often mistakenly being used interchangeably. In this regard, **Figure 3** introduces a simple framework that can be used to easily distinguish between traditional distributed databases, distributed ledgers, and blockchains. Distributed ledgers are a subset of distributed databases, and blockchains are a subset of distributed ledgers.

Figure 3: Blockchain and distributed ledgers are types of distributed database



Source: Global blockchain benchmarking study, 2017

The major difference between distributed ledgers and traditional distributed databases is the use of an adversarial threat model, which assumes that not all nodes are honest. In general, the term 'distributed ledger technology' refers to all initiatives and projects that are building systems to enable the shared control over the evolution of data without a central party, with individual systems referred to as 'distributed ledgers'. If one wants to describe a system that has global data diffusion and/or uses a data structure of chained blocks, one should call it a 'blockchain'.

1.2 Blockchain: Technological aspects

In this section, first I'm going to introduce the basic element that compose Blockchain technology and how is structured. Later on it will be illustrated which are the major elements that boost this technology to one of the main innovation of our era. In any case, Blockchain technology can assume different function that goes beyond a single definition. For these reasons, this work aim to let the reader understand the basics elements by emphasising the main aspects needed for its applications in Industrial context.

''You have to think of the blockchain as a new utility. It is a new utility network for moving value, moving assets." – William Mougayar

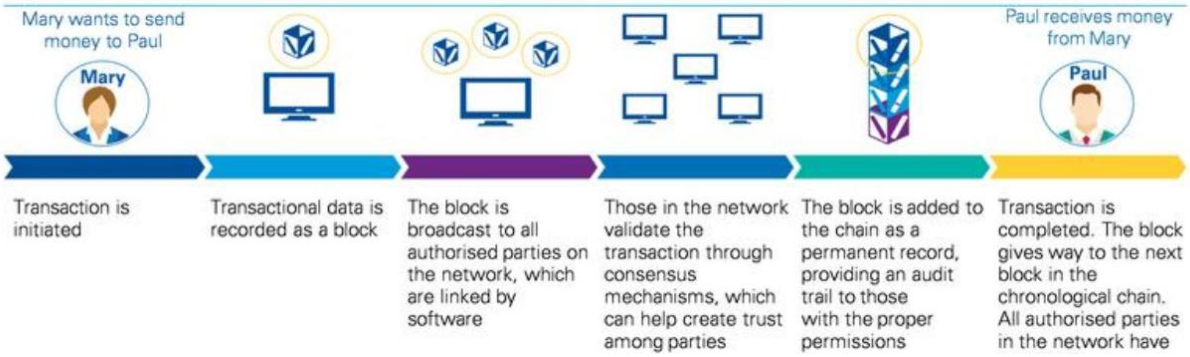
Even if there are several distributed databases beyond blockchain, it is designed to constantly achieve reliable agreement over a record of events between independent participants. From a different perspective, participants in a blockchain network have to reach a consensus in order to modify and update the shared ledger.

This process is achieved through consensus mechanism which ensures that each participant's view of the database is exactly the same of the others participants. Moreover, the combination of the consensus mechanism with a specific data structure based on cryptography, allowed blockchain in its first applications to solve the so-called 'double spending' problem – the same digital file being copied and transferred multiple times – without the need of a central authority that prevents the spending of the same digital file twice. At this purpose, since the digitalization has been significantly affecting our way of living and especially in industrial processes,

blockchain has given the possibility to facilitate the transfer of assets and other data without needing a trusted third party.
In concrete, blockchains enable the transfer of information as a digital files without relying on a central authority. The elimination of a central third-party brings further benefits not only in terms of costs, in fact, participants can independently verify what is going on in real time giving more transparency and reliability. This ensures that all participants have a consistent view of the shared ledger and, in case of any improper alteration of the data (e.g. tampering, malicious actors) the network will be immediately reject them. Despite the ability of blockchain technologies of being decentralized is one of the main value proposition, this technology goes beyond by providing immutability, transparency and reliability in industrial systems and business context.

Before going through practical features, it is important to understand the structure and concepts of the Blockchain that have inspired the pioneer, Satoshi Nakamoto. First, the meaning of Blockchain can be easily found on the word itself composed by: Block and Chain. More in general, it represents how this system is structured, specifically: the digital information stored within the blockchain are grouped in ‘’blocks’’ in which each of them are linked through a cryptographic operations named ‘’hash’’ forming a digital ‘’chain’’. Essentially, **Figure 4** shows a basic representation about how blockchain works: if Mary wants to send money – or another asset – to Paul, a transaction is initiated and grouped in a block. Once the block is broadcasted on the network, through a consensus algorithms transactions have to be validated in order to add the block to the chain. If validation is completed, the block gives way to the next block in the chronological chain. Obviously, this process is done in real-time where all authorized parties in the network have access to a shared, single source of truth.

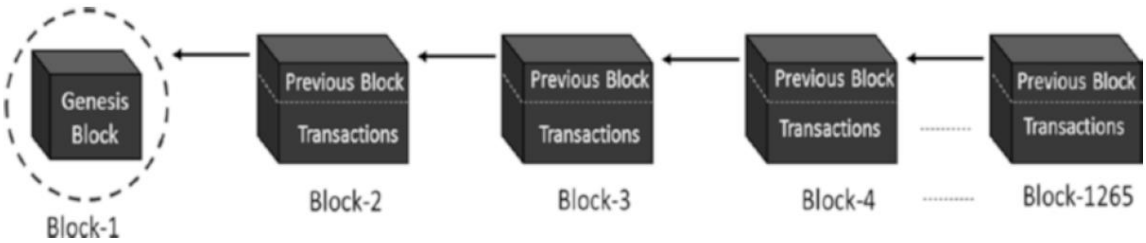
Figure 4: How it works: blockchain basics



Source: KPMG, 2018

More in general, a simplified representation of blockchain could be imagined as follow in **Figure 5:** the structure of blockchain technology is represented by a list of blocks with transactions in a particular order.

Figure 5: chain of blocks



Source: Personal reproduction

To summarize things, the blockchain is a decentralized, distributed ledger of different kinds of transactions arranged into a P2P network. This network consists of many computers, but in a way that the data cannot be altered without the consensus of the whole network (each separate computer).

In the context of blockchain technology is it possible to lists five basic elements:

1. Node: They are participants in the blockchain and are physically made up of the servers of each participant: it can be a person, a firm or a single device (sensors, machines, robot, etc) that perform specific actions.
2. Transaction: They represents the historical actions that are took placed by nodes and, once added to one block they can not be altered after being validated, approved and stored. Moreover, transactions are time-stamped chronologically in the shared ledger:
3. Block: It refers to the group of transaction that after being validated they will grouped within a block.
4. Ledger: It refers to the set of blocks in which all transactions are stored and shared among nodes that have the same copy.
5. Hash: they are cryptographic hash function is a one-way function that uniquely and securely identifies each block.

1.2.1 Which problems can solve blockchain technology?

Some have touted blockchain as the biggest innovation in computer science (Tapscott, 2016). Others consider this technology to be "the biggest disruptor to industries since the introduction of the Internet''. Blockchain can be useful in situation where there is a desire to minimize the degree of trust required between participants, or where participants would like to reduce the dependence on intermediary services. In this direction, the distributed nature of blockchain can solve security problems that arise from the abuse of trust, such as fraud. In fact, 'the financial cost of fraud 2018' has estimated that globally, fraud is costing £3.24 trillion each year, a sum equal to the combined GDP of the UK and Italy.

Alternatively, through the combination of cryptographic science, game theory and Byzantine fault tolerance, the blockchain ensure high level of security of the system in which participants can fully rely on the system itself.

The success of blockchain technology can be found in its characteristics and the benefits it provides to users which include:

A. *Security*: the system securely protect data and transaction in the shared ledger using a distributed approach. This protection is done through simple encryption that hide and protect individual transactions (Mohamed et. al, 2019) More specifically, asymmetric encryption by providing the public and private keys is the basic technology that ensure the security of blockchain (Yang Lu, 2019).

B. *Immutability*: It is a fundamental characteristic of blockchain. Once a transaction is recorded, it cannot be altered and if the transactions are broadcast to the network, then everyone has a copy of it. With time, when more and more blocks are added to the blockchain, the immutability increases and after a certain time, it becomes completely immutable. (beginning blockchain). Although this is seen as a strength, it could be also considered a disadvantage every time a remedy or an edit is needed.

C. *Reliability*: The peculiar characteristic of Blockchain that makes it reliable is that it keeps a shared, single reality of data across multiple locations within the network. This nature of Blockchain makes it much more reliable than any trusted centralized institution. (block on marketing). Further, according (Underwood, 2016) blockchain technology redefine the concept of trust, attributing reliability not in people but in mathematics behind the technology.

D. *Transparency*: in public blockchain, transactions are transparent and publicly available for everyone to check and validate without the need to go through a central authority. This mechanism enable trust among all the users in the network being able to view all transactions that have occurred (Nakamoto 2008).

To sum up, Blockchain technology has potential to revolutionize industrial processes and many other sectors that will be listed in the following chapters by providing and ensuring fundamental principles such as: Security, Immutability, Transparency and Reliability. In this way, we are now witnesses of a shifting of

trust's concept. Especially, the actors involved have to rely on the system itself avoiding problems such as asymmetric information and agency theory.

1.2.1 Governance of blockchain: *consensus algorithms*

The core element of any Blockchain application is its consensus protocol needed for information sharing, replicating state, and broadcasting transactions, among participants. (Viryasitavat et. al, 2018). In general, all the users in a decentralized network must reach an agreement about state of the blockchain. To explain this concept a step backward is needed by coming back to transactions. Every new transactions is grouped to others by creating a ''block'' that is added to the ''chain'' of chronological transactions. In this way, every time a block is generated the chain becomes longer and longer. Effectively, the chain represent the shared ledger of transactions owned by all participants.

At this time, it may be possible to wonder who and how transactions can be validated if any central authority has the power to do so. At this purpose, it is fundamental to explain that: before adding a new block to the blockchain it is necessary that it is checked, validated and encrypted. To carry out this step, there are numbers of consensus algorithms, Proof of Work is the most popular that leverage the Bitcoin blockchain. A complex mathematical problem is solved which requires a conspicuous commitment also in terms of power and processing capacity. This operation is defined as "Mining" and is carried out by the "Miners". Since this is an important commitment with considerable waste of energy, in cryptocurrency mining for example that commitment needs to be remunerated and encouraged. On one hand, in "Private" or Permissioned blockchains, this role (Miner) is performed according to governance by the authority that activates the blockchain itself. On the other hand, in ''Public'' or Permissionless blockchains, this role can be played by

any participant in the blockchain and the Miner is encouraged with forms of remuneration that depend on the type of rules or governance defined by each blockchain.

Proof of Stake is a consensus algorithm blockchain that deals with the main drawbacks of the proof of work algorithm. In this one, every block gets validated before the network adds another block to the blockchain ledger. There is a little bit of Twist in this one. Miners can join the mining process using their coins to stake.

Proof of Elapsed Time (PoET) is one of the best consensus algorithms. This particular algorithm is used mainly on permissioned blockchain network where you'll have to get permission for accessing the network. These permissions networks need to decide on the mining rights or voting principles.

At this point, I would like to specify that the aim of this paper is to focus on Private and consortium rather than Public blockchain. Since nowadays major Public blockchain represents cryptocurrencies markets, from a business and industrial perspective Permissioned blockchain will represent the core topic of the following paragraphs.

Coming back to the consensus protocol, with Distributed Ledger Technology like Blockchain we are experiencing the field of distributed databases that can be updated, managed, controlled and coordinated not just at central level, but in a distributed way by all the actors. More specifically, the Blockchain is updated only after obtaining consensus and each node is updated with the latest version of each individual transaction of each participant. In this way, each operation remains indelible and unchangeable on every single node. More in general, each participant possess a copy - immutable - of each transaction. Clearly, this step represent a drastic change from the traditional centralized logic, when the verification and

authorization were centralized and the whole process were managed centrally. This architecture model allows us to interpret the database in a much broader sense than in the past. We can no longer simply talk about Ledger as archives, but we must talk about Distributed Ledger Technology as a new relationship between people and information, where the Blockchain represent the perfect example.

1.3 Blockchain typologies: *public, private and permissioned*

From our history we have learned that things change during time and development brings innovations. Since 2008, Nakamoto's white paper gave an input to knowledge cryptocurrency such as Bitcoin and the underlined Public Blockchain technology to which the platform is still based. In this way, as development and interest increased, Private Blockchain started to arise.

From this perspective, what has been written in previous paragraph perfectly reflect mechanisms of a Public Blockchain , but recently the development of Private Blockchain gained a substantial importance especially at industrial and governative level . In light of those considerations, it was considered appropriate to illustrate principles of Public Blockchain in order to better understand how private Blockchain could contribute in Industrial context.

More in general, rather than developing a public and fully decentralized system, it could also be feasible a Blockchain closed ecosystem where access are controlled and not everyone can join the network. In these systems, therefore, the authorization to modify or read the status of the blockchain is limited to a limited number of users.

This can actually be done also thanks to the many guarantees that the blockchain offers especially in terms of authenticity and data security.

In any case, beyond the theoretical debates on the subject, the distinction between the different types assumes a fundamental importance above all for those who intend to study the phenomenon in its various context. Moreover, this diversification acquires even more value in relation to the objectives of this work which, analysing the blockchain applications in the *supply chain*, deeply clashes with this distribution. In this regard, as will be seen in the following chapters, enterprise solutions are almost all private cases. For these reasons, attention must be focused on the substantial differences between these solutions that can be grouped in the following typologies:

1.3.1 Public or permissionless blockchain

In Public Blockchain, as anticipated before the network is open for everyone to participate. Bitcoin and Ethereum are examples of such blockchains. Therefore, public blockchains require the time-consuming, resource intensive Proof of Work or other means to achieve the consensus and byzantine fault tolerance to eliminate hackers. As previously defined, public blockchain is a system capable of offering a high level of security thanks to the presence of: a complex consensus mechanism that pushes the miners to invest heavily in computational power; public-private key cryptography and a governance mechanism in function of which the degree of influence of a single actor within the network is proportional in the process of consensus and to the amount of economic resources that he can make. This type of blockchain is defined as "completely decentralized" (Risius et. al, 2017). However, (Reyna et. al, 2017) pointed out that it is unlikely that public blockchain will likely

be used much in supply networks where buyers are purchasing products from seller. When trade assets are confidential and are exchanged in a supply network, and participants require privacy, public blockchain would not be a good solution. Therefore, private or permissioned blockchain that incorporate privacy and confidential measures would be more desirable.

1.3.2 Private blockchain

The Private Blockchain is a blockchain in which the authorizations for writing and editing individual blocks are kept completely centralized. As far as reading authorizations are concerned, these can be kept public or they can also be limited to a finite number of users. The private blockchain can be defined as a traditional centralized system with the addition of a degree of cryptographic verifiability. In this way a private blockchain is certainly more suited to traditional business models in which aspects such as privacy and / or sharing data maintain a strategic dimension at company level and must therefore remain under the control of the company. This aspect does not necessarily have to be perceived negatively but, rather, it must push the programmers and the innovators to think of the solutions that marry and embrace the needs and the needs of the companies.

The fact that this type of infrastructure, at least at first sight, does not have the same revolutionary impact as public blockchain, does not mean that it cannot in any case play a preponderant role in making business activities and processes more effective, transparent and efficient.

1.3.4 Consortium blockchain (permissioned):

The blockchain consortiums are distributed databases in which the consensus mechanism is controlled by a set of preselected nodes (Risius et. al, 2017). Consider, for example, a "consortium" of 10 financial institutions, each of which manages a single network node.

In this case the mining activity could be reduced in the joint agreement between the different participants. In these terms, the consensus mechanism would be built around a voting system with pre-established majority thresholds. For example, it may be enough 80% of the nodes to sign a block in order to validate transactions.

As for reading permissions, in the consortium blockchain these can be either public, or released to all or nodes of the network, which are limited to some participants. This type of blockchain due to its intrinsic characteristics is defined as "partially decentralized" and can be considered a hybrid between public and private solutions (Risius et. al, 2017).

This in fact contains within it both typical characteristics of public solutions, or less control over network activities, and intrinsic characteristics of private blockchains, such as the need for greater reliability on system operations. A leading examples of these private or permissioned blockchain is an open source effort called *Hyperledger*, initiated by IBM, Intel, and others, it is now being run by the Linux Foundation.

Private blockchains and blockchain consortiums fall into the broader category of permissioned blockchains.

On the basis of the considerations made it is therefore possible to summarize the main characteristics of public and private blockchains in order to be able to

understand more clearly the implications deriving from the implementation of one or the other solution ***(Table 1).*** In this regard, the main advantages and essential features of a public blockchain can be summarized as follows:

- Public Blockchains provide high security for nodes participants among network. The consensus mechanism allows to make it very difficult, if not impossible, to make changes to the database, thus increasing the trust placed by users in the system. Furthermore, being open and accessible to anyone creates a network effect within the platform that makes the blockchain increasingly safe and secure. Against this extreme security there is the slow validation in the blocks (in Bitcoin every 10 minutes) and the wasteful energy waste due to the work done by the miners.

As may it concern about Private and Consortium Blockchain the main advantages can be summarized as follows:

- Private and Consortium Blockchain can modify and leverage governance rules of the platform, further, mining nodes are known a priori and have a previous trust. The Private or Permissioned blockchain is based first and foremost on a set of rules shared by all the actors. The rules are part of the development and to implement a Private blockchain it is necessarily to work in the planning and design phase both on the infrastructure and on the application logic. Governance is an integral part of the design process and represents the basis on which production activities are then implemented as a set of rules that allow to guarantee the absolute safety of the blockchain for all the players and of course the achievement of the objectives of business of companies and organizations that will be called to use it. Furthermore, transactions are validated faster, because only a few nodes they have this role. In addition, possible errors can be solved in a short time through a manual intervention.

To sum up Private blockchains are regarded as more suitable for business-to business (B2B) applications when privacy concerns, such as identity anonymity, business competition, are considered.

In light of this analysis it is easy to understand that the optimal situation, in terms of implementation of technology, varies from sector to sector. In some cases the implementation of a public blockchain can clearly be the optimal choice, in other cases instead, the greater control given by the private blockchain makes it necessary for a certain system. Consider for example the private sector such as a company engaged in a *Supply Chain* ecosystem, where trust in the system can be past. For this reason a private blockchain (or permissioned) could be preferred compared to a public one. In this regard, the aim of this work is to illustrate benefits of Consortium and Private Blockchains at enterprise level and business context by providing significant solutions in terms of efficiency and business development.

Table 1: Comparison among public ,consortium and private blockchain

Property	*Public blockchain*	*Consortium blockchain*	*Private blockchain*
Consensus determination	All miners	Selected set of nodes	One organisation
Read permission	Public	Could be public or restricted	Could be public or restricted
Immutability	Nearly impossible to tamper	Could be tampered	Could be tampered
Efficiency	Low	High	High
Centralised	No	Partial	Yes
Consensus process	Permissionless	Permissioned	Permissioned

Source: Zibin Zheng and Shaoan Xie, 2018

1.4 Blockchain evolution and main business applications

With the term Blockchain we mean the technological paradigm that allows to develop Cryptocurrency applications: the Bitcoin protocol represents the first one of the possible realizations.

The association with the concept of Bitcoin can still generate some misunderstanding between non-experts, but the Blockchain - the technology underlying the mechanisms that regulate cryptocurrency transactions (of which Bitcoin is the best known) - seems destined to have a completely different role.

The blockchain is not just Bitcoin. The virtual currency is in fact only one of its possible applications. Without centralized management, in fact, the blockchain allows you to send any data in a secure manner, drastically cutting the chain of intermediaries, and thus allowing a secure data exchange between two people and that's it, without having to use third-party media such as a e-mail provider, or an external Cloud Computing service.

At this purpose, Swan (2015) defines evolution of Blockchain technology in three distinct levels of commercial adoption for business applications. According to this distinction, Blockchain technology systems are based on:

> **Ledgers:** the immutability of the ledger allows to notarise events with a specific timestamp
>
> **Token:** the univocity of digital tokens do not allow to replicate and double spend them. This will result as a gain of value
>
> **Smart contract:** the automation of contracts allows new business models.

1.4.1 Ledgers for business

The first level of the blockchain is related to its immutability. The activities listed on the register cannot be changed and cannot be removed. Thanks to this feature, blockchain technology acquire a digital notary who certifies facts and data and assigns them a certain date. Distributed notarization of events generates a new way of storing and demonstrate facts about many topics, related to individuals but also companies, the state, artificial intelligence objects and much more.

This new possibility of certification and use of the contents will bring in first place at the birth of new search engines that will allow to read, compare and analyse information with an important new dimension, the temporal one.

PUBLIC LEDGER

The most widespread ledger are governmental such as the land registers for which some states like Russia and Sweden are starting to record sales of homes, land and in the future of cars, on a distributed and certified system on blockchain. In fact, There are many public registers or documents with public validity and applications are growing continuously. For example, the Estonian street authority receives digital medical certificates notarized on blockchain to grant driving licenses without further need to provide documentation from the citizen. The ministry of Estonian health is also preparing the register of people that intend to donate on the blockchain in order to guarantee transparency, availability and access priority.

There are numerous application examples in academia, such as Holbertson School in California that will use the blockchain for academic certificates or the University of Pisa which intends to certify the academic curriculum. Furthermore, the ACI (Automobile Club of Italy) with the support of EY MyCar, has created a system to

record all events related to a vehicle on the blockchain. It deals with of events produced over time by the supply chain linked to the care of the vehicle (coupons, repairs, tire changes, mileage, etc.) and the goal is to provide an official and truthful version of the history of the car, useful for example at the time of sale.

Finally, there are registers on blockchains that allow you to store digital assets offline and unlock availability on request, such as *Goldilock*. These logs allow you to notarize events and automate their consequences without necessarily requiring human intervention.

SUPPLY CHAIN CERTIFICATION

In the global industry, counterfeit goods represent a value of around 461 billions of dollars. In addiction to this, there are also problems related to quality and product safety, on which the consumer often does not have sufficient information.

Blockchain technology supports companies in supply chain traceability, following the product from the origins of its components to the moment it reaches the final consumer. The company earns in terms of reliability and credibility and has an efficient tool to monitor suppliers. The final consumer instead, finally has the opportunity to get to know the entire product chain. In this perspective, it is then possible to register an advantage in economic terms, where the use of technology makes it possible to eliminate intermediaries.

Among those who are already implementing blockchain traceability, Food producers and large distribution companies such as *Walmart, Nestlé, Dole Food, Driscoll's, Tyson Foods and Unilever* are emerging by defining and applying the correct way of using blockchain technology to trace foods along their global distribution chain.

Since September 2018, Carrefour has allowed Italian customers to access information relating to the product purchased through a QR Code and to consult product data. The first product that Carrefour made traceable is chicken raised outdoors and without antibiotics. Barilla has started an experiment involving basil producers which trace all the data relating to cultivation, irrigation, pesticides office workers and mowing. Subsequently, each single batch is followed up to delivery. Tracking is possible thanks to blockchain technology supported by the infrastructure IBM cloud.

On the contrary, the adoption of blockchains to monitor supply chains is not limited to the world of agri-food. For example, the goal of *Everledger* blockchain is to certify the origin of over 1 million diamonds to promote a positive impact on the social, on the environment and the economy. Mediledger, on the other hand, is responsible for tracking medical products and complies with GS1 standard that allows you to identify, acquire, share and exchange data and makes it accessible and understandable to companies and consumers along the production chain.

Further, the fashion industry is using the blockchain to track the supply chain and certify the origin of the raw materials. Generally the QR Code comes inserted in the tag to ensure that the customer can verify that the product is authentic and not counterfeit.

In maritime transport, blockchain technology is used to reduce the 'trade finance costs', which amount to 20% of the shipping cost. Another example is *TradeLens* blockchain shipping solution that combines 94 organizations, 20 port operators and numerous customs authorities with the plan to reduce the transit time of a shipment by up to 40% and the costs of billions of dollars. Maersk, the large Danish container company, says that the platform "allows importers and exporters, customs agents,

customs, governmental and non-governmental agencies, to collaborate in business processes and information flow in a secure way.

1.4.2 Token for business

The second level of the blockchain after the immutability of ledger is about Tokens, or digital coins. The special feature of these digital objects is that they are not reproducible. If we take a photo with our smartphone and we share it with someone we are copying it: the result is that there will be two copies of the same photo each located on a device. The tokens instead, once sold they are no longer available and not available to spend them again, as if the photo we send could not be more accessible on our mobile once sent.

The novelty resides in the transfer of ownership written on the blockchain registers and the token is available only to the new one owner. This seemingly simple property allows you to manage it completely new compared to the past the attribution and exchange of value on the Network.

CRYPTOCURRENCIES AS SELF-VALUE GENERATION

The most well-known tokens are cryptocurrencies such as Bitcoins. They were created in January 2009 and are a mere system of exchange of value. The value of cryptocurrencies is tied exclusively to what people attribute them, as well as the energy consumption necessary to generate them, which becomes more and more over time. In this direction, the value is therefore not addressed, guaranteed or managed by a state, but only by the system. Obviously you need to pay close

attention to this type of investment to avoid that, as in the past, from exchange instruments they become instruments speculative. In this regard, the best known example is that of tulip bulbs that in the Netherlands of 1600 came to be worth more than houses, to then become the first speculative bubble of modern history.

On the other hand, the advantages of cryptocurrencies like Bitcoin are different, like absence bail-in (how to resolve a banking crisis through the exclusive and direct involvement of its shareholders, bondholders, account holders), holidays, withdrawal limits or bank hours to be subject to.

Today there are thousands of cryptocurrencies on the market, a phenomenon that reminds us what happened in the early 1900s, when cars were new technology and had appeared in the list of many manufacturers who became car manufacturers, and then focus on the maturing of the market. Likewise also on the in the face of cryptocurrencies there will be a strong concentration in the coming years.

THE VALUE TRANSFORMATION OF TOKENS

A second innovative utilization of tokens consists in the possibility of assigning a value of real world. Today, for example, it is possible to buy a building in New York worth 30 million dollars through its so-called *"tokenization of value"* on the Ethereum blockchain.

The concept of tokenization consists in the possibility of representing the value of a certain asset in many shares or many tokens, and sell them directly online on a blockchain. A popular phenomenon at the moment is to collect money from individuals (crowdfunding) to finance initiatives or companies divided into tokens and sold on blockchains through the so-called *ICO (Initial Coin Offering).* An increasingly used method, so much so that the value of offers collected in 2017, amounting to over 6 billion dollars, was equal in the first quarter of 2018.

In this context, ICOs can also be understood with a broader meaning than simple actions. For example Paris Saint-Germain is launching a Fan Token Offering which will give owners several benefits, including offers, exclusive tickets and meetings with I players. Newcastle and Cardiff will follow the example of the Parisians. Even the same bonds can be recreated on blockchain as already offered today also by the World Bank.

The killer application of tokenization could however come from the world of video games, where the digital assets of the game itself have acquired great value e they can be bought and sold, especially if made unique by the producers of popular games like Farmville.

In the future the blockchain could become the world reference standard for exchange ownership of digital goods or certificates of ownership of physical goods. Assuming an equation, Blockchain is about shifting value like the container standard is to move physical goods. Less costs, more speed and less friction.

TOKENS AS A JOB TRANFORMATION

The third use of tokens consists in using them to reward the activities carried out by people. Especially, loyalty systems represent the main application in this sense, where in exchange for activities useful for the company, customers are rewarded with tokens.

There are already many initiatives that allow you to manage corporate loyalty programs customers like *block.gyft.com, Loyyal or Sandblock*. The latter allows you to earn tokens in exchange for shares and to buy prizes not only by the company that issued the tokens but by all those present on the platform. Sector-specific systems have also been created. *Trippki*, which offers trip tokens for having stayed

in a hotel, it is an example. Or *Travelchain*, which allows users to collect their travel information and share it with suppliers of tourist services in exchange for tokens, enhancing the data of individual users.

Tokens can also be used to reward loyal customers in the editorial field, for example the erotic site *Tube8* will launch a blockchain platform to reward views with cryptocurrency tokens. More generally, services for the management of scores are already emerging today communities convertible into cryptocurrency like *Bitnation*.

In the future, remuneration for the actual job will also be defined. An example in this latter sense is *Steemit*, a social network where you are rewarded to write or edit content. To defend the value of this particular token, some of the rewards take between 3 months and two years to be converted into common currency. Further, even querying the search engines can be a paid activity. For example *Presearch.org and Bitclave* offer cryptocurrency in exchange for the action taken and select independently whether to direct the user to the search engine or to sites such as Wikipedia or Youtube.

1.4.3 Smart contract for business

The advent of blockchain technology has created a number of potential innovations in handling business activities across various industries and not only. Smart contract is one of the most critical elements in the design and application of blockchains (Swan, 2015). More in general, if we want to understand how blockchain works, we must knowledge about smart contracts and how they can interact with this technology.

The terms *smart contract* was coined for the first time by Nick Szabo in 1994 as a ‘’digital transaction protocol that execute contractual conditions’’

More in general, they are similar to contracts in the real world. The only difference is that they are completely digital, which means a small programming code that is stored inside of a blockchain. Essentially, (Chiap, 2019) argue that the purpose of a smart contract is to satisfy contractual condition automatically by minimizing inefficiencies., especially in industrial sector where intermediaries tend to be inefficient and non-cost-effective. In this perspective, cryptocurrencies and digital money transfer could represent a basic example of a smart contract application. Alternatively, the real potential of smart contracts resides on its nature to be applied upon assets value transfer such as (smart property) or concept like smart factory and supply chain management, that will be explored later on.

Ethereum is one of the most popular decentralized platforms for smart contract applications. Users may design their contracts by defining data structures and functions in each contract and subsequently deploy the contract on the blockchain. More in general, it could be argued that smart contracts perfectly match blockchain properties, by providing an ecosystem where trust is intrinsic to the system itself. The agreement is not bounded by the law, but by the contract itself through the consensus of the network. Smart contracts are written in a programming language, so they are unambiguous, and logic. Furthermore, it is not necessary for an external authority to evaluate the conditions and take decisions, since this role is replaced by the consensus of the network. Smart contracts define the rules and automatically require the parties involved to respect them, in a decentralized way, without the need to rely on central authorities. When the conditions of the contract are met, the smart contract independently performs specific actions, for example transferring money or the ownership of an asset. (Chiap,2019)

As a result, transaction time and costs will be reduced, since smart contracts can execute themselves. Also, by incorporating the Internet of Things (IoT) into the blockchain, contractual fraud will be easily detected and prevented. Furthermore, the integrity of asset transfer made by the contract will be improved with the shared database confirmed by many network participants and the enhanced security of a contract.

Under the many watchful eyes of the P2P network, BT helps reduce hidden, invisible risks that cannot be easily detected by a limited number of participants (e.g., seller, buyer, financial institution) in typical business transactions or supply chain activities. In other words, BT enables its adopter to exploit multiple layered security measures. In this direction, smart contracts aim to automize every process that require contractual action among untrusted actors. At this purpose, to better understand how they work a concrete explanation is needed.

An example could be the home delivery of food. A smart contract can be created that guarantees a discount on the price of food based on the time that was required for delivery. For example, if the delivery requires:

• less than 30 minutes: full price;

• between 30 and 45 minutes: 20% discount;

• more than 45 minutes: 30% discount.

These three conditions would be saved within the smart contract together with a timestamp that identifies the moment in which the order was made. When a customer places the order, the entire amount is blocked within the smart contract and, once delivery is completed, the actual price to be paid is established based on the time taken for delivery according to the rules of the contract. All in a transparent and automatic way. Wonderful isn't it?!

Further application of smart contracts could be provided by the ability to deploy solutions in governing and managing business transactions in multi-party setting. Especially, the unique characteristics of smart contracts, along with characteristics of blockchain, improve the potential for the synchronization and automation of business operation and processes. (Chang & Chen, 2019). More specifically (Macrinci et. al,2018) argued a widespread adoption of blockchain and IoT technologies by proposing a blockchain based supply chain management solution for IoT-enabled smart containers. Especially in solution for shipment management, the smart contracts play an essential role in triggering notifications and enabling the participating entities to continuously monitor, track and receive alerts if any violations occur. Therefore, ensuring the integrity of the items within the shipment.

As we have already talked about smart contract, here will follow a business point of view and potentiality within business context.

Smart Contracts made possible the birth of Smart Marketplaces, distributed markets which give the intermediary a strongly reduced role, the third party function as guarantor is no longer necessary. In some cases this figure is completely absent. In fact, the so-called sharing economy can thus be applied to everything we use or that we have on subscription, such as minutes for calls, Wi-Fi, the use of your PC, our car, bicycle or accommodation. All it can be shared and sold automatically on Blockchain.

Smart marketplaces are already widespread and represent the various product sectors. For example, *Openbazar*, the distributed and open source marketplace that does not include fees on transactions and on which you pay in cryptocurrency, could be the replacement for eBay. Further, for the sale of luxury watches, *Soma.co* can

be used instead which will also allow the transfer of the original ownership certificate.

Compared to tourism, *Cool Cousin* is the evolution of Lonely Planet and Tripadvisor. Started in 2016, today it has 500 thousand users. Those who provide indications are paid with CUZ token directly from users of the service.

There are numerous candidates to represent the future of the Airbnb model, such as *Lockchain*, *Betoken* or *Beenest* operating as a hotel and smart marketplace apartments that completely eliminate the intermediary and his commission.

On the B2B platform front there are many projects today including *TraDove* for the management of fast and secure transactions between companies in different countries. The project was created to manage the problem of trust and makes the social network of TraDove available to partners, where the different parties can meet and see the commercial history of the companies.

