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Blockchain Technology as a tool of modernization In supply chain management Case: TAPHCO SPA

Developed by:

ATTOUT Ahmed Ali

EL HADJ NOUNA Abdelfateh

supervised by:

Dr. TOUMI Djamila

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Abstract

The supply chain is one of the most complicated areas that need continuous updating and performance, on the other hand, technology is always offering innovations and new performance. The Blockchain technology is one of these innovations that attracted the interest of experts and consultants to deploy it in the economic sectors, the supply chain is among the first of these sectors. TAPHCO spa is a company in the pharmaceutical sector that is looking for performance in its Information System and its Supply Chain, which is subject to requirements to International standards such as GMP and FDA, it represents a good field of study to participate in the proposal of this innovative technology by its advantages and its opportunity in this sector.

Key word: Blockchain, Supply Chain, Information System, Pharmaceutical, GMP & FDA,

ملخص

تعتبر سلسلة الإمدادت من المجالات المعقدة و التي تحتاج تطويرات و تحديثات دورية و متواصلة. في الجانب الآخر نجد التطور التكنلوجي لا يبخل بتقنياته و ابتكاراته الحديثة ليقدم حلولا و يطور أكثر. و تقنية البلوكشين واحدة من الابتكارات التي استقطبت اهتمام الكثير من المختصين و الخبراء لاستعمالها و اسقاطها على المجالات الإقتصادية، سلسلة الامدادات تعتبر من الاول المجالات التي تخضع حاليا لهذه الدراسات. طافكو هي شركة في مجال الصناعات الصيدلانية و التي تبحث عن تطوير و تحديث نظام معلوماتها و سلسلة امداداتها ، و هو المجال الذي يخضع لعدة أنظمة دولية مثل نظام ممارسات الصنع الجيدة، و إدارة الأدوية و الأغذية ، و يمثل هذا مجال الدراسة الأمثل لمشاركة هذه التقنية و اشراكها في الاقتراحات بامتيازاتها و اظهار الفرص التي تتمثل لها في هذا المجال.

الكلمات المفتاحية : البلوكشين ، سلسلة المدادات ، نظام معلومات، صناعات الصيدلانية ، إدارة الغذاء و الأدوية.

Résumé

La chaine logistique est un des domaines les plus compliqué et qui a besoin d’une mise à jour et une performance continue, d’un autre coté la technologie ne cesse d’offrir des innovations et de nouvelle performance. La technologie Blockchain est donc l’une de ces innovations qui attirait l’intention des experts et Consultants pour la déployer dans les secteurs économiques, la chaine logistique est parmi ces premiers secteur. TAPHCO spa est une entreprise dans le secteur pharmaceutique qui cherche la performance dans son System d’information et sa chaine logistique qui est soumis à des exigences de normes Internationales tel que les BPF et les FDA, ceci a représenté un bon terrain d’études pour pouvoir participer à la proposition de cette technologie innovatrice par ces avantages et son opportunité dans ce secteur.

Mot clé : Blockchain, Chain logistique, System d’information, Pharmaceutique, les BPF & FDA,

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First thing first I would like to say Thank you my Allah for giving us the power, the ability to write this Master thesis, the courage during the whole Academic path, and achieve our actual state.

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ATTOUT Ahmed Ali

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List of Abbreviations

SC: Supply Chain

SCM: Supply Chain Management

ERP: Enterprise Resource Planning

IT: Information Technology

IS: Information System

SCQM: Supply Chain Quality Management

IoT: Internet of Things

ID: Identifier

P2P: Peer to Peer

DB: DataBase

ICO: Initial Coin Offering

RM: Raw Material

AC: Article of Conditioning

PE: Polyethylene

TD: Technical Direction

QCL: Quality Control Laboratory

CEO: Chief Executive Officer

CTO: Chief Technical Office

Introduction

Today the one who masters the technology masters the market, and also the digitalization of the company has become an obligatory step for any company. In the term of technology, there is an evolution in an exponential way and among the technological revolution we hear about the blockchain that some call "the revolution of trust". This technology brings benefits in several sectors, including supply chain management, which is one of the most complex sectors and its development and performance represent a key advantage for the whole company.

1 Study Context:

The pharmaceutical industry represents one of the sensitive sectors that attract experts for development, and from this, the opportunity at TAPHCO SPA was a great opportunity for a field of study in which we better understand the pharmaceutical sector and its SCM, and this can open the doors of the professional in an important sector that is subject to strict regulations that it must comply with.

TAPHCO SPA has started the process of realizing an ERP system to facilitate the work and help in the management which will allow adding one of these ideas on the Blockchain technology and new thoughts to have a high-performance system.

1.1 Reasons for the choice of theme:

Being two students with an IT and management background that will have to bring the added value according to the objectives of the academic training that allowed us to have double competence.

First, we were interested in the technology that is already starting to make a new business model worldwide, and the COVID-19 confinement period allowed us to see the contribution of this technology even more in the fight against this crisis. And to collect more information about it and push us to introduce the notions of this technology in the technological culture in our country starting in our school with our thesis.

The choice of the sector was made after research on the areas where the blockchain brought a plus and our school launched the new field of Logistics Management, and so it pushed us to look into the importance of technological development in SCM in general and the pharmaceutical industry in particular.

1.2 The objective of the study:

Scientific research must have a precise objective that adds value, and in our case, we can summarize the objectives of our research in the following points:

- Introduce the notion of the Blockchain and invite people to become interested in this technology.
- Identify the opportunity that can be for the implementation of Blockchain
- Identify problems and anomalies encountered in the SCM for the pharmaceutical industry.
- Obtain a small professional experience in this field for our future objectives.
- Improve our knowledge and try to contribute to the modernization of TAPHCO SPA.
- Get ideas on the feasibility of blockchain implementation from a technical and managerial perspective.
- Discover the challenges facing the implementation of this technology and its integration into current information systems.
- Illuminate images on Blockchain projects in the SCM and get an idea of the new technological generations in blockchain logistics.

2 Research Relevance:

2.1 Theoretical relevance:

The need for innovation is a questionable phenomenon, not to innovate is to refuse to adapt to an increasingly demanding market, in terms of innovation in information systems is reflected most of the time has a complete strategic change in the flow of information most of the time to create added value to the company, but in Algeria and more particularly in the big companies one refuses to open up to improve an IS which is already considered as efficient, our study aims at Introducing the use of the Blockchain in a virgin and difficult Algerian market and to open up to get out of its comfort zone.

2.2 Managerial relevance:

Our training at the School of Management added to our theoretical research of articles and scientific journals we have transmitted a relatively deep knowledge on the management of information systems in a company, our theme allows us to suggest the use of a technology Ensuring traceability and transparency in the monitoring of product information flow in the SC to facilitate it, whether to the manager production manager quality department or the national organization of the pharmaceutical industry.

Therefore, our problematic has been oriented on the following question:

1 What opportunity can the blockchain technology have in the modernization of TAPCHO's supply chain?

And we have decomposed Our question to a sub-question:

1. In which parts can the Blockchain be implemented?
2. What impact can blockchain technology has on improving the flow of information within TAPHCO's supply chain departments?

3 Memory organization

To bring elements of the answer to these questions the continuation of our work will be structured in three parts:

The first chapter entitled “literature review and conceptual framework” will be divided into two parts a literature review including studies on scientific journals on blockchain in the field of the supply chain, and a conceptual framework divided into two parts, a first on theoretical definitions on blockchain technology and a second theoretical study on the supply chain.

The second chapter entitled “Methodological framework and organization” will also be divided into two parts: the first one will focus on the methods and techniques adopted for the collection of information, and which made it possible to answer our research question and the second one on the presentation of the study field.

Finally, the third chapter entitled will be devoted to the study of a possible application of the blockchain technology on a real field and the modeling of this technology.

Chapter 01: Literature review & Conceptual Frame

Section1: literature review:

In this section, we will mention some concepts proposed by articles and white papers made by official organizations who manage researches about Blockchain technology and the implementation, and which problems can solve by this technology.