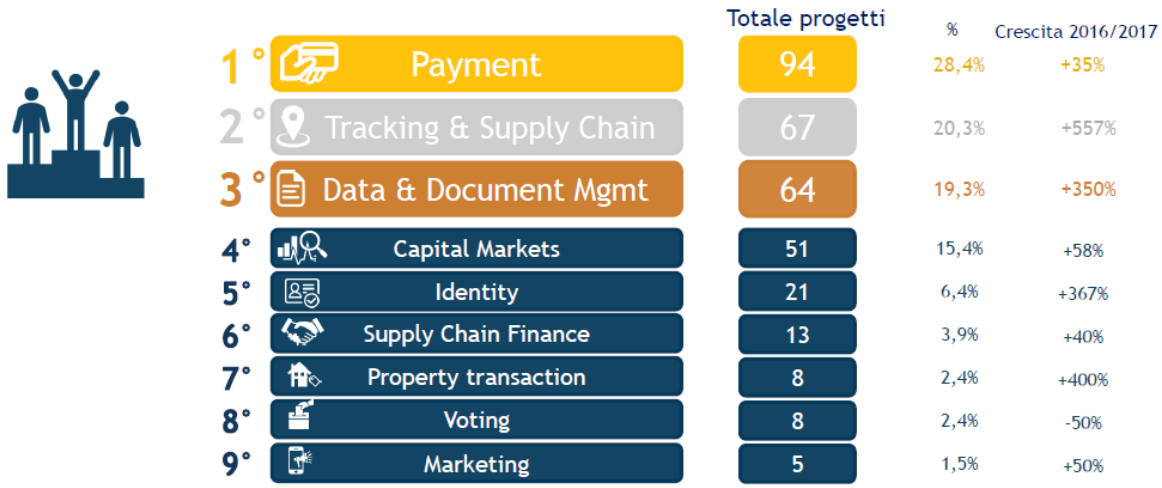
In this regard, Smart companies are likely to be the next step. Companies completely automated systems that can work directly through use of the blockchain. Like the Flight Delay insurance service created for late arrivals flights where everything, from the calculation of the premium to the disbursement in case of delay, is completed directly from the system.

1.5 Blockchain domain applications

After its launch in 2008, the blockchain has gained great visibility especially for the important implications that it has entailed on a financial level. But virtual money is just one of the possible applications of the distributed database. In fact, the blockchain, thanks to itsintrinsic characteristics and its technological peculiarities, presents many different solutions that transcend the crypto-currency.

In this regard, a study proposed by the ‘’Osservatorio Blokchain del Politecnico di Milano’’ (Valeria Portale, 2018), conducted on 331 projects and shown in the figure below, it can be seen how the features offered by the distributed database impact on different application contexts. From **Figure 7** emerges that almost 25% of the projects analysed are developed in the *supply chain* with a growth between 2016 and 2017 of over 550 percentage points. *Tracking & supply* chain are second in the ranking proposed by the Observatory for the number of projects proposed.

Figure 7: Ranking of ongoing blockchain sector



Source: Osservatorio Politecnico di Milano 2018

The blockchain in supply chain offers many applications ranging from product tracking to payment automation. Based on these considerations and in light of the interest shown by companies and the community of developers, we have chosen,

within this research paper, to go and analyze precisely the blockchain innovations within the supply chains. In this regard, Chapter 3 will present a possible use case of technology implementation in the supply chain, while Chapter 4 will deal with its applications in detail.

In order to have more delineated picture of the technology, it was decided to describe its implications within the different application areas. So let's see the most important.

1.5.1 Blockchain in industry 4.0 ecosystem

Thanks to the blockchain in the industry 4.0 it could be possible to exploit the decentralized logic of the Blockchain to produce technologies able to better support the production, logistics and supply chain, as well as other "core" areas of the company.

The Blockchain allows solutions in particular for the processing industry, for the management of internal and external product logistics and for the management of supply chain relationships.

In particular, solutions have been developed that make it possible to bring the logic of the "trust"; which is widely used in the field of digital payments even in the context of transactions that have as object "packages" of data that represent the identity of certain products and their production logics.

Even though in the context of Industry 4.0 significant advances has been done to connect the digital and physical realms of manufacturing, there are some challenges to be addressed. These challenges are mainly related to the connectivity and information exchange among different actors (firms, machines, sensors etc..)

involved in the network. Some of these challenges according to (Mohamed et. al, 2019) are security, trust, reliability, traceability and better integration of the value chain.

At this purpose, one of the most promising technologies to be applied in industrial environments is Blockchain. While the initial focus of blockchain was on application in the finance sector, nowadays is far more potential in the physical world of manufacturing, agriculture, logistics, energy and every fields that could leverage its benefits. In fact, Blockchain incorporates techniques from peer-to-peer networks and cryptographic to support a distributed shared ledger among a group of entities.

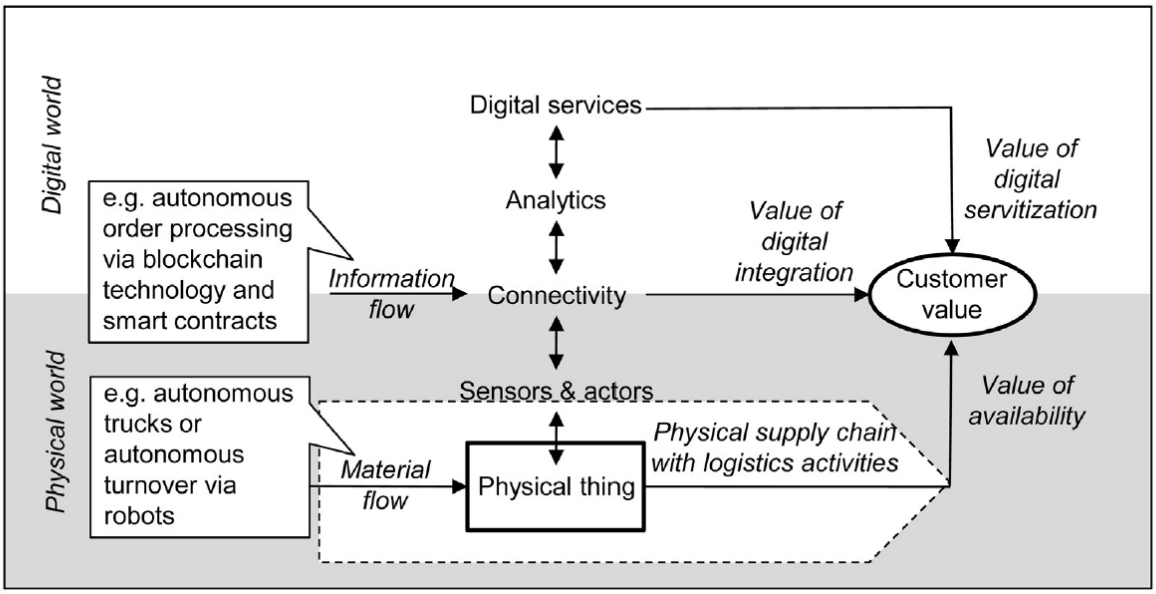
Especially, three are the main areas where blockchain could significantly impact Industrial paradigms such as:

1. Efficiency-Cost reduction: process updating, simplification, disintermediation.
2. Innovation- Service digitalization: new business models, diversification, differentiation.
3. Cybersecurity- Truth, trust, integrity: security of transactions, privacy, immutability.

In this context, as can be seen from **Figure 9**, the Blockchain technology would enhance the connection of the physical world into a digital one. In fact, within a supply chain ecosystem where physical logistics activities are performed, blockchain technology could guarantee an high level of connectivity and analytics of physical thing. In this way, the material flow and information flow converge into a digital services provided by the value of digital integration between physical and

digital world. Here, the blockchain technology enables value of digital servitization that is converged to a significant increase of **customer value**.

Figure 9: a logistics-oriented Industry 4.0 application model



Source: E. Hofmann, M. Rusch, 2017

1.5.1.2 The industry 4.0 paradigm

‘’The world is experiencing an economic and political upheaval that will continue for the foreseeable future. The forces of the Fourth Industrial Revolution have ushered in a new economy and a new form of globalization, both of which demand new forms of governance to safeguard the public good. Whether it will improve the

human condition will depend on whether corporate, local, national, and international governance can adapt in time[1].''

Industry 4.0 is a broad vision with clear frameworks and reference architectures, mainly characterized by the bridging of physical industrial assets and digital technologies in so called cyber-physical systems. Promoters of this idea expect Industry 4.0 to deliver "fundamental improvements to the industrial processes involved in manufacturing, engineering, material usage and supply chain and life cycle management" (Hermann, 2016).

The concept of Industry 4.0 has gained large popularity and importance since it was first introduced by the German government at the Hannover Fair in November 2011. The aim and the core of each industrial revolution is to increase productivity. This disruptive process is also known as the "fourth industrial revolution", which identifies a new paradigm shift with respect to the three previous industrial revolutions. In fact, as can be noted from the **figure 7** the first industrial revolution was the

introduction of mechanical production (1784). From (1870) electrification and the division of

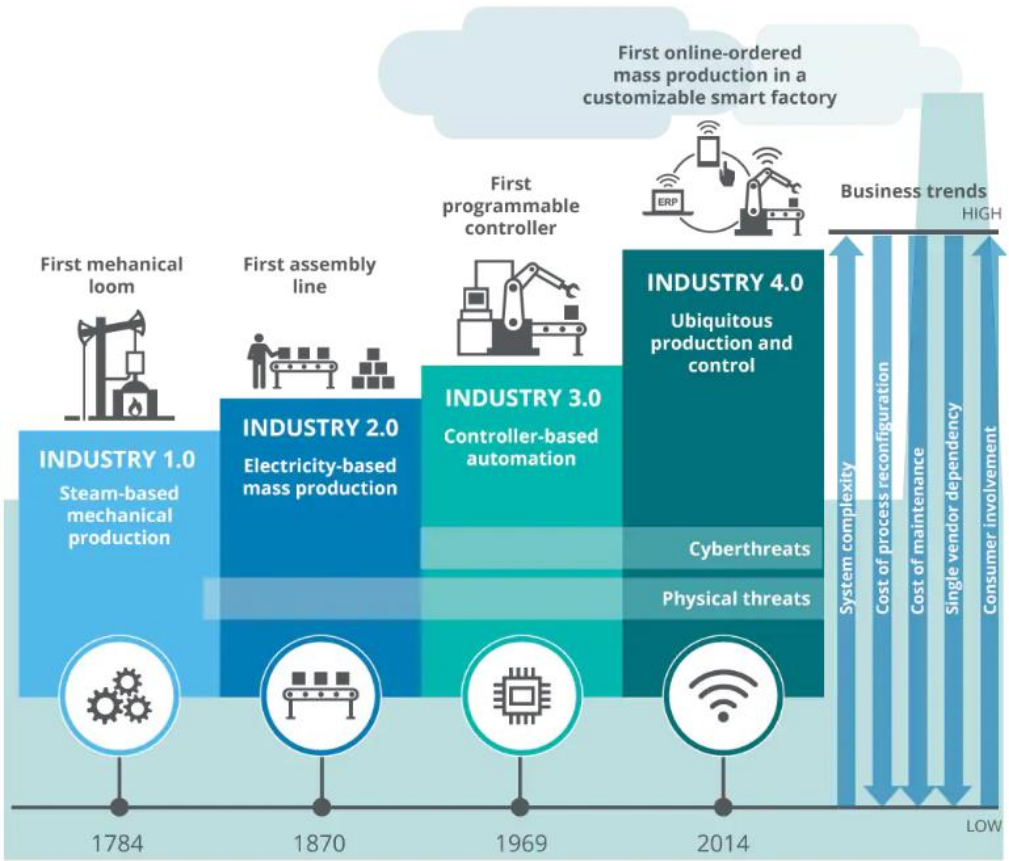
labor (i.e. Taylorism) led to the second industrial revolution. The third industrial revolution, also called "the digital revolution", set in around the 1970s, when advanced electronics and information technology developed further the automation of production processes.

The term "Industry 4.0" became publicly known in 2011, when an initiative named "Industrie 4.0" – an association of representatives from business, politics, and

[1] Klaus Schwab, Founder and Executive Chairman, World Economic Forum, "Globalization 4.0"

academia – supported the idea as an approach to strengthening the competitiveness of the German manufacturing industry (Kagermann et. al, 2011). Promoters of this idea expect Industry 4.0 to deliver "fundamental improvements to the industrial processes involved in manufacturing, engineering, material usage and supply chain and life cycle management".

Figure 8: Progression of cyber and physical threats for each industrial revolution



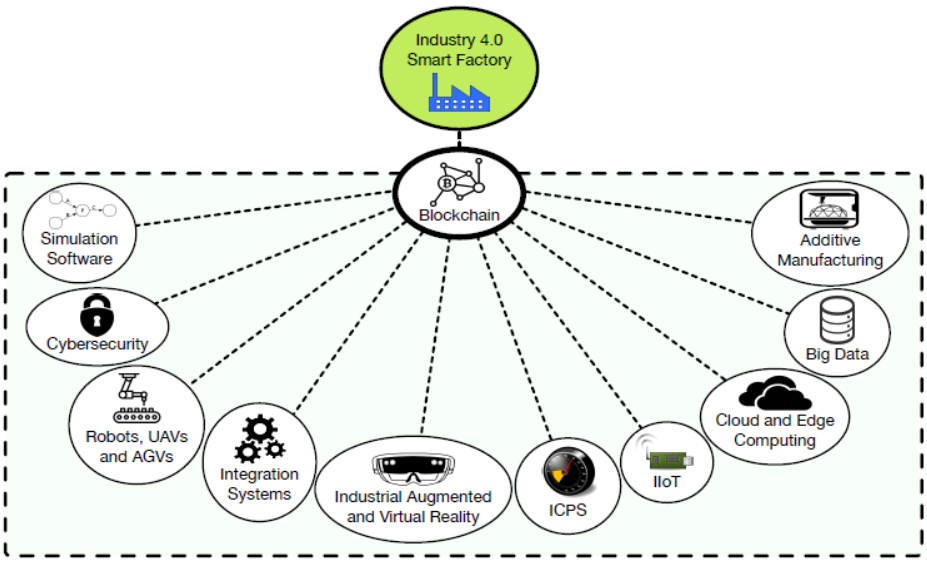
Source: Deloitte 2018

This new industrial paradigm is based on customized individual production, on horizontal integration in collaborative networks and on digital supply chain integration. However, the real added value is linked to the different concept of production and distribution of products and in particular to how companies create and distribute the right value. The product as a physical object, finds a new dimension in a technological the ecosystem, by spreading information throughout its life cycle. For the first time, alongside the physical product, personalized services are source of further profitability. In this way, manufacturing goes from being product-oriented to service-oriented, by leading organizations toward a technological shift. This concept has *Smart Manufacturing* as its central element (Kagermann et. al, 2011) changing even the way people work. This new industrial stage demands a socio-technical evolution of the human role in production systems, in which all working activities of the value chain will be performed with smart approaches (*Smart Working*) and in information and communication technologies (Marodin et al, 2017).

The Fourth Industrial Revolution has both expanded the possibilities of digital transformation and increased its importance to the organization. Numerous definition can identify this new paradigm. Essentially, the value proposition of the Industry concept 4.0 is closely associated with end-to-end digitization of all physical assets and with integration into digital ecosystem of all value chain partners (Pereira et. al, 2017). In this regard, one of the foundations of Industry 4.0 consists in gathering as much data as possible from diverse parts of the value chain. By providing such a level of connectivity, the Industry 4.0 paradigm enables autonomous communications among multiple industrial devices distributed throughout a factory and on the Internet (Tiago et.al, 2016).Examples of such enabling technologies are Artificial Intelligence, Blockchain, the Internet of Things,

Additive Manufacturing, Robotics, Cloud computing, and others to drive more flexible, responsive, and interconnected enterprises capable of making more informed decisions. All the mentioned technologies need to be seen in that perspective whereby integration is a key where the convergence of IT ***(Information Technology)*** and OT ***(Operational Technology)*** laid the foundation toward connected factories, smart decentralized and self-optimizing systems and the digital supply chain **(figure 9).**

Figure 9: Main Industry 4.0 technologies



Source: Iscoop

In this perspective, according to a study performed by PWC and shared by WEF in 2016 – companies from all sectors are embracing ‘’Industry 4.0’’: about one third

of 2000 companies surveyed in 26 countries has shown an high level of digitalization, and is expected to rise on average from 33% to 72% by 2020.
To sum up, the essential goal of Industry 4.0 is to make manufacturing – and related industries such as logistics – faster, more efficient and more customer-centric, while at the same time going beyond automation and optimization and detect new business opportunities and models.
Here listed are some of the key benefits of Industry 4.0:

- Enhanced productivity through optimization and automation
- Real time data for a real-time supply chain in a real-time economy
- Better quality products.
- Improved agility.
- The development of innovative capabilities and new revenue model.

1.5.2 Blockchain in finance

Blockchain capabilities deliver banking innovations to revamp the experience for customers by reducing transaction times from hours to seconds, eliminating manual processes, and eradicating unnecessary intermediaries in trade finance, digital identities, and cross-border payments. With blockchain, you can conduct business rapidly and securely, moving from paper based to blockchain-stored transaction records, which can enable easier expansion to underserved markets, such as small and medium enterprises.
Banks continue to struggle with manual processes and stringent requirements for managing, tracking, and securing domestic and cross-border trade transactions.

Blockchain can increase financial efficiency by reducing manual manipulation. In intercompany transactions, blockchain will create one version of the ledger allowing intercompany transparency and settlement at the same instant. This will allow Finance to focus more towards value creation activities. The use of smart contracts will enhance governance and compliance of intercompany transactions.
For example, IBM and eight European banks have created We.Trade, which is a multiple-bank collaboration that is building trusted digital trade chain connections with smaller enterprises.

1.5.3 Blockchain in energy sector

One of the most promising sector where Blockchain can significantly impact is represented by what is called smart metering. It is estimated that in the EU alone, the transition towards a more sustainable and secure energy system would require an investment of €200 billion per year for generation, network and energy efficiency development. Moreover, according to senior consultancy such as Deloitte and PWC, Blockchain have the potential to disrupting energy related products as they become digital assets that can be traded interoperable. In this context, Internet of things (Iot) application combined with blockchain can play a significant role in the vision of smart grid and P2P energy trading.
More in general, through a digitalization of the energy system blockchains could provide
innovative trading platforms where prosumers and consumers can trade interchangeably their energy surplus or flexible demand on a P2P basis (Andoni et al., 2019). In this perspective, will see smart appliances, automated control of heating, ventilation and air conditioning units, adoption of EVs and the rise of self-generating prosumers. The smart grid vision states that interconnected

smart devices will be able to coordinate and react to price, renewable availability or grid stability signals by adjusting accordingly their power consumption. It is clear that the Blockchain technology promises to be able to organize and track very small energy flows and control signals at the lowest transaction costs. It fits seamlessly into strategies that put the customer at the centre.

1.5.4 Blockchain in the healthcare

Blockchain can simplify the Healthcare sector by providing consistent advantages. (Jaude et. al, 2019) identify three main areas where this technology could operate.

- Easier to access medical data
- Medical data sharing
- Standardization of medical records

Overall, medical records continue to suffer a lack of innovation. It is possible to argue that sensitivity of healthcare information and privacy concern slow down the innovation pattern of this sector. Blockchain may offer a solution by helping patients get easy access to their data. Instead of having to navigate through multiple laws and processes of medical service providers in order to retrieve the information, this can be accomplished with the help of the distributed ledger and the ability to maintain privacy through the public and private key. Moreover, easy identification of the user and granting access to the appropriate medical records while keeping the overall data anonymous is made possible in the Blockchain.

another problem in relation to healthcare and medical information stems from the privacy and anonymity concerns pertaining to medical information in patient files. The dilemma faced by the medical profession is that medical data are extremely valuable for research purposes and the improvement of overall medical conditions

and operations, but at the same time this information is highly sensitive and faces massive legal hurdles with regards to sharing and aggregating the information from the various sources. Blockchain solves this by allowing the anonymization of the patient's medical data while keeping intact all pertinent medical information and rendering it serviceable in the aggregate.

The decentralization of medical records through a common Blockchain ledger would also allow for the unification and standardization of medical record information. This will allow easy transferability and follow-up across the spectrum of health service providers which would lead to the improvement of overall health and patient services.

1.5.5 Blockchain and Iot

Even in the Internet of Things the blockchain finds a great utility: thanks to its ease of data exchange, in fact, the blockchain technology could be used to facilitate communication between connected IoT objects, in addition to making data exchange safer and faster. The blockchain is then used as a platform for solutions that aim to manage the identity of things. Thanks to the correct identification of this identity, it is possible to create supply chain certification solutions based also on the data coming from things (IoT) and to work on supply chain certification. One of the most significant examples is that of the food supply chain.

The themes of identity management in the Internet of things so important because today the end-to-end recognition of virtual or physical objects should be more secure in terms of privacy and cyber security. Blockchain could dramatically help in this direction.

For example, objects that receive and send messages from the real world *Slock*.it is based on Ethereum and allows to unlock the padlocks, for example for rent bicycles.

ElectricChain is a system that certifies the production of seven million generators of solar energy distributed in the world thanks to Sun Exchange by using SolarCoin as cryptocurrency. Final, *TBox* is a cube that certifies the presence of the customer in a certain hotel and guarantees the veracity of online reviews.

1.5.6 Blockchain for government

An important function of government is to maintain trusted information about individuals, organizations, assets, and activities. Local, regional, and national agencies are charged with maintaining records that include, for instance, birth and death dates or information about marital status, business licensing, property transfers, or criminal activity. Managing and using these data can be complicated, even for advanced governments. Blockchain technology could simplify the management of trusted information, making it easier for government agencies to access and use critical public-sector data while maintaining the security of this information.

Current government systems rely heavily on paper-based and traditional forms of document authenticity and identity requirements. In most countries in the world, it is not possible to use a digital ID to receive sensitive or critical government services. This is due to the lack of adoption of digital identity frameworks and standards that can both ensure privacy and security while allowing unique identification of individuals within a society.

Blockchain is aptly able to solve this problem by allowing the creation of a public and private ID whereby the individual would be able to authenticate themselves at any point while allowing the sharing of public information to be anonymous. Furthermore, the immutability and decentralization aspects of its management ensure that the information shared with the appropriate authorities is accurate and authentic.

Chapter 2 – Challenges of modern *Supply Chain Management*

Before to illustrate in detail what a Supply Chain is, for the purposes of the discussion it was decided to define in general terms what is meant by logistics and what its role is within organizations. Over the years, with the changing of the competitive environment, the concept of logistics has undergone important changes and has taken on a central connotation within the corporate landscape, until today it has become one of the key activities for the satisfaction of the final consumer.

The chapter continues with a detailed analysis of the challenges and critical issues that characterize the current supply chains and in broader terms the Supply Chain Management. In these terms, technological innovation aim to solve, at least in part, many of the problems that currently characterize the supply networks. The key element that unites these new tools lies in their ability to provide solutions that encourage companies to re-engineer their processes to better meet the demands of the final consumer. Technology in these terms obliges companies to reformulate and rethink their supply chains to make them more flexible and able to adapt to the new challenges imposed by the market and competition. Finally, based on these considerations, the transition from Supply Chain to Digital Supply Chain will be described and analysed in the final part of the chapter thanks to the support offered by digital technologies.

2.1 *Supply chain* definition

Since Blockchains significantly impact Supply Chains, a wider explanation of what are the concepts and why is so important in business today is needed.

The concept of Supply Chain Management (SCM) is relatively new. Essentially, it was first articulated in a white paper in a white paper produced by Keith Oliver and Michael Weber in 1982.

Basically, SCM builds upon a network that is constituted by the actors involved in a business. It seeks to achieve a linkage and co-ordination between processes and other entities along the pipeline such as: suppliers, customers and organization itself.

In this direction, (Christopher, 2016) defines SCM as: ‘‘A network of connected and interdependent organizations mutually and co-operatively working together to control, manage and improve the flow of materials and information from suppliers to end users’’.

From this definition it emerges that business environment is characterized by a complex network of actors and elements that go beyond internal processes of a company. Furthermore, it can be argued

that companies during years had to switch focus from internal to external dimension that embed organization involved within the network.

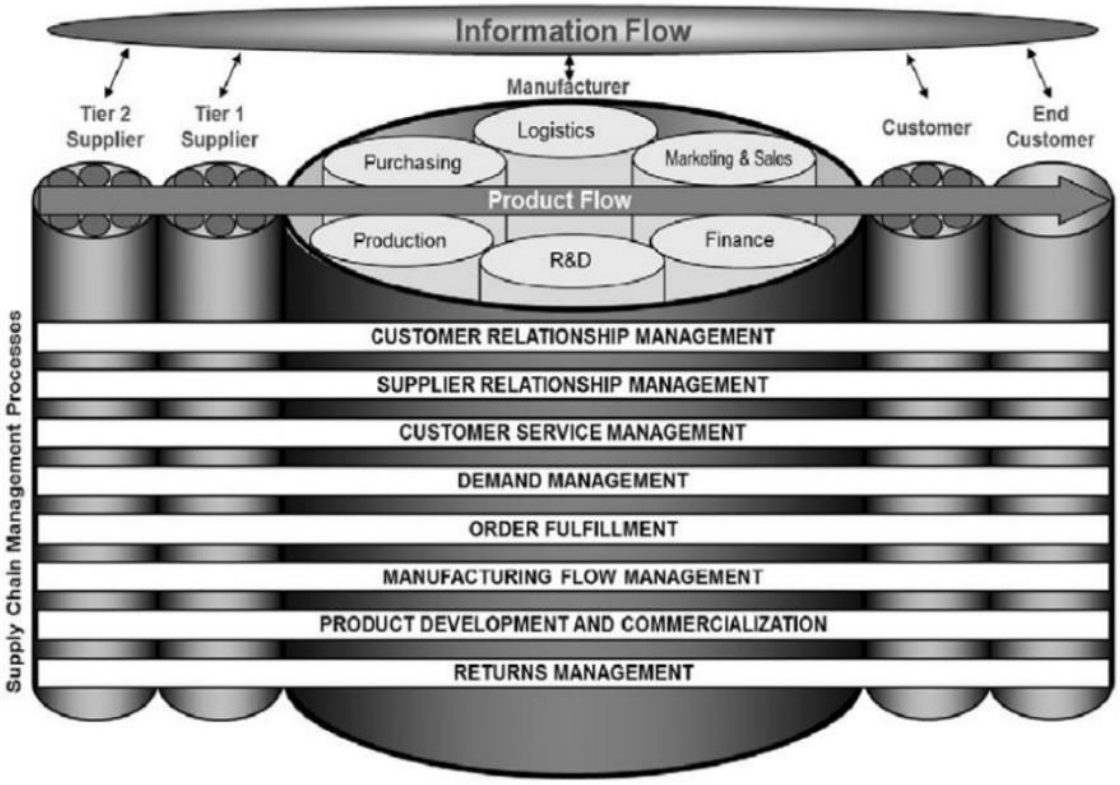
In this terms, behind the supply chain concept is that co-operation and co-ordination between materials and entities as an integrated system rather than a series of independent activities, significantly enhance efficiency and profitability.

Therefore, the company no longer has to manage only internal exchanges, but also those of the entire ecosystem in which it operates, concentrating its attention on the final customer who becomes the goal of the whole activities carried out by the entire network. (Tunisini A., 2003).

For these reasons, and in the light of the greater complexities that have characterized the competitive landscape, in recent years there has been an increase in the interest of companies and institutions in relation to the strategic management of supply chains.

In other words, a position of enduring superiority over competitors in terms of customer preference may be achieved through a better management of the supply chain. The process of SCM can be divided into the eight categories of customer relationship management, supplier relationship management, customer service management, demand management, order fulfilment, manufacturing flow management, product development and commercialization, and return management, as shown in **Figure 10**.

Figure 10. The supply chain Management Framework



Source: Herman, 2016

In this direction, it can be argued that we are now entering the era of ‘’supply chain competition’’. More in general, the difference from previous model of competition is that an organization can no longer act as an isolated and independent entity in competition with other similar stand-alone organization. On the contrary, the need to create value delivery system that are more responsive to fast-chancing markets and the ability to innovate by leading the success over the competition. (Christopher, 2016).

2.1.1 The concept of integrated and *smart supply chain*

In order to be successful within the digital economy, organizations have found themselves having to manage the integration of technologies, people and processes not only within their own company but, even outside of company boundaries. The SCM systems have facilitated cooperation and collaboration between companies both with suppliers and customers and business partners.

The technological solutions supporting Supply Chain Management, such as ERP or CRM systems, have been able to offer important benefits. Despite this, their management and implementation has raised several challenges and issues that organizations have been constantly facing.

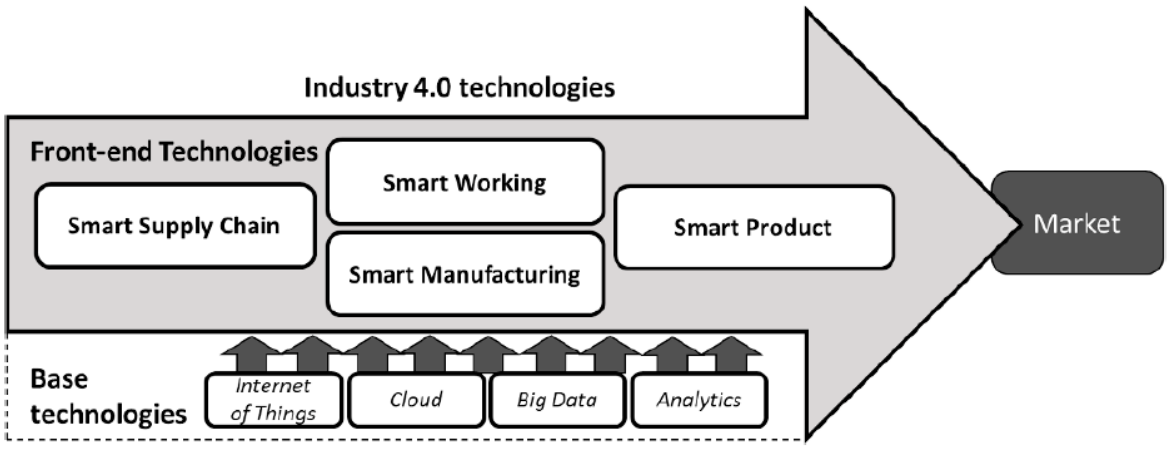
In these terms, system integration and process re-engineering have proven to be key strategies that enable companies to maintain their market position and pursue a competitive advantage. The integration does not only involve the implementation of shared ERP systems, but also the integration of ERP and SCM systems with

CRM, PLM (Product Lifecycle Management) and e-procurement systems, so that they are all connected to each other in order to foster cooperation and collaboration along the entire value chain.

In today's highly dynamic business environments, many companies are expanding, contracting or redesigning their supply chains. Due to rapid technological growth, classic supply chain models have rapidly evolved, leaving space for what we know today as a *supply chain network*. The Supply Chain Network is an organic and dynamic system in which all the companies are integrated with the aim of improving the overall value of the entire chain. Integration is the process of redefining and connecting the parts of a whole eco-system in which every single entity operates. In the twenty-first century we have witnessed some global changes that have contributed to the birth and development of supply chain networks. First of all, as a result of globalization, the proliferation of multinational companies, joint ventures, strategic alliances and business partnerships have proven to be critical success factors. Other practices at production level have been adopted in order to make companies more flexible and able to react quickly to continuous market changes. These include the Just in Time, Lean Management and Agile Manufacturing practices. Secondly, technological changes and in particular the dramatic fall in the cost of communication technologies have made it possible to radically change the coordination between the various members of the supply chain network (Christopher, 2016).

The use of IT to share data between entities involved along pipeline is, in effect, creating a *virtual/ smart supply chain* by operation in a *smart work environment* **Figure 11.**

Figure 11: Theoretical framework of Industry 4.0 technologies



Source: International Journal of Production Economics, 2019

A virtual supply chain can be distinguished from a traditional supply chain because of its flexibility to quickly adopt and adapt to changes in the business environment (Chandrashekar et. al, 1999). Essentially, they are information based rather than inventory based In this context, Internet and development of applications upon it, have enabled partners in the supply chain to act upon the same data.

Outside the factory, Smart Supply Chain includes technologies to support the horizontal integration of the factory with external suppliers to improve the raw material and final product delivery in the supply chain, which impact on operational costs and delivery time (Thobe et. al, 2017). On the other hand, inside the factory, Smart Working considers technologies to support workers tasks, enabling them to be more productive and flexible to attend the manufacturing system requirements (Marodin et. al, 2017).

First, the horizontal integration, supported by the Smart Supply Chain technologies, involves exchanging real-time information about production orders with suppliers and distribution centers. While Smart Manufacturing includes intra-logistics

processes with technologies for internal traceability of materials and autonomous guided vehicles, other technologies are needed to connect factories to external processes. Digital platforms meet this requirement, as they provide easy on-demand access to information displayed in a cloud, integrating suppliers and manufacturers. The tracking of goods can be remotely monitored, maintaining warehousing at optimized levels due to real-time communication with suppliers. In addition, digital platforms can also reach customers by tracking product delivery and attending specific customer demands (Stock et. al, 2018). Digital platforms can also integrate different factories of the company by sharing real-time information of the operations activities among them. On the other hand, Smart Working technologies aim to provide better conditions to the workers in order to enhance their productivity. Thus, humans and machines are considered in the Industry 4.0 concept as an integrated socio-technical mechanism (Buterin, 2015). Industry 4.0 considers also remote control of the operations activities by means of mobile devices, which improves the decision-making processes and enhances the information visibility of the process, two aspects that contribute for the Smart Working as well.

2.2 Challenges in actual supply chain

The competition that distinguishes most industrial sectors today is represented by important and substantial innovations compared to the past. First of all, the client holds an increasingly central position by becoming an active actor, to which companies have to be able to satisfy their requirements. Furthermore, customer's choices are no longer based on price alone, but also on other factors, both material and immaterial, associated with the quality of the product or service provided. Recently, academics (Stephen Vargo and Robert Lusch, 2004)encapsulated this idea in a framework termed the ‘’service dominant logic’ (SDL). The SDL concept

implies that value is created through the interaction of the supplier and customers through a process known as a Co-creation. The idea behind Co-creation is that companies wishing to gain a competitive advantage should seek to embed themselves in the customers value chain. At this purpose, such idea implies a high level of customer engagement so that the supply chain and logistics implication of this transition from the traditional product dominant logic or service from logic are considerable. (Chirstopher, 2016). For instance, IBM originally was a computer system manufacturer but now is primarily a provider of services in IT and related fields.

These changes have led organizations to pay more attention to their offer, trying to personalize it to meet specific consumer needs. This picture is significantly complicated if other important factors are taken into consideration which have further aggravated the business activity such as: globalization, technological development, shortening of the life cycle of commodities, changing competitive conditions. Within this complex ecosystem, the rapid evolution of environmental variables, supply chains have experimented new configurations capable of guaranteeing flexibility and dynamism, indispensable for being able to compete in an environment characterized by high uncertainty (Global Supply Chain Survey, Pwc).

In this way, The focus has shifted from managing internal activities to seeking stronger integration with all external actors in order to better satisfy the end customer. The progressive increase in variety, variability and uncertainty has boosted companies to adopt models characterized by a growing increase in opening the boundaries by focusing on core competencies.

In an increasingly complex environment like the one just described, the Supply Chain Management activity has proved to be increasingly difficult and complex. Now let's see in detail what the challenges facing today's supply chains are.

1) COMPLEXITY

In the last decades, as already extensively described above, the global competitive landscape has undergone profound changes, especially in terms of: variety of goods available on the market and degree of product customization. Further to this, as previously suggested rather than supply chains we should talk instead about *networks.*

In this direction, as a result of outsourcing activities that previously were performed in-house, combined with the trend to offshore manufacturing, many companies have found that they added to **complexity** of their operation because the degree of *interdependency* across the network has increased. (Christopher,2016). **Figure 12** illustrate the framework of a complex supply chain.

In its strictest sense, (Christipher,2016) has argued that complexity does not mean complicated – although complex systems are often complicated – but rather it describes a condition of interconnectedness and interdependencies across network. To better understand, a good example of a complex system could be the weather. Many different influences combined to create a specific weather condition, each of those influences are themselves the result of an interaction and hence a small change in one element can fundamentally affect the final outcome.

Within this articulated ecosystem, in order to survive, individual companies have begun to use new models of strategic management of the activities thanks to the contribution offered by new technologies. What we called virtual companies fall within this context. The virtual company can

be defined as a set of autonomous and independent operating entities that act in an integrated manner and are configured each time better as a value chain to pursue the business opportunities offered by the market.
The supply chains have therefore begun to adopt systemic approaches to the management of physical and information flows. In order to adopt new technologies, companies have had to rethink their supply chains adapting them to the demands of greater flexibility and agility imposed by the market and by competition.

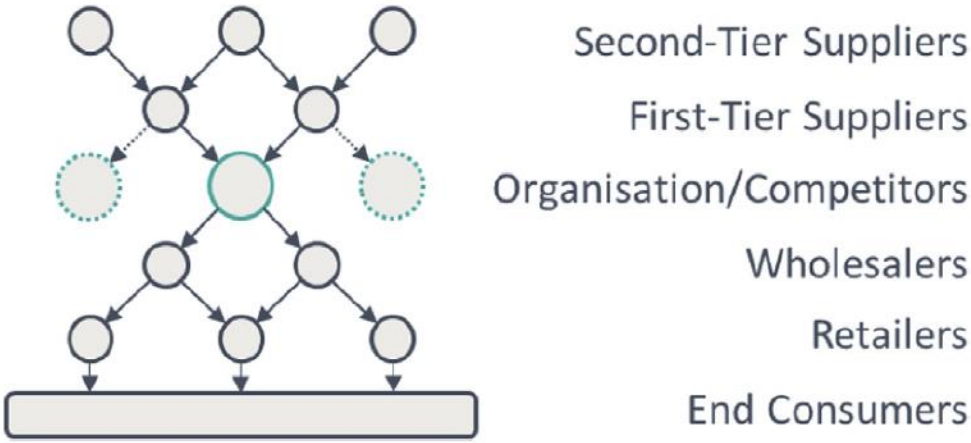
Summing up therefore, the increase in complexity within supply chains is mainly due to:

- Network complexity
- Process complexity
- Range complexity
- Product complexity
- Customer complexity
- Supplier complexity
- Organizational complexity
- Information complexity

In front of an increasing complexity of the whole eco-system in which companies are involved within the *value chain,* they had to find solutions in order to improve: *Efficiency, Responsiveness and Flexibility.*
These are therefore the challenges that characterize today's supply chains and to which companies constantly need t address: greater efficiency to better compete within an increasingly globalized market; greater flexibility or the ability to adapt to the changes imposed by the market through the improvement of its corporate

organization and its technological resources; greater *responsiveness* or better ability to adapt to changes in final demand to better serve its customers.

Figure 12: A complex supply chain with many stakeholders



Source: Análisis et. al, 2018

2) SUSTAINABILITY

Sustainability is one of the key themes of this new millennium and is one of the great challenges of the current supply chains. Within this context, the companies that are part of the supply network, as the main players in the world ecosystem in which we live, have found themselves having to face the great issue of corporate sustainability.

The definition of sustainability that is most widely used originates from United Nations Brundtland Commission which reported in 1987: *meeting the needs of the present without compromising the ability of the future generations to met their own needs.*

Basically, CRISTOPHER, 2016 emphasized the importance of examining the impact of business decisions on three key arenas:

- Environment
- Economy
- Society

In this context of supply chains we can build on the triple bottom line philosophy to encompass the wider idea that sustainability is concerned with ensuring the long term continuity of business as well as contributing to the future well-being of society. For example, one element in a 'green' supply chain might involve utilising transport capacity more efficiently through better routing and scheduling. In doing so, not only the environmental impact of transport reduced, but also the cost to the company.

To better understand the impact of business activities on sustainability, the example of the laptop used by Thomas Friedman (Friedman et. al, 2005), the author of the World is Flat, is a case point. He estimated that the Approximately 400 different components in his Dell computer had travelled hundreds of thousand of miles from all their different sources and through the assembly and distribution process to reach him. As a consequence, the continued upward trend in global sourcing has inevitably led to products travelling greater distances. Inevitably, it can be argued that there is clearly a correlation between transport-intensity and a supply chain's carbon footprint. Not only there is an economic benefit to be gained by improving transport-intensity but also a potential positive environmental impact – this is the concept of *eco-efficiency* [2]which is rapidly becoming a major issue in global commerce.

[2] Holiday, V.O., Schimidheing, S. ans Watts, P., *Walking the talk: The business case of sustainable Development,* San Francisco, Bennet-Koehler Publishers., USA, 2000

What practical steps can organizations take to improve the transport-intensity of their supply chain?
(Christopher 2016) emphasized five critical steps in this direction:

- *Review product design and bill of materials*
- *Review sourcing strategy*
- *Review transport options*
- *Improve transport utilization*
- *Use postponement strategy*

In addition to the attention given by governments and institutions, the issue of sustainability has been the centre of numerous programs and projects at international level. In this regard, it is important to cite the work proposed by the World Economic Forum on Sustainable Development Goals (SDGs) here. The Swiss foundation has indeed developed seventeen goals for the 2016-2030 period, which must be achieved worldwide in order to make the planet in which we live a suitable place to continue to host the human species. The document is characterized with respect to the previous one of the Millennium Development Goals (MDGs), aimed at the period 2001-2015, for the universality of the defined objectives: these in fact apply to the whole world, not only for developing and non-developing countries. They not only engage governments, but all those who work in the 183 states that have signed them, in civil society, voluntary organizations and businesses.

Companies in taking the first steps towards achieving a sustainable business must first seek greater transparency in their business processes. Transparency and visibility are

in fact, as we will see in the next paragraph, two essential prerogatives and two important challenges of today's supply chains, which, by their nature, are linked to the theme of corporate sustainability. In fact, only through the understanding and control of products and business processes can organizations implement improvement and development policies aimed at a more "fair" use of resources. In these terms, the contribution offered by digital technologies allows companies to radically change their way of doing business by ensuring greater compliance with sustainability standards in environmental, economic and social terms.

3) TRASPARENCY IN SUPPLY CHAIN

Globalization has dramatically increased the trans-national commodity movement, complicating supply chain management globally. Nowadays, it is very difficult for companies to trace the information related to each single step that takes place of a single product from the producer to the final consumer or in the opposite direction from the customer going up the entire production chain. Moreover, the presence of multiple actors, each of which contributes to production even beyond national borders, makes the traceability of the current supply chains a truly very complex activity. The direct consequence of companies' inability to track information is the lack of transparency in supply chains. Consumers, governments, and companies are demanding details about the systems and sources that deliver the goods. They worry about quality, safety, ethics, and environmental impact. Farsighted organizations are directly addressing new threats and opportunities presented by the question, “Where does this stuff come from?”. An article from HBR argued that supply chain transparency requires companies to know what is happening upstream in the supply chain and to communicate this knowledge both internally and externally. One reason the process has become increasingly

important is that more consumers are demanding it. For instance, researchers at the MIT Sloan School of Management found that consumers may be willing to pay 2% to 10% more for products from companies that provide greater supply chain transparency. In this study, consumers valued information about the treatment of workers in a product supply chain and the seller's efforts to improve working conditions.

Further, the annual survey of *Global Manufacturing Outlook* KPMG argued that greater transparency of supply chain operations is becoming more important, as manufacturing are demanding a more agile response from their suppliers. Full supply chain visibility rose to become the third most important strategic priority in 2017, according to a global survey of supply chain professionals. However, only 6 percent of respondents believe they have achieved this aim.

Based on what has been illustrated so far, the lack of transparency does not exclusively concern individual companies, but the entire supply chains and the longer the chains are stretched or fragmented the more difficult it is to keep track of the products and information associated with them.

In fact, traceability within the extended supply chain requires the involvement and collaboration between all the actors involved and can only take place if there is interoperability between the information systems.

The lack of coordination between the different links in the chain means that the information is recorded separately within the different software systems. This phenomenon also occurs within the same companies and is due to the lack of shared tools that put different business functions in communication with each other. As a result, in addition to not having access to data, companies do not have visibility on what happens within the organization or in broader terms of the supply chain. Partial forecasts generate distorted visions of reality that therefore cannot, by their nature, be used to support the decision-making process.

For many products, origin is an essential feature of what the customer buys, even if it is an intangible or a difficult-to-verify quality. Broadly, halal, kosher, and organic foods are indistinguishable from the alternatives—the distinctions are important to certain consumers, but in a blind test most would have no way of identifying them. Few people could actually tell the difference between an authentic and a top-end fake Rolex watch or Louis Vuitton bag. Counterfeiting is such a huge problem because, after all, an ethically made shirt looks and feels identical to the sweatshop alternative. The fact that consumers nevertheless care about ethics and authenticity is indisputable: Provenance is already a big deal—and getting bigger.

Now let's see in detail which are the main problems related to traceability in the current supply networks and how these can be solved:

A. REGULATORY POLICIES

One of the dimensions that make the tracking of information within supply chains complicated lies in the difficulty of companies in facing a wide variety of different regulatory systems that are constantly evolving. There are still requests that overlap or conflict even within individual national systems. For example, in relation to the food sector, different laws exist in different jurisdictions and are in contrast with one another in relation to: allergens, the tracing of ingredients, the declaration of nutritional values, the use of pesticides and much more (Sachs et. al, 2017). This, as can be well imagined, generates problems that are not insignificant to companies: these in fact struggle to define at the technological level or internal policies standards that can be used at a wide range in business. Since the regulations are different for each country or region, each individual company is faced with a

multitude of traceability requirements, either internal or external required by the countries in which it exports.

B. LACK OF DIGITALIZATION

Global supply chains need to be digitized in order to be able to support a complete traceability of products and related information. Today the lack of adequate technical solutions aggravates the speed of response by generating an inefficient flow of data. A further problem concerns the lack of interoperability between the different information systems which often means that the control and auditing activities must be performed manually. Fortunately, technological progress and the advent of digital technology have allowed the development of new solutions such as the blockchain that allow to overcome and resolve these critical issues.

Here a quick review of the systems currently used to guarantee traceability and transparency in the supply chains is proposed. The objective of the analysis is to describe its characteristics and the limits of these solutions in order to understand the potential impact of new technologies.

According to GS1, a data traceability system should include a series of basic components that allow to manage:

- identification of objects, parts and places;
- the automatic capture (by reading or scanning) of the movements or events that involve a specific object;
- the recording and sharing of data tracked both internally and with other actors in the supply chain in order to allow visibility and ensure that what happens is actually achieved.

In any case, due to the obstacles described above, in a complex and extensive supply chain, characterized by numerous intermediaries and the lack of visibility on the

processes, many of the challenges regarding the traceability and transparency of the supply chain are not resolved thanks to the use of these systems. Furthermore, the tools for automatic data capture are very expensive, complex to implement and difficult to apply both for large volumes and for bulk goods. In many cases, therefore, the traceability challenges materialize in the lack of product registrations with consequent enormous damage for the entire supply chain (Sachs et. al, 2005). To avoid these problems, companies can now obtain technological solutions aimed at guaranteeing the traceability of information at every level of the supply chain and above all the immutability and transparency of the saved data. In these terms an important contribution can be offered by the blockchain technology as will be described in detail in the next chapter.

2.3 How blockchain impacts manufacturing supply chains

One of the most interesting aspects of blockchain technology is that it enables safer and more transparent control of operations. Supply chains are basically a series of transactional nodes that allow products to be transferred and moved from the factory to the point of sale. Thanks to this technology, in fact the transactions between the various operators of a supply chain (from production to sale) can be documented in a decentralized register, thus reducing transcription costs, delays and possible human errors.

The Blockchain technologies are in fact able to follow the four phases of the supply chain (product identification, delivery, customer registration and after sales) and support numerous applications ranging from anti-counterfeiting activities to the

management of changes of ownership up to that of the programs of warranty repair or maintenance.

In this context, blockchains are, potentially, a disruptive technology for the design, organisation, operations, and general management of supply chains. Its ability to guarantee the reliability, traceability, and authenticity of information, along with smart contractual relationships for a trustless environment all portend a major rethinking of supply chains and supply chain management (Gupta et. al, 2018).

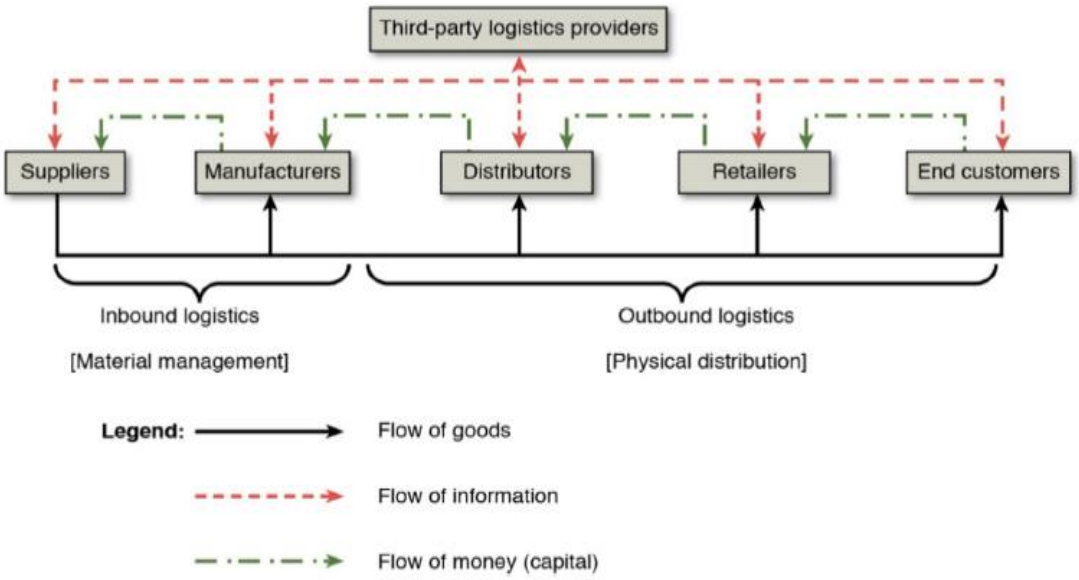
Especially, along manufacturing chains much of the information are currently kept within silos, fragmented and disconnected across what are often multi-actor, multi-sited systems. This often come as a result of a lack of authentication and verification of information shared between different stakeholders, all managing their own information silos throughout the manufacturing process. In this context, disparate systems that are used by multiple entities across a supply chain can block visibility across the ecosystem, creating an atmosphere of distrust and leaving all parties at risk (Blockchain for business, 2019).

At this purpose, in this section it will be illustrated how Blockchain and smart contract impact the Supply Chain Management and business community. On one hand, The unique characteristics of smart contracts, along with the characteristics of blockchains, improve the potential for the synchronization and automation of business operations and processes (Chang, 2019). On the other hand, Blockchains also provide better transparency in tracking the status of property during processes along the pipeline an better flexibility for capital exploitation to obtain business value (Swan,2015).

In this direction, it can be argued that we are in front of a technology that are re-shaping the logic of doing business by providing new value added solution and

business models in manufacturing industry. Before to dive deeply upon implications of blockchain technology, (Gupta et. al, 2018) have proposed a general graphic of one traditional supply chain transformation towards a blockchain-based approach shows in **Figure 13.**

Figure 13: Illustration of typical supply process



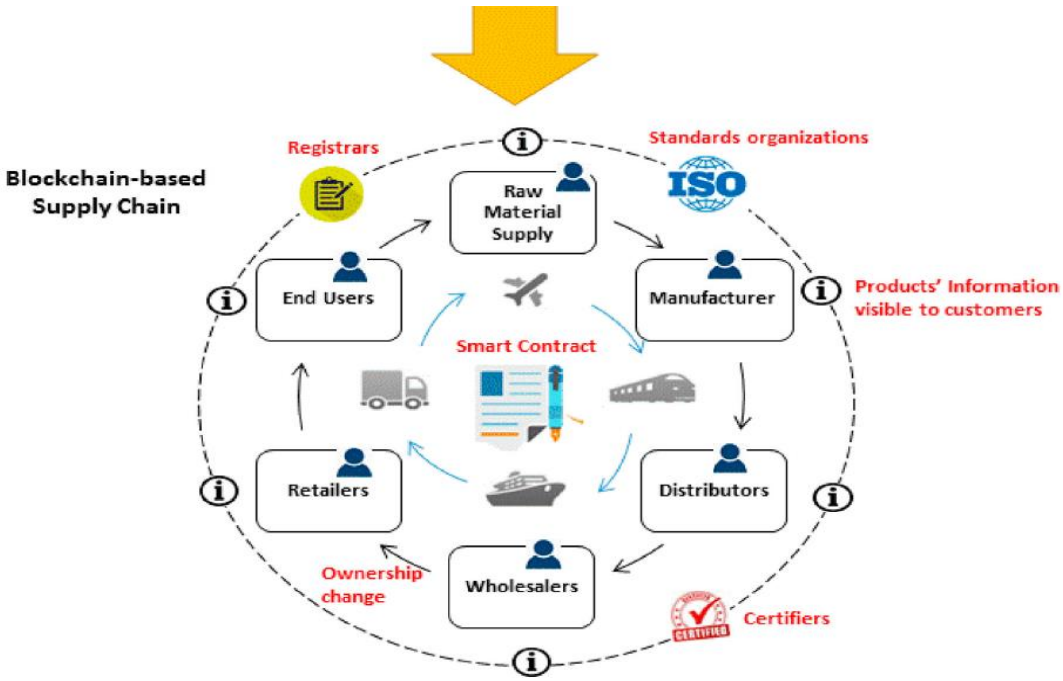
Source: Min and Zhou, 2002

On one hand, traditional supply chains are characterized by a significant fragmentation of information among actors. In this context, traditional tracking utilizes tremendous labour resources for the confirmation and coordination of updated information regarding process status. Typical methods used for tracking range from phone calls, e-mail correspondence and web based services such as EDI, VAN or ERP. As a matter of fact, this method reduces transparency among supply chain participants.

On the other hand, **Figure 14** propose a blockchain framework where, four major entities play roles in blockchain-based supply chains; some not seen in traditional

supply chains. *Registrars*, who provide unique identities to actors in the network. *Standards organisations*, who define standards schemes, such as Fairtrade for sustainable supply chains or blockchain policies and technological requirements. *Certifiers*, who provide certifications to actors for supply chain network participation. *Actors*, including manufacturers, retailers, and customers, that must be certified by a registered auditor or certifier to maintain the system trust (Baker et. al, 2015). By incentivising this circular economy, Blockchain platforms together with smart contract and digital solution have the potential to improve connectivity among trading partners through the integration of digital and physical world, which includes a shared visibility of transactions and information flows across the supply chain. Further to this, reduction of the verification costs and networking costs can be achieved without intermediation. (Tian, 2016)

Figure 14: Supply chain transformation



Source: Chang & Chen, 2019

To mitigate those frictions, Blockchain reliability and transparency are meant to more effectively facilitate material and information flow through the supply chain; with automated governance requirements. This transformation may result in a broader shift from an industrial durable, commodity, products economy to an information, customisation economy. (Gupta et. al, 2018). In this context, the (Global Blockchain Survey, 2019, p.24) clearly shows that Blockchain can impact four different applications within supply chains. Those are:

- Product tracking
- Product tracing
- Automated payment
- Document identity management

2.3.1 Product *tracking*

Tracking refers to the ability of a company or supply chain to track products across the entire supply chain. The *tracking process* should not be confused with the *tracing process* which will be discussed later. The latter in fact consists in the activity of collecting and analysing the information acquired through tracking.

But what are the current problems related to product tracking and how does the blockchain solve them?

Nowadays , most of the companies at a global level use ERP systems and devices connected to the production system (such as smart tags or intelligent sensors) to track products from when they enter the warehouse to delivery to the end customer. Despite the large investments in digital infrastructure, many companies still have limited visibility on where their products are at a given time. This is because, even if the production process of a product can be recorded digitally within the management systems, when it is shipped, the information can no longer be traced by the system.

In this scenario, the blockchain, thanks to its distributed nature that enables information sharing, presents itself as a potential solution to problems related to product traceability. In fact, within a *blockchain-based system*, each product is characterized by a **unique digital profile** that contains all the information entered by the different actors along the supply chain. In addition, a tag such as a barcode, an RFID tag or a QR code is connected to each product. The *tag* represents the unique cryptographic identifier of the product itself connected to its digital identity. In this way, using the digital identities of the product and the actor, it is possible to create a smart contract for each product-actor couple in such a way that only the parties with the correct digital key can have access and / or are authorized by contract, to enter information on a specific item. Furthermore, the same mechanism can be used to manage the tracking of products during transport between two different nodes of the chain or to the final consumer. In these cases, in fact, the containers of transport can be equipped with GPS systems or IoT sensors connected in the blockchain related network.

Therefore, it seems clear that tracking products through blockchain enhance transparency, reduce counterfeits and costs related to the entire supply chain management, and improve the interactions between the different chain partners.

For example Vechain is a permissioned blockchain platform based on Ethereum blockchain, it was developed by the Chinese BaaS company BitSe, based in Shanghai and founded by ex-managers of IBM, Louis Vitton and Alibaba. Developers of Vechain aim at completely eliminating the threat of the market of counterfeit goods, using the potentialities of smart contracts and blockchain technology. The US Chamber of Commerce estimated that the counterfeit goods' market reached about 450 billion $ in 2016, equal to the 2.5 % of the world's whole trade volume, and, the 86% of these products came from China and Hong Kong. Furthermore, the report of Chamber of Commerce showed that the most afflicted sector by the counterfeit market is the fashion industry, and exactly in this way, Vechain has moved. Indeed, at the beginning of 2017, the company started a pilot project in collaboration with a Chinese fashion company, named Babyghost, to protect original products by counterfeit market. Although it is based in New York, Babyghost is a Chinese fashion company which target young girls, and in latest years, it is one of the most growing fashion companies in China. Original garments of the brand were recorded on the Vechain blockchain, in the meanwhile, the articles were identified by a chip developed by Vechain and a QR code. The Vechain chip is similar to a NFC tag, but, it is linked directly to the blockchain, so, it uploads autonomously information on the ledger. The chip is encrypted by the system of the two ID keys, one public and the other private: the public key is stored in the blockchain and it can be verified by the VeChain app.

2.3.2 Product *tracing:* certify quality, provenance and standard

The *traceability* of products is the process parallel to tracking and refers to the ability of a company to analyse, process and manage the information acquired throughout the supply chain.

Tracing, therefore, refers to compliance with the standards and regulations of the law in relation to the quality and origin of the products. This involves the entire certification process whether it concerns compliance with regulations, belonging to a particular geographical location or a trade association.

Verifying the integrity of the declarations resulting from the certifications is an expensive process that requires a long and exhausting control process. Furthermore, the extension of certifications to regions with high levels of corruption has further complicated the viability of these tools.

The traceability of products, through blockchain, can be ensured thanks to the joint use of smart contracts and IoT devices. The latter in particular, allow to obtain a continuous flow of information relating to:

- Provenance of products;
- Conditions of products;
- Standard regulations;
- approvals obtained from internal and external control systems for companies.

This information is transferred within the blocks and once stored it is immutable. So they are shared in the distributed system and are accessible in real time from every node of the blockchain. The substantial technological difference between

tracking and tracing lies in the fact that in the latter case, blockchain is not used to keep track of the products but, to verify, through checks performed by software programs or by external entities (intelligent sensors or regulatory authorities external), that the standards are respected. In the same way, smart contracts can carry out checks on the data entered to verify that individual participants are behaving correctly.

In this regard, if we imagine a small oil producer who claims to use only olives grown in Italy without the use of chemical agents. In this particular case, thanks to the possibility of cross-checking the data entered by the farmer, the system could calculate the maximum number of bottles that can be produced in a given year. For example, the calculation could be based on the conversion factor between the quantities of the harvest and the bottles produced.

In this way, the verification of the quality of the products can also take place thanks to the direct inclusion within the blockchain of *Certifiers and Standard Organizations* as we have seen in Figure 14. So, the tracing of the products shows how the blockchain can be used for solve auditing and compliance problems, at the same time retain customers and achieve greater transparency.

For example, The American multi-national *Walmart*, which is the largest retailer in the world with 11 695 stores in 28 countries, is exploring, through different pilot projects, the possibilities offered by the blockchain in tracking fresh products from the producers to the shelves of the stores, along the supply chain. The last project, it is going to undertake, will be placed in China, in collaboration with IBM and the Laboratory for E-Commerce Technologies by Tsinghua University National Engineering; the project will be pursued also in collaboration with the Chinese online retailer "JD.com". IBM will provide its blockchain permissioned platform, while Tsinghua University will act as a technical advisor sharing its expertise in the

key technologies and in the China food ecosystem. Blockchain adoption in tracking food products represents an opportunity to monitor closer and in real time the processes, that items passed through along the supply chain, and to assure the safety of products and the validity of certifications. The final goal of this project was declared to be the creation of a "standards-based-method" to collect data about the origin, safety and authenticity of food, assuring real-time traceability throughout the supply chain, thanks to the adoption of the blockchain technology.

2.3.3 Automated *payment*

(Omran Y. et al., 2017) defines the Supply Chain Finance as an integrated approach between two or more organizations within a supply chain, aimed at the joint creation of value through the planning and control of financial resources at an inter-organizational level.

Especially, automatic payment management supports the financing of supply chains. In fact, the distributed ledger allows to reduce delays on payments by avoiding the occurrence, especially at the level of small and medium-sized enterprises, of financial crises which, in some situations, can also lead to the collapse of the company. The (partial) digitization of supply contracts and the consequent automatic management of payments takes place thanks to the use of smart contracts (Omran Y. et al., 2017). As previously mentioned, this allows the company to cancel or in any case reduce the time and delays associated with the payment of supplies. The digitization of contracts also makes it possible to verify that the conditions expressed by the parties are respected. In this way, before making the payment, the software automatically verifies that all the clauses included in the digital contract are respected.

In these terms, the blockchain could solve this complex and expensive mechanism by integrating smart contracts with the delivery of the product, which establish that the payment must take place upon receipt of the goods. In this direction, by exploiting the information that is shared on it, simplifies the process of verifying the financial soundness of buyers and / or suppliers. This is of paramount importance and is required whenever a lender is involved as an intermediary in a payment. At the same time, the distributed ledger increases transparency on transactions, making it possible to resolve problems related to the resolution of any disputes on non-payments.

So, benefits introduced by smart contracts in the automation of payments are:

• reduction of administrative and personnel costs;

• reduction of payment times for supplies;

• delimitation of responsibilities between the parties making it easier to resolve lawsuits

• reduction of negotiation costs;

• improvement of the corporate image and the relationship between buyers and suppliers.

Furthermore, the use of the blockchain allows to increase transparency and consequently to improve trust and the relationship between the parties involved.

2.3.4 Document identity management

Blockchain is a distributed database among all the nodes of the network. In other words, all participants interact with the same updated copy of the database when they interface with the system. Thanks to an algorithm and / or to the governance rules written within the blockchain, it is also possible to check the veracity of the data entered and adjust the authorizations for sharing information (Swan, 2015).

Each *item* exchanged between the network nodes is identified within the system by means of a unique digital profile. This means that every single object when shared within the system has a unique and immutable identity. Uniqueness is a fundamental element as it allows us to clearly and indisputably identify each individual transaction regardless of its nature.

In fact, thanks to the unique digital identity, each individual user can interface directly with the single and unique shared copy of the item. Furthermore, the blockchain allows the connection between the different ERP systems allowing: on the one hand to share information and in this particular case the supply documents; on the other hand to synchronize the different management systems with each other.

This is because within each company, ERP systems could manage document flows through customized codings which are therefore different for each organization (Banerjee A., 2018). Through the blockchain it would be possible to exploit the univocal identity of the documents to coordinate the management between them.

In this paragraph it has been chosen to focus attention on the digitization of the documents that characterize the exchange of products and / or services along supply chain. At this purpose, it was preferred to distinguish supply *documents* separately from *transport documents*.

The first one are related to the purchase order, order confirmation, shipment documents, billing etc. by involving just the supplier and the buyer. The second ones, as we will see later, concern all the carriers that take part in the transportation of the goods between a customer and the supplier. In international transport, in fact, the number of actors involved is very high and concerns customs authorities, government authorities, shippers, border authorities, banks, insurance companies, couriers, transhipment parties. Each of these plays a key role in the transport of goods from the supplier to the customer and continuously interacts with it.

We are here in the event that, following the technological criterion, the two applications cannot be considered distinct since the blockchain is used at the technical level in the same way. While, from a functional point of view, the distributed database allows you to manage document flows to organize and carry out processes that are structurally distinct from each other: the process of sending and receiving the order and the transport process. Consequently, the blockchain is developed to serve different functionalities.

Maersk case

The A.P. Moller-Maersk is the largest transportation company in the world, indeed, one of seven containers shipped globally is controlled by Maersk. Currently, the shipping industry is characterised by a lot of paperwork and bureaucracy that take a lot of time, increasing in this way the delivery time. Moreover, in June of the last year, a malware called NotPetya attacked the communication systems of more than 7 000 shipping companies, among which Maersk, and terminal operators, exploiting a weakness of the Microsoft Windows operating system. The hack attack caused congestion at 76 ports around the world, resulting then in delivery delays and in losses for shipping companies. In November, Maersk estimated around 300 million $ the losses caused by the cyber attack. To sum up, the shipping industry is a field

which is trying to innovate itself through the use of both IT systems to support operations, and OT devices to monitor the containers' journey, but, the actual system presents still some inefficiencies and points of weakness, as showed by the hack attack. Thus, Maersk decided to start the collaboration with IBM to constitute a joint venture with the objective to launch a permissioned blockchain platform to track the shipping of containers and to provide an international standard of communication, which could reduce cost and time caused by the bureaucracy. Indeed, Maersk estimated that bureaucratic activities like the writing of contracts and documents stand for a fifth of the total shipping cost of a container. The Maersk project could start in the March 2018, and the two companies want to market firstly, two types of solution:

• Shipping Information Pipeline: it will guarantee the visibility of freight all along the supply chain; • Paperless Trade: it will digitize and automate documents through the usage of smart contracts.

The blockchain platform is provided by IBM through the IBM Cloud and based on Hyperledger Fabric 1.0. Actually, the collaboration between the two companies was dated on 2016, when they started to drive some pilot projects to analyse possible benefits of blockchain in tracking containers during the water transportation; in these pilot projects the companies partnered with: Dupont, Dow Chemical, Tetra Pak, Port Houston, Rotterdam Port Community System Portbase, the Customs Administration of Netherlands and US Customs and Border Protection. In addition, it was pursued a similar solution by an important port operator of Singapore, in collaboration with IBM, and Maersk itself already tried the solution for a trans-Atlantic shipment of goods from Schneider Electric, a French energy management and automation company. In this pilot project, only Maersk and IBM managed the nodes, while the other parties of the chain could only access to the platform to see data; instead, in the new application, each company will manage its node.

Moreover, in the new blockchain based service, IBM and Maersk deploy also other cloud-based open source technologies such as artificial intelligence, IoT and analytics: manufacturers, shipping lines, freight carriers, port and terminal operators, shippers and customs authorities will be able to access to the platform's virtual dashboard, using their credentials.