1 Blockchain-Based Quality Management Framework

In the fourteenth IEEE international conference on e-Business Engineering, a work was published that uses an integrative approach that proposes a framework based on Blockchain technology for SCQI. Made by Si Chen (1), Jiaqi Yan (1), Rui Shi (1), Yani Shi (2), Zhuangyu Ren (1), and Jinyu Zhang (3).

(1) School of Information Management Nanjing University, Nanjing, China.

(2) School of Economics and Management Southeast University, Nanjing, China.

(3) Software Institute Nanjing University, Nanjing, China.

The recent quality scandals reveal the importance of quality management from a supply chain perspective. Too many related studies focusing on supply chain quality management, actually the technologies used have difficulties in resolving those problems of trust in the supply chain. The main reason lies in three challenges brought of the traditional centralized trust mechanism: self-interest/information asymmetry in production processes/costs and limitation of quality inspection. Blockchain is a technology that can solve this kind of problems, in this paper the discussion was about how to improve the supply chain quality management by adopting the blockchain technology and propose a framework based on this technology.

The work was parted on 3 sections and a conclusion in the last, the first section it talked about the problematic of scandals that we have talked about, and the second one proposes a Blockchain-based SCQM framework, it explains the new supply chain system that can be built in which information sharing and quality control is assured, this framework consists of Blockchain, Smart Contract and various IoT sensors buy providing a safely distributed ledger that contains various information about quality, assets, logistics, and transactions. The smart contract assures privacy protection and automation in the system while IoT sensors gather data from the real world. The framework architecture is composed of 4 layers (bottom IoT layer, Data layer, contract layer, and business layer in the top) in which layer has a function.

The third section uses a laptop supply chain for a case study. Based on blockchain and RFID (Radio Frequency Identification), a system for traceability is proposed in China in which the logistic data is shared, suppliers on the supply chain provide components and parts to the manufacturers, when the components are produced, based on the data collected from IoT sensors and their numerically controlled machine tools system, the qualities of processes and products are monitored in real-time, in this way, suppliers and manufacturers can find errors in time and control it in timely. The blockchain is used to store data about the processes in real-time,

There is a possibility that a competitive supplier provides the same kind of components for example CPU or Screens, but using smart contracts, every competitor has its ID with particular access authority, and no one can access the data from each other. And during the whole process, the IoT sensors are gathering data and all this will be treated in the system by Blockchain and smart contract.

In the last the framework proposed will provide a theoretical basis to intelligent quality management of supply chain based the blockchain technology, it provides a foundation to develop theories about information resource management in distributed. Virtual organizations, especially distributed, cross-organizational, and decentralized management theory. The work was proposed to evaluate the framework and it will be applied to design an intelligent SCQI system for a real-world application.

The work was supported by the Natural Science Foundation of China (NSFC No. 71701091, 71701043, and 71704078) and the Chinese Ministry of Education Project of Humanities and Social Science (No. 17YJC870020). (Chen, 2017)

2 Blockchain for retail

By trying to reach directly to the end-users obtain profit by strategic planning and delivering consumer satisfaction retail industry-trusted the ability of technology innovations. An Accubits white paper demonstrates what Blockchain technology provides as possibilities for retailers.

This white paper with a Semi-systematic approach based on articles, a thorough review on how to adapt the possibilities that blockchain opens to the retail world, and tips on preparing a blockchain strategy for retailers is detailed

Retail as every market based on different parties faces some challenges as Data security, storing sensitive customers data “financial credentials, identity theirs 2017 had cybersecurity breaches, information stolen. Or Consumers demands: which is the transparency of process and originality of products, also rising regulatory compliance requirement: with ensuring legal trade documentation, Supply chain, and logistics visibility: border trade policies, fuel prices volatilities, result in widespread uncertainties in supply of the product and raw materials. and finally Counterfeits goods.

Blockchain was the answer was as It can create a strong transactional framework for data and monetary with-it database capability.

Blockchain in retail bring some possibilities as an Authentic premium product with blockchain: as it can store the info needed including the origin sources, process details, packing data, quality info…in an immutable ledger incorruptible or can’t be manipulated These tags are verified by customers or government for validation and stop the popularity of counterfeits. Also Lowered costs with cryptocurrencies with the use of cryptocurrencies it deleted the needs of government agencies to process payment so transaction fees live lower with the absence of third-party approval. an Automated and secured transaction with a smart contract, the use of smart contracts independent from manipulation allowing stakeholders actively trade in the market with conformity and a Better customer trust secured data and transactions, the data use of customers is accessible to them and avoid illegal sell of it or they can allow it monetization.

The Blockchain solutions were focused on a Smart product tag solution with tamper-proofing tags information and allowing utilization to verify the authenticity of the product. a Blockchain wallet enabling fast and smooth blockchain-based monetary transaction, this wallet would serve as a point of service as a point of exchange for other trading partners accessing the retailers' blockchain ecosystem. An Inventory management solution supply chain visibility stage by stage into product lifecycle to facilitate retailers to manage inventory. A Delivery assurance solution providing accurate information of purchase product to shoppers, and anticipation of delays during calamities for physical stores merchants and notify their suppliers and finally a Reward and loyalty solutions: rewarding shoppers with cryptocurrencies

This review examined the state-of-the-art of blockchain technologies and proposed various solutions to make the retail efficient as when it comes to technology, the technology-based blockchain offers a vast monetary option to the digital retail market. It is hoped that the

proposed blockchain implementation model will be able to determine the best option for blockchain implementation in the retail market. (https://accubits.com/ , 2020)

3 Blockchain in SCM

In 2017 Accubits technologies published an article about the use of blockchain for an efficient supply chain this paper discusses how the efficiency of supply chain systems can be improved using blockchain technology.

In this article, the current status of the blockchain and some of its applications are reviewed. The potential benefit of such technology in the manufacturing supply chain is then treated in this article and a vision for the future blockchain-ready manufacturing supply chain is proposed using a systematic approach.

The article started with Issues faced in current supply chain systems as a Lack of transparency: supply chains lack a common infrastructure or a database that can be accessed by all the participants, logs can easily be manipulated by the party involved, some parties still rely on paper records to document data. Also, the Inefficient tracking supply chain for international trade is highly fragmented with several local players handling the last mile services which means difference tracking provisions and this leads to the unreliable paper trail, brokers have been providing basic tracking services but it shows poor transparency sometimes it ends up with failed handoffs, loss or cargo or shipping delays. Or High middleman markup there is a whop in shipping and logistics spending with the increase of air freight rail transportation and storage costs, intermediaries becoming gatekeepers of the industry, and making major profits under the guise of managing the freight and insuring the goods. Adding to that Lack of accountability: with a lack of transparency, some supply chain parties hide and inflate revenue numbers this led to more investment in the inspection of goods shipped by the manufacturer. And finally, Inefficient resource allocation just 75% of all supply chain asset is used at any given time, the major disparity is on renting and maintaining warehouses, trucks, factories.

The Blockchain technology Is related to cryptocurrency, it’s a digital ledger incorruptible with programmed economic transaction recording the financial transaction and everything of value, allowing all participant in the network it adds Unmatched transparency with incorruptible data stored and maintaining record and transparency with an automatic update in real-time across the network. Enhanced security because the entrance saved in the ledger are cryptographically

signed plus the decentralization to ensure incomparable risk management, Superior asset management, and the Smart contract allowing automatic enforcement and execution of the agreed steps by stakeholders and execute the pre-set actions with specified conditions.

The research came the solution of How blockchain is the best fit for supply chain solutions this was by Enhanced visibility and superior quality control across the supply chain with a distributed ledger accessible to all participants providing real-time updates and tracking, an Optimal resource allocation real-time tracking of the shipment and visibility grant calculation of the required resources and management of storage facilities, adding to that deducing market trends based on various parameters accumulated on the blockchain or Enhanced security and decentralized brokerage attaching barcodes and tags to shipment permit automatic verification and reduce counterfeiting and theft chances.

But I seem that It might encounter some challenges Interoperability issues lack of standardization between a various blockchain or enterprises obstruct it optimal utilization, or Legal and regulatory framework lack of central governing body and set regulations creates various legal hurdles adding to that different location of the network node of the blockchain.

As an example, the article mentioned some Use cases such as the Food industry with the blockchain-based solution work on tracking the food from the farm to the fork focusing on where it grown, the chemical and the fertilizers, or how and where was the raise of the animals and their hygiene. The Pharmaceutical supply chain which is the largest targets for targets and counterfeiting so the blockchain concentrate on the ingredients mentioned of the label, the country of origin of the product and expiration date, or the Automotive supply chain with logging and labeling component of the automobile, giving access to consumers for dealer's authenticity verification about the vehicle. Or details verification of the vehicles by law enforcement agencies and insurance companies.

And Concluded that A transparent autonomous, Smart contract executed is a perfect solution for supply chain system problems, with visibility of all terms of payment to supply chain authorized participants to the data using their private keys, automated transactions with smart contract holding the payment escrow releasing the funds automatically when the pre-agreed conditions are accomplished, and time stamping, verification of the decentralized record in all network with in case of any fault detection the blockchain notify all the stakeholders. (https://accubits.com/ , 2020)

Section2: Conceptual Frame

1 Blockchain technology

One of the first known digital disruptions was the internet and especially the famous protocol TCP/IP (Transmission Control Protocol/ Internet Protocol) back in the 970s. It was the concept that allows communication between 2 participants. This protocol came up with its protocol packet switching design, which was more open and peer-to-peer with no need to pre-establish a dedicated line between parties.

In the 1990s the internet was made accessible to the public via WWW (World Wide Web), it was supposed to be more open and peer-to-peer because it was built atop the open and decentralized TCP/IP. That was a revolutionary technology that allows building a new business, new technologies on top of it and became what is today more centralized. People get used to what technology offers and they are just fine if an international transaction takes days to settle, or it is too expensive, or it less reliable.

With looking closer to the banking system we will see that the bank's system offers too many services such as transaction between people, for example, Ahmed from Algeria can send money to Abdelfateh in the UK that takes days and it's too expensive, we see that the bank is the trusted part between Ahmed and Abdelfateh but what if new technology can enable trust and security without the need of third party and centralized system? And yes, Blockchain was the missed internet piece to do it.

Satoshi Nakamoto the pseudo name by which the world knows the creator of Bitcoin in 2008 he published a whitepaper that explains what is the bitcoin and tries to change the process of payment. Banks form centralized institutions that maintained the transactions record governed interactions and enforce trust and security.

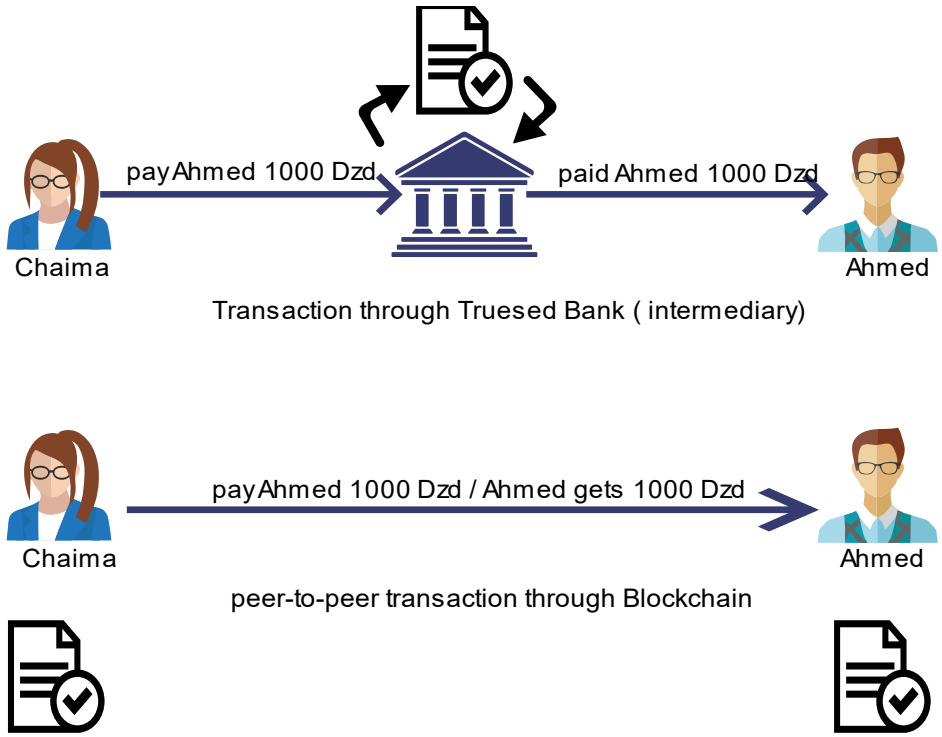
So, Satoshi Nakamoto invented a cryptocurrency called Bitcoin that was enabled by the underlying technology— blockchain. This currency is just a use case of blockchain that made a blockchain more and more famous and S addresses the inherent weakness of trust-based models. This invention was the point of start to make the buzzword today which is the blockchain. (Bikramaditya & al, 2018, p. 2)

1.1 What is Blockchain technology

This technology is a buzzword in the IT world and we can find too many definitions, to understand it we will need to understand it from two perspectives, business, and technic to make clear what is it and how it works.

"Blockchain is a system of records to transact value (not just money!) In a 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." the next figure shows us the perfect example to explain it better. (Bikramaditya & al, 2018)

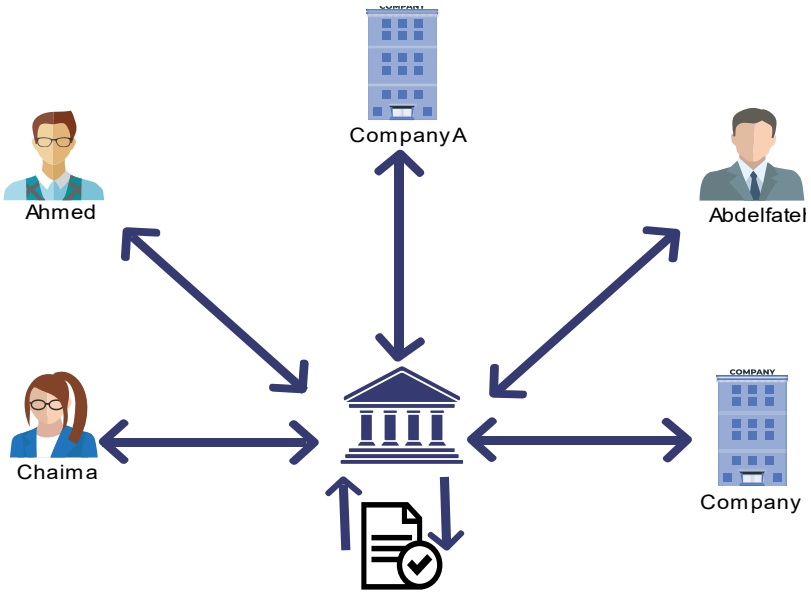
Figure 1 transaction through an intermediary vs peer to peer transaction



Source: made by us from the concept made in the book of Beginning Blockchain

by looking at another example. A typical transaction happens in seconds, but its settlement takes weeks. Certainly, That's not desirable in this digital age. The following figure shows us the current situation.