2.5.3 The case of IBM food trust

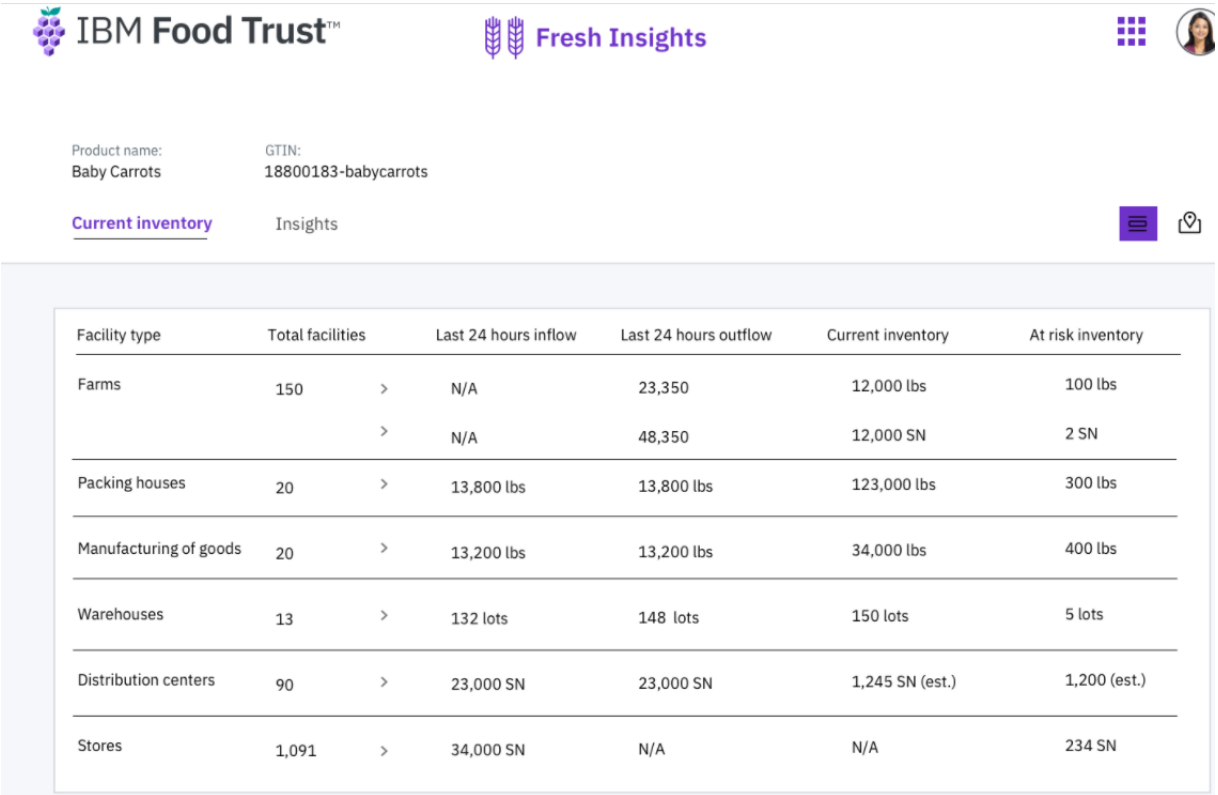
One of the most popular platform that enable transparency in supply chains through the application of Blockchain technology is represented by IBM Food Trust (IBM,2019). Today's consumers demand transparency on where and how products are made. Regulators around the world also require information about supply chains — with penalties for noncompliance. Beyond the need for information, complex supply chains depend on trust to function properly. But distrust between organizations has historically discouraged them from sharing or relying on shared data.

The solution provides authorized users with immediate access to actionable food supply chain data - from farm to store and ultimately the consumer. The complete history and current location of any food item along with its accompanying information (i.e. certifications, test data, temperature data) can be readily available in seconds. In this direction, a permissioned blockchain is used to enable participants to enter and control access to their encrypted blockchain data. In doing so, IBM combines supply chain modules with blockchain core functions, delivering business value to the food ecosystem from the combination of governance, standards and interoperability, and technology.

At this purpose, I found relevant to illustrate how ‘’IBM Food Trust’’ blockchain platform is used in a business context through a module-base approach, by addressing various pain points and needs in the food industry:

- Fresh Insights **Figure 15:** Connect disparate product data to draw insights and gain visibility into inventory across the supply chain, compare metrics across location, view dwell time and time since production/to expiration, and calculate at-risk inventory. You can identify inefficiencies, improve freshness, and reduce product losses. Further, inventory can be seen at every point o the supply chain that help to identify current problem areas and any at-risk inventory.

Figure 15: Graphic representation blockchain interface

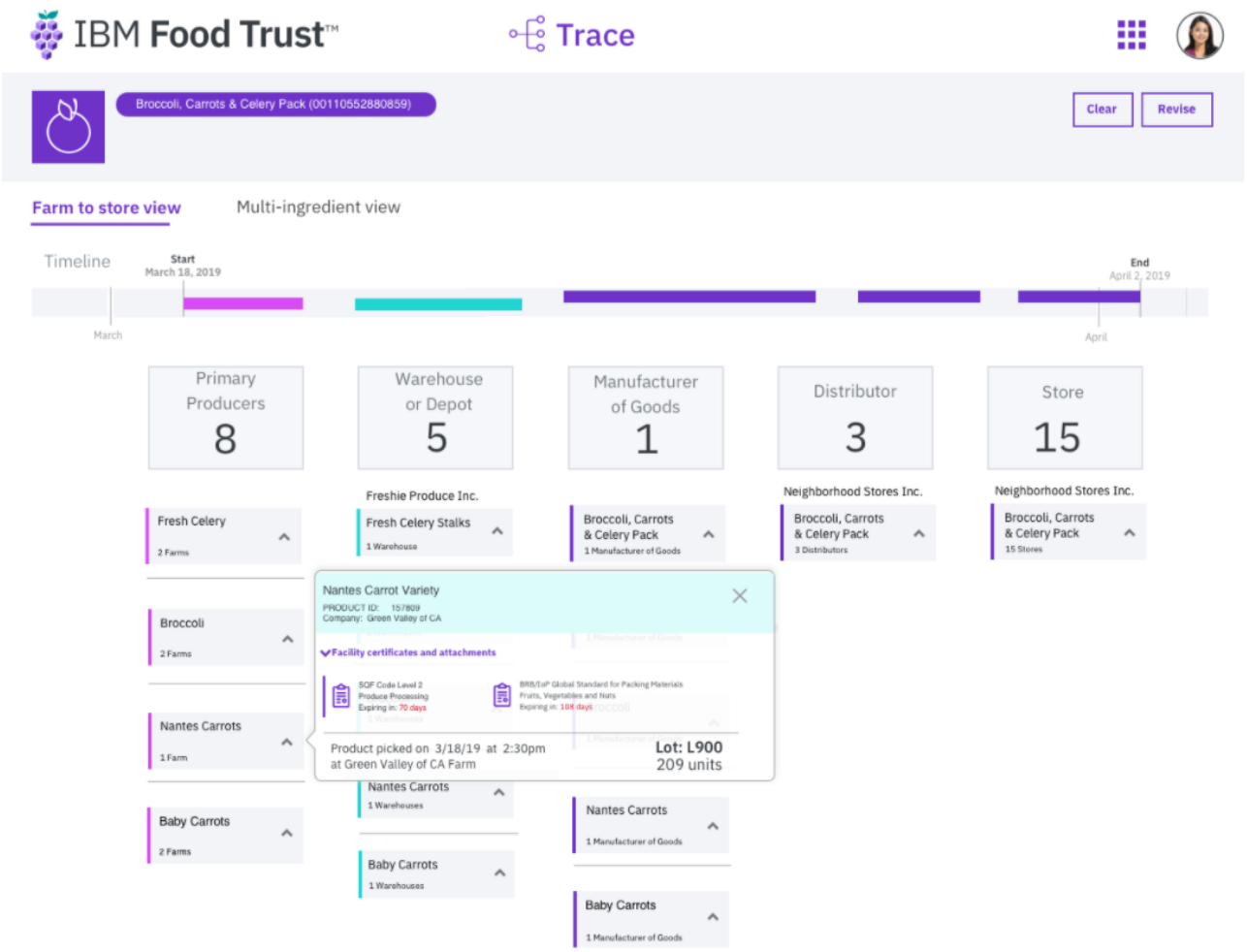


Facility type	Total facilities		Last 24 hours inflow	Last 24 hours outflow	Current inventory	At risk inventory
Farms	150	>	N/A	23,350	12,000 lbs	100 lbs
		>	N/A	48,350	12,000 SN	2 SN
Packing houses	20	>	13,800 lbs	13,800 lbs	123,000 lbs	300 lbs
Manufacturing of goods	20	>	13,200 lbs	13,200 lbs	34,000 lbs	400 lbs
Warehouses	13	>	132 lots	148 lots	150 lots	5 lots
Distribution centers	90	>	23,000 SN	23,000 SN	1,245 SN (est.)	1,200 (est.)
Stores	1,091	>	34,000 SN	N/A	N/A	234 SN

Source: IBM food trust, 2019

- Trace **Figure 16:** Provide the provenance of your product through immediate access to end-to-end data. Trace also shows real-time location and status, and allow expedited product recalls. This module enables participant organizations to quickly and accurately determine the path that a given shipment has taken.

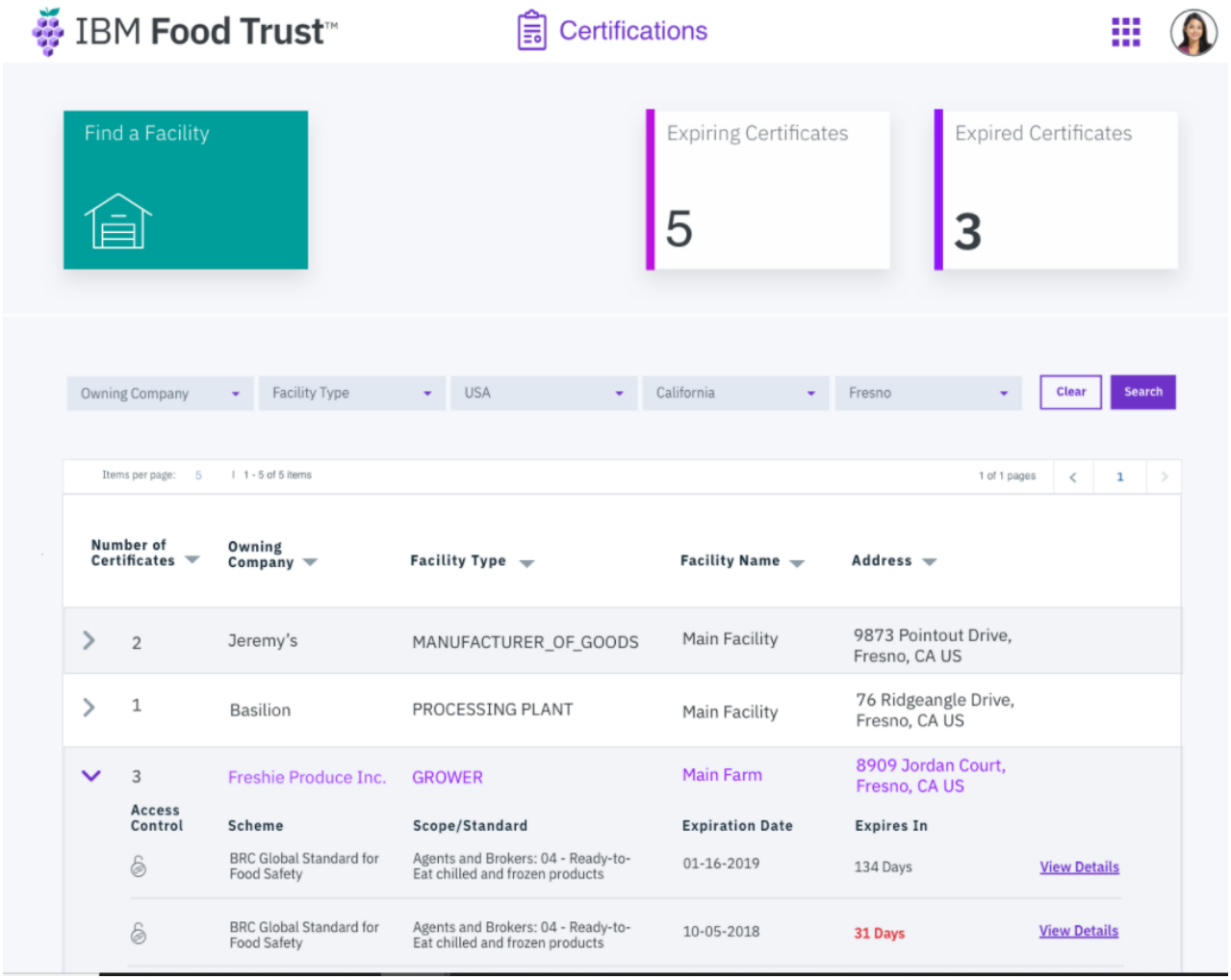
Figure 16: Graphic representation blockchain interface



Source: IBM food trust, 2019

Certifications **Figure 17**: Digitize business critical certificates and inspection documents to optimize efficiency for information management, certify provenance, and ensure authenticity. The user can see all certifications, when they expire, and additional details. With the Certifications module, documents can be checked regularly, or as they are needed in the event of a safety investigation.

Figure 17: Graphic representation blockchain interface



Source: IBM food trust, 2019

This model aim to illustrate how could improve transparency and visibility along the pipeline
where all participants can collaborate in a secure and purposeful way. At this purpose, data connector application programming interfaces (APIs) allow enterprise IT teams to efficiently upload supply chain data from existing data stores (such as SAP) to their IBM Food Trust network for seamless integration of data from enterprise systems to an IBM Food Trust solution network. Smaller organizations can onboard data through an easy-to-use web experience.

As a matter of fact, it is fundamental to underline that each member organization owns its data on the blockchain network and maintains full control over who can access different data elements. All data is made accessible only as data owners grant permission to share relevant records.

Chapter 3: Blockchain for fashion supply chain: The Halmanera case

3.1 Introduction

For fashion players 2019 will be a year of awakening. The ones who will succeed will have to come to terms with the fact that in the new paradigm that is taking shape around them, some of the old rules
simply don't work''. This is the alarm launched by the annual survey ''SoF[3] 2019 '' about the fashion industry. It is a clear warning for players that now need to be nimble, think digital-first and achieve ever-faster speed to market. They need to take an active stance on social issues, satisfy consumer demands for ultra-transparency and sustainability, and, most importantly, have the courage to "self-disrupt" their own identity and the sources of their old success in order to realise these changes and win new generations of customers. The implication is that change has become a key priority among industry leaders, with a particular focus on digital and speed-to-market.

Footwear companies have exceptionally competitive capabilities to design, develop and deliver products to retailers in lead times that can be measured in days. Despite these efficiencies, footwear manufacturing processes pose significant

[3] SoF: The State of Fashion 2019

environmental and reputational risks, which can potentially impact a retailer's profitability, brand equity and operational capabilities.

However, the complex nature of apparel and footwear product manufacturing processes could be found in a lack of trust along the supply chain. The journey of these products, from raw material to finished goods, often spans multiple geographies, manufacturing sites and agents, and very often courses through opaque and distrustful networks. A report issued by ''Cognizant in 2017[4]'' laid the foundation of three key characteristics of footwear industry; underlying a situation where current operational activities are no longer able to ensure transparency and efficiency within footwear sector:

- Very short product lifecycles and small manufacturing batches
- Highly fragmented processes accomplished in complex global supply networks
- Transformation of plant and animal-based raw materials that extinguishes the original biological structure

Although databases do exist, they are often fragmented and do not provide a single view of product provenance. For these reasons, traditional centralized approaches, solutions and technologies are incapable of keeping pace with this increasingly fragile ecosystem. On the contrary, distributed ledger technologies such as Blockchain could provide a feasible solution. This aspect will be illustrated in the next paragraphs.

In this regard, it is also predicted that 2019 will be a year shaped by consumer shifts linked to technology, social causes and trust issues. Only those brands that

[4] Cognizant report 2017: a blockchain-based framework for appareal and footwear supply chan traceability

accurately have the courage to "self-disrupt" will emerge as winners. Consumer shifts enabled by technology were particularly salient, with "mobile obsessed" cited as the most important of the trends.

An increasingly important priority **is sustainability and transparency**, reflecting rising concerns on the part of consumers and companies about how to alleviate their impact on the environment and social issues. From an **operational perspective**, another persistent trend has been the desire to address cost structures at an organisational level, including efforts to improve productivity.

Priority investments in sales growth named for this year were **omnichannel** and e-commerce, developing CRM capabilities. Fashion players should seek to couple productivity enhancements with necessary innovation efforts, such as automation and digitalization of production, analytics-driven decision making, review of omnichannel footprint and reorganisation for better agility. Those that are successful are most likely to reap rewards in terms of outsized performance by boosting productivity through greater efficiency and cutting costs.

Speed in production is critical to every fashion label and retailer. In the ''SoF'' survey, the 54 percent of USA and EU purchasing interviewed said that **proximity to customers** is becoming more important. Undoubtedly, **the consumer psyche is changing fast**. Consumers are global, demanding, always connected and informed. At this purpose, in fashion industry companies must be community-centric and audience-centric to survive.

In this regard, modern fashion consumers expect exceptional experiences whenever they interact with a brand and its products. In response, top marketers are expanding their mandate beyond traditional responsibilities like brand awareness and loyalty to take ownership of the entire customer journey. On one end of that journey, brand

awareness shares top billing with consumer engagement as a key objective for 83% of fashion marketers surveyed (Certilogo, 2019), on the other end, marketers ranked conversion and customer satisfaction as nearly equal in priority, with brand loyalty rounding out the top 5.

The sector is therefore facing complex phenomena within a constantly changing market environment. Specifically, the Italian footwear industry needs to understand and predict the challenges that must be addressed in order to survive to the international competition. In addition to this, it is also necessary to be able to reach important results in terms of operational efficiency to support the production process, thus reducing the crossing times of the various phases and accelerating the dynamics of innovation in materials, forms and distribution channels. All that with the purpose of a more responsive approach toward an increasing demand of expectations among all the actor involved within the supply chain.

Only through cultural and technological innovation, in fact, the footwear industry will be able to align demand and supply to reach more ambitious horizons: waste reduction, sales planning through sustainable production systems capable of increasing productivity by safeguarding the balance of the planet that we will return to our children. Without forgetting the material aspects linked to the market and the business, which will have to respond ever more smartly to requests for transparency from consumers who will no longer limit themselves to buying products, but more and more they will marry values and the narrative capital of a brand. At present, many companies do not have the tools to play this game and face ethical changes within global supply chains. For these reasons, without the knowledge of the products that are bought and sold, it is not even possible to structure a strategic plan. At this purpose, different realities (local and international) have decided to invest

in the issue of traceability, the only way that allows them to respect the new paradigms of the global market and enhance the product and brand, marking a clear difference with respect to competitors.

3.2 Globalization and production value

With the internet and the massification of communication, access to information and knowledge was also facilitated, as most global information flows through mass media, and nowadays, side by side with economic interdependence, cultural globalisation is gaining force. Cultural globalisation is a consequence of what The World Bank defines as globalisation, which means, the growing interdependence of countries resulting from the increasing integration of trade, finance, people and ideas in one global market place.

Over the last ten to fifteen years, the Footwear ecosystem and the European fashion industry have undergone a process of globalization, with the subsequent transformation of productive and commercial scenarios. The effects of globalization and the subsequent economic-financial crisis, have triggered an abrupt level of contraction in terms of impact on the production system: between 2000 and 2015 the number of employees in the sector registered a –32%, the number of footwear companies on the national territory has been reduced by 35% from about 7,500 units to less than 6,000 and production levels have more than halved (-51%) going from just under 390 million pairs in 2000 to 191.2 million in 2015. As anticipated, the strong changes that have taken place and the general disorientation generated by the entry of many new international competitors. As a matter of facts, a lot of companies and entire segments have been drawn out all over the world.

3.2.1 The evolution of consumers: the role of *sustainability*

Nowadays, relationships between companies and consumers have changed drastically. If we think of past business models, companies were able to design a strategy in which consumers were adapted. To date, market dynamics have forced actors to have a broader vision based on ‘’ focus on the user’’ strategies where customers are at the centre and strategies are designed based on their continuous needs. Basically, we have witnessed a real evolution and revolution of consumer needs due to phenomena that have led companies to think about how to create value. At this purpose, one of the most important challenges of fashion brands concerns the concept of **sustainability**.

In recent years, sustainability has become a buzzword and turned a few heads. Just as consumers today are taking a closer look at the food they consume and the chemicals they put into their bodies, they are also shifting their purchasing decisions to create a cleaner environment through the shoes they fit. Today, consumers are aware about their purchasing more than ever: by paying attention not only to the quality of products, but also to the entire supply chain, production processes, and product afterlife.

In this direction, one of the biggest culprits in the fashion industry is “fast fashion,” that it is referred to products that are made cheaply to meet demands for the hot new styles. However, fast fashion is putting our future planet at risk. Footwear is responsible for one on fifth made by the apparel industry as a whole, with more than 700 million metric tons of carbon dioxide produced as a by product of its manufacturing and raw material extraction each year. As social responsibility becomes a larger platform for innovation and fuel for change within the industry,

NPD data shows that 36% of 18-34 year olds have made a purchase in the past year to support a brand's social position.

In this regard, sustainability encompasses different areas of company activity and can be broken down into the sustainability of:

- Process
- Product
- Social
- Traceability

For example, the French fashion brand ''Veja'' makes sneakers with raw materials sourced from organic farming and ecological agriculture that the founders say avoids chemicals and polluting processes. Prada has recently launched a project that uses regenerated nylon, Luxottica has promoted welfare initiatives aimed at solidarity microcredits, or the Balenciaga initiative to support the World Food Program are concrete examples on the topic in direction.

This means that today, in the footwear sector, sustainability issues become indispensable both from an ethical and economic point of view. In fact, a PwC study in 2018 shows that 90% of consumers are willing to pay a premium price for the purchase of Fashion products made in an ethical and sustainable way. In this direction, a great opportunity for Italian companies is represented by **Made In Italy** concept. Without any doubts, the craftsmanship, protection of workers, bond with the territory, strict rules on pollution and certification of the supply chain are the fundamental values in terms of sustainability. Not by chance, the volumes of production in Italy of luxury is undergoing a constant growth that has brought the luxury brands to an exponential growth from 6.6 billion in 2008 to 14.8 billion in

2018 in 10 years, registering a +123 % in 10 years. In this sense, the adoption of more sustainable lifestyles will be strongly pushed by companies, industries and brands, as they will use sustainability as a source of innovation, developing new solutions and new products. Communicating this shift to consumers in an effective way, as part of wider marketing campaigns, will represent a fundamental change in the way brands operate and plan their strategies. This will ultimately influence the behaviour of consumers, regulators and even other companies.

3.2.2 Digital revolution

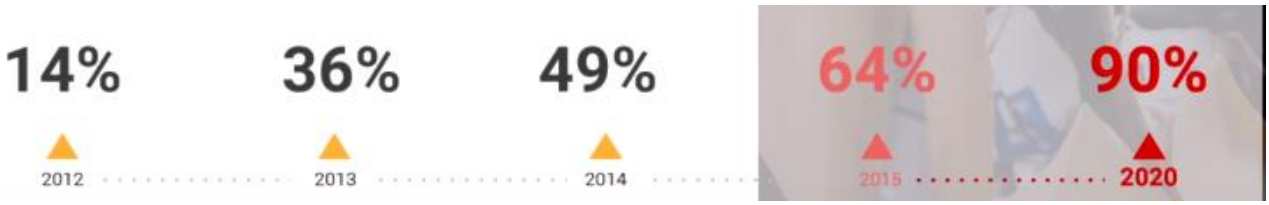
It is not a novelty that technological, digital and organizational innovation are key points to cope with the dynamics affecting the supply, demand and distribution also in the footwear system. However, in footwear industry the delay in innovation processes is a factor that threatens to affect the competitive capacity of the sector.

In this regard, the ISTAT survey on innovation conducted as part of the European project CIS (Community Innovation Survey), relating to the 2016-2018 period, brings the footwear sector to the third position in the industrial sphere and to the last of the manufacturing sector with the sole 32.2% of innovative companies. Even with respect to the share of companies that have successfully introduced at least one product or process innovation in the three-year period of reference, the serious delay in the sector emerges, considering that only 20.2% of footwear companies have successfully experimented with innovation, compared with 37,2% of manufacturing in general. Even the characteristics of the tested innovation show the delay of the sector, in fact, product innovations that represent that represent a novelty for the international market (European or extra-European) have been adopted only by 8.3 and 6.4% of footwear companies.

On the contrary, observing instead the spread of non-technological innovations of an organizational and marketing nature, a more decisive attention emerges from companies in the footwear sector with respect to these choices of innovation. Especially, if we talk about digital innovation, footwear industry is seeing a constant stream of innovation, with technology creating new experiences for customers. Essentially, the online or digital world have been influencing what the customer is going to choose. With the widespread access to internet across the globe, virtual presence is now a reality for a growing number of people. Asos, for example, is using visual search to let customers purchase items that they've seen, even if they don't know the brand or the name of the item.

From this perspective, we have witnessed a drastic change in the relationship between brands and consumers, which at the Point of Sales (Pos) in the store or e-commerce are very informed thanks to digital channels such as social media, websites etc. In this way, the purchasing path becomes more complex and less linear due to the fact that all digital touchpoints with consumers have a very strong influence on what the consumer will acquire**. Figure 18** illustrates the percentage of in-store sales that is influenced by digital environments.

Figure 18: Percentage of in-store sales influenced by digital



Source: Isa insider

Undoubtedly, the multitude of communication channels available gives the opportunity to establish different typologies of contact with a brand. For this reason, a company must be able to concentrate resources towards **a tailored omnichannel strategy**. The omnichannel integration, should conduct companies beyond traditional retail strategies, by integrating IT components and online experiences that will lead consumers to a new buying journey.

In this context, an omnichannel strategy can be defined as: "Meeting people on the channels where they are shopping and buying, whether it's in a physical store or an online store or on social media, and connecting the dots between those channels. The purpose is to keep customers moving around within the brand ecosystem, with each channel working in harmony to nurture more sales and engagement." In other words, companies must draw a strategy where a modern approach to commerce by focusing on designing a cohesive user experience for customers at every touchpoint.

At this purpose, since customers' expectations are always rising, by taking the time to invest in new technology and capabilities, companies can rapidly create valuable new customer experiences, manage them cost-effectively and continue evolving them to keep pace with a rapidly changing world. In this context, a product can no longer be only and purely craftsmanship plus creativity and heritage: we need to add values and emotion to it. Products need to be meaningful. **How we engage with our audience?** It is about customer and non-customers that want to engage with you on the digital side.

From this perspective, the brand is not only here to sell product to the client. It's also about communicating and conveying messages and values to the entire community of the brand.

The ability to use the brand as a platform, not only to convey creativity and product is a central point to improve market share but also to use the platform to raise

awareness. Further, the chairman of the fashion group of Fosun International *Casey Hall* argued: ‘’we need to create our **brand narrative** and tell the story in their own language and how that relates to our brand DNA’’.

It’s time to not only push product but also to push the values and to explain the creative process in a better way. It can be resumed as the ability to create an **authentic storytelling**. The creativity of the brand becomes very relevant and important for customers.

3.2.3 Transparency against counterfeit

In today’s world of post-truth politics and “fake news,” consumers distrust of governments and media has extended to every aspect of their lives, from food to medicine and fashion. Surveys suggest that trust in businesses fell in 40 percent of countries in 2017, with more than two in five consumers saying they didn’t know which brands to trust. In this regard, fashion industry dramatically suffers from a rising trust deficit. Recent high-profile data breaches at a number of online fashion companies, and in other industries, have left consumers wondering whether they should share information with brands and retailers.

Consumers has been rising questions such as: what are you hiding? - What is luxury today? - Is it a logo or is it a product that I know has not cost someone’s life or the environment? So consumers have acquired more power with time in terms of information and the easy way to switch brands.

As one of the most traditionally opaque industries out there, footwear faces an especially challenging future in this regard, but instead of grappling to invent new ways to beat the **trust deficit**, it could look to other industries for inspiration and

best practice. The kind of radical transparency that some fashion players will embrace tomorrow is being played out in the supermarkets today.

Transparency has become an important issue further along the pipeline in the supply chain, with consumers increasingly concerned about issues including fair labour, sustainable resourcing and the environment. 42 percent of millennials say they want to know what goes into products and how they are made before they buy. This might include information about product origins or the environmental impact of manufacturing. Further, we can not ignore that footwear is consistently identified as one of the top targets for fakes, and a new report from the Better Business Bureau, "Fakes Are Not Fashionable," makes it clear that counterfeiting can be as damaging to consumers as it is to brands and the overall economy. The phenomenon does not only concern the quality and perception of the product. It can affect consumers' health when dangerous and non-conventional products are put on the market. Also, in this case there are two victims of the scam: honest brands called upon to defend themselves from the attacks of speculators and people who do not always have the tools to verify the authenticity and quality of the products they buy. Within this complex scenario, the only possible way for your companies is to offer product traceability, through a technology that certifies data and information, makes them immutable and limits the phenomenon of imitations . On the other hand, there is an evidence: people no longer buy a product only because of its intrinsic characteristics, but they value the image, the story and the sphere of emotional values linked to the brand. For this reason it is important that your company always shows itself transparently, offering rational and 100% guaranteed selection criteria.

The problem is that companies are split into departments and that causes fragmentation and silos. We need to move from a centralised system to a more decentralised one. From this perspective, feasible solution started to arise recently: Designer Martine Jarlgaard, for example, has launched a pilot to track clothing

from raw material to consumer using **blockchain**. In this way, this protocol could ensure transparency by disclosing how companies operate. What's clear is that while technology has played a part in generating much of today's mistrust, it can also be leveraged to restore trust and confidence. **Blockchain**, for one, has the potential to fix this. retailers could garner greater trust through the product lifecycle, as it could tell consumers not just where an item was made, but also who it was made by, the conditions they worked in, how much they were paid, the composition of the garment, where the fabric was grown and what chemicals had been used.

3.3 Blockchain for fashion industry

Considering ongoing challenges of the sector listed so far, companies are looking for solutions to guarantee high efficiency performances along the supply chain and new horizons for their customers. These are the new challenges for which the global footwear sector is called. Since that the turnover of counterfeit goods in Italy for the fashion industry is around 2.2 billion euros (SoF, 2019), companies are constantly looking for solutions to certify the originality of their products. By guaranteeing the originality of a product means its uniqueness and certifying its origin.

At this purpose, one of the most widespread solutions today consists of the so-called "Smart Labels" which constitute a turning point with respect to the simple barcode system. In fact, the protection of a brand can be made if and only if the product is uniquely identified in order to show evidence of its originality. To date, these

systems have been implemented with different RFID, NFC, QRCODE and BARCODE mechanisms. Although these solutions described above could be described as definitive solutions to the problem of counterfeiting and the uniqueness of the product, they face limits as far as it concerns:

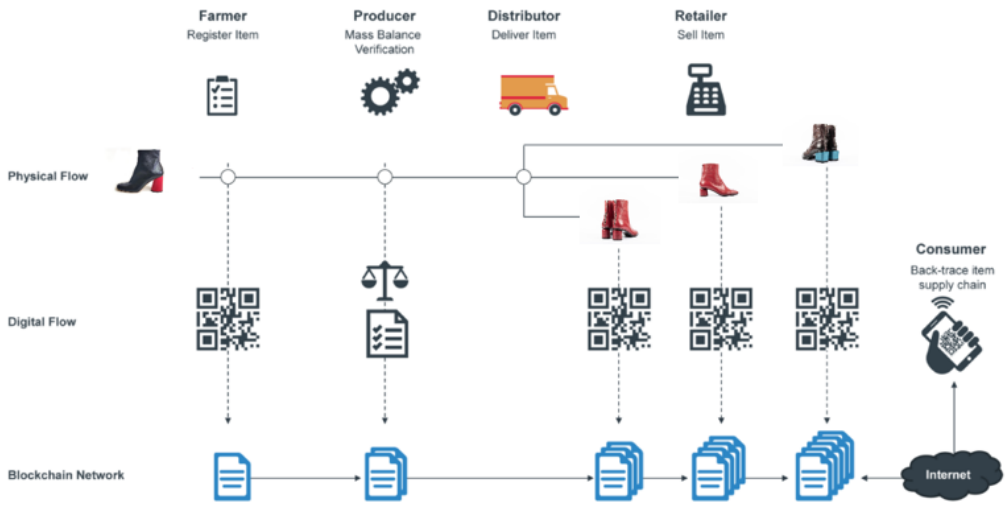
• Uniqueness: the solutions described above can be easily counterfeited through copy of the tag;

• TAG management: typically the unique codes associated with the tags are recorded in cloud platforms not managed directly by the companies concerned;

• No Innovative Customer Experience.

For these reasons, one possible solution provided by blockchain technology is that it enables the so-called **''digital twin''** of the product, that is, a perfect copy of the product but which has life only in the digital world. At this purpose, **figure 19** shows how physical products can be represented in a digital environment such as the blockchain technology. In this context, the creation of a digital twin, unique, which follows the product in all its evolutions, transformations and sales processes allows*:* Curbing the phenomenon of counterfeiting (black market); Shed light on the exchanges and dynamics of unauthorized distributors and retailers; Trace the supply chain, certifying the quality and create new channels for communication and engagement with the end customer.