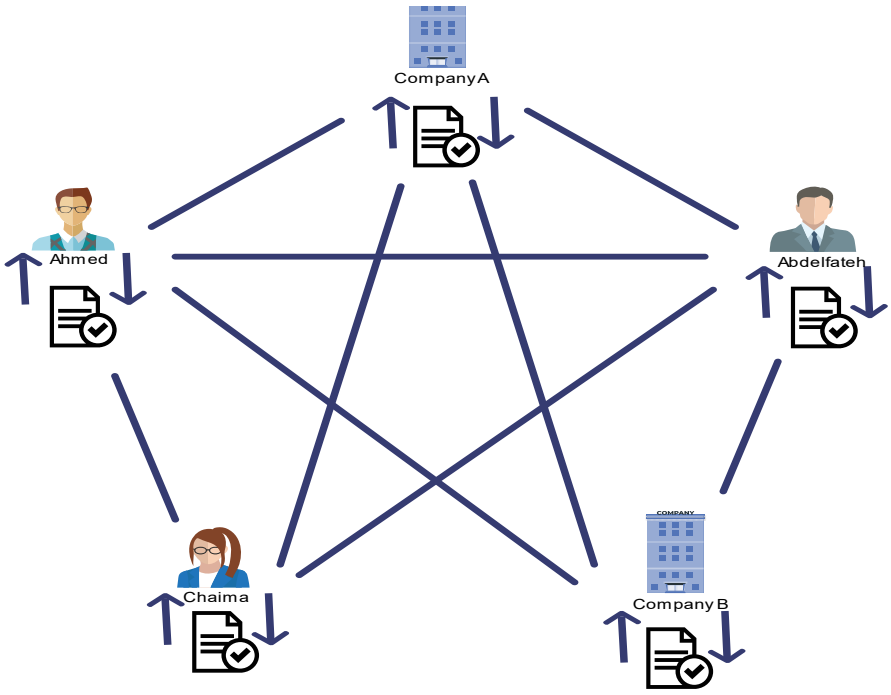
Figure 2 Stocks trading through an intermediary clearing house



Source: made by us from the concept made in the book of Beginning Blockchain,

with a decentralized & peer-to-peer system, everyone wants to buy some stocks from a company or another one he will just directly buy from them with the instant settlement, with no need for clearinghouses.

Figure 3 Peer-to-Peer Stocks trading through blockchain

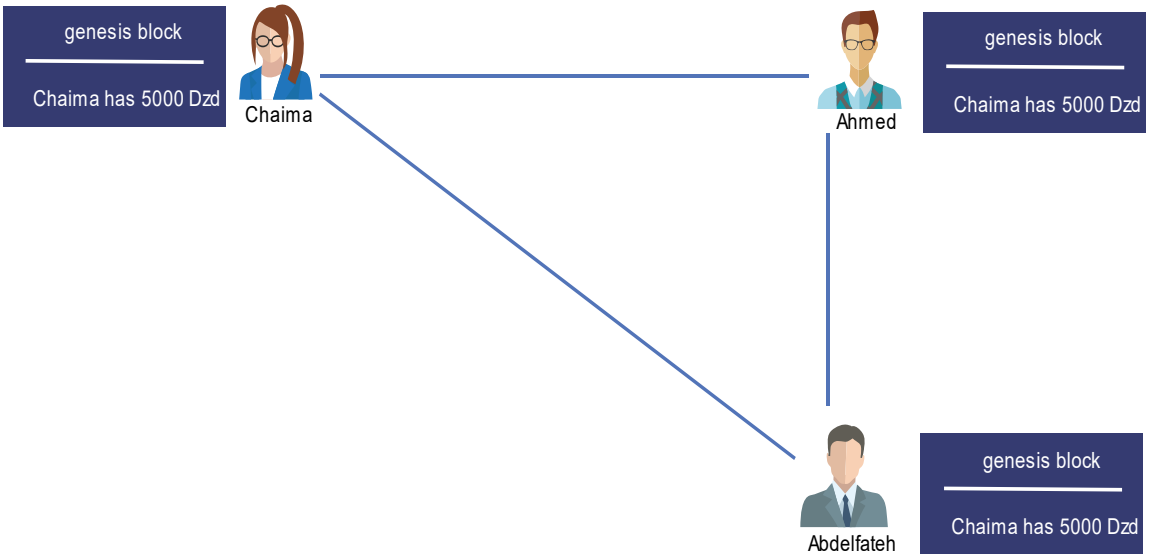


Source: made by us from the concept made in the book of Beginning Blockchain,

Note: transaction and settlement are not two different entities in the blockchain setting just like fiat currency, if someone pays 1000 Algerian Diners, he will not own it anymore. Then 1000 Algerian Dinars' notes were physically transferred.

Let us go now to the technical part and see how it works briefly because we are not obliged to know every little detail about the technical side but we should have an idea about how blockchain record that.

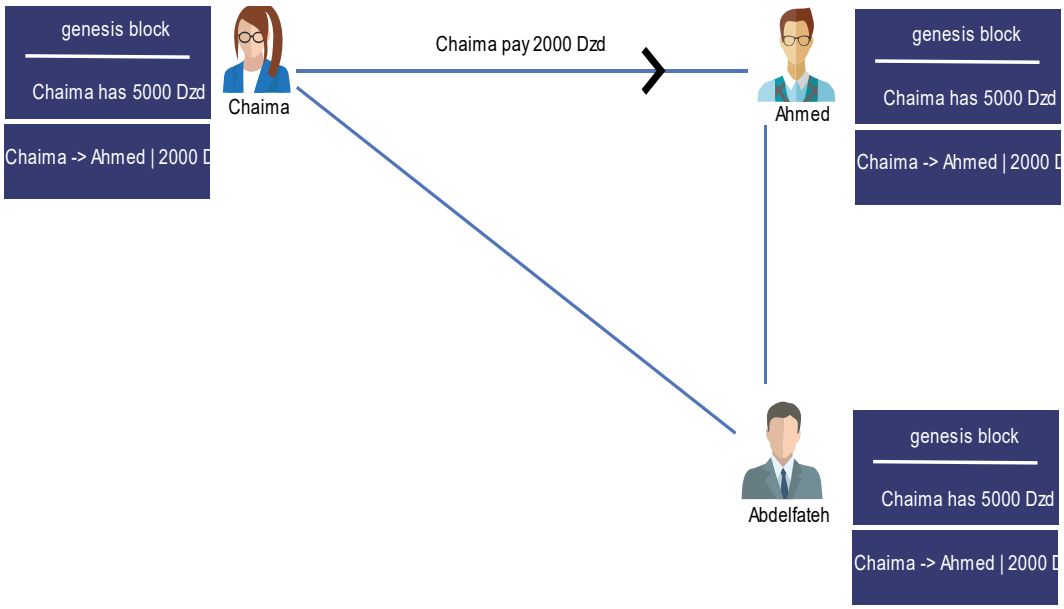
Figure 4 The genesis block



Source: made by us from the concept made in the book of Beginning Blockchain,

The genesis block is the first block in the chain that contains the information that Chaima has 5000 Algerian Diners and the generation of this block is the first step as shown in the figure.

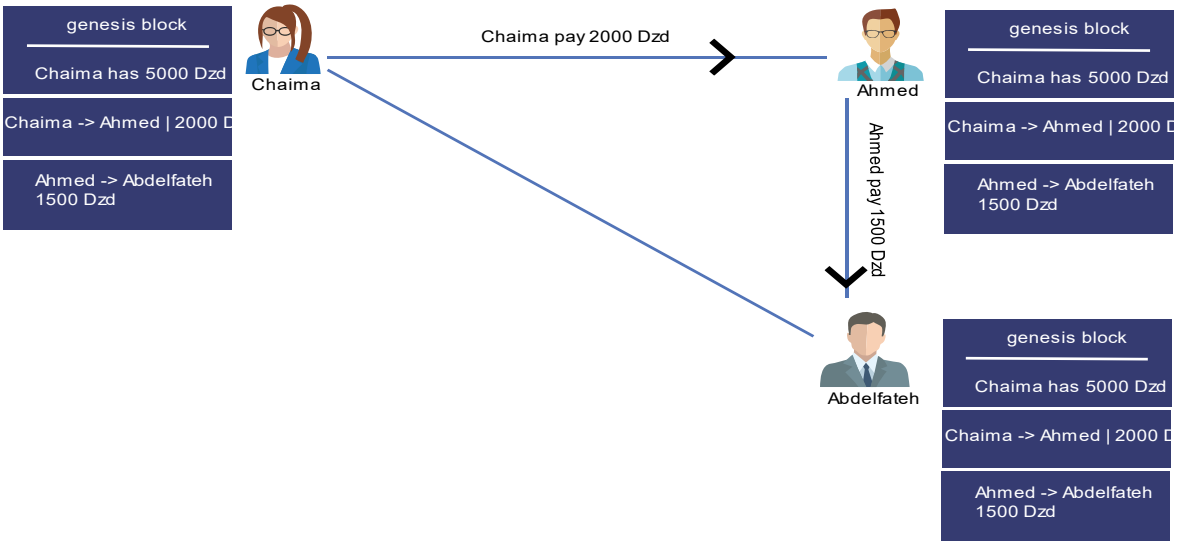
Figure 5 First transaction



Source: made by us from the concept made in the book of Beginning Blockchain,

Chaima makes a transaction by paying 2000 Algerian Diners to Ahmed. Observe how the blockchain gets updated at each node.