Figure 19: from physical to digital



Source: Mise 2019

In this scenario, the key word is **Blockchain**. Blockchain technology enables security from hackers due to its encryption features and provides data history transparency. Digital twins will benefit from these features, as it can transmit data securely. Both SME and large companies are beginning to utilize blockchain technology to store physical objects, and connecting digital twin technology will soon be the next step. In order for this to succeed, specialized distributed ledger platforms that allow sharing information amongst digital twins are needed. Digital twins on a blockchain will also help brands protection and counterfeit items. Creating a digital twin of a product on blockchain would see its transaction records saved, along with information about where it was made, and its previous owners. In addition to this, for the first time in history companies who combine blockchain with virtual simulations will be able to track their product globally with extreme accuracy – this will totally eliminate the number of stolen goods across the globe. The blockchain is the technology that is progressively acquiring greater popularity

in the supply chains of any type of sector, establishing itself as a crucial solution for verifying the origin of a product and for the implementation of track-and-trace solutions along the entire supply chain distribution.

Thanks to its intrinsic characteristics, the blockchain acts as a backbone for exchange transparent and secure information between different companies, different technologies and different systems within a secure digital ecosystem. The advent of blockchain could bring actors and products involved into new global market opportunities, in which the concept of conscious purchase is made stronger every day. Especially, it is a solution that goes beyond technology itself because is able to establish new relationships between all the players in the supply chain. A relationship based on criteria of **trust** and transparency, which offers concrete benefits: by increasing turnover and credibility for sellers, more satisfaction and loyalty for those who buy the brand.

In this regard, these advantages inevitably pass from technological innovation. With the advent of blockchain, users can show the whole story behind product through tools that emphasize the truth by involving emotionally the consumer. All this in complete safety, within a certified and reliable database that stores information enhancing the efficiency in both customer engagement and supply chain perspective.

3.3.1 A blockchain application for a footwear smart ecosystem: *Trusty solution* (technical explanation)

Finally, we are at one point where a concrete demonstration on how blockchain could impact real business. At this purpose, in this section a short introduction is needed to illustrate a blockchain solution provided by an innovative start-up. **Apio** is a company founded in 2014 with the aim of creating a hardware and software ecosystem capable of scaling and interoperating in the most varied fields of application of the Internet of Things. Apio, which in Latin means "Put in Communication", is born from four smart students of the Università Politecnica delle Marche and evolves rapidly towards the creation of the Apio Srl company, imposing itself in the Marche region as a reference company for the new technologies of connectivity, transmission and data analysis.

Thanks to the collaboration with important partners such as IBM and Var Group, Apio was among the first to develop blockchain projects based on the IBM permissioned blockchain platform in the food sector, by releasing a blockchain-based solution named**: Trusty**.

Thanks to blockchain technology, IBM Food Trust creates visibility and an unprecedented reliability in the food supply chain. In this regard, **Trusty** is a platform that allows products to enter a global, competitive market, where the first thing a customer wants is to be sure of what he is buying. Trusty allows your product to be accompanied by its story and by the company's story. Thanks to a QR-CODE, the customer will be able to access all traceability information, history and places that characterize the product. Thanks to Blockchain technology, the information will be certified and will have legal value.

After numerous interview and emails with the CEO – Alessandro Chelli – it has been carry out an analysis of the Trusty platform and its main features first. Then, a concrete implementation and possible solution within the fashion industry has been taken into account.

Undoubtedly, a solution such as Trusty can and should be integrated with business software. More concretely, Trusty consists of three main components:

1) **Dashboard**: Management and analysis platform. Management intended as company profile creation, product declaration, document insertion, traceability page editing etc. Data analysis since the platform allows for insights on the supply chain and on customers who interact with the pages of traceability and engagement.
2) **API**: APIs are computer interfaces that allow you to integrate software between them. Through the APIs it is possible to integrate ERP, CRM, MES software and other business systems in order to automate the data entry process.
3) **Customer Engagement Page**: The Customer Engagement Page is the traceability page that can be used to communicate to the consumer the characteristics of a product, traceability and additional information that the producer wants to give to its customers.

In fact, through the association of products to a digital asset registered in blockchain it is possible to create an immutable identity that undergoes transformations through transactions and follows the processes of sale, up to the customer's account, all in complete transparency. Through a QRCODE or an NFC tag, customers can track the history of products and verify that the seller is the actual owner at that precise moment. At point of sale the product is transferred from the seller's account to a customer’s account where can register to have further services (guarantee or quality

certificate). In this way, from that point the actor that have the right to transfer the product is the effective owner, solving the Tag clone problem.
In this context, especially in footwear industry, the underline solution (Trusty) could be able to address following issues:

- **Counterfeiting**: through the creation of a digital asset univocally associated with each one

product, it is possible to trace the passage of the product throughout the supply chain. From raw materials to the whole production processes, avoiding the phenomenon of counterfeiting, as the assets will be moved from one account to another, through digital transactions as they are processed or sold. Similarly to what happens for cryptocurrencies, only the owner of an asset is able to carry out the transactions necessary to move the product from your account to the account of the buyer.

- **Sales network control**: Through the tracking of sales that guarantee authenticity

to the product, it is possible to follow punctually all the sales phases, recognizing the sellers
unauthorized.

- **Quality**: through the traceability of the entire supply chain, customer service can level up by going back to the production information of a certain good. In particular, it can verify information such as the geographical location of a production plant, the number of employees, the certifications held, the origin of the raw materials used, etc.

Further to this, the implementation of blockchain protocol could open new innovative scenarios for fashion players. By handling effectively issues presented

above, blockchain could also leverage marketing tools, offering a new customer experience by giving greater visibility to the brand. In this context, further developments of Trusty blockchain solution could came up with innovative tools such as:

1) **Data analysis applications**: based on the place of purchase of the products and on the number and the position of each "scan" within the supply chain, fashion houses have the possibility to follow a product not only during the production process, but also in the network of distribution and sales;
2) **Customer loyalty applications**: through a dedicated user section on the website, fashion actors can allow their customers to check a digital history about all purchased products, verifying their guarantee and authenticity. In this way, the brand acquires a direct communication channel with the customer.

From this first introduction, Trusty solution has the potential to transform the way that individuals and organizations interact, the way that business collaborate with one another, the transparency of processes and data, and, ultimately, the productivity and sustainability of our economy. In fact the ability of blockchain solutions such as Trusty to track, trace and authenticate product, record contracts, guarantee the movement of information and record transaction means it can be used across the entire value chain, benefitting businesses and consumers alike.
In this regard, among fashion players, it is believed that blockchain will (in the short term) have the largest impact on traceability across the supply-chain. On the contrary, beyond supply chain based solution, Trusty has the potential to change the way consumers shop and pay for products. In fact, from a consumer perspective, blockchain solutions could be implemented as an alternative payment platform based on cryptocurrencies and token economy. Further, a blockchain solution such

as Trusty may also offer a superior means of powering loyalty programmes, marketing services and, more in general as a revolutionary approach to new customer engagement strategies.

Despite blockchain technology could impact a multitude of processes and operational activities, the focus of this paper is aimed to implement the Trusty solution in a fashion business context.

To sum up, from a broader analysis of the fashion industry, Trusty could significantly impact three main areas that will be illustrated in the following paragraphs:

- Consumer: customers that, thanks to the QR-CODE scan, can access a series of exclusive contents, such as videos, traceability information.
- Brand: Through a content creation interface, uploading images and information, in this way the manufacturer has control of the product even in the middle of the sales network.
- Partners: Technology experts, supply chain experts, but also influencers, journalists who, thanks to the platform and the ability to certify information, can create certified content for the products with which they interact.

3.3.2 Implications of *Trusty* solution for consumer-brand relationship

The integration between offline and online is rewriting customer experience paradigms. We are all hyper-connected. In Europe, 36% of consumers consult your smartphone before completing the purchase in shop. The 30% check the availability of the product within the various points of sale before moving on home and 90% of in-store sales are influenced by digital. Offering a better shopping experience means make the right move to transform a potential buyer in a real customer. Enter a QR code within a label it is not a technological quirk. On the contrary: it is a sign of identity, of differentiation, of transparency towards the customer.
According to the **Harvard Business Review**[5], "customers who had the best past experiences spend 140% more compared to those who had the poorest past experience." **American Express** tells us that "55% walked away from an intended purchase in the past year because of a poor customer service experience." The arrival of social and mobile-empowered customers has increased the pressure on companies to deliver great customer experiences.

With Trusty, finally it can be built a new digital space, to establish with the your audience a relationship of authentic and mutual trust. In this era of digital intermediation, recurring technological advancements (e.g. blockchain, virtual reality) provide new opportunities for brands to foster their relationships with consumers.

[5] HBR: The Value of Customer Experience, Quantified, Peter Kriss, 2016

The adoption of this foundational technology from businesses is reported to affect several aspects of their marketing performance, including brand communications, the design of online marketing campaigns and the brand's transparency to consumers (Risius and Spohrer, 2017). As blockchain features have the potential to change the way consumers interact
with and connect with brands, firms need to consider carefully how they might become affected by rapidly growing blockchain enabled apps (Tapscott, 2017)

Hence, an important question can arise : *How does the adoption of blockchain technology such as Trusty affect a firm's efforts to build and enhance consumers' relationship and experience with the brand?*

A. Improving corporate brand positioning and brand image: token and authentic storytelling

Digitalization and the dominance of social media have brought technological advancements to the forefront of research around how companies can build their corporate brand image or co-create their brand meaning online. In this vein, the adoption of Trusty could affect a corporate brand's image by enhancing communication skills through an **authentic brand storytelling strategy**.

In this regard, ''Brand Storytelling'' remains one of the key strategies to stimulate consumers' interest in various brand elements and render them more memorable in consumers' minds (Dessart et al., 2015). Storytelling is not inventing a story. Is about the fulfilment of needs, respond to questions, engage on an emotional level,

connect, find your voice and listen to voices in the intersection of brand and customers.

As consumers seek experiences appealing to their emotions and dreams, blockchain apps such as Trusty, could help firms share a more inspiring and meaningful story to external audiences. Brands with an authentic history could leverage their corporate image by sharing their brand identity and long heritage into each of their products equipped with blockchain apps. For instance, ‘’Cantine Marramiero’’ (i.e. wine firm) enables consumers, through a virtual reality blockchain app, to find out about the story of each of their products, from its production to the store, by scanning a barcode on each bottle of wine. This way, customers could search and gain deeper knowledge on the spot about the brand they purchase, making their experience with the brand more compelling and factual. On the other hand, brands could face increased threats fuelled from the integration of blockchain features in their storytelling efforts. Brand communication and positive user-generated valence might no longer suffice for sustaining an authentic brand image in the long term. Firms might have to integrate blockchain apps to enhance their storytelling practices behind their brand portfolio and design more informative, authentic and interactive experiences with consumers.

B. Consumer participation in blockchain-enabled brand loyalty programmes

Although brand loyalty programmes traditionally aim at increasing consumers’ share-of-wallet loyalty to the brand, evidence shows that brand loyalty schemes might not always be correlated with programme loyalty. Also, the tightly defined rewards in point redemption, the fragmentation of loyalty schemes and the elimination of strong rewards for loyalty over time resulted in lower consumer

motivation to participate in loyalty programmes. As a result, consumers often do not realize the value of loyalty programmes or their programme loyalty might not evolve into brand loyalty. In response, brands have embraced the use of modern technologies to reduce customer churn or enhance customer's participation in such schemes. Through blockchain adoption, brands are enabled to use digital currencies (tokens) as a means of better loyalty points' redemption, improving customers' experience with such programmes (Iansiti and Lakhani, 2017). At this purpose, customers exchange their loyalty tokens with others, allowing them to break out of one-size-fits-all loyalty programmes and gain a wider variety of rewards available.

In this vein, Singapore Airlines announced the adoption of a blockchain-based loyalty scheme in partnership with other national retailers. Their customers can have a "digital wallet" for all their loyalty points with the option of redeeming them at varying local partners; they would no longer have to wait for long periods to accumulate their points. Blockchain-enabled loyalty programmes could also incentivize customers to cash loyalty points out in other industries or exchange them for other currencies if their value significantly increased. In fact, by increasing the variety of redemption options could significantly increase the internal value of digital currencies for consumers, further encouraging their participation in blockchain-enabled loyalty schemes. Given the high visibility of blockchain transactions to all users of the network, brands could potentially offer more customized bundles of rewards to their customers over time, based on their prior redemption activity and their exchange preferences. Startups like Loyyal already offer blockchain-based loyalty incentives, which are easily exchangeable across different markets by using tokens to support and verify their value. At the corporate brand level, blockchain adoption could drive brands to expand their partnerships to promote their own digital currencies. Just like brand alliances were formed to raise

awareness in the minds of consumers (e.g. Star Alliance), brands could profit from attracting and convincing consumers to redeem their points through their blockchain loyalty programme, instead of attracting them as customers in the first place.

Such loyalty programmes could affect customers' experience with the brand (Lemon and Verhoef, 2016), resulting in more positive user-generated content about the firm's products and services. This development might be quite appealing for emerging brands, new brand extensions or in cases where firms seek to build brand recognition rapidly amongst consumers (e.g. when entering a new market). In this way, loyalty then becomes not something that is built-on to a product, but rather something that is built-in to the product/protocol that will be a function of maximized customer utility and innovative flexibility.

3.3.3 Implications of *Trusty* solution across the *supply chain*

A. BLOCKCHAIN AS A SERVICE OF SYSETM INTEGRATION

Supply chain is complex today. Multi organization, highly disjointed, and geographically spread are some of the cornerstones of today's supply chain. Traditional tracking processes rely heavily on manual operations to achieve information synchronization among supply chain participants. Enterprises with more resources undertake expenditure to develop a centralized mechanism, such as an EDI, CRM or ERP system (Catalini et. al, 2016), to solve information synchronization issues among others.

In effect, an end-to-end supply chain, from the most basic raw material to the final product in a customer's possession, is opaque. More specifically, every time a product comes in, they have to fulfil the order, send an invoice and ship the product. Then they wait for the invoice to be paid. At the same time, they're also receiving shipments of raw materials, parts, or other products from upstream partners. But supply chain systems are changing. Blockchain is creating new opportunities for companies to gain visibility into their supply chains, and that's going to affect how companies think about their ERP systems.

These systems (ERP) are solutions, not products. We're not talking about generic software that any company can take off the shelf and use immediately. ERP systems go through massive amounts of customization to fit each individual organization. For one thing, it's difficult to change the system later on. Adding new features or overhauling the entire system is expensive, so only large companies can really afford it. There's also the issue of interoperability. Every party along a supply chain has their own custom ERP system. The manufacturer, wholesaler, and retailer usually operate on different software. That creates a situation where no one has more visibility than the activity one step to their left or right. Each company's "trust boundary" only extends to their own system. They know who sold them the product, and they know who they sold it to. But they don't have exposure to the entire supply chain.

At this purpose, Blockchain technology with its unique features provides the possibility to innovate process design. The main element required for building a decentralized network is the adoption of a shared ledger and the verification of transactions that comprise the contents of the ledger. Blockchain technology, as a distributed ledger technology, could leverage its potential to achieve synchronization of tracking information. This innovative thinking, along with the use of smart contracts, offers opportunities to reduce the endeavours and enterprise

resources required to confirm process status, which in turn accelerates the execution of the next process. From a process re-engineering perspective, blockchain technology facilitates process automation and disintermediation via the use of smart contracts (Pearson et. al, 2019).

More in general, Blockchain has the potential to unite a large supply chain network using a decentralized system. By integrating blockchain solutions into existing ERP software, the two systems can work together to improve the automation of supply chains. This means every company can maintain their own internal ERP system, while joining one rule-enforced blockchain network.

This has a few distinct advantages. In fact, it significantly enhance visibility across the supply chain. Each participant can trace the product's journey from the manufacturing floor to the retailer's shelf, helping to eliminate product diversion and counterfeiting. For example, the data and business rules that currently reside with three companies would be available in one network. And each transaction between the companies would automatically be recorded on the blockchain. Companies can still keep and record the private data that's relevant to them, meaning they won't have to share business intelligence. But they would finally have visibility into the entire chain of custody.

In this direction,(Reyna et. al, 2017) argued that benefits in integrating actual enterprise business applications with Blockchain is twofold. Firstly, it will bring transparency, and secondly, it can reduce the cost of tracking and reporting which is significant. As a matter of fact, Supply chain information tracking could facilitate the flow of information among players. Moreover, it is possible to match suppliers and buyers through further transformation of this system. This timely response enables business process automation; the lack thereof has formerly been a hindrance for many incumbent players. This prototype enters the process flow into a brand

new phase, thereby reducing the role of traditional intermediaries along with the costs of time and money (Chang et. al, 2019).

For example, FINLYNK it is considered the world's first blockchain integrator for ERP systems by developing a seamless plug and play integration for SAP, Ethereum and Hyperledger blockchains. In this sense, IBM has shown that there are more than 100 million dollars of invoices which are in dispute between actors, and it takes an average of 44 days to resolve it. This can be easily avoided up to approximately 90 to 95 percent using blockchain.

In this regard, the ability to incorporate blockchain technology into various business processes to improve the operational performance of supply chains in different industries in the foreseeable future is promising. Blockchain is additive technology. It's not going to replace the need for internal ERPs. Rather, ERPs and blockchain will work together to strengthen the integrity and automation of supply chains. But as adoption increases, the benefits of using blockchain will also grow. As more users work with blockchain, the network effects will multiply. Most companies will keep their customized ERPs, but piece by piece, they'll begin to identify what can be done in a standardized way across the industry. Those are the processes blockchain will be used for.

B. REDUCE COUNTERFEIT CONSUMPTION AND ENHANCE BRAND TRANSPARENCY

Within fashion industry, as mentioned on previous paragraph, counterfeit products remain a key issues especially in market such as luxury and online purchases. Despite efforts to reduce this phenomenon, sales through social media platforms and online commerce exacerbate the sale of fake goods with harmful effects on businesses and consumers.

Blockchain-based apps such as Trusty, could enable brands to track the entire lifecycle of each product (from sourcing to production) and associate it directly with manufacturers. This level of certification will allow illegal merchandise to be more easily located and reduce the chance of fraudulent products reaching consumers. Moreover, in verifying the entire lifecycle of product purchases, consumers can reduce disinformation risk in their purchases (Montecchi et al., 2019). Decreasing information asymmetry and chances for fraudulent product info could eventually result in increased brand trust from consumers. Echoing these benefits, various organic food suppliers already use Trusty solution as authenticity providers of products for consumers, minimizing concerns about the authenticity of their intended purchase.

Through blockchain-based apps, also fashion luxury brand would be enabled to eventually reduce the harmful effects of counterfeit consumption but, more importantly, to reduce consumers' perceived risk and uncertainty in various consumption settings. As a matter of facts, this is because of the increased visibility of their supply chain activities, production process and/or service delivery process that blockchain networks offer to their users. As a result, interactions with brands would become more transparent, enabling firms to build consumer trust in the brand in the long term.
In fact, Trusty is likely to enable brands to become more transparent to external stakeholders in providing information regarding the route of a product from raw materials to manufacturer to distributor to retailer, and finally, to the consumer.

An early example of the technology in action is the firm that uses blockchain apps to monitor their whole production process. For instance, the sneakers manufacturer, Greats, has used blockchain technology to create smart tags that can track their

sneakers to the factory, so they are impossible to counterfeit. Existing blockchain platforms, such *as Trusty, Provenance or Babyghost* could also allow customers to source products and track granular details of their production. Through blockchain, firms can also make their internal service chain more transparent to their external stakeholders.

At this purpose, prior work in the service profit chain stream establishes that firms can enhance their performance through better connecting their internal production efforts with customers' experience . In this way, consumers might be able to gain a more comprehensive understanding about the value chain practices and its products, without relying on external sources of information, such as firm communication or online reviews. This heightened supply chain transparency could alleviate consumers' concerns about product quality, a firm's suppliers labour practices, etc., and eventually increase their trust in the brand.

Brands could also utilize smart contracts to enhance their brand promise consistency when interacting with customers. By incorporating brand promises, customer policies (e.g. refunds) or contractual agreements into smart contracts, each party can ensure the other party's

compliance with the contractual obligations previously undertaken. The public verification and transparency of these promises made from brands can reduce any distress from the customer's side. For example, when customers sign contracts with service providers and agree on a specific date on which the available service needs to be delivered, smart contracts would automatically refund the customer if this condition is not met. In eliminating the costs and delays associated with traditional contracts, consumer perceptions that they being treated fairly will be enhanced and brands can easier demonstrate to their customers that they deserve to be trusted.

3.3.4 Implication of *trusty* solution for payments and contracts

For a business that processes credit cards or bank transfers to fund its operations, transactions can end up being costly and time consuming. Credit card transaction fees average anywhere from 1.5% to 3%. This doesn't include other fees such as monthly minimums. Companies pay these fees to compensate for the fact that they cannot be 100% confident about the trustworthiness of every customer or supplier. It's a big "Trust Tax."

Meanwhile, it is not like bank transfers are any better. They can take anywhere from 2-5 days in the US and international can take 2 or 3 times longer, and there's more and higher fees for those.

To make matters worse, the **Nilson Report** estimates that in 2016, losses topped $24.71 billion.

From a consumer perspective, blockchain solutions such as Trusty could allows them to save time and money on payments. Either through the use of cryptocurrencies, or by facilitating cheaper, faster validation of credit payments, eliminating the cost currently incurred by banks.

On the B2B side, there are plenty of challenges when it comes to commerce. According to the **Atradius Payment Practices Barometer**, only 50% of businesses check buyer credit worthiness, request secure forms of payment, or both, and 81.5%

of companies report employing credit management policies to mitigate trade risks. This does not even mention all of the value lost by payments not arriving on time, with average payment terms for the Americas of 28 days and the average Days Sales Outstanding of 48 days, according to some estimates. In this direction, the interoperability of blockchain and smart contract could be used to replace traditional letters of credit.

Beyond B2B and B2C, there's a humanitarian element to address with not-so-ulterior motives. There are 2 billion people in the world who do not have access to the traditional banking system. Banking the unbanked serves the greater need of extending capital to those previously unable to prove themselves trustworthy to participate in the global economy, growing an entirely new market in the process.

In Satoshi Nakomoto's whitepaper, the entire point of Bitcoin and peer-to-peer digital currencies is the elimination of middlemen and the increase of trust. Every payment could be automatically verified. Each customer or vendor can immediately prove his trustworthiness "by demonstrating ownership of the private key that can access funds." People that were too costly or risky to serve (say in a developing country) can now become customers.

The benefits are clear: faster transaction processing times and reduced fees means that either prices are lower, sellers keep more of the revenue, or both. Accepting these currencies will provide a competitive differentiator for some companies.

For one simple example, let's say you put on a customer or partner event that has 1,000 people attending with an average ticket price of $500. Today, you are paying $10,000 in credit card fees. What if you could reduce it to $1,000 or less by accepting digital currencies? It may not make sense for every activity, but it will allow you to get more value from your marketing budged. In this regard, an example is represented by the BitcoinValley in Trentino Alto Adige region, in Italy. Living

over there means living in an area where bitcoin is a real alternative to traditional payment systems.
In fact, 6,000 km² showroom where the first protagonists are citizens in the form of traders, entrepreneurs and consumers. As bitcoin is open technology, the BitcoinValley initiative is also for everyone and for everyone's benefit by offering services such as: drinking, eating, paying rent, making gas, having fun and playing sports, but also paying taxes, meal vouchers for students, electricity, gas and general shopping.

Further to this, Trusty could be able to creates digital records of consumer's purchases, moving product warranties from paper onto the cloud via blockchain – keeping them up-to-date and easily transferable. Consumers are able to maintain a virtual warranty wallet, saving retailers and manufactures administrative work.

3.4 The case study: *Halmanera* company

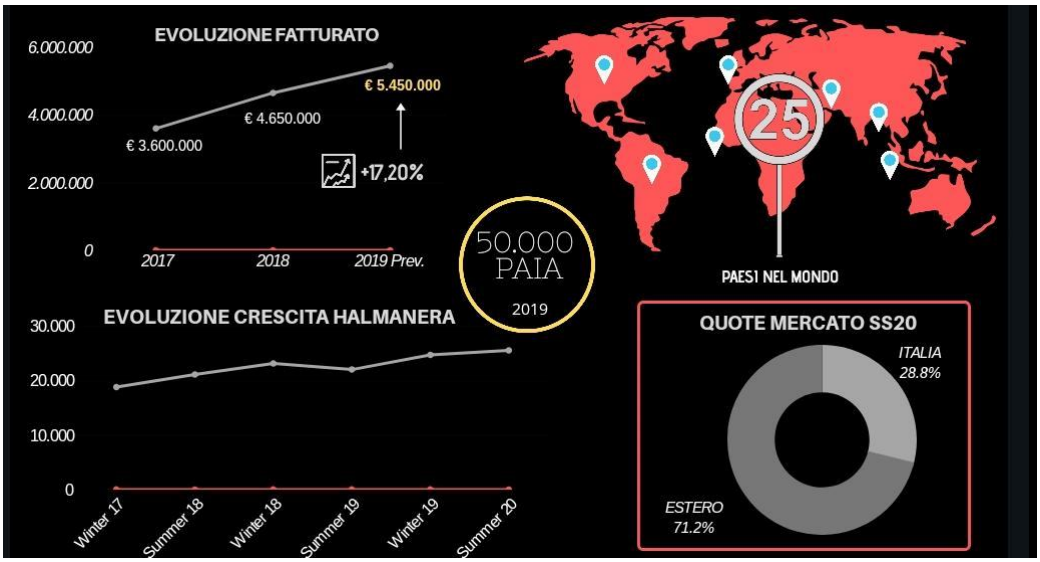
The company that will be presented in this work is Halmanera: founded in 1979 in Porto Potenza, province of Macerata, it is a leading family-run brand from the Marche region in the national and international fashion sector. This company deals with the production and marketing of high quality women's shoes. Halmanera is specialized in particular in the design and construction of the shoe following all the production processes internally, capable of autonomously conducting the entire production process, starting from the design of the sample to ending with the marketing of the finished product.

Recently, the company opened its first store in Shenzen (China), by enhancing a strong market position in international markets. Halmanera has a turnover of around 6 million euros with around 25 employees. Beyond the superb design, Halmanera's distinctive characteristics towards the competition are the quality and the great craftsmanship of its products. Furthermore, human know-how plays a fundamental role in all phases of product development, that contributes to an international success and competitive advantage typical of Made in Italy.

Following several years of business, the positive performance of its products have encouraged Halmanera to start new business initiatives and to expand its business activity which have allowed it to take a leading position within national market and to undertake relations with foreign players. In fact, the great experience and expertise in the sector has led the Halmanera brand to establish itself in more than 25 countries worldwide. Driven by a continuous expansion in international markets, the company is particularly active in the B2B markets, without neglecting the fundamental B2C channels.

As anticipated in the previous chapter, the continuous evolution of market demand, especially in a sector such as fashion, requires continuous product and process innovations. In this regard, the ability to combine human know-how with the latest generation technologies will be one of the main challenges to address in order to be competitive worldwide.

Figure 20: Key performance indicators



Source: Personal reproduction

3.4.1 The ongoing business model

The business model describes, in general terms, how the company creates and captures value. Although managerial literature has already introduced the term since the 1950s, companies often find it difficult to describe their business model, often confusing it with terms such as business plans or, even more simply, the reference market.

Halmanera was born with the vision to create a company that would produce high quality shoe, keeping craftsmanship techniques and ensuring a mix of design and comfort unique in the sector. In this regard, the relevant company performances have allowed the development of collaborative relationships with important players and platforms within the footwear neetwork. In fact, thanks to a punctual communication strategy in traditional channels such as Instagram and Facebook, the company manages to reach its target customers.

Halmanera's main reason for pride, and the element that constitutes the real basis of the company's success, however, is the highly qualified staff made up of expert figures in the sector and specialized technicians, by ensuring fast, efficient and high quality services. In the current footwear competition, however, the most critical activities such as the design, the conception and realization of the product and the study of the customer's needs are activities for which the differentiator of success is represented by the presence of innovative technologies capable of to support human know-how.

The footwear company has always been organized in organizational units that stand out for the specific skills assigned to them and that govern the entire production process transversely. Examples of functions are: administration, commercial,

production, purchases, design. The company activity is then carried out through processes that pass through the individual functions and which consist of different phases carried out by one or more of these organizational units. The task of the functions is therefore to oversee the various processes of them competence and to ensure the success of a good product, which is then necessary for carrying out the following phases. Therefore, there are many processes in shoe companies, some of which are common to other production organizations, others typical of the sector:

• Market analysis and study of customer needs;
• Product and sample design;
• Industrialization of the product to make it effectively reproducible;
• Procurement and Logistics;
• Production planning;
• Production: cutting, joining, assembly, finishing and quality control;
• Marketing

Halmanera carries out direct control activities in every single function of the entire process. This means that it is able to autonomously follow all the phases of the production process, typical activities of the so-called " final companies " which will be illustrated in the following paragraphs.

Nonetheless, if we want to indicate which are the most important functions, Halmanera's ownership gives substantial priority to the performance of four main corporate functions:

A. Market analysis and study of customer needs
B. Procurement and Logistics
C. Production planning
D. Marketing

Halmanera's business activities will now be described in more detail, this will give us the way for the main problems encountered and the possible solutions proposed according to the logic of technological innovation such as the Blockchain.

A. Market analysis and customer requirements

The first step for a company that wants to meet an ever increasing demands of customer needs is to capture market trends and opportunities for innovation. In this context, therefore, the ability to anticipate the market and the requests of potential customers becomes fundamental. In this way, companies that manage to acquire insight on the main needs of users, will be able to anticipate what are the market logics. Halmanera, through studies and research conducted internally, is constantly looking for innovative methods in this direction. This is a process of collecting and evaluating data that serves to identify areas where improvement is needed. The results of the analysis can highlight problems or gaps that will be highlighted in the following paragraphs. This step is particularly important because it forms the basis on which decisions will be made in subsequent functions. Therefore, the collection of information, and the subsequent transformation of the data collected in terms of needs, turns out to be one of the most impactful activities that a company such as Halmanera must face.

B. Procurements and logistics

Analyzing the case closely, another fundamental aspect is dictated by the supply chain management ability. Especially, procurement and logistics play a key role in terms of efficiency and effectiveness along the entire supply chain. In this direction, Halmanera is responsible for the purchase of materials, components and accessories necessary for production. This entails constant management and evaluation of relations with suppliers. In other words, as explained in chapter 2, at this stage the optimal management of physical and information flows is an element of significant importance for the survival of companies. The ability to manipulate and make information available is a distinctive element of the most advanced companies. The management systems - economic, quality, environmental and others - are more effective if supported by objective elements for detecting the economic and other parameters of the company processes. However, the ability to adequately manage information flows requires a series of interventions both on the technological level and on the organizational and process level. Usually the procurement of the main raw material takes from 4 to 6 weeks, this requires a high effort for the synchronization and transmission of orders along the entire supply chain. Moreover, the risk of not receiving the goods on time could lead to delays in deliveries and therefore to produce devastating negative effects.

C. The production planning

Production planning consists in the planning and control of the production processes in the production plants. Production scheduling creates a structure of the production control, on the basis of which detailed programming can be performed.

Production scheduling systems allow the company to have a single database from which all the people participating in the process can draw. In addition, the system ensures the real-time updating of data. In this way it is possible to manage production control and detailed system-based programming, effectively controlling the receipt of orders and the use of support management systems. In this direction, the main objectives set by the company consist in optimizing the use of internal and external resources in short execution times. Especially in a sector such as footwear, where the delivery times of the materials are particularly long. For example, the supply of hides, in the case of Halmanera, is a minimum of 6 weeks. It is clear that IT systems such as ERP allow access to a better level of visualization along the entire supply chain. One of the aspects that will be analysed will be the evaluation and adequacy of the IT systems within the company.

D. Sales and commercialization

In this phase, in which I actively participated through an internship, the Halmanera sales team has the task of selling the finished product but not only, communication and customer assistance is essential. Basically, in this phase the sales team establishes a first approach with customers through appointments in the showroom and participation in fairs and events. At a later stage, the team has the task of transmitting the orders to the production department which will have to act accordingly. This is a very delicate phase because in 70% of cases, customers make changes both in quantitative and qualitative terms. The strong dexterity of these processes could result in negative effects such as the increase in lead time and the redundancy of information. In these terms, the sales team has the task of establishing a connection between customers and the company.

3.4.2 The business model canvas

Even if companies are not aware, all of them have their own business model. In fact, the business model represents the logic through which each company manages to create, transfer to and appropriate customer value. In this regard, consisting of nine elements, this model represents a structured way of describing what a company like Halmanera does and allows you to distinguish different ways of creating and capturing value starting from the same technology. In other words, the business model canvas helps companies understand what 'ingredients' are needed to compete. Below it has been offered a brief description of six of the nine components of the business model canvas with reference to our case (the structure of costs and that of revenues and distribution channels are excluded).

VALUE PROPOSITION

The value proposition describes what the company offers its customers in terms of product / service. Being a manufacturing company, the company stands out from the predominant craftsmanship, original and exclusive design. Hence, the quality of the individual products certainly creates a significant gap with respect to competition. All this is combined with a highly refined and innovative design through a contractual collaboration with a third party.

CUSTOMER SEGMENTS

The "customer segments" dimension describes who are the most important corporate customers.
Such customers can be represented by two extremes. On the one hand we find a mass market,
characterized by customers who have the same problems and therefore do not need products e
continuously different solutions, while on the other from a niche market, for which the company
must develop solutions (not only products, but also distribution channels and relationships) from customer to customer. In this context, Halmanera's strategy is clear: to satisfy a niche market by referring to a female audience.

CUSTOMER RELATIONS

The third dimension concerns customer relations and therefore analyzes how the company interfaces with the customer. Except for the support mechanics, the company does not have a complaints archive as they consider it not very relevant. In addition, the only direct touchpoints with clients are represented by fairs. As far as post-sales relations are concerned, there was a strong manual of relationships managed by exchanges of e-mails and telephone contacts, without the proposal of a platform capable of receiving feedback.

KEY RESOURCES

The fourth dimension looks at the company's key resources. The firm owns tangible resources, such as machinery, tools, financial resources, and intangible resources, such as brand and human resources. As for tangible resources, it is possible to distinguish between machine tools, measuring devices, assembly systems, robots, autonomous vehicles, etc. The analysis shows that the company is equipped with machine tools, measuring devices and systems assembly. However, human resources are far more incisive than tangible ones. In fact, it is precisely the experience of the employees who contribute most to the company's growth.

KEY ACTIVITIES

As far as the key activities are concerned, it has been tried to analyze three of them. The first activity refers to the fact that companies carry out a process mapping. In this context, there is no mapping that is paper or digital. A second key activity is that of research and development (R&D). In this direction, the R&D activities are mainly carried out by the sales team without the assistance and connection with any academic subject. This is mainly aimed at marketing activities and target customers.

KEY PARTNERS

As for the key partners, Halmanera mainly has collaborative relationships within the value chain. In detail, it is possible to identify suppliers of raw materials and components as more collaborative partners. For these actors, these are long-term collaborations, over 10 years. In addition, some customers have proven to be

particularly strategic for entering new markets. This is due to the great ability to establish high quality and long lasting interpersonal relationships, without however following specific evaluation processes of the ideal partners.

From a first analysis it is possible to draw some reflections that can be summarized as follows:

a) Halmanera is an 'artisan' company with the production of multiple small ones lots;

b) Within the company, the key resources are still the people who operate in production, sales and marketing, while research and development activities are less developed

c) the key partners are upstream of the supply chain, as demonstrated by the importance of relationships

with suppliers of raw materials and technologies; while

d) there is low collaboration with the customers, few and selected, with whom we probably could

improve the degree of interaction; finally

e) companies are in a transition phase towards the use of digital tools (as for

example highlighted by performance measurement).

3.5 The ongoing challenges

Witin the footwear ecosystem, SME such as Halmanera has been faceing a multitude of challenges that could undermine its competitiveness. Especially in a sector such as the footwear industry where competition is very high, two fundamental aspects have been identified: the supply chain as we have anticipated, and innovation development. Let's see them in detail.

3.5.1 The *logistic/supply chain* challenge

Footwear industry is one of the leading sectors of Made in Italy, with a recognized product excellence and consolidated international vocation, which has taken the challenges of globalization in time, expanding its presence on markets all over the world. Following a careful analysis of both internal and external factors, Halmanera, like most of the players in the sector, have grown by broadening their horizons towards a culture of service, which focuses on the competitive level not only in giving a good product at the right cost, but also in the right place at the right time.

Undoubtedly, my experience in the commercial field has led me to identify different aspects that affect the efficiency and effectiveness of the company's business. In this direction, it has been conducted an analysis that aim to illustrate the most critical points within the Halmanera supply chain.

The increased flexibility of demand with the continuous proposal of new collections that overcome the logic of seasonality and the growing complexity and

heterogeneity of the distribution channel call for new responses of physical and information organization. In these terms, the synchronization of production with sales in a vision of continuous and coordinated flow, to produce what is really sold, is the fundamental function of the supply chain.

In fact, production is scheduled as soon as the sales campaign ends. Considering that there are two main sales campaigns: summer and winter, lasting about two months each, production will be forced to stand still waiting to receive sales orders from the sales department. For this reason, it will be necessary to conceive the organization of information and goods flows in an organic vision, which introduces time as a competitive factor, with advantages of absolute economic importance: low inventories, reduced risk to sales, immediate responses to market reactions and so on. Such a scenario impacts on the costs incurred by the company but above all on the possibility of new strategic and organizational choices for the benefit of integrated and reactive systems, such as potentially the Blockchain.

Today, a company such as Halmanera is experiencing complex situations due to the effect of a series of elements that have a great impact on logistics processes, such as speed, both in terms of response times and the exit times of the collections: the variety of increasingly rich collections of models, items and variants: outsourcing many of the production activities to subcontractors; flexibility in terms of variability of demand and requests for customizations. As a result, the company has to manage a multitude of business relationshps with different actors along the supply chain. All this implies for Halmanera the need to manage continuous design and programming cycles, as well as the rationalization of equipment and production cycles. In this direction, it is fundamental to conceive the supply chain as an inter-functional process, managing all the phases from the proposal of the collection to the delivery of the finished product to the customer, maintaining the quality of the products.

In terms of solutions, it is clear that various activities must be carried out in the context of all the processes that in some way impact with the logistics one. As part of the product creation and development process, it is necessary to structure a collection plan to provide production planning as far as possible in advance: leathers, colors, accessories (configuration); this can allow on the one hand the reduction of the variety of items and on the other facilitate sales because the customer himself can move on a more rationalized proposal.

It is then necessary to carry out interventions aimed at integrating the order management process, so that sales information can be made available as soon as possible. In the area of operations, there are three sub-processes that require particular attention in order to optimize the logistics chain: *industrialization, production planning and actual production*. As far as the industrialization phase is concerned, it is necessary to coordinate the production of equipment, such as shapes and dies, as much as possible, by developing product information with production planning, so as to synchronize production launches and supplies. As far as production planning is concerned - more delicate because it summarizes several variables: deliveries, supplies and production capacity - it is necessary to carry out the planning of needs in the best possible way and from this derive the supply plan taking into account the delivery times of the materials and of the components and times of passing through the different processing phases. Furthermore, it is essential to plan the production of the internal and external departments, taking into account the production capacities required and those available, in order to manage any imbalances with production advances. Finally, as regards production, while considering the high levels of manual skills and craftsmanship of the various stages of transformation, it is necessary to review the internal handling in detail, rationalizing the factory layout and optimizing material flows, through the

principles of reducing waste typical of the lean production approach. As far as logistics and distribution are concerned, it is necessary to start by building partnerships with strategic suppliers, measuring their performance and synchronizing supplies with planning.

Among the aspects inherent in the improvement of the logistics organization in the footwear sector with a special focus in our case, there is that related to the transmission and use of information along the supply chain. The problems arising from a poor sharing of information in this structure lead to accentuate the negative effects of market fluctuations and the variability of demand, with the result of increasing costs and limiting efficiency. An overall view of the state of the supply chain, which describes the situation of the warehouses, the forecast of short-term demand and the flows in place in relation to the individual actors represents an important tool in controlling the chain itself, to be implemented through an integrated, capable logistics structure. to collect data at all stages of the process and to interpret them by processing them on the basis of a global model. A specialized logistics operator can provide the skills and resources necessary to set up such a structure and to effectively manage its operation through modern Supply Chain Management techniques. The latter, supported by a sharing of the demand models, can be advantageously used, in particular, to reduce the effects of the so-called *whiplash, or bullwhip effect*, which leads to amplify the fluctuations of the inventory levels as you goes backwards in the chain. In addition, the same techniques offer tools to optimize inventory levels and handling capabilities in relation to each other. The transition from intentions to the actual realization of innovation in processes and technologies is taking place differently in the various Italian industrial districts, but in general still not sufficient. The obstacles are cultural, also because facing decisions, such as outsourcing logistical activities and / or carrying out internal innovation, on issues that do not constitute the company's

core business, needs a correct assessment of the cost / benefit ratio on which it is missing, precisely , adequate internal awareness. Innovation should be driven by external skills which, by borrowing and adapting thirty-year successful experiences in other industrial sectors, can cut the Gordian knot and trigger without delay a process of mutual innovation and emulation that produces a competitive repositioning of footwear manufacturers on the front of the service. Adequate attention to the triggering of these phenomena must be given by the institutions responsible for industrial policy, in order not to disperse and indeed give new impetus to the assets of industrial fabrics that are still winning players in global competition.

3.5.2 The *innovation* challenge

Technological, commercial and organizational innovation represents a key aspects to face the dynamics that concern supply, demand and distribution also in the footwear system. Especially in recent years, where market dynamics are becoming increasingly complex, the ability to integrate new technologies with company products and processes will be fundamental. For these reasons, starting from the analysis of the market and customer needs up to marketing, Halmanera must be able to integrate technological innovation with the know-how that has always characterized it. In fact, in footwear, not unlike what is found in other manufacturing sectors, the delay in innovation processes is a factor that risks influencing the competitive capacity of the sector.

In this regard, the Istat survey on innovation, conducted within the European CIS (Community Innovation Survey) project of the 2016-2018 three-year period, reports that among companies with at least 10 employees, the share of innovative

companies out of the total number of companies in the sector it is 32.2%. This figure places the footwear sector in the third to last place in the industrial sector and the last in the manufacturing sector. Also with respect to the share of companies that have successfully introduced at least one product or process innovation, there is a serious delay in the sector considering that only 20.2% of the footwear companies have experienced an innovation successfully, against 37.2% of the manufacturing in general. The total investment in innovation, which totaled € 15.5 billion in the industry, also highlights the delay in the footwear sector. In the face of higher expenditure values in the pharmaceutical sector (19,300 euros), in the manufacture of other means of transport (19,200 euros) and in the electronics industry (15,600 euros), the companies in the leather and footwear sector are positioned with an average value equal to 7100 euro per employee, below the industry average which has an average expenditure per employee equal to 8,300 euro, a low value that derives from a total expenditure of innovative footwear companies equal to 650 million euro.

Looking more closely at the Halmanera case, the only technological innovations adopted so far have been the integration of a cloud platform (Dropbox) for the shared management of documents such as: invoices, payment updates, photos, price lists; an ERP system and a platform for e-commerce management. Starting from the cloud platform, it is useless to deny that security is one of the problems that requires the greatest delicacy of evaluation in cloud computing environments and a growing difficulty among those who decide to jump on the cloud. Also, allowing users to access applications remotely via the cloud is a fantastic scenario, but what happens when the user starts uploading files to the cloud? With all the files uploaded, the risk of data loss increases, leading to high management costs. Finally, no IT infrastructure is 100 percent guaranteed from operational disasters or discontinuities. A striking example is the storm of June 2012 that hit an Amazon

Web Services data center, leaving some of the biggest cloud-centric customers like Instagram, Netflix and Pinterest unproductive for about six hours.

Following my experience at Halmanera, critical factors emerged in the use of the cloud platform. In addition to the problems listed above, there was a significant redundancy of information through the exclusive use of the platform for sharing any type of file. Especially, given the strong manual nature of the information processes, data is often lost due to human error to be taken into consideration. Especially in the commercial area, in the management of invoices and payments, the need for an integrated and inter-functional information system visible to all stakeholders could give significant input to company efficiency and beyond.

Even the characteristics of the experimented innovation show a delay for the company and especially for the sector in general. In fact, the membership of the leather industry in the industry with low research and development intensity and low investments in technologies determines a difference in the levels of diffusion of innovation registered by the sector compared to others.

Another relevant element that affects the technological innovation of companies in this sector can be derived from cultural barriers. In this regard, small and medium-sized enterprises in the supply chain such as Halmanera are often family-run. In this case, the experience and technical expertise in the construction of the product can dominate what may be the strategic and competitive choices. In the absence of specialized professionals, establishing a constructive dialogue for an analytical approach to corporate problems is almost unlikely.

On the other hand, by observing the spread of organizational and marketing non-technological innovations, levers that as known have assumed a central role in the fashion system in general in competitive repositioning, a more decisive attention emerges from the company in question compared to these choices of innovation.

More specifically, Halmanera looks at logistics and marketing as two viable innovation tracks. Attention to logistics and marketing also appears to some extent also imposed by distribution dynamics. Indeed, it is necessary to observe how this sector experiences a profound innovation in the sales channels. In fact, sales channels such as e-commerce are having a decisive impact on the company's sales. For this reason, a careful strategy focused on online communication is one of the competitive advantages of the company. In fact, channels such as Instagram, Wechat and Facebook are at the top of the corporate priorities, but as anticipated in the previous paragraphs, market dynamics change quickly and the exploitation of new technologies will be of primary importance.

Without a doubt, it is also useful to note how footwear entrepreneurs look at the effects and functions of technological innovation. In our case, like the majority share of the sector, it attaches importance to innovation processes especially with respect to the possibility of generating a reduction in operating costs and to a lesser extent than an expansion of international markets. The cost factor is of course at the center of production choices but the push towards the search for new products with greater added value and new markets highlights the need to innovate to improve the ability to penetrate abroad and consequently also renew the organizational models. In summary, the company was more oriented towards transparency towards the final consumer and the guarantee of product quality, followed by a logic of sharing data along the supply chain. Specifically, the common need of the reference sector is to develop a traceability system that can become a point of reference for all players in the supply chain and in particular for the final consumer. All this will allow to reduce the negative impacts related to the phenomenon of counterfeiting and, at the same time, to give support to the footwear industry in addressing the growing requests from consumers increasingly sensitive to issues related to environmental sustainability and the ethics of production. Moreover, shared

management of information along the supply chain will be able to improve coordination between the different actors, allowing a reduction in lead time, increasing agility and efficiency and contributing to reducing costs.

3.6 Key findings: toward the *smart* footwear factory

The evolution of market dynamics requires the footwear system to develop a process of technological innovation. In this direction, to ensure a response to the continuous evolution of demand, and to face the challenges present within the supply chains, the main effort of the footwear companies must be to be able to obtain a constant increase in efficiency levels through the innovation. In this regard, the new factor that could accelerate the transformation processes is represented by access to the so-called technological opportunities of industry 4.0, based on production models of the intelligent factory.

For the sector, it would mean moving from processes organized according to the logic of manual intensive, to new models based on the interaction between craftsmanship, automation and digitalization. In fact, automation and digitalization would guarantee production efficiency gains such as to be able to re-install production lines in Italy. Our fucus within the research is based on one of the many enabling technologies of the Industry 4.0 paradigm: the Blockchain. However, when we talk about Industry 4.0, especially in the footwear sector, in addition to the Blockchain we can refer to the main enabling technologies that underlie the smart factory:

- Internet of Things (IoT),

- Big Data Analysis,

- Network of remote servers (Cloud Computing),

- Additive manufacturing,

- Automation through robotics,

- Custom technologies (Wearable Technologies).

In a smart factory, production is supported by a circuit of intangible assets such as "the conception, research and development, design, innovation, modeling and programming of production, logistics, communication, order management in the supply chains. global, brands and related meanings, marketing, the increasingly interactive relationship with the world of distribution and consumption "(Rullani 2015). The production system of the intelligent factory therefore acts as an integrated system guided by ICT technologies and automation in which man interacts by governing processes in a flexible, creative way and where the needs of the final consumer, properly acquired, are the basis of all production and distribution choices. In fact, in order to face such a challenge, small and medium-sized enterprises like Halmanera will have to take note that the new factory must:

- Reorganize processes according to a more efficient logic;
- To have a technological apparatus that allows flexible production management, oriented to the demanding needs of end customers;
- Rethinking a relationship between man and technology in a key of seamless integration.

In this context, the work replaced by the robot is not eliminated and placed outside the production cycle (at least in the experiences examined) because the efficiency gain allows the work to be moved to ensure maximum human input to non-automated processes, concentrating it precisely on the work for higher range products and higher added value as well as customized products. In fact, it would

be a matter of promoting human-machine interaction that puts the human factor at the center of a process in which the added value of his work is crucial. For example, the investment in robotics is important but the costs are not higher than those of traditional machinery. The expense for a robotic cell with a processing cycle of 30 seconds per pair (one third of the human cycle) without risks for humans and without manufacturing defects is equal to about 180-200 thousand Euros. In fact, it seems that one of the critical points highlighted in the Halmanera case is the high level of investment that is not within the reach of many companies in the sector.

Beyond this, it is possible to affirm that information technologies represent the key technological factor through which to develop innovative approaches to product design and rapid prototyping and production in the continuous exchange of information with demand.

The innovation in footwear in particular is manifesting itself in the following phases or functions:

- Virtual prototyping in the context of New Product Development activities

- Introduction of robotics in production processes

- New channels of communication and integration with partners within the supply chain

- Ecommerce and enhancement of personalized demand on the basis of inputs directly collected from customers.

Chapter 4: A BLOCKCHAIN BASED MODEL: The Halmanera case

4.1 METHODOLOGY

The methodology used to define the application of blockchain technology within a business context such as Halmanera has been structured around three main fields of investigation. First, a systematic literature review was conducted on both technology and the footwear industry. After that, an empirical research was conducted focused on the analysis of case study with the aim of comparing and possibly validating the results found from the literature review. Finally, the internship experience has allowed us to analyse the bottlenecks present within the company, proposing a model based on the individual needs of the case under study.

Essentially, regarding the review of the literature (first phase), it was possible to access the main search engines for technical and scientific material such as: Emerald, Elsevier etc. In addition to this, numerous reports and specialized websites have been utilized. Further, to address case studies (second phase), the primary sources of information were: websites, reference newspapers and announcements found on the websites of companies and / or technological partners. The websites were fundamental because they allowed, on the one hand, to access and constantly update data and information. On the other hand, to further deepen the individual initiatives thanks to interviews and dedicated articles. Furthermore, as regards the startup projects, the websites of the individual companies were relevant, at least in

the first analysis. However, the most reliable information was found in the white papers. In the absence of these, it has not always been possible to clearly determine the types of technology used and especially the DLT.

In this context, it is considered important to underline how most of the literature examined tends to focus more on the potential deriving from the implementation of the technology and less on the technical aspects connected to it. In fact, a good part of the writings do not go into the issues and implications inherent in technology almost as if there were some fear in spreading the information. It is believed that the reasons behind these media choices lie in the fact that technology is still in an embryonic stage and therefore there are currently no real and complete solutions capable of meeting the needs of the market and consequently worthy of being mentioned in the scientific literature.
However, it is worth continuing to deepen the knowledge on the topic, refine the capacity, evaluate the benefits but, above all, do not escape the challenges deriving from the implementation of the blockchain.
In fact, the only possible solution remains continuous research aimed at finding answers to the technological, ethical, social and political problems which today are the basis of the major scientific dissertations.

Finally, the internship experience at the Halmanera shoe company allowed me to analyse and evaluate the implementation of a model based on blockchain technology. This allowed me to interview the managers within the company and acquire a complete view of the corporate framework. I would like to clarify that, instead of focusing on technological elements, the work has ben based on the proposition of a new business model and its possible implications at the level of interaction between actors present within a supply chain.

4.1.1 Research objectives

In this paper, a study of blockchain technology is reported to one of the most relevant sectors of Made in Italy, the footwear sector. The basic idea of the project is that distributed ledger technology can play a key role in improving the interactions between actors along the supply chain and improving transparency in the offer of Italian products to consumers. The intrinsic characteristic of the underlined technology has showed its potential within different business applications, in particular of small and medium-sized enterprises which, even if they constitute a fundamental portion of our social and economic system, often find themselves competing in unbalanced conditions within of complex and extensive national and international supply chains. For these companies, Blockchain technology can prove to be a very useful tool because it can allow them to enhance the quality and excellence of their productions, allowing them to take on a more prominent role and, therefore, a stronger negotiating power in the different value chains.

Within this scenario, a question arises: " *Why the Blockchain technology has been chosen? "*.

To answer this question, it was necessary to use an 'inclusive approach'. This means that, before proposing the blockchain as a possible solution, the needs and requirements of the company were analysed and interpreted. In this way, the principle was to adopt a model not starting " from technology " but " from the needs " of the company and the actors that make up the supply chain. In fact, only after carefully acknowledging which were the main difficulties, was it possible to proceed with the adoption of a business model based on Blockchain technology.

In this direction, also through the help of the startup " Apio srl " it has allowed me to define a model of approach to the needs in the field of traceability and coordination within a complex, structured and replicable ecosystem. In fact, although simplified, the representation of the supply chain developed during the project constitutes an important contribution to the conceptualization of inter-chain cooperation and traceability models that could be adapted to other sectors of Made in Italy. This enabled solutions that normally can only be found by multinational companies or large consortia.

In this regard, the challenge that I wanted to launch by starting this project ("to understand what the problems of a Made in Italy chain were to find, if possible, a shared solution, trying to understand the role that the blockchain can find in it") has led to go beyond technology.

Experimentation has made possible to understand that in order to restore competitiveness to companies, the approach to follow is basically what allowed our country to give life to the great excellences that still distinguish it at an international level: manufacturing capacity, creativity, craftsmanship, skills , culture and ability to create a system. From this point of view, the blockchain be one of the main enabling technologies to strengthen the ability to create a system around the deepest and most consolidated values of our community. Specifically, in order to explore the potential of the proposed technological paradigm, it was decided to analyse the peculiarities of a specific sector - the footwear industry - and to focus on the issues of: Traceability, trust and transparency, visibility of the supply chain and enhancement of Made in Italy. For these reasons, the technology selected to meet the needs identified is the Blockchain which, due to its intrinsic characteristics, allows you to trace and verify the authenticity of data and information in a secure, immutable, and especially in real time.

4.2 Italian footwear ecosystem

The footwear sector is one of the pillars of the international fashion system and has always been the undisputed leader among manufacturers of luxury footwear with a high fashion content. In this scenario, the sector represents a reality of absolute quantitative importance, and even more qualitatively on a national economic level. This success of the entire sector is connected, as already discussed, to the enterprising entrepreneurial initiative that led to a strategic repositioning based on high-end productions and to the typical sector " supply chain " structure, consisting of an efficient system of sub supply of raw materials, accessories, components and presence on the territory of specialized model makers and stylists. What follows is a territorial concentration of final and intermediate companies in areas organized in industrial districts, the most important of which are located in Veneto, Emilia Romagna and Marche. For these reasons, given the importance that Italian production holds internationally, enhancing Made in Italy is a priority.

Looking at the overall performance within the national market , undoubtedly has suffered due to the many difficulties already highlighted. **Table 2** compares the situation of Italian footwear industry between 2017 and 2018. The analysis reveals a slight drop in production levels (-3.3% in volume compared to 2017), but at the same time also a new peak in foreign sales in terms of value (+ 0.8% compared to 2017). Despite this, the Italian footwear sector has a turnover of 14.3 billion euros, employs 75,000 workers and exports 85% of the production. These important data indicate how, in the face of the great transformation and downsizing of the sector, the "made in Italy footwear" has been able to carve out for itself a space, however small, capable of generating a high level in value.

Table 2: the Italian footwear industry 2017/2018- Highlights

DESCRIZIONE *Description*		2017	2018	VARIAZIONE % *Variation %*
Aziende *Companies*		4.708	4.505	-4,3
Addetti *Employees*		76.600	75.680	-1,2
PRODUZIONE *Production*	paia (milioni) / *pairs (millions)*	190,7	184,3	-3,3
	valore (milioni Euro) / *value (million €)*	7.797,56	7.861,24	+0,8
EXPORT	paia (milioni) / *pairs (millions)*	211,1	203,2	-3,7
	valore (milioni Euro) / *value (million €)*	9.195,55	9.585,40	+4,2
IMPORT	paia (milioni) / *pairs (millions)*	333,9	336,1	+0,7
	valore (milioni Euro) / *value (million €)*	4.655,14	5.161,36	+10,9
Saldo commerciale *Trade balance*	paia (milioni) / *pairs (millions)*	-122,8	-132,9	-8,2
	valore (milioni Euro) / *value (million €)*	4.540,40	4.424,05	-2,6
Produzione per l'interno *Production for domestic consumption*	paia (milioni) / *pairs (millions)*	28,1	27,4	-2,3
	valore (milioni Euro) / *value (million €)*	1.121,76	1.106,02	-1,4
Consumi interni *Domestic consumption*	paia (milioni) / *pairs (millions)*	194,5	193,6	-0,5
	valore (milioni Euro) / *value (million €)*	3.629,87	3.627,69	-0,1
Export/Produzione % *Exports/Production %*	paia / *pairs*	85,3	85,1	-0,2
	valore / *value*	85,6	85,9	+0,4
Import/Consumi % *Imports/Consumption %*	paia / *pairs*	85,6	85,8	+0,3
	valore / *value*	69,1	69,5	+0,6

Source: ISTAT

Despite all this, however, Italy, with approximately 184.3 million pairs produced and one always active trade balance, it is still by far the first producer off footwear in the European Union, ahead of Spain and Portugal, with a market share approximately equal to 1/3 of the total production.

By further widening the borders, Italy appears to be internationally the eleventh country by number of pairs produced and the ninth exporter at the level worldwide, as well as only the third in terms of export value . This primary position in the global markets of the footwear industry is reflected in one extraordinary competitive ability that is based above all on very high standards quality of the products and then on the working capacity of the district workers they make traditionally the basis for innovation.

The competitive repositioning of many Italian companies towards high products added value and, therefore, towards higher range footwear, has resulted in a redefinition of the relationships between **local, intermediate or final companies**, e the world's leading companies. The latter in particular, by seeking more and more suppliers capable of guaranteeing reliability and above all quality, began to direct their production choices towards small national realities, thus contributing to bringing the processing back to the original districts. The need, therefore, to establish commercial relationships with specialized subcontractors to obtain the best solutions from a qualitative point of view, has led to the development of real models of co-designing production in an increasingly important information exchange, made possible by the spread of links computer scientists on shared platforms.

The client footwear company, at the top of the value chain, is thus transforming itself into a sort of tertiary company which, starting from the continuous observation and interpretation of the signals coming from the market and demand, designs new

models to then give production instructions. , co-planning together with the associated third party companies. It is therefore clear that, in the Italian footwear sector, several production models and an intricate series of relationships persist that involve the final and intermediate companies, and which lead to obtaining that competitive advantage over the high-end production capacity. The relationships that are thus established between the final client companies and the subcontractors, specialized in activities such as cutting, hemming, assembly and in the production of forms, heels, soles and insoles, assume those positive characteristics of collaboration that give life to a process of problem-solving and continuous improvement, thus feeding the innovative path.
In this context, to better undestrand how Halmanera work, a definition between final and intermediate company need to be done:

- **Final companies: Halmanera**
  The term "final companies" is referred to those companies that are vertically integrated and therefore capable of autonomous driving the whole production process, starting from the design of the samples to finish with the marketing of the finished product. However, they can be defined as "end companies" even those companies that focus only on the phases with the highest added value, For example, keeping under its control only critical activities such as sample preparation and production. To top it off, they can though also those companies which, not having at all of production plants simply act as customers and concentrate exclusively on phases such as product design and / or marketing. Many Italian companies have developed in the Italian district production structure these, mostly able to coordinate the entire process also through any outsourcing of production.

- **Intermediate companies**

  The traditional model of intermediate company is characterized by the fact that it does notvcontrols neither the upstream phases, such as product conception and development, nor the downstream ones, such as marketing and distribution. Therefore, not having direct relations with the end market, nor even its own trademark, the district intermediate company can assume the identity of:

  - *Sub-contractor company*, which specializes in the production of semi-finished and / or products components such as shapes, heels, soles, insoles, various accessories, or that it manufactures a specialized phase of the production process such as cutting, cutting
  joining and assembly following the client's specifications;

  - *Third party company*, which can control the entire production process with a certain degree of autonomy, starting however from the design phase for only finish with assembly and packaging.

4.2.1 A simplified supply chain framework

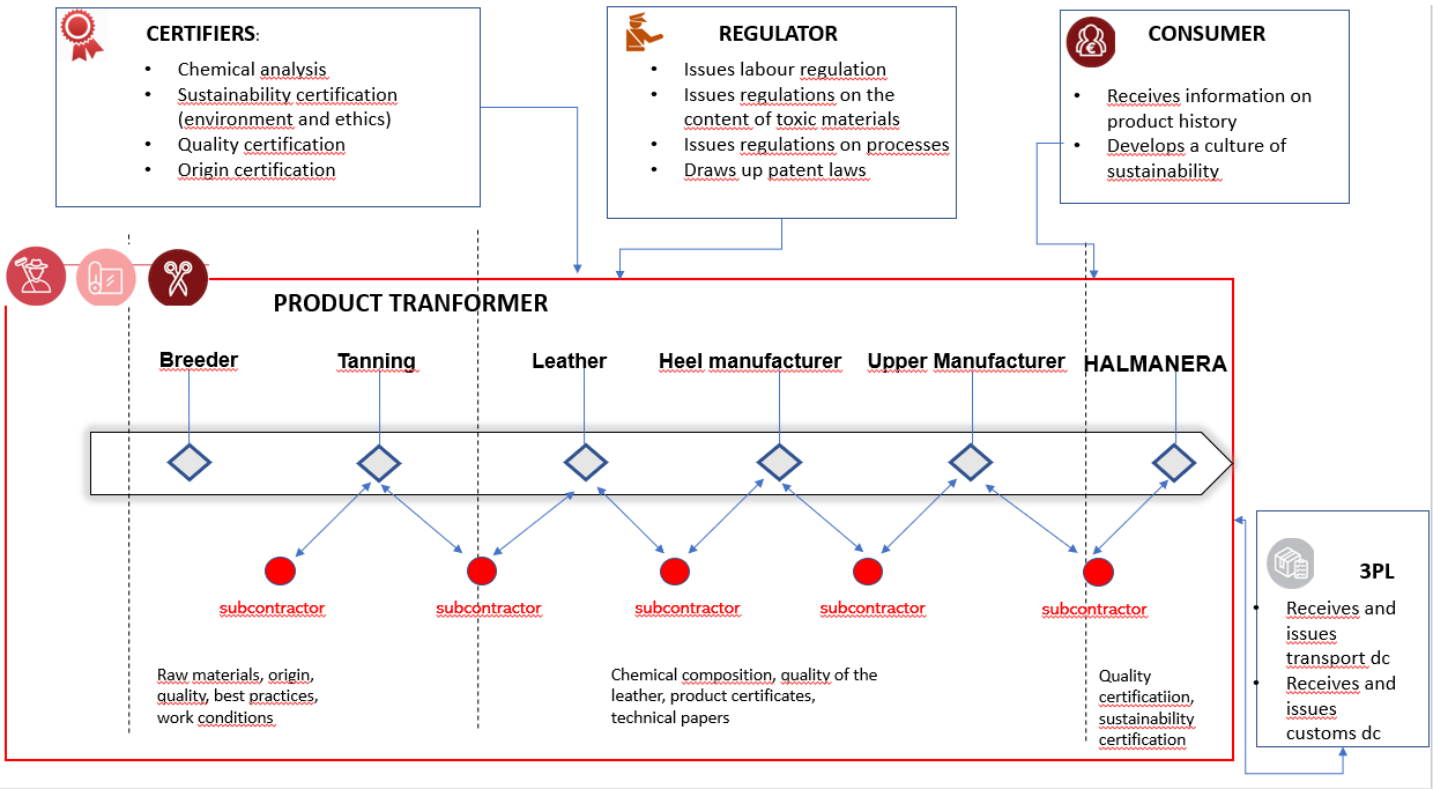
To better understand the potential in the application of this technology, the main focus is to understand and analysis of the ecosystem in which Halmanera acts. In fact, only after a careful analysis of the sector's problems is it possible to understand the solutions proposed by the blockchain. In this regard, the reproduction of the ecosystem, albeit simplified, in which Halmanera operates, is essential.

First of all, in this phase a selection of the main actors has made, by identifying them based on their role and relevance. From the company analysis and from the interviews with the company's management, it was decided to identify five main actors that are named ‘’product transformers’’ in order to build up a simplified

supply chain representation of the footwear ecosystem in which Halmanera operates **Figure 21:**

1. The skin breeder
2. The Purchasing Manager for Semi-finished Products (Manufacturing Company)
3. The certifier
4. Halmanera (Brand)
5. The final customer

Figure 21: Supply chain footwear ecosystem



Source: Personal reproduction

On one hand, those acotrs listed above can be identified as the main and crucial product transformer involved in the production of a shoe. On the other hand, the supply chain ecosystem rely on a multitude of entities that either directly or indirectly contribute to the system. Interactions and interconnection among those entities and product transformers are crucial. For example, a blockchain-based framework such as without involving a 3PL or could not produce any benefit. At this purpose, here below will be presented the tasks and contribution of every actor involved in the footwear supply chain of Figure 21:

- The first group of identified actors is represented by footwear transformers: these include breeders, leather transformers (tanning, dyeing, preserving) and the Halmanera brand that orders accessory leathers. At each stage of the process, the actors must comply with the request expressed directly by Halmanera which collect orders and commission downstream product transformer.
- Furthermore, the actors in the supply chain rely on a dense network of subcontractors for the supply of accessories (e.g. hinges, soles, semi-finished products etc.). The management of the interactions with the subcontractors - logistic management and possible quality controls on the product - involves an expansion of the delivery times, and rework in case of poor quality.
- Certification bodies issue documents to ensure compliance with environmental sustainability, ethics and quality standards. These assume a high value especially in Asian countries (Japan, Korea, China) as they are particularly sensible about purchasing certified products. It should be noted that it is currently not easy for an actor to know exactly what types of certifications have been obtained by the actors upstream and, above all, on which batches of product they apply, if we consider that there are few

documents that travel in long paper form the supply chain. Furthermore, there are often regulatory differences between country and country regarding the mandatory nature of certain certifications.

- Third party logistics (3PL) often play a fundamental role along the supply chain. Since the are in charge of receiving and issues transport documents, Establishing and maintaining trust with shippers and carriers is not an easy task. 3PLs need to rely on third-party services to evaluate creditworthiness and past records before moving a shipment. Using blockchain technology, 3PLs will be able to build their reputation, as well as see other users' reputation, based on real performance indicators such as: real time traceability, loading time, on-time pickups and deliveries.
- Regulator is in charge to issues regulation that must be followed by the entire supply chain entities that operate within the blockchain ecosystem. In this way, it can be a public entity that express standard to respect by improving the information flow within the system.

Undoubtedly, as anticipated previously, the causes of the critical issues need to be found not only in the structure of the business ecosystem - which is undoubtedly fragmented - but also in the difficulty of tracing and tracking products and information flows along a complex and fragmented supply chain. For these reasons, a blockchain-based solution could drastically impact positively the entire network of participants by enhancing a new concept of interaction and interconnection. Now it's time to look over how a blockchain affects Halmanera's supply chain!