Figure 6 Second transaction



Source: made by us from the concept made in the book of Beginning Blockchain

For other transactions, the same update and process in the network, and all get informed and updated.

We need to notice that the transaction data in the blockchain is immutable and every transaction is fully irreversible or editable. And every new transaction is validated by all contributed nodes.

We used the banking system because we have seen that is the perfect example to explain this technology and it was the first system vised by the project of Bitcoin but in our thesis, we will talk about this technology in the supply chain. Then we got a definition clearer and more adaptable to our subject.

"Blockchain is a distributed ledger technology that provides an immutable audit trail of transactions, allowing for transparency while maintaining data privacy, and uniting disparate sources of data from various stakeholders." (Treshock, February 2020)

At the end of this section, we want to say that there are too many definitions of the blockchain invariant book but all for the same architecture that we have seen in the section. (Bikramaditya & al, 2018, p. 4)

1.2 The motivation behind the Blockchain

We know all that push human to innovate is to be facing a problem and trying to solve it by learning about it and no exception than for Blockchain technology, we conclude after learning about this technology that it arose cause of a need to address the inevitability of uncertainty in the existing economy.

Uncertainty could never be eliminated, but only lowered. The traditional way to lower uncertainty is to have always the institutions that have acted as third-party lawmakers, or lack of trust whenever there was a need for an agreement between parties. A typical example would be buying an item on eBay, you would always need as much certainty as possible about the trade. No reason to trust each other, but they complete the trade because they trust the third party, which is eBay who represents the party to assure the legitimate trade. To trust an institution, you need to research about it and gather information about as much as possible, Blockchain is kind of a solution in this situation in the case it offers a DAPP with a P2P network and high security to assure some level of certainty. That was the main reason to adopt this technology in a trustless society.

For the implementation in a trustless environment, the Blockchain represents the ideal technology but alone it's not responsible for the success of the complete implementations. It's assisted by other protocols that make it a resilient technology and robust. The main reason why

we can implement Blockchain in a trustless network is the decentralization of computations in the dese P2P networks and the maintenance of secure and publicly a distributed ledger that gives transparency over the entities, and P2P network make sure that every node is having the latest version of the ledger.

"*The need for decentralization is the key motivation behind the blockchain technology, and decentralization is achieved by distributing the computation tasks to all the nodes of the Blockchain network"*. (Bikramaditya & al, 2018) Too many problems of traditional systems can be solved by decentralization, for example as we saw previously about the banking systems, whenever the existence of the institutions who represent the third party. In the centralized server, there are just a few backup servers for load balancing and there could be a situation where all servers could be flooded with requests and the server shutdown but in a decentralized network, this kind of situation can't be an issue because all the transactions are distributed across the nodes. Technically every nide can act as a backup node when the transactions fail, maintaining the integrity of data in the network achieved by maintaining a distributed ledger of blockchain data. The factor key for the integrity of the ledger is the immutability. After this, we can conclude the motivations behind blockchain technology which are the need for trust network, security, and transparency. (Bikramaditya & al, 2018)

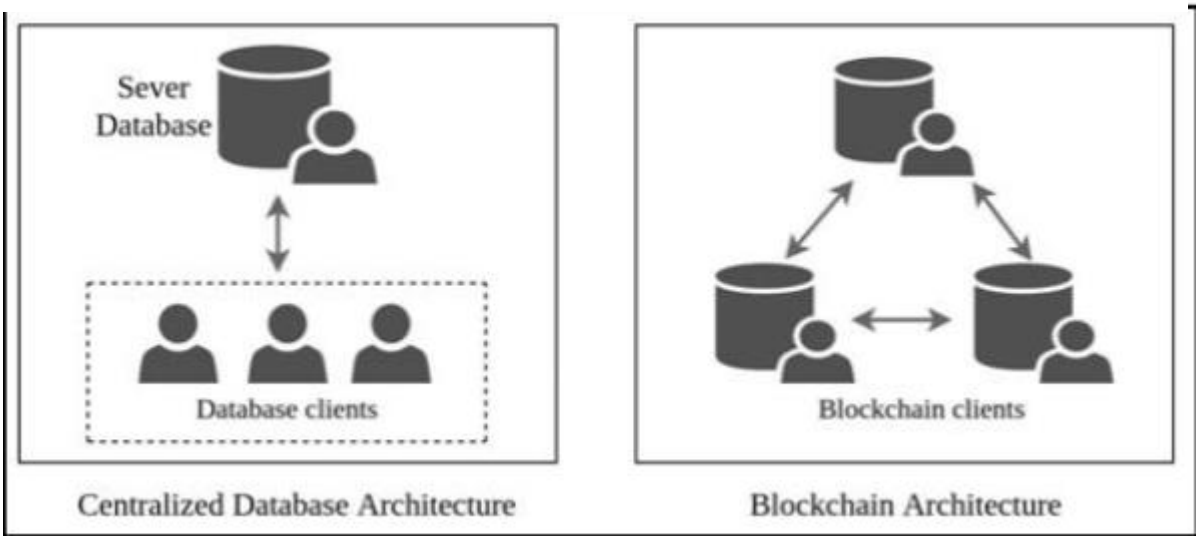
1.3 Blockchain & Database

As we noticed before, Blockchain allows us to stock information which is a mutual point with a definition of a Database but there is a difference between them.

To make it simpler, a relational database follows the CRUD Operational model and that means we can Create, Read, Update & Delete Data, each DB has an administration when it is created, most of the cases of DB are maintained in a single entity which is controlled by the all of the application and that makes a centralized architecture.

In the other hand, we find the Blockchain, we can only append and read data so we can Create and Read blocks & No Update No Delete (CR~~UD~~), the Blocs can be only created and appended to the chain and no one has access or ability to update or delete Data. Blockchain is designed for DAPPs with a decentralized architecture. (Koshik , 2019)

Figure 7 Diagram showing the architecture of DB versus Blockchain

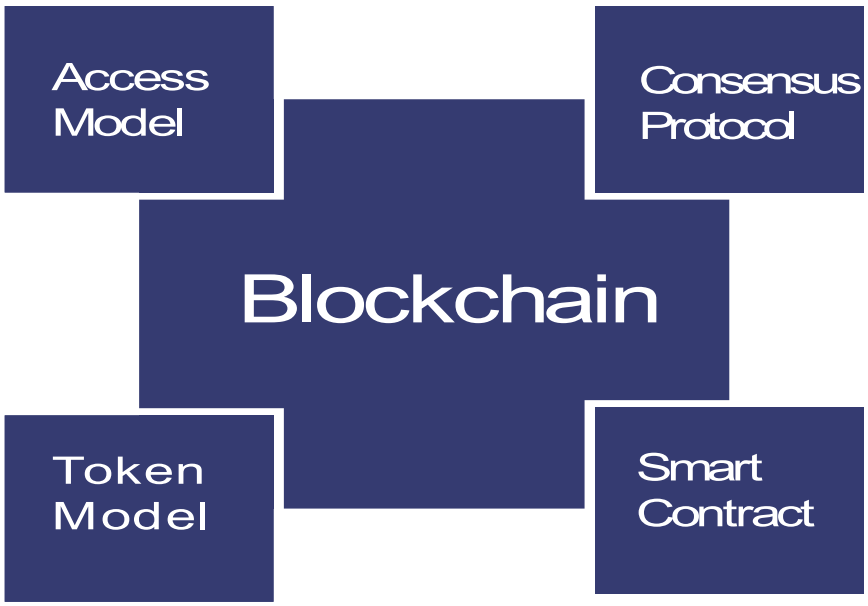


Source: foundations of blockchain

1.4 Basic elements of Blockchain

The blockchain system is composed of elements, and this element gives it a special characteristic that we will explain in this part. Let's take a look at the following figure.

Figure 8 Basic elements of the Blockchain system



Source: made by us from the concept of the article Blockchain technology for intelligent environments (11 October 2019)

In the figure, we notice that Blockchain is composed of 4 principal elements and every element contains other elements. (Spyros & al, 2019, p. 3)

1.4.1 Access Model

The ledger's policy regarding which participates (nodes) are allowed to act in which roles. Now we can devise the ledgers into two categories. (Spyros & al, 2019)

1.4.1.1 Permissoinless Blockchain

We can find it also as **open** or **public**, any computer can join the ledger if it has network access, and can take up also any role, it may participate as a validator also known as a miner, contribute in building consensus, as a verifier (full node) or other roles at least a simple user to issue new transactions. This model of the ledger is used a lot of blockchains including the famous digital coin Bitcoin, Ethereum, Litecoin, and the Dogecoin the supported coin by the famous Businessman Elon Musk. (Spyros & al, 2019)

1.4.1.2 Permissionned Blockchain

In this category, every node needs to be authenticated and authorized to take up certain roles. A validator could be restricted by the ledger to a plaited set of authorized nodes but locally any node can verify the correctness of the ledger. It could be also required the authentication and authorization to just read the ledger. In this case, it becomes a private ledger.

The permission models between ledgers differ greatly. Also, there is an interaction between the permission model and the consensus protocol: the PoA consensus model is only possible in the permission ledger. (Spyros & al, 2019)

1.4.2 Token Model

The ledger usually contains a token model, which essentially implements its cryptocurrency, used to express and transfer the value within the scope of the ledger. For Bitcoin, Litecoin and many other blockchains, tokens and token transactions have been the reason their existence. There are two mechanisms to support the token mechanism in the blockchain: UTxO-based and balance-based. (Spyros & al, 2019)

1.4.2.1 UTxO Based

Which stands for unspent transaction output, the mechanism used in Bitcoin. The idea is that each transaction generates one or more tokens as its output, by spending some previously

generated tokens, i.e., outputs of past transactions. For example, if Chaima wants to transfer four bitcoins to Ahmed has two tokens worth two and three bitcoins, but she can Blockchain transaction uses her 2 Bitcoin and 3 Bitcoin tokens and generates 4 Bitcoin tokens Link to Ahmed's wallet and have a new 1 Bitcoin token linked to his wallet as change.

The UTxO model does not store account balances. Instead, customers should track all expenditures and Generate tokens for the entire blockchain to calculate account balance locally (Spyros & al, 2019)

1.4.2.2 Balance Based

The model is one adopted by Ethereum. It compares the balance with each wallet which is updated directly by the transaction. For example, Chaima pays 4 Ethers to Ahmed, which only reduced Chaima's balance by 4 Ethers, while Ahmed's balance increased by the same amount.

Please note that to prevent replay attacks (i.e., multiple resubmissions and execution of past transactions), each user's serial number has been signed and attached to each transaction, thereby preventing Execute any given transaction for the second time. (Spyros & al, 2019)

1.4.3 Consensus Protocols

The most innovative breakthrough of the blockchain is the establishment of trust based on a large amount of trust usually untrusted nodes. This is achieved through a complex consensus mechanism, as mentioned above, which is essential to the operation of the blockchain. Some blockchain consensus mechanism has been designed, which is very different. The protocol essentially constitutes a voting mechanism for verifying and validating records stored in the blockchain. We will review some of the consensus mechanisms in this part. (Spyros & al, 2019, p. 5)

1.4.3.1 Proof-of-Work PoW

We can find it under the name of Nakamoto consensus because it's the first and most popular consensus mechanism for blockchains, used in Bitcoin. It is based on the combination of (1) the longest chain winning principle, (2) the calculation problem of establishing (or mining) the next block, and (3) the reward for mining the new block into the chain. The most commonly used computational problem is reverse hashing, which is to find value, and this value is called Nonce whose password hash satisfies certain conditions. We agree that the hash function is irreversible, in this case, the only way is to find a solution is to use the brute force techniques.

Unfortunately, reverse hashing alone does not have any real scientific or social reasons or benefits. Its sole purpose is to encourage participating nodes (called miners) to invest their resources in the chain that has become the longest chain (i.e. the winning chain), thereby effectively reaching consensus on a specific version of the chain and gaining unanimous approval.

Unless a single entity controls more than 50% of the world's mining capacity, it's in every miner's Interested in following the rules. Unfortunately, with the increasing popularity of large mining pools, the situation where more than half of the global hash power is aggregated under a single management Entity is no longer impossible. Thus, the danger of what is known as the 51% attack cannot be entirely ruled out.

The application of this mechanism requires huge energy. If we take a look at Bitcoin's mining, we will find power expected to surpass the power consumption of some countries like Ireland or Denmark by 2020. In terms of their carbon footprint and their effect on global ecology, this puts the long-term viability of PoW at stake. That's why there was a strong research effort to create an alternative consensus mechanism which will mention some below. (Spyros & al, 2019)

1.4.3.2 Proof-of-Stake PoS

PoS is an alternative mechanism after seeing the problem of waste energy and the issue of 51% attack previously in the PoW mechanism, and miners are called validators, and the act of mining a block is called minting or forging a block. Contrary to PoW the validators are not in direct competition to get the Nonce. Instead, the network elects which validator should mint the next block, thus preventing the wasteful process of PoW mining.

Nothing is random in the selection of the next block's validator, to become a validator, a node has to deposit something considered valuable by the community essentially a pledge or collateral as a security deposit, called a stake. This stake remains reserved and is returned to its owner, and all transaction fees for minted blocks. If a validator approves a fraudulent transaction it will lose all transaction fees. We can call this a profit-based motivation used to make validators follow protocol.

The reason for selecting validators proportionally is simple: the more You risk losing, the less likely you are to cheat. However, this encourages the rich-gets-richer model, while the richest

nodes are repeatedly appointed as validators, charge all transaction fees, and getting Richer. The use of coinage has been devised to alleviate this problem, it's to increase the chances of the node being appointed a validator and this depends on the time since the coin was last used as a stake. It can't be used again until a certain period has passed.

It's right that this protocol is an alternative to PoW but also it is not without drawbacks. PoS operation costs are negligible and enable a single validator to participate in multiple PoS blockchains using the same machine. Especially when the blockchain is forked into many concurrent versions, and nothing prevents the validator from supporting any Number, or even all at the same time, because of no matter which fork becomes an advantage. In this case, PoS chains may take a long time to settle, and that diminishes the blockchain's append-only, tamper-proof nature. And this provokes a new type of attack called nothing at Stake. It is a theoretical security hole in the PoS system. This problem may occur at any time when there is a fork in the blockchain, it may be due to malicious behavior, or it may happen accidentally when two honest validators propose a block at the same time.

Also, we find facilitation which is called the tragedy of the commons in the above modus operandi. Other miners join a fork in fear of losing their stake if it wishes to initiate a fork in a PoS system and it is sufficiently large, then it enabling to overcome and prevent the fork.

To improve this mechanism, it exists too many academic research initiatives in universities and community of developers. One of these initiatives is called Ouroboros and explore a solution based on the forking mechanism of a blockchain.

This mechanism is used a lot in blockchain projects like Blackcoin, Peercoin, and some discussion about the switching of Ethereum and another project. (Spyros & al, 2019)

1.4.3.3 Proof-of-Authority

It delegates the validation and block to a certain set of authorized nodes who are acting the administrators in the system. The suitable for permissioned blockchains as we saw previously. Transaction throughput may be high, and blockchain parameters may be high Fine-tune it according to the specific needs of the private network they serve. But trust does not appear Internal motivation of stakeholders but outsourced to system administrators to ensure A sufficient number of authorized nodes perform safe and error-free operations.

Most of the PoA-based consensus mechanism is based on so-called Byzantine consensus protocols. These protocols stem from the seminal work of researchers Lamport, Shostak, and

Pease in the early 1980s and later works of Castro and Liskov, and also this protocol was employed in many cloud databases. (Spyros & al, 2019)

1.4.3.4 Proof-of-Elapsed Time PoET

The proof time or elapsed time (PoET), this mechanism is introduced by Intel (Santa Clara, CA, U.S.), using its CPUs Software Guard Extension (SGX) function to enable the processor to run unmodifiable trusted code. It used a simple logic; every participant has to wait for a random period and the first node who finish waiting become the validator. It is a simple election protocol and uses the negligible power of the CPU in the execution. However, this is guaranteed by the trusted code based on the Intel-SGX feature.