4.3 *A blockchain based model scenario*

In this section, a blockchain-based model within the footwear sector is proposed. Specifically, how it could leverage and level up the concept of ''Made in Italy'' from both supply chain and customer perspective. The basic idea is that distributed ledger technology can play a key role in improving transparency in the offer of Italian products to consumers and visibility along the business network.

This has the greatest impact on those companies operating in our territories and in particular on small and medium-sized enterprises such as Halmanera which, although constituting a fundamental portion in our economic and social system, often find themselves competing in unbalanced conditions within complex national and international ecosystem. At this purpose, blockchain technology laid the foundation to be the technology that allows the company to enhance the quality and excellence of its productions, assuming a prominent role towards new business models.

The Information Technology processes adopted so far by the company is not able to provide a sufficient transparency and synchronization of business processes to the entire supply chain, nor in a comprehensive manner that guarantee consumers requirements in terms of origin and provenance of production. As anticipated before, given that logistics, business management processes and information flows are managed by **non-automated channels** (telephone; fax; email etc.) based on paper documentation, there is still no connection between all companies involved along the supply chain. In this regard, **fragmentary, incomplete and contradictory information** deriving from traditional operations, do not offer reliable and shared information in each step of production and do not allow timely actions to be taken in the event of malfunctions or irregularities.

In this context, the blockchain can provide a secure, distributed and shared vison of information with respect to the actors in the supply chain, creating new and reliable connections between ecosystems that did not previously exist. As anticipated in the previous chapters, this technology enables and facilitates the registration of an asset in a business network or ecosystem.

This scenario is possible thanks to the attributes of blockchain technology that have been illustrated in chapter 1. In a context in which many small actors compete and collaborate through a supply chain that extends beyond national borders, the application of the blockchain can have a positive influence on small and medium-sized enterprises, because it simplifies the interactions and transactions between the different actors, whether they are control bodies, certifiers, clients or producers on their own or on behalf of third parties. Furthermore, the possibility of having an updated history of the operations carried out constitutes the basis on which each member of the network will be able to build his own "reputation", as he is responsible for the information he registers there. As a result, companies could strengthen their position and visibility within the supply chain, both nationally and vis-à-vis international competitors. Finally, looking down the production chain, better traceability at the supply chain level would make it easier to develop applications that allow greater transparency towards the end customer, allowing a more informed purchase.

From a business perspective, especially in footwear industry, there are several areas where blockchain could impact actors involved. In this regard, it has been have tried to condense the 6 advantages that the blockchain can offer to a company such as Halmanera.

1. Eliminate manual processes and repetitive logics for data validation.

2. More reliable data structure about the origin of the products, with one consequent growth in the consciousness of consumers trust, quality and environmental impact.
3. Improvement to the logics of market access and the development of new products.
4. Reduce the risks associated with the spread of counterfeit products.
5. Cut the costs of financing and credit rates, thanks to transparency and to the certainty of product handling.
6. Increase the efficiency and visibility of your production, aligning it with the real demand.

4.3.1 THE SIMULATION: *Trusty* for footwear

To better understand how blockchain could operate within the footwear ecosystem in which Halmanera operates, five main players has been identified in the previous paragraph. At this point, we will simulate the life cycle of the product along the entire supply chain, involving the main players that characterize the reference ecosystem. This representation will help us understand how, through the application of this technology, multiple improvements can be achieved that go beyond the logics of the supply chain and the internal management of some information processes.

In fact, in addition to the support of Made in Italy and the enhancement of the quality of products and processes, the blockchain allows the end consumer to view

the main information relating to the processing stages for a shoe to verify quality, sustainability, ethics and origin, towards a new shopping experience based on the concept of storytelling.

In this direction, **Figure 22 shows a view of the solution structure** where: a **manufacturing company** requests the **breeder** from a batch of material that must be certified as organic. A **certification authority** can validate (or not) the batch of raw materials and the attached documentation, before the batch can be shipped to the manufacturing company and that it is subsequently processed and shipped to the **brand (Halmanera)** to be assembled and sold to the **consumer**.

Specifically, when a blockchain solution such as Trusty is implemented within the Halmanera production chain, the implemented features allow:

1. To the **breeder** of the raw material (leather) to send the documentation to the certification authority, to obtain approval, responding to the request to achieve leaner interactions with the certification bodies. It is possible to upload selected certificates, among the many available, for each of the chosen areas of action;

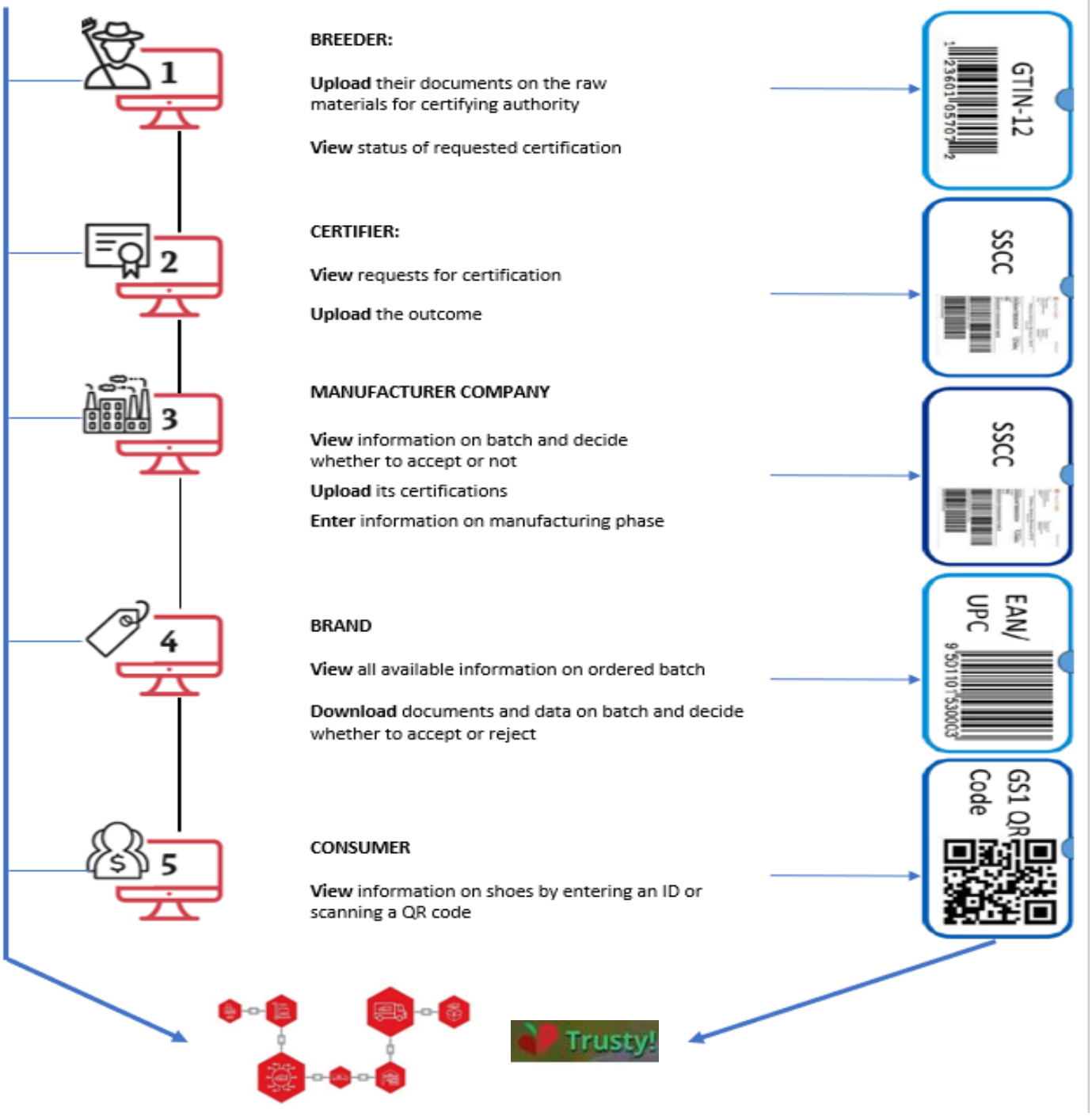
2. **The certification authority** to view the grower's certification requests, in order to view it and then approve or reject it;

3. To the **manufacturing company** to accept or reject a batch of incoming raw material, associate it - if approved - with a product and enter information relating to the origin of the processing phase;

4. The **brand (Halmanra)** to have visibility on the processing phases undergone by the raw material (processing, painting, tanning), on the origin and any certifications available;

5. The **final consumer** to obtain summary information (origin, quality, sustainability, ethics) on the product he is purchasing.

Figure 22: Structure of data registration on blockchain



Source: Personal reproduction

Despite its simplicity, the proposed architecture includes all the components of a blockchain-type application, including the definition of a Smart Contract that contains the consent logics that allow validating the transactions performed by users. In fact, in this case Smart Contract provides constraints such as:

- ✓ Uniqueness of the IDs of the traded assets (batch of raw material or finished products);
- ✓ Existence of the asset ID before each change, to prevent incorrect information from being entered. This implies that the breeder must start the process by entering an ID for the batch of raw material, which will subsequently be associated with a product ID;
- ✓ Verifies that at each stage of the process, the asset in question has all the validation timestamps that refer to the previous steps. For example, before sending to the manufacturing company, it is verified that the batch of raw material is associated with the production timestamp, creation of the asset on the blockchain and validation by the certification authority;
- ✓ Verifies that each actor performs only the operations allowed for his role (for example, the certifier can only accept or reject the documentation exposed by the other actors, but cannot modify its content.

It seems clear that, in a business context such a Halmanera company, the implementation of blockchain technology would involve a completely different approach, based on digital principles and following a logic based on secure and transparent information. As anticipated in the previous chapters, the blockchain's vision is to redesign what are the actual business processes within a footwear supply chain. Especially in the case of Halmanera, the need for transparency, traceability and coordination between the actors present within the supply chain represent elements of primary importance that a blockchain solution could satisfy.

In this regard, to make this happen, from a practical point of view before analysing benefits and the implementation of the blockchain model, first of all setting up a blockchain solution in supply chains generally requires the following steps:

1. Identification and Registration of the actors:

As a first step, all actors in the supply chain need to be identified and assigned roles based on their position in the supply chain. In the case of footwear, for example, the key actors are the breeder, the leather, the spinner, the tanner and retailers. It is clear that also sub-supplier could be registered, the more the actors are registered the better is the outcome of the solution.

All the entities involved will be provided with a public / private key to reflect their digital identity on the blockchain. In this way, records are now available for inspection on the blockchain by the entire community. It also provides the trust element that enhance the reputation within the network.

For example, all mapped raw material producers, process intermediaries and manufacturers are registered onto the network and assigned a digital signature to sign their transactions.

2. Assets Registration:

As anticipated in chapter 3 the key idea is to create a "digital twin" of physical assets so that the digital twin can be traced through the shared ledger. This digital twin is recorded in the immutable shared ledger and used by subsequent actors in the value chain as input for their decision making and risk management processes.

This process creates a token or digital identity for the asset. In fact, this digital identity of the assets is the key to transacting on the network. For example, the tanner processes 2 tons of leather and registers it on the blockchain.

3. Digital settlement of asset delivery against payment:

When goods are delivered to the next actor in the supply chain, settlement of the transaction can occur instantaneously using a digital currency once the next actor confirms receipt of the physical goods and digital twin. In this context, a smart contract can automate this in real time. Once the actor accepts the batch, automatically, using a digital currency wallet the funds will pay the seller.

4. Digitize manufacturing and production workflows

Each actor digitizes its own workflow and declares it to the network for validation and approval. Validated workflow data elements are used as smart contract parameters, and as a basis for anomaly detection. This steps could significantly impact the inter-connection among actors by giving information in real time directly to the entire network. For example, when Halmanera receive an order from a customer, this information could be visible in real time by all the supplier. Clearly, this will impact the lead time and costs across the entire supply chain.

5. Link outputs to inputs:

Each subsequent actor in the value chain would link the inputs it uses to the (digital) output created in the previous phase and then add on any new output information following their production process. For example, in Halmanera supply chain's case,

when a raw material changes form (eg the leather), the traceability system should link outputs to inputs by logging certain characteristics of the transformed material (eg the weight and quality), generating a mutually agreed upon identification number for the new output, and adding this information to the blockchain.

6. Includes verifications and risk profiles

Crucially, a blockchain-based process does not replace the responsibility of business actors to carry out verification of information inputted into the blockchain. Blockchain is a means to gather, store, and analyse due diligence information, but does not replace the human element. Assessments of business relationships, such as on-site inspections and audits, are still an important part of a risk-based approach. The type of assessment that an enterprise employs will be tailored to the nature of the risk. The outcomes of these controls / audits can be uploaded by authorized parties on the blockchain, allowing supply chain actors to have a view on the risk landscape throughout the supply chain, depending on the type of blockchain permission structure being implemented. For example, a certification agency could file its inspection report on a site visit of a leather producer on the blockchain, or a kid breeder could upload a certificate of non-mulesing (an animal cruelty prevention measure) to its raw material digital twin when it is first written to the blockchain.

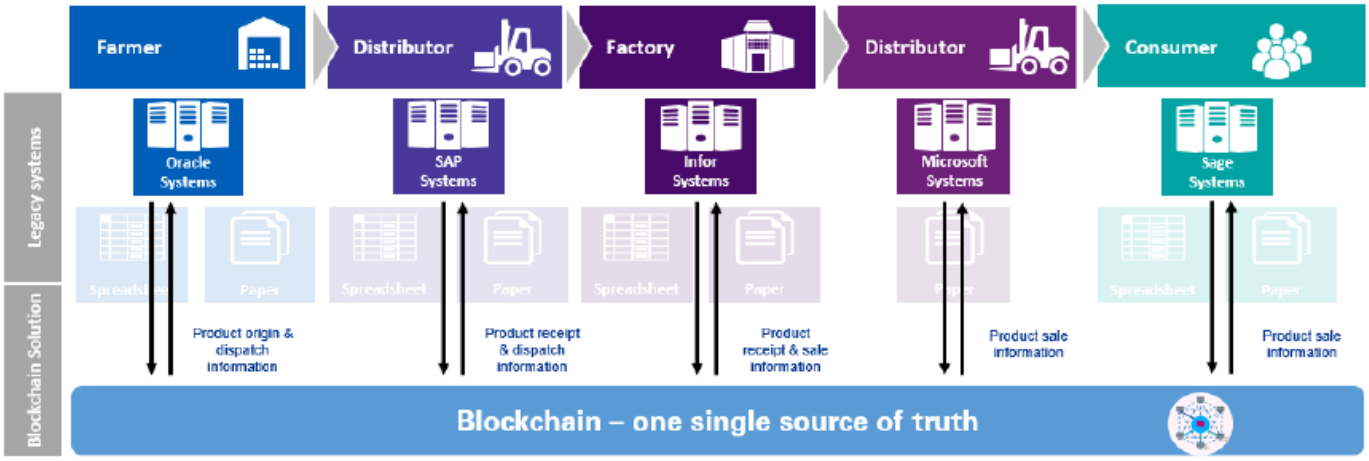
7. Create access to information

Supply chain actors should be able to view the information on products and materials in their supply chains. In line with the features of the technology, the

blockchain should enable meaningful disclosure to the public and other relevant stakeholders.

Within this ecosystem, following a well-defined strategy and through a digitization process, the vision that proposes blockchain technology can also be implemented in small businesses such as Halmanera. Especially, what will allow this technology can be defined as a " shared vision " of the supply chain by all the actors present within the network. **Figure 23** shows an example of " shared ledger vision ".

Figure 23: Example of a shared ledger vision



Source: Deloitte, 2019

Furthermore, it is useful to specify that this scenario described directly and indirectly impacts further business areas that go beyond the concept of supply chain. And it is precisely the large operating margin that allows the Blockchain to be attributed as one of the most revolutionary technologies. Despite the numerous areas of application described in chapter 3, the next paragraph will focus more on

the solutions that Blockchain technology can bring to you, with two protagonists of the research: Halmanera (fashion-brand) and Customers.

The analysis on the proposed model highlighted how blockchain technology appears particularly suitable for the enhancement and support of Made in Italy, as it allows to overcome the traceability problems typical of the processes currently used by the company (Halmanera). In addition, it has been conducted an analysis on the factors that enable blockchain technology to new customer engagement paradigms and the improvements it brings to all the players in the supply chain.

4.3.2 The logic of the solution: practical assumptions

Undoubtedly, given the prototypal nature of the solution, the enabling features cannot be exhaustive of all the possible interactions between the players in the supply chain. In this regard, it is necessary to make considerations on two fundamental aspects: **the reference ecosystem and the production process.**
As far as the first one is concerned, not all the players in the footwear industry have been taken into consideration; for example, there are no analysis laboratories which contribute to carrying out checks on materials processed along the production chain and subcontractors. In addition, the current network only has one actor per type, while in reality each actor - for example the manufacturing company - can maintain relationships with multiple actors upstream and downstream. In this direction, when we talk about a manufacturing company we are exemplifying the role that raw material transformers (leather) could play on blockchain, whether they are tanners, stitches, packers or subcontractors.

Regarding the production process, and therefore the interactions between actors and the work flow, we can assume that: the breeder regularly sends batches of raw materials to the producer in an automated and continuous way. In addition, the certifier must approve the documentation uploaded by the grower of the raw material before the latter can make the batch information visible to the manufacturing company. This hypothesis is restrictive because in production conditions there is no material time to approve each batch before its shipment. We also consider that, all certification documents are paper and can be authenticated as well as dematerialized and registered on the blockchain. This clashes with the degree of the current level of digitization of the supply chain. In addition, each asset can be sent to a single entity: in a production scenario, one-to-many logic should be implemented so as to allow each company to interact with a plurality of upstream and / or downstream actors.
These operating hypotheses constitute simplifications adopted to carry out an experiment aimed at achieving the set objectives, but they can be reviewed and released in any subsequent phases based on the production scenario to be implemented.

For the purpose of applying this technology, it is also essential to clarify that:

A. It is necessary to verify that the requirements for real-time availability of information are reconciled with supply chain timings that are sometimes long (e.g. the approval of certifications can take too long compared to the need to comply with delivery constraints);

B. There is also a need to establish governance and a relationship between different supply chains that use different applications (based or not based on the same blockchain).

Therefore, points outlined so far imply a revision of the consensus rules and an adaptation of the application logics of this technology which, despite being simplified, impacts the traditional business logics. In this direction, the **functionality** of the application and the **user interface** are fundamental pillars that we have illustrated with Apio's Trusty application. In fact, the solution must provide the final consumer with aggregate data on the certifications associated with a product and not the detail of the individual processes.

For this reason, it is necessary to distinguish between information that - tracked allows to facilitate intra-chain interactions and those that instead allow to give visibility to the final consumer on the characteristics of the product he is purchasing.

Lastly, the company highlighted the need to increase the level of digitization of the documentation exchanged along the supply chain (involving the relevant bodies), for example by allowing the use of digital versions of documents currently accepted only in paper format.

All the suggestions proposed by the participants in the initiative represent a starting point for evolving the prototype solution developed and constitute an added value for the design of a supply chain approach that can benefit all the actors involved.

4.4 The blockchain business model

Discussion with the company where I worked for, enabled the collection of functional requirements for a blockchain type-solution in support of Made in Italy in the footwear sector. Once the reference ecosystem is characterized and understood, it is necessary to define the future business model based on key benefits of blockchain. The starting point for the construction of the business model is the definition of the asset (or token) to be exchanged among business participants. By its nature, blockchain is a distributed, decentralised and collaborative structure which enables players to interact on an equal level. However, this result is only possible if a network effect is reached whereby the number and type of participants justifies the investment and enables the construction of scalable business over time. One of the best ways for incentivising the entry of new players in the network is to establish a climate of mutual trust among participants, for reassurance as to the security of exchanged data and agreement on rules – Smart Contracts – which guarantee the validity of shared information. In other words, if the primary objective is to support Made in Italy, promoting excellence and local products, companies, bodies and associations must converge towards a common model of exchange and tracing of information which increases purchased product value for the end consumer.
In this way, it emerges that by setting specific rules, enabled by smart contract, the participants of the network are able to trust each other. Only in presence of mutual trust, the network of enterprises could along the supply chain could contribute to develop and implement the blockchain technology.

This is possible by evaluating the impact on the network, identifying areas of saving on costs or process improvement for each component of the ecosystem.

Basically, this model is structured around three main pillars **Figure 24:**

- **The business model**: represents the peer-to-peer exchange on blockchain
- **The governance model**: define right rules for participants
- **The incentive model**: everyone within the network is in a win-win situation

Following, details on what each of these components entail are provided below, before describing the suggested technological model.

Figure 24: Base elements of the blockchain business model

Source: Mise, 2019

4.4.1 The *governance* model

Once the ecosystem is defined with the specific business model, rules and processes must be defined, namely the governance model. In this context, the term governance indicates two complementary elements to take into consideration:

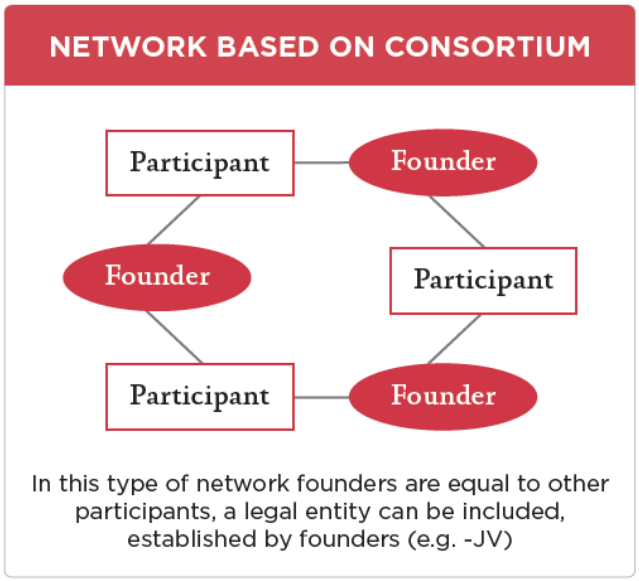
1. *Governance of solution.* Refers to all rules which determine how organizations using a solution interact with each other. In this context, we can refer to the 3 typologies illustrated in chapter one (Public, Private and Consortium).
2. *Blockchain Governance.* Refers to the structure and process which determine how blockchain technology is maintained and evolves over time. This category includes entry/exit methods for new and existing players over time, the management of information, the level of privacy etc.

In both cases there are two different components that can affect the governance model: **incentives**, that will be presented below, and a **mechanism for coordination between parties**. Especially, the latter must be prepared whenever the incentives of participants fail to align, giving rise to a need to define a process for convergence towards common objectives. As highlighted in the diagram below, the Governance of the solution may be a network based on different models:

- *Consortium Network :* if the network is of an Industry Utility kind, it may be useful to create an equal consortium, in which all participants can join the initiative upon payment of a fee, monthly for example, given that costs and benefits are distributed and tangible for everyone (for example in relations between a bank and its customers and other banks). For the blockchain solution to be sustainable, all market players must join it (for example, the advantage of reduced transaction costs between players is due to greater transparency guaranteed by blockchain and is reduced by the

presence of a third actor, another credit institute, which has not joined and thus must be approached with traditional business logics. (Figure 25)

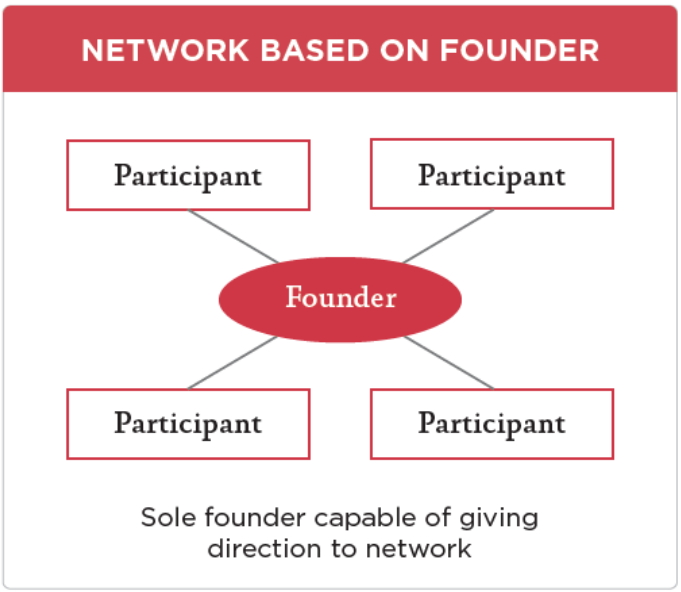
Figure 25: Consortium network



Source: Mise, 2019

- *Private or FounderNetwork:* this model is particularly suitable when there is a very strong player in the supply chain, which can involve companies up and down stream. The founder becomes a guide within the network and can decide to implement an access fee or otherwise, based on expected benefits. This governance configuration can be adopted in the context of our case since **Halmanera** could have the power to involve a multitude of actors upstream and downstream (Figure 26).

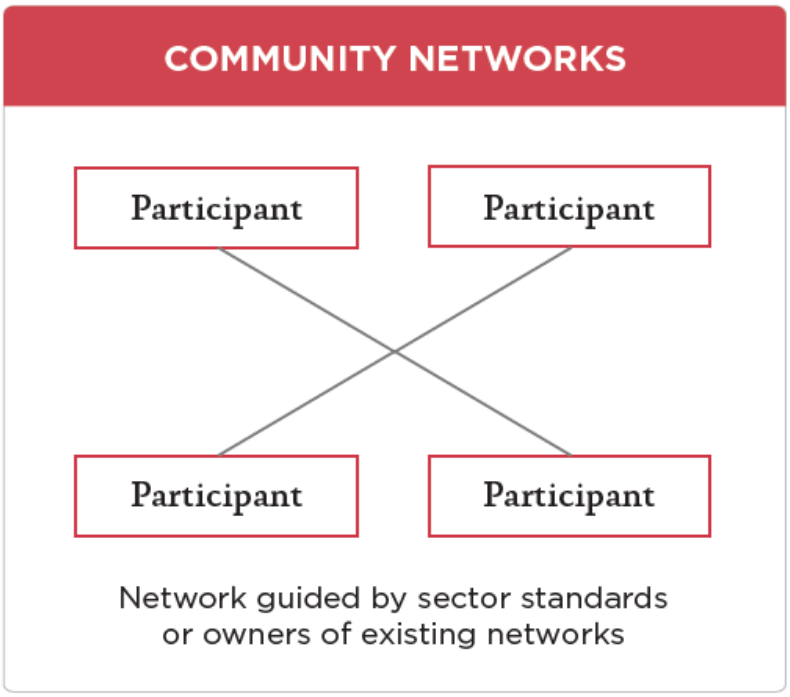
Figure 26: Private network



Source: Mise, 2019

- *Public or Community Network*: created in contexts in which there may not necessarily be a pre-existing business, or for the creation of new interaction opportunities among players involved. Plastic Bank is an example in this sense, which incentivises the collection and recycling of plastic, with the distribution of tokens in the form of economic incentives, thus creating an "inverse" supply chain which complements the traditional one of plastic material processing (Figure 27).

Figure 27: Public Network



Source: Mise, 2019

4.4.2 The incentive model

When a blockchain solution is built, its success depends on its capacity to create value which is recognised by all ecosystem participants. Advantages of belonging to the network must be clear and evident before the technological development of the solution and should incentivise the participation of players. Five main types of incentives can be identified:

a. reduction of costs to increase operative efficiency;
b. improvement of end user experience;
c. new opportunities for earning thanks to the acquisition of new customers;
d. improved management of operative risks, with consequent reduction of associated costs;
e. reinforcement of image and leadership on market.

It is essential to create a model of incentives which changes over time and is based on what participants hope to achieve from using the solution. To analyse the **model of incentives**, the following considerations can be shared, in more general terms regarding the economic feasibility of an initiative, based on three analysis directives:

1. *The characteristics of business network participants:*

For the initiative to be able to yield sustainable benefits, capable of justifying creation and operating costs over time, it is important that participants live up to certain criteria:

- Representation of main players of the production chain (customer-provider relations) to cover the most important information flows and value;
- Focus on quality production with industry certifications;
- Involvement of a supply chain head, capable of promoting the attributes of quality, origin and sustainability in the eyes of the end consumer;
- Involvement of at least one actor that is sufficiently structured to act as a guide for the implementation of governance and funding best practices.

Within this scenario, players involved during the blockchain-based model in chapter 4 enabled an in-depth exploration of the initiative's importance for covering aforementioned needs. Despite the simplified model, it is possible to express a preliminary positive evaluation regarding the capacity to represent the main customer-provider relations to cover the most important information flow. Further to this, it is possible to argue that Halmanera could act as ''*supply chain head*'' according to its position at the end of the supply chain. The company, should be capable of promoting the benefits and of the solution downstream the supply chain. It should be also the pioneer of quality, origin and sustainability in the eyes of the end consumer.

2. *Categorization and estimate of attainable benefits:*

In this context, and in relation to the study case, attainable benefits from adopting a blockchain solution can be divided into three categories:

a) Increased turnover
b) Reduction of costs
c) Intangible or indirect benefits

Increased turnover can substantially be attributed to three phenomena:

- Reduced counterfeiting
- Greater commercial success (volumes) of characteristics products through quality, provenance, sustainability and ethics attributes through the storytelling features enabled by the blockchain technlogy
- The biggest price premium obtainable through the characteristics of intermediate and end products.

The reduction of costs is correlated with two main principles:

- The simplification of communication processes between players involved, with a relative reduction of burdens of reconciliation and management of exceptions;
- Dematerialization of document flows

Lastly, the **main intangible benefits** can be categorized as follows:

- Image, visibility and brand perception;
- Increased intermediary brand visibility in the supply chain in the eyes of the end consumer;
- Promotion of a sustainable and quality Made in Italy production model

Obviously, the entity of said benefits, coupled with an estimate of their value, varies according to the type, quantity and field of application of a blockchain-type solution and is difficult to quantify beforehand. Based on opinions and preliminary findings collected within the company, it is still possible to express a favourable assessment regarding the attainability of said benefits to such an extent as to justify investments necessary for the start-up and growth of the initiative. In this regard, next paragraphs will focus on the evaluation of main benefits that a blockchain solution could provide, and to what extend they are going to provide new services and business solutions.

3. Incubation, incentivisation and funding tools:

Incentive tools which can be made available to companies in order to support the initiative in economic-financial terms can be divided into two main categories:

1. Measures usable by single companies to improve own competencies and performance and to buy innovative equipment and technologies
2. Measures usable by companies for the development of aggregation projects, based on ‘’systemic’’ technologies or which in any case aim to favour complex transformation processes of business systems.

These two classes of measures seems to be tied in with the case at hand. Clearly, the ability to maximize those financing could led small players such as Halmanera towards new paradigms of digitalization. Here below I'm going to illustrate the actual regulatory framework available in our country.

To improve own competencies and performance as well as to purchase innovative equipment and technologies. Former ones include:

- **The purchase of specialized consultancy services** to support technological and digital transformation processes through technologies specified by the National Enterprise 4.0 Plan and the modernisation of enterprise management and organisation structures (voucher manager – art. 1, paragraph 228, Budget Law 2019);
- **Facilitate access to credit** to buy or lease machinery, equipment, plants, instrumental goods for productive use and hardware as well as software and digital technologies (new Sabatini Law - art. 2, Legislative Decree no. 69, 21st June 2012 as amended.);
- **Support staff training** in subjects pertaining to technologies of the Enterprise 4.0 Plan (Tax credit for 4.0 training expenses - art. 1, paragraphs 46- 56, Budget Law 2018);
- **Support investments** in new instrumental assets, material and immaterial goods (software and IT systems) functional for the technological and digital transformation of productive processes (hyper and super amortisation - art. 1, paragraphs 90-94, Budget Law 2016 as amended.);
- **Funds for interventions with the aim of favouring the development of AI, Blockchain and IoT applications** (art. 1, paragraph 226, Budget Law 2019) – drawn up to favour the development of artificial intelligence, blockchain and internet of things technologies and applications, the Fund aims to fund research and innovation projects to be carried out in Italy by

public and private entities, including foreign ones, in strategic areas for the development of said technologies, functional for the country's competitiveness.

- **Digital Transformation** (Art. 29 Law no. 58., 28th June 2019 Conversion into law, with amendments, of Legislative Decree no.34, 20th April 2019) – drawn up to favour the technological and digital transformation of SMEs, the Digital Transformation measure grants financial concessions for projects for the implementation of enabling technologies identified in the Enterprise 4.0 plan (big data, augmented reality, advanced manufacturing solutions, additive manufacturing, simulation).

4.4.1 Strategic pathways: a deep dive

To successfully execute a strategy based on a blockchain business model, it is essential to articulate the context and the impact of the solution provided. This means that, to reach the desired outcomes a company should follow a strategic pathway towards the implementation of a blockchain solution. Especially, small and medium-sized companies such as Halmanera will have a more structured and experimental approach to Blockchain when they first experience industry 4.0 paradigms.

In fact, before describing in detail what the operational steps that will integrate the blockchain within the footwear supply chain will be, it is necessary to propose a strategic reference model suitable for the case. Especially, the reproduction of the supply chain ecosystem illustrated in the previous paragraphs has allowed us to have a clear image and a satisfactory perspective of the context in which Halmanera operates. This means that, before going on to implement a blockchain-type solution such as the one described in the previous paragraphs, the company is required to

follow an inclusive approach which has as its first step that of assessing its own needs that drive the implementation of such solutions. From there, we delve into the strengths and essentials of blockchain to reveal how it can effectively complement related processes and systems.

At this purpose, it can be identified four main strategic pathways, the first and second has already been addresses previously in chapter 4, the third and fourth will be analysed in depth because they are related to the specific processes needed to structure a blockchain business model. Here listed the four main strategic step:

1) ***Assess and Evaluate:***

This first step can be referred as the establishment of the main objectives and the evaluation of the current state and accuracy of the supply chain. On one hand, this step it is essential to address key objectives such as traceability, visibility and establish high-level objectives, measures stakeholder commitment and a course of action. On the other hand, it allows to assess the level of accuracy, verifiability and reliability of the current processes and information related to the information and production flows. Further, it will assess the impact from customers, suppliers, sub-suppliers, agencies and all the actors involved among the supply chain. Especially, this strategic objective is what has been illustrated so far in the previous paragraphs of the chapter 4. In this direction, Fashion companies can find this stage to be the ideal starting point to conceptualize and model the supply chain, information flow and the technology landscape. What follows are strategic options available to determine the course of action.

2) ***Model a process information and technology, framework and principles:***

In this context, blockchain initiatives will never succeed unless stakeholders are woven into a string of processes where expectations, objectives and value are clearly articulated. There is no better way to achieve this than creating models which give form and a specific structure in three areas: operations, information and technology. In this context, the company needs to model the sourcing supply chain with a focus on: Supplier selection, material and process consolidation with procurement operation about the operational perspective. Further to this, it is fundamental to capture all the data points to record, measure and report transparency. This is the stepping stone to traceability, as all participants need to be recorded and verified. Lastly, it is recommended to create an initial technology model that depicts the flow of information through the chain, from breeder to customer. This point has been addressed by previous paragraph as well.

3) ***Build and Operate:***

This section will be the focus of my research because it clearly address the objectives of the paper. In this direction, the company should build, integrate, pilot and evaluate to achieve incremental value. In this section, Prioritize the features that are most critical for the use case, and these are where blockchain will create the maximum impact is crucial. In fact, it

consist on the real integration and scale the information flow into the larger technology landscape.

4) ***Measure and Communicate:***

The last step is to measure the quality and usability of information. This mean to measure the overall value that the solution is providing by measuring the benefits of all stakeholders, including external partners.

To sum up, the four strategic pathway set up the ground for the implementation of a blockchain based model. The first two steps can be described as represent an overall analysis of the ecosystem where the company operates. This gives to the company the basis to start the implementation of a blockchain solution. In this regard, the blockchain practical application can be found in points 3 and 4 that will be analysed in details below.

4.5 Final considerations: toward a blockchain model application

Clearly, during this trip we focused our attention on possible solutions that Distributed Ledger Technologies such as Blockchain within the footwear context. At this point of the research, by virtue of the specific characteristics of the blockchain and the illustrated needs of a company such as Halmanera, some recommendations that should be adopted will be presented below.

4.5.1 Digital transformation strategy

The ongoing digital transformation is involving every organization at 360 degrees, starting with the pillars on which every company act. The traditional models for analysing the competitive context of a company have changed and we can say with conviction that if Michael Porter rewrote his famous essay on Competitive Advantage Theory today, he would certainly speak of process, product but also advantage by presence and competence digital. In this context, this digital revolution is based on data and needs not only knowledge of enabling technologies, but also of open ecosystems and core processes that need to be transformed. In fact, digital transformation, if applied to marginal processes, often has little appreciable results, but when applied to core processes, the effect could be disruptive. In our case, Halmanera's ability to outline a targeted digital strategy on the four main business areas should be one of the biggest challenges:

o Market analysis and study of customer needs
o Procurement and Logistics
o Production planning or Marketing

The continuous evolution of market dynamics, products and services are testing the players in the sector. For these reasons, reacting to change strategically could be one of the guiding criteria for Halmanera. To do this, and to orientate correctly in these new digital ecosystems such as the Blockchain world, the ability to make right strategic decisions, but also to have adequate tools (Tools) and necessary skills (Skill) is essential. To date, we could never imagine a company that is not Internet Native, that is, oriented towards predictive data (Advance Analytics) because there

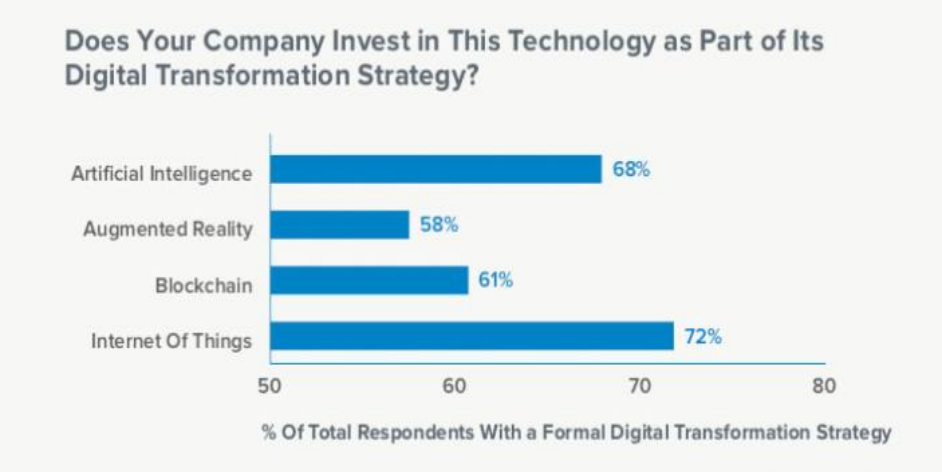
is no more time for the interpretation of historical trends. In this regard, the Digital Transformation process aims to create innovative solutions to assist and help people and organizations to carry out their mission in a consistent and coherent way; providing them with solutions capable of increasing the ability to perceive contextual signals, to process the information collected and to interpret and automate the actions to be performed.

For these reasons, the effect of digital transformation is not the use of enabling technologies, but a process guided by a strategy of revisiting and redesigning ways of working, business models and new values to offer. To do this, it is therefore recommended to accelerate knowledge and confidence in new digital paradigms to seize the enormous opportunities connected to them.

In particular, it would be advisable to implement facilitation tools and methodologies such as: coaching and design thinking capable of increasing awareness and sharing an innovation path for internal employees and external partners. In addition, experts in so-called enabling technologies are needed, able to select and integrate the management of the digital tools on which the transformation is based, correctly interpreting the product impact of the new technologies and therefore, to manage their redesign. To do this, you need a strategic vision and the willingness on the part of managers to open up to new challenges. After fully understanding the opportunities of a digital transformation, a strategy can be outlined with the help of technology experts.

For this purpose, the Blockchain can be part of a digital transformation strategy for a company like Halmanera. In this direction, the digital identity company - Otka - commissioned a report where it emerged that for 61% of companies, blockchain is part of the plan of a digital transformation strategy as shown in **figure 28.**

Figure 28: Does your company invest in this technology as part of its digital transformation strategy?



Source: Otka, 2018

Other technologies that ranked higher than blockchain were Internet of Things (68%) and Artificial Intelligence (72%). The knock on effect of this is the concept of "Zero Trust". Because a larger slice of the team is remote or contractors, Okta says that "modern businesses should no longer have a" trusted "internal network and an" untrusted "external network." Instead, users need to be able to have secure access regardless of location, network or device. This will forever change the interaction between man and technology, optimizing every daily activity through ever more intelligent tools that study man, understand his needs and interact with him directly.

4.5.2 Promotion of supply chain 4.0

Another fundamental aspect of which we have extensively talked, concern the supply chain processes which are still strongly based on paper documentation. It would therefore be useful to stimulate a progressive digitization of the same, facilitating the recovery and sharing of information between companies, the supply chain itself should be the main promoter for the activation of change processes in this direction. Currently the product information is distributed among different actors. It could therefore be useful to try to define an overall strategy for the management and coordination of the supply chain data that allows to build the story of the product and the values it bears. In this direction, Halmanera being the upstream Brand that commissions the production activities of the partners, could outline an innovation dissemination strategy along the entire supply chain. In fact, it is well known within the supply chain that the integration of information along the supply chain is really scarce and limited to the exchange of strictly contractual services, compared to a real data sharing.
The lack of technological development within the entire sector is also due to cultural barriers that guide artisan companies to adopt traditional systems and processes. For this reason, an international brand like Halmanera that operates within a global market should acquire a vision oriented towards innovation policies and best practices suggested by the leading players in the sector. In particular, the company should improve supply chain relationships and corporate networking activities: in particular, companies should learn to work in teams, both among themselves and within them. Virtuous examples that dictate the rules of success are referred to the relationship system activated by the LVMH and Gucci brands.

It is no coincidence that in both cases we are faced with Blockchain-type projects that inspire industry players to follow their business models. On the other hand, it

is possible to say that the protagonists of the sector are those who manage to seize new opportunities, transforming them into a well-defined digital strategy aimed at the specific needs of each individual actor.

4.5.3 Partnership with *startup* and *universities*

Another way that might seem obvious is dictated by the strengthening of the productive world and the academic research world. To this, the possible synergies that could be created with startups expert in technological innovation and blockchain are also added.

Starting from the first point, in particular school / university should better intercept the needs of entrepreneurs in the sector both in terms of human resources and the transfer of new technologies. The training of human resources appropriate to the needs of the production system is fundamental. In this scenario, Halmanera could establish relationships with research institutions in order to strengthen strategic and managerial skills. This however, involves a cultural and mental openness towards new horizons, compromising what can be called traditional routines.

On the other hand, the relationship with startups and system integrators can be considered crucial for the realization of a Blockchain project as described above. The relationship between Startup and blockchain has always been a special relationship. For those who create and develop innovation, blockchain is much more than a technology, a platform or a development environment. The relationship between blockchain and startups obviously affects the technological dimension, but extends to many other areas of innovation. For this reason, investing in a relationship with a startup would mean investing in the future technological development of a company like Halmanera.

In particular, the business model adopted by startups and / or by technology providers is largely common. In fact, unless in rare cases, companies offer Baas services or Blockchain As A Service. In other words, these offer blockchain solutions (in 98% of cases they are B2B) in exchange for an economic fee on a temporal basis (monthly, half-yearly, annual). These contracts are very similar, if not coinciding, to those of the user license: that is, the suppliers design their own blockchain solutions or make their know-how available or offer their own structured applications on existing DLT, for then grant them to the companies (under license) in exchange for a cash consideration. This is a formula already widely adopted especially in the software field. The range of services offered obviously depends on the number of different solutions / applications that startups are able to offer and range from technical consultancy, technological implementation, to Analytics services on the data collected etc.

In this direction, we have already introduced Apio: a startup that could be the case for Halmanera. In particular, Trusty was described: IBM's blockchain partner platform developed and applied in a sector such as agrifood. In an interview, the CEO and founder of Apio - Alessandro Chelli - wanted to underline the possibility of customizing the Trusty platform to the needs of the footwear sector. In this scenario, Apio is recommended as a possible main partner for the realization and implementation of the Blockchain project. However, the collaboration between companies and startups in Italy is not yet particularly widespread, but is growing. As highlighted by the 2017 Survey Innovation of the Startup Intelligence Observatory, which has collected the testimonies of over 270 Italian companies, only 7% of them have been collaborating with a startup for more than three years. 31%, the highest "slice", has been collaborating for less than 3 years. 27% of the

sample declares to have collaborated in the past with a startup and not to do it anymore, while 23% simply do not have this type of collaboration in place and do not plan to do it. Data that shows how, in our country, the path of open innovation, the paradigm for which a company is looking for innovation from outside, is still uphill.

For these reasons, Halmanera's big challenge will be to take advantage of existing opportunities before it is too late.

4.5.4 Peer to peer onboarding platform

Peer-to-peer onboarding platforms are open and public digital platforms through which buyers and suppliers can exchange and share information.

The founding element of these new solutions consists precisely in the possibility of getting in touch with new potential customers and / or suppliers in order to amplify their business opportunities.

These are decentralized peer-to-peer platforms or structured around a consensus mechanism that allows the elimination of the intermediary. Consequently, the data and information that is shared are public and not kept under the control of a centralized entity.

After registering on the platform, the individual actors enter company information on their digital profile. These, after being saved within the blockchain, cannot be changed and are visible to all the actors of the network. Each node can enter information in relation to (Ganeriwalla A., M. Casey et al, 2018):

• soundness / financial position;

•terms of payment;

• quality standards;

• prices of the products or services offered;
• delivery requirements;
• specifications of products and services;
• conflict resolution procedures;
• distribution channels and conditions;
• availability of materials;
• lead time

After authenticating and receiving the pair of cryptographic keys, the individual actors can use the platform to manage onboarding activities of new suppliers. The governing rules relating to individual transactions are managed thanks to the contribution offered by smart contracts.
The information in the database can then be updated on the basis of the results that companies obtain in relation to onboarding activities. Scores can be defined directly by a decentralized algorithm, saved on the blockchain and visible to all users of the system. This has enormous potential, especially for all those companies (SMEs and micro-enterprises) who have to build a reputation on the international market and who, at least in the initial phase, do not have the tools to compete with the big providers.
Going into more detail from a technological point of view, the platforms to manage onboarding activities could be structured as follows:

1. The buyer makes a purchase request for raw materials or parts specifying a series of criteria such as: the price, the delivery date, the quantities, the characteristics of the product, the payment conditions, etc. generates a smart contract which contains all the

conditions expressed by the buyer. This is then signed cryptographically by means of the private key.

2. Suppliers using the platform are notified of the placement of a new order. These, if interested, can at this point immediately prepare an offer that includes the data and the potential conditions that they would like to impose on the contract.
3. The buyer at this point chooses the supplier on the basis of some predefined criteria at the initial stage (such as, for example, the first of the suppliers who meets the required criteria). This process can be completely automated or the program can choose the supplier automatically (for example after having received a certain pre-established number of offers)
4. At this point the supplier cryptographically signs the smart contract with the private key; consequently the contract can be executed. The onboarding operation ends as soon as a matching between supplier and buyer is identified. In this regard, by executing the smart contract, it could issue an alert, informing supplier and buyer of the conclusion of the transaction. In the event that the clauses were to be respected, the smart contract could be structured to also support the automation of payments and / or the closure of a real supply contract (written according to standard rules). In this case yes.

it would go from onboarding platforms to purchasing platforms or more complex platforms that allow you to manage the purchasing process (marketplace) independently.

Obviously, additional clauses that trigger when specific events occur can be added to the smart contract. For example, a delay in delivery could result in a penalty for

the supplier. Alternatively, in purchasing platforms, in order to guarantee greater protection to the supplier, payment could be postponed or this can only be done with the goods delivered.

In these terms, in order to avoid fraud or dishonest behaviour, it is essential that a verification mechanism is inserted on the reliability of the data entered by the suppliers. The control activity, in this particular type of platform, can only be managed directly by the company providing the service and / or by a third party super partes. In business solutions, therefore, there is no elimination of the intermediary who is instead asked to play an essential role in verifying the truthfulness of the information entered by the individual suppliers. Otherwise the control could be managed by connecting the blockchain to the ERP systems. In this case, company information could be used to monitor the exchange of goods between individual actors. The information entered would be encrypted and therefore visible only to those who have the correct authorizations to read them. However, these are solutions that are too far from reality today.

In any case, although it is not possible at the enterprise level to eliminate the intermediary, the benefits offered by these solutions are still many thanks to the distributed and transparent nature that distinguishes them. In fact, since the information is shared and visible between all the nodes of the network, the incentive to adopt dishonest behaviours that could seriously damage the image of companies is reduced.

Furthermore, unlike the current marketplaces, these solutions allow to better define the responsibilities of the individual actors. In these terms, in fact, since the information entered within the smart contract is immutable and visible to all network participants, the management of any legal actions would be easier and faster.

However, the most significant impact of the introduction of these new digital platforms concerns the democratization of the procurement processes. Through the use of onboarding platforms it is in fact possible to reduce barriers to entry and increase market competition. Thanks to these new platforms, SMEs or micro-enterprises have the same possibilities as large providers to serve the market. Since the onboarding mechanism is completely automated and decentralized, the supplier, in order to be selected, is sufficient to comply with the contractual conditions imposed by the buyer. Consequently, matching is not influenced (at least in part) by the resources or contractual power available to the supplier.

Another important advantage is the increase in flexibility in managing supply relationships. Thanks to the onboarding opportunities offered by the platform, in fact, individual companies can more easily modify their supplier base and, consequently, continually reconfigure their business relationships to better respond to changes in demand.

Thanks to the global nature of the platforms, the supply opportunities offered to individual organizations increase exponentially. In an increasingly competitive market, the greater flexibility offered by the use of onboarding platforms can in fact become a critical success factor.

Finally, the onboarding platforms allow you to reduce the costs of due diligence. In fact, today there are entire business functions within companies whose sole objective is to seek the best supply conditions on the market. Through the introduction of peer-to-peer platform onboarding this process could be deeply simplified with huge savings both in economic and time terms.

The first to propose a peer-to-peer onboarding platform based on blockchain technology was the American company Dun & Bradstreet (D&B). The US group is known worldwide for having developed a proprietary system that assigns each company a unique identification code called DUNS (Data Universal Numbering

System). In recent months, D&B has tested a blockchain system that allows its customers, on the basis of DUNS codes, to verify the identity of a potential business partner.

The platform works like this: for example, take a company A based in the United States who wishes to purchase a product for the first time from company B based in Singapore. Company A, before concluding the deal, intends to verify the authenticity of B. Since both companies are part of the D&B blockchain consortium, A can download the supplier information from the database and verify through its DANS number that it is a reliable company. The D&B blockchain is built on Ethereum but remains a blockchain consortium.

In summary, the benefits introduced by the implementation of peer-to-peer platform onboarding are:

• reduction of barriers to entry with consequent greater openness to the market in favour of small and micro-enterprises;

• reduction of research costs;

• increase in market competitiveness;

• greater flexibility and transparency.

4.6 Final considerations and *use cases*

Blockchain technology within the supply chain, especially in the footwear sector, currently find little space. Despite this, Europe "plays" a very important game and Italy is among the top 10 countries worldwide in terms of Blockchain projects in 2019.

As Valeria Portale - Director of Osservatorio Blockchain Politecnico di Milano points out - there are skills, there are developers who are working on it. In fact,

companies have certainly invested more than last year (from 15 to 30 million euros), but the courage to really believe on it still lacks. The footwear world, as has already been highlighted, appears to be very attentive to the issue of traceability, the finance world has been active for the longest time, the world of government and insurance are getting closer in a more convinced way. Finance is the sector that before others believed in the blockchain. Already in 2016 it had started the first experiments by individual actors with projects set to "silos" that had the primary objective of understanding what could be done with the blockchain.

If we look inside the luxury sector, especially in the fashion where Halmanera operates, a significant experimental character still emerges. In any case, blockchain could affect positively the concept of *Made in Italy*, according to Valeria Portale is the transition to the creation of an Italian ecosystem, with infrastructure projects capable of supporting more complex developments. In other words, the footwear industry can understand how to build projects that are more focused on the supply chain and not only on product traceability.

Unfortunately, companies still lack complete knowledge of these technologies such as blockchain. Only 4 out of 10 large companies claim to know them, and unfortunately the share decreases when the size decreases. According to data from the Blockchain Observatory of the Politecnico di Milano, only 2 out of 10 of SME field responds affirmatively. *What impact will it have in perspective?* Only 12% of large companies and 3% of small companies think that "something significant will change" in the next 5 years. Once again, the consideration is that there is a lot of work to be done to make this technology consistent. Moreover, the technology providers have worked hard to explain the value of the blockchain, now a growth of commitment is needed: it is necessary to allocate resources and transform perspectives into results. And just to get the results there are three recommendations that come from the Observatory's research.

1. Avoid to set up closed ecosystems;

2. Interacting with existing blockchains and not directing investments towards new platforms. Clearly explain that interacting does not mean immediately becoming a node in a network, or participating through an application;

3. Focus on knowledge of technology with the courage to experiment.

In fact, according to Valeria Portale: "In Italy a lack of market awareness of the potential of this technology constitute a big problem. Thus, the few that dealt with it chose to go abroad where the economic structure was already more familiar with these. themes. ".

Looking over to the data of the Blockchain Observatory of the Politecnico di Milano, there are 28 blockchain *startups* in Italy, while the *use cases* involving Italian companies are 14. Of these, 35.7% that means five out of fourteen cases, concern blockchain applications in *supply chain*. Especially, mainly related to offer solutions for *tracing and tracking products.*

Within the fashion sector, it is possible to illustrate some use cases:

1TRUEID

First of them is 1TrueID blockchain platform, implemented by *United Colors of Benetton.* The company is able to create and attribute to each product a digital identity through labels with a unique code. Through this code the customer can follow the journey covered by the product through the entire supply chain, check the type of fabric it is made of and know the country in which it was made. An important anti-counterfeiting tool, guarantee of authenticity and uniqueness of each item. In fact, to access all product information, by downloading the 1TrueID App on the App Store and Google Play and frame the QR code label on the Black Pop collection with your smartphone, the Blockchain technology is currently available to exert all that useful information towards transparency, sustainability and data certification. Further to this, with a video posted on YouTube, the Vilnius store in Lithuania announced that it is now also accepting cryptocurrency payments (Bitcoin, Ethereum, Dash, Nem and Steem). Arturas Zuokas, the co-owner of United Colors of Benetton's Lithuanian franchises, said that: "Cryptocurrency payment will be available everywhere in the future. We are pleased to announce that United Colors of Benetton in Vilnius is the first to accept cryptocurrencies. We would like to support the idea of freedom and different payment options ".

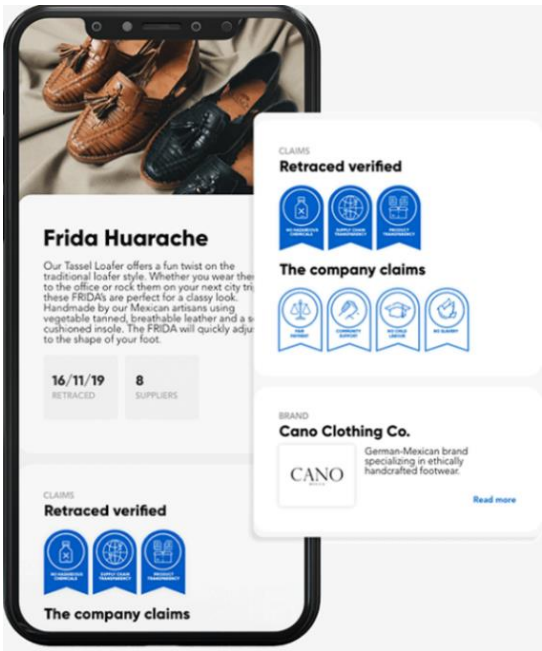
RETRACED

Tracking and product tracing is the core element of *Retraced,* a German start-up that provide solutions for fashion companies. . Their mission is to provide the end-consumer with deeper insights into the fairness and sustainability standards of the fashion brands' supply chains.

Retraced is production ready and implements its transparency solution into the supply chain of CANO, the sustainable footwear brand they founded in 2016. Retraced is using the Oracle Blockchain Platform to provide a reliable platform to verify the materials used in the shoes. The CANO footwear company has built a brand of shoes that are both ethically sourced and uniquely fashionable. CANO produces sustainably sourced handmade Mexican huaraches. CANO uses the Oracle Blockchain solution to promote traditional craftsmanship as well as fair and sustainable production practices. The application, according to co-founders Lukas Pünder and Philipp Mayer, offers "track-and-trace capabilities that allow each shoe to tell its own story, reveal every face behind the product that has helped bring it to market and show the origin of its raw materials. " In this context, with retraced's advanced blockchain tracing system, brands are able to efficiently collect as much supply chain data as possible - even down to the origin of the product's raw materials. This information can be mapped digitally, helping provide supply chain visibility and oversight for management.

Furthermore, **Figure 29** shows that the blockchain can be leveraged as a communication platform with the help of the mobile app. In fact, end-consumers can scan their product of interest to get information on the product's origin, it's raw materials, as well as sustainability and fairness KPIs This innovative touch-point allows brands to connect their products and production standards to their customers, before and after purchase.

Figure 29: Example of user interface



Source: Retraced.com

PROVENANCE

Provenance is a digital platform that empowers brands to take steps toward greater transparency. With their blockchain based software, businesses can easily gather and present information and stories about products and their supply chains, including verified data to support them. By connecting this information to things - in store, on pack and online, we can all discover the origin, journey and impact of products.

Aiding the global movement to increase transparency in the fashion industry, Provenance has, in collaboration with Martine Jarlgaard, proved blockchain's

potential for forging greater trust in businesses along a fashion supply chain, enabling brands to provide verified information about the materials, processes and people behind products. The first garment ever tracked with blockchain technology was presented at the Copenhagen Fashion Summit's 'Solutions Lab' in Denmark, May 2017.

NIKE

In 2019, The US Patent Office has today issued sportswear brand Nike's patent for its blockchain-compatible sneakers dubbed "CrpytoKicks.". Basically, the patent outlines a system whereby blockchain can be used to attach cryptographically secured digital assets to a physical product, in this case a sports shoe. It seems Nike's platform will also track the ownership and verify the authenticity of sneakers using the blockchain-based system. When you buy a pair of the "CryptoKicks," you'll also receive a digital asset attached to a unique identifier of that shoe. As a result, there is digital scarcity of the digital assets, as their production is effectively tied to the production of real sneakers.

NEW BALANCE

Toward customer engagement, Footwear giant New Balance has announced it will be using blockchain technology in the fight against counterfeit trainers. The Boston-based manufacturer has turned to distributed ledger to enhance trust and provenance with the release of its latest basketball shoe.

New Balance brought in blockchain specialists Input Output Hong Kong to develop the 'New Balance Realchain' – a distributed ledger technology platform built on the Cardano blockchain. The pilot programme – launched in tandem with the release of the OMN1S shoe – will grant customers the ability to record ownership of the footwear.

Each purchase comes with a Realchain card which aligns to a microchip embedded within the fabric of the shoes. Using the New Balance app, owners can hold secure data about authenticity and record of sale. Ian Fitzpatrick – New Balance's head of marketing – said the move was about maintaining provenance and quality. "We are using blockchain technology to innovate at multiple points of the customer lifecycle," he said. "We're also helping customers feel confident that the footwear they are purchasing fulfils the quality promise that is central to the New Balance brand."

It's also IOHK's first foray into the retail industry with its blockchain systems, which is why its chief executive – Charles Hoskinson – is using the pilot project as a test to see what other use cases may evolve. "We're looking forward to seeing what New Balance customers make of the opportunity to protect their investment by verifying the authenticity of their new purchase forever, on the Cardano blockchain," he explained. "We believe that the New Balance OMN1S will be just the first of many products authenticated as genuine in this way, doing away with the need for paper receipts or certificates of authenticity forever."

4.7 Conclusion

Undoubtedly, Blockchain technology is one of the greatest technological innovations in recent years. Not surprisingly, the World Economic Forum considered distributed Ledgers to be one of the six '*big-trends'* that will transform the world in the coming decades.

The opportunities offered by this new technology are innumerable and can generate significant direct impacts on every aspect of the economic and social ecosystems. In fact, the blockchain must not be seen simply as a technological solution, but as new, decentralized approach to the concept of trust. In this scenario, the ability to digitally decline a new concept of trust makes this technology potentially suitable for assuming political and social value as well.

In this direction, the blockchain can be considered a new paradigm, or a new way of interpreting the great theme of decentralization and collective participation. Although the interest of the media has focused mainly on the financial sector in recent times, this technology has the characteristics to have a destructive impact in various industrial sectors.

Based on these aspects, it would be unreasonable to think that blockchain cannot change some of the key activities within the *supply chain management*. In fact, intrinsic features enables to increase transparency, product tracing, support the fight against fraud and counterfeiting, synchronize and democratize the supply relationship making it fairer, improve the relationship with the partners, manage *collaborative Analytic* activities, automate *the decision-making process* making. These are just some of the enormous possibilities offered by this new paradigm. Others have still to be developed and it will be up to entrepreneurs and developers

to give voice to their creativity to bring out applications capable of impacting every aspect of corporate and human life.

Basically, there are two elements that make blockchain more interesting than other digital technologies.

First, the blockchain stimulates cooperation and collaboration between the participants of a network. This is one of the main objectives on which Nakamoto's thinking was structured and is at the basis of the principles of democratization and equity that underlie the new technological solution. This dimension, among other things, is maintained with the transition from *public to private solutions*. In fact, the distributed database, even if controlled by a central authority, plays the role of shared infrastructure, as a function of which companies can share information. This allows entities to adopt models characterized by a growing degree of openness to the outside, allowing the individual entities of the *value chain* to focus on *core businesses* and acquire complementary ones from third parties.

In addition, from an economic perspective, cooperation can create new business models within competitive environments, where companies can establish new relationships that stimulate the sharing of information and therefore of resources. In fact, the blockchain enables new fairer and democratic space of business in which *collaboration and integration* are fundamental from an external and internal point of view of the company.

Secondly, an other important element that makes this technology particularly relevant from a *corporate* point of view lies in the ability to create s corporate restructuring processes. In fact, organizations, in evaluating the implementation of the blockchain, find themselves forced to examine and rethink their organizational processes. This is because the blockchain is an infrastructure solution requires

companies to organize and define their activities in order to be able to integrate them with the benefits offered by the *distributed ledger.*

However, it should be argued that, like any information system, the implementation of blockchain technology would be useless if it were not able to serve one or more specific *business processes.* In this direction, since blockchain constitute the freamework on which the other applications can be developed, requires managers to integrate and redesign activities both at the individual company and at the entire supply chain level.

Essentially , the benefits offered by this new technological solution are innumerable. In any case, as repeatedly stressed within the paper, there are still many challenges that must be faced in order to hope to reach a systemic implementation of the technology within the supply chains.

In this regard, alongside the technical limits occurred that are partially resolved by adopting *private* solutions, there are others of an economic, ethical and social nature which in turn profoundly hinder the adoption of distributed systems.

First of all, it is necessary to underline the scarce interest of management towards this technology. Indeed, managers have not yet managed to meet the innovation challenges connected to the blockchain. The reasons for this lack are due difficulties they have been facing with the complex technology. On the other hand, the cultural deficiency that leads companies not to invest in a new solution when it is in an embryonic phase. Ignorance about this new technology is indeed a widespread problem that does not only cover businesses.

In this regard, one of the main limitations affecting *distributed ledgers* concerns the absence of adequate skills and knowledge. The considerable complexity of the

solution slows down its spread among organizations, not understanding its benefits, and prefer to wait for the advent of *best practices* before thinking about a systemic adoption.

Those problems, couldalso affect consumers that do not get clear image of how the distributed ledger works, rely on the media for more information. These mostly focus their attention on financial aspects of the blockchain by not highlighting the uses and opportunities that these solutions offer in the different application areas.

On the contrary, in relation to the regulatory aspects, it can be noted that even if they assume a relevant position in relation to the development of a technological solution, in the case in question do not present a real obstacle for companies. In fact, within the blockchain landscape, regulatory difficulties mostly concern security and data privacy. In relation to the supply chains, deficiencies at the regulatory level are not a problem. This because in permissioned and private blockchain there is a central authority on which the participants in the network place their trust and which checks that the information shared are priced in respect of privacy.

To complicate an already complex framework, there is the lack of reference technical standards at *the enterprise level*. The adoption of standard solutions is of fundamental importance to encourage the diffusion of technology and, as far as data emerges, no dominant model has emerged yet. This is obviously correlated to the embryonic state of the blockchain and for this reason the solutions that populate the market today are very similar to each other.

Within this scenario, data on which considerations can be made with some certainty concerns the type of *distributed ledger* used in the individual solutions. In this case, it has been found how in part, *startups* structure their blockchains starting from

DLTs present on the market, on the other hand, in almost all cases, corporate solutions involve *permissioned distrubuted ledger.*

In this regard, despite permissioned solutions are more feasible, by their nature they deeply differ from the reflections and conjectures that led Nakamoto in 2008 to launch Bitcoin. In fact, permissioned blockchains do not eliminate the centralized intermediary with all the consequences that this entails on a technological, ethical and economic level.

In this regard, even though the paper has somehow privileged and justified the adoption at the business level of private blockchains it is necessary to underline how these, in many situations, diverge from their original definition. Consequently, it could be assumed that if the market continues to move in this direction, the dominant model that will emerge will probably take the form of *a permissioned blockchain*. At this point, however, we should ask ourselves if, in these terms, we could continue to talk about blockchain or if, simply, these solutions are nothing more than distributed systems. This is obviously an open topic and, in this regard, the scientific community sometimes tends to consider them still blockchain, albeit private, sometimes defining them pure and simple databases.

Considering these statements, at this point it is significant to define what the next *steps* must be to follow in order to achieve the adoption of blockchain technology in the *supply chain*.

First, continue experimentation and pilot test are needed so that we can hope to resolve *open issues* that today afflict the technological panorama of the blockchain. In these terms, a joint effort by the *scientific community and developers* is required which allows to: speed up the entry onto the technology market; create reference technical standards.

Furthermore, *best practices* must emerge in relation to the use of blockchain within companies. In fact, in order to gain a significant development of this technology, numerous success stories must still materialize that serve as a stimulus for the entire business landscape.

On the other hand, at a regulatory level it is essential that institutions understand and anticipate possible problems related to the legal aspects, avoiding that they are an obstacle for innovation. In fact, if this result is not achieved, it will not be possible to fully exploit the enormous benefits that this new technology is able to offer. Finally, all *players* involved must spread knowledge about technology in order to stimulate investments but, and, to allow anyone to understand its benefits. In fact, by spreading culture businesses and communities can hope to get out of the recession years that characterized this historical era. The spread of *know-how* also allows for more and more programmers to acquire the skills necessary to program decentralized databases, thus promoting the new technology.

These are key challenges that must necessarily be addressed so that we can hope to see blockchains applied in the companies of the future, especially in a sector such as the footwear industry.

In conclusion, it is important to underline how revolutionary as this technology may actually not be considered the solution to all problems. Consequently, before starting a project a question arise: *"Do I really need a blockchain?"*. In fact, even if it is not possible to predict how market dynamics will change in five or ten years, it can be considered that blockchain is not the best solution in all cases and that perhaps traditional databases, in different contexts, will remain technology dominant.

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