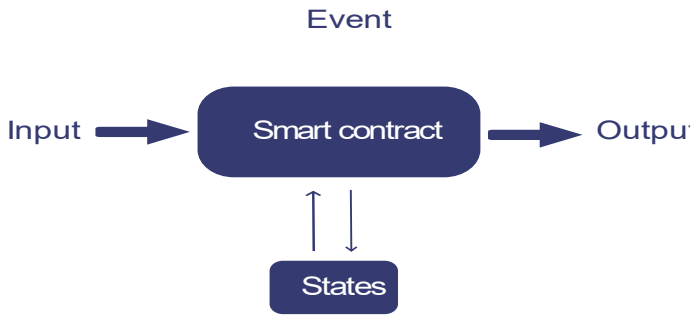
An example of using PoET is Hyperledger Sawtooth, which is mainly developed by Intel. (Spyros & al, 2019)

1.4.4 Smart Contract

Talking now about new groundbreaking innovation to the blockchain world. With a smart contract, Blockchain is promoted from special-purpose tools serving application like Bitcoin to general-purpose platforms, it allows developers to execute costume code in the chain.

Smart contracts are executable programs. They are usually written in high-level computer programming languages to express arbitrary business logic or predetermined standards to trigger value transfer. Ethereum is the first introduced smart contract support, ushering in an era of rapid innovation to solve some of the most challenging problems in technology and society. To allow transactions to be made, a smart contract exports an API consisting of one or more functions. We can find two types of functions there. Read-only function the program state of the smart contract is executed locally on the node that calls them. Calling such functions does not create new transactions for the underlying ledger. A read-write function which is executed in all nodes and requires a new transaction. To be clearer, nodes who act validator of blocks have to execute all smart contact’s functions.

Figure 9 Smart contract



Source: made by us from https://www.kaleido.io/

You will ask yourself how this work, you should know many features are existing in smart contracts we will mention some of these features that we found concerned about our subject (Spyros & al, 2019, p. 6)

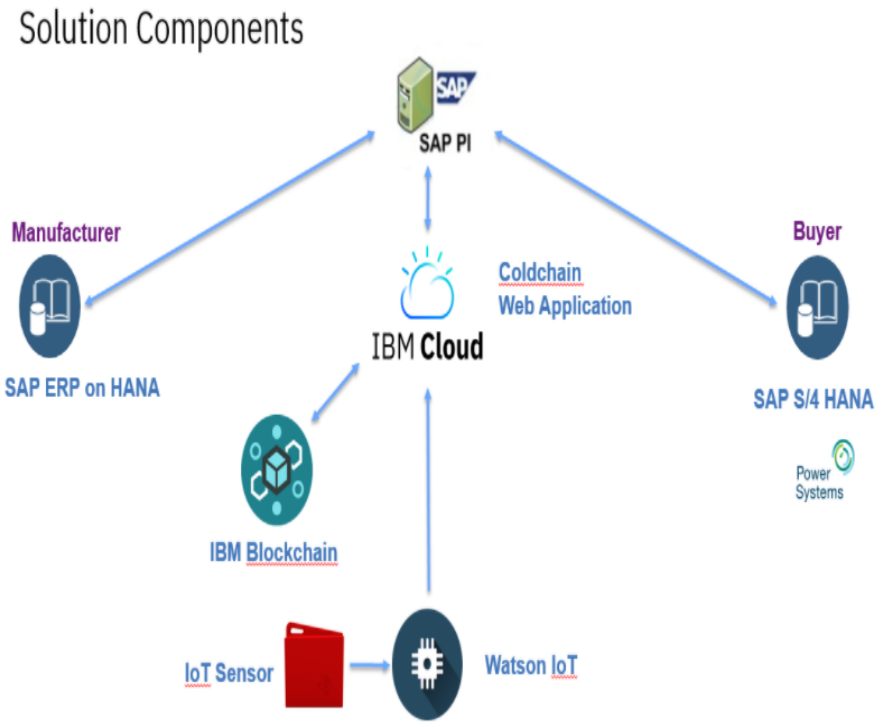
- **State storage**: the smart contract can store its state into a ledger.
- **Turing-complete computation**: This allows them to implement arbitrary logic for any type of custom ledger Application field.
- **Interaction with other contracts**: a smart contract can call functions from another smart contract to interact with them.
- **Input from the external world:** Smart contracts can get input from external sources. But it gets updated by a trusted external organization.
- **Input from a ledger itself:** smart contracts allowed to get any data from the ledger.
- **Insurance:** for example, AXA was the first insurance group that offered an offer using blockchain technology using the fizzy platform. How does it work? When you buy flight delay insurance on the fizzy platform, we record the transaction in the Ethereum blockchain, a tamper-proof computer network, which makes the contract itself also tamper-proof. This smart contract is connected to global air traffic databases, and when a delay of more than two hours is noted, compensation is triggered automatically.
- **Auctions**: People can bid for assets in the system without an intermediary, for each bid, verify that the owner does have the amount by retaining the amount Until the bid is higher or the timeout expires to complete the purchase.

- **Access control:** smart contract can be used to manage access and actions. (Spyros & al, 2019)

1.5 Blockchain in Information System

People and organizations use information every day. The components used are mostly called an information system. *«an information system (IS) is a set of interrelated components that collect, manipulate, store, and disseminate data and information and provide a feedback mechanism to meet an objective.”,* (George & M. stair , 2013) in term of software and Databases, Blockchain represents a big innovation in which could bring new performance to the actual information systems. Besides, we have some companies that worked on projects and software with the integration of blockchain technology inside the system to add performance and redesign some business models. For example, we mention IBM which provides service of Process Integration in the SAP system using the architecture shown in the figure below. (George & M. stair , 2013)

Figure 10 the architectural components associated with the Cold chain solution



Source: https://www.ibm.com/

Not only IBM who worked on this example but Amazon, Microsoft also and other companies, Blockchain then represents a real opportunity for those companies to redesign business and

create a new framework to improve the software layers of the information systems. (George & M. stair , 2013)

1.6 Blockchain Uses caises

As we said blockchain is a technology not only for cryptocurrencies but we can implement it in a different domain. In this part, we will mention some of the use cases we can find about it.

1.6.1 Supply chain Management

The main issues discussed in the articles and between experts are:

- Lack of transparency when products move through their supply chain.
- Problems with the product authenticity, because consumers sometimes receive counterfeit goods.

As we all know, a supply chain is a network established between an enterprise and its suppliers. Blockchain is expected to find remedies to solve supply chain problems through asset digitization.

It allows products to be marked and assigned a unique identity and then transplanted to an immutable, transparent, and secure blockchain. Blockchain helps to track important product information such as product status, shelf life, time, and location. By enabling blockchain asset digitization, the supply chain of products can be effectively transplanted to the supply chain.

Consumers can verify the authenticity of purchased goods through a supply chain that supports blockchain. Products can be accurately tracked at different locations and stages in the supply chain. This way, stakeholders will have the capability to isolate and tackle any potential issues. (blockchain council, 2020)

1.6.2 Digital Identity

Today, as centralized entities become more susceptible to identity theft and data breaches, digital identity is becoming an issue. Ownership is concentrated in the hands of the apps and services that we agree to use our data. Digital identities can be described as online records of information about individuals and organizations.

In the blockchain, users can control their information. Instead of providing consent to many service providers, users can store their digital identity data in encrypted digital hubs. Individuals can control access to the center and can also withdraw access if necessary. Using blockchain technology, users can control their digital data and how it is used. (blockchain council, 2020)

1.6.3 Voting

Voter fraud is a major problem that plagues the current voting structure. This requires one voter to vote at the polling station. This lowers the overall voter turnout. Voting is one activity that must have the option of being carried out online also. However, online voting has been resisted by many due to concerns such as security and fraud. The blockchain can record the records that have been voted, so it can successfully eliminate these concerns. The tamper-proof function of the blockchain makes it difficult to crack the voting system that supports the blockchain. Using the blockchain, the voting process can be easily conducted within the range of voters' houses. This may lead to a substantial increase in voter turnout. (blockchain council, 2020)

1.6.4 Fundraising

Although the "initial coin offering" helps democratize the funding process, this funding model has some drawbacks. ICO investment does not represent traditional equity, therefore, investors have limited investment rights. Some of the limitations of traditional financial markets are intermediary fees, floating costs, and delays in clearing and settlement.

Security tokens are blockchain-based tokens that enable companies to sell tokenized financial instruments such as debt and equity. The advantages of security tokens are:

- The lower minimum investments by enabling fractional ownership.
- They can be transferred immediately and traded on the 24/7 secondary market.
- This reduces the cost of the investment process as tokens are held by the individuals thereby removing the need for brokers and custody accounts.

Compared with Initial Token Offering (ICO), Security Token Offering (STO) is a more mature and regulated form of investment. Since stakeholders must legally register their products and services with their respective national regulatory agencies, STO may have fewer regulatory issues. (blockchain council, 2020)

1.6.5 Health care

Current issues:

- The doctor lacks a clear and complete understanding of the patient's medical history. This hinders the provision of effective healthcare solutions.
- Counterfeit or counterfeit medicines are also a major problem in the medical supply chain.

Blockchain will act as a tamper-proof and secure database to alleviate the problems faced by the healthcare industry. Patient medical records can be stored on the blockchain. This will make it easier for medical practitioners to better understand the patient's medical history. Blockchain will also help tag and track medicines at every stage of the supply chain. It will serve as a medium to ensure the authenticity of the drug. Patients can also control the data stored in the blockchain. Only if the patient grants them the same permissions, other people can view their data. (blockchain council, 2020)

1.6.6 Notary

The main part of owning assets is in paper form. This leaves room for falsification of records or fraudulent activities. Notarization is a fraud prevention process that ensures that all parties to a transaction ensure that documents can be trusted and are authentic. Blockchain technology will add significant value to the process of notarization. The tamper-resistant and transparent feature of blockchain makes it a suitable candidate for notarization. Blockchain can be used for notarization to ensure proof of existence. Since the creation of the document, the blockchain has helped to prove the existence of the document and can also detect modifications. You can verify whether the document has been changed by hashing the document. If there is any change, the document will generate a different hash value and the owner will be aware of the change. (blockchain council, 2020)

1.6.7 Intellectual Property

Poorly maintained IT agreements can cause unnecessary legal disputes. Adding a blockchain system can be used as a platform to provide accurate and clear ownership of IP assets. Tamper-resistant blockchains can provide a timestamp to indicate the exact recording time of an idea. This will solve any disputes regarding the origin of an idea. Blockchain also provides intellectual property owners with the added advantage of protecting their IP asset infringers (such as patent trolls).

This was some of the use cases discussed between experts and proposed for development we can’t mention all the use cases but we can say that this technology Is a big point which attracts companies to invest in, we will present a theoretical solution in one of the next sections. (blockchain council, 2020)

2 Supply Chain

The supply chain is an important if not the most important component in industrial activity, ensuring the coordination of different activities of the company's functions, it begins with the supplier and ends with the final customer, passing through a manufacturing and storage activity, its ultimate goal is the achievement of better product quality with an adequate economic condition for the company.

This section will consist of the elaboration of a theoretical framework encompassing both logistics and supply chain management, allowing us to focus on the role occupied by both concepts in the management of a business.

2.1 Logistics

From the supplier to the customer the product goes through a process of several operations that are as important as each other, these operations are known as Logistics.

The mastering of a logistic process guarantees a competitive advantage to each company that defines it concerning its competitors in the market.

In this part, we will retrace the evolution of logistics from the military field to companies, and evoke these different definitions over time as well as the different existing types of logistics.

2.1.1 The military origin of logistic

According to Roumi and Thomas If we follow the origins of logistics we go back to the ancient Greek civilization where it was considered as a set of means to provide necessities to the armed forces and coordinate their activities.

General Antoine Henri Jomini devoted a chapter in his book where he mentions the perfect organization in the examples of Alexander's conquests or the Napoleonic wars. (Lyonnet, Senkel, & Marie, 2019)

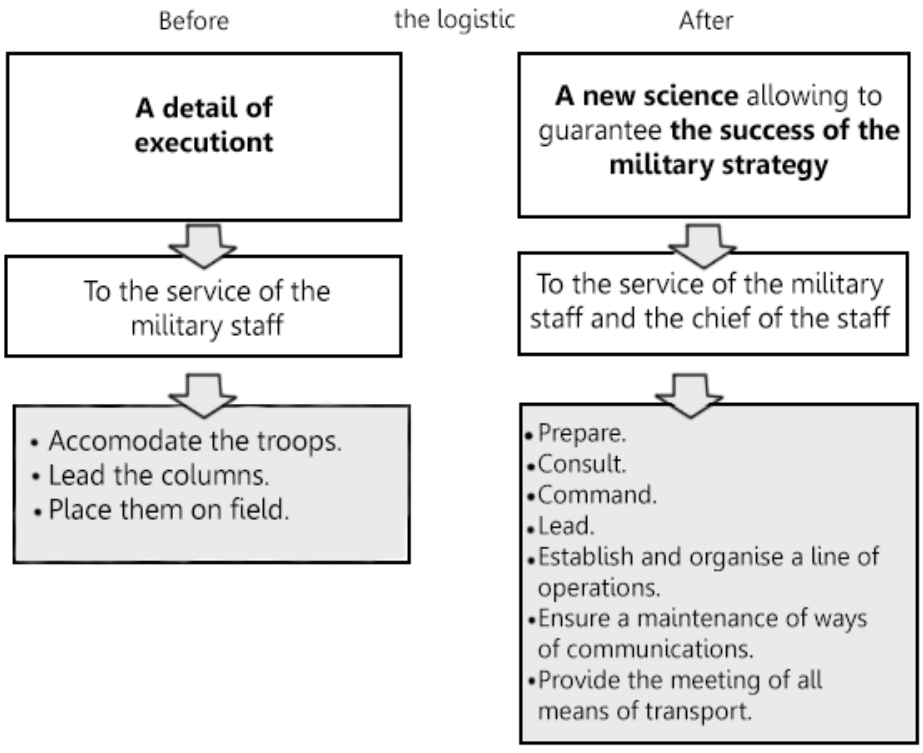
Alexander the Great is considered to be the first warlord to innovate in mobility and living supply by incorporating logistics into strategy as a necessity for pro... The conditions that can be envisaged in the campaigns. By considering it as a determining factor in the outcome of

battles. He had given autonomy to logistics with a commanded logistics corps to provide support. (ROUMY & THOMAS, 2004, p. 7)

The works dealing with Alexander the Great All are unanimous his method of preparing conquests was summed up on the safety of the water support, food supply on the roads to borrow. With locations and dates of consolidation of the fleet with stores for a period of camp studied from season to season. (Lyonnet, Senkel, & Marie, 2019, p. 4)

In 1800 and 1807 Napoleon created the artillery train and the crew train in that order. The aim was to carry out military transport operations by military personnel (a bit like a service process). This was due to the high mobility required by the increasing size of the Napoleonic army and the remoteness of the battlefields.

Figure 11 schematization of the evolution of logistics or the art of moving armies according to General Antoine Henri Jomini



Source: Supply Chain Management, Publisher: Dunod, Author(s): Lyonnet, Barbara Senkel, Marie-Pascale 2019, P3

2.1.2 The appearance of logistic companies

2.1.2.1 Period of separated logistics (before 1975)

After the Second World War in the 1950s, with the known economic growth and the strong demand concerning the low production rate and above all very weak competition, the appearance of production workshops with a work organization based on Taylorism contributed to a national market.

Companies following a productivism approach with the aim of mass production, the product is expected by the customers, stock management turned to the minimization of the storage what is called < zero stock> as the product was sold without shortening the delivery times or improvement of the quality of the product.

The mode used to be Taylorism the logistics was separated into trades and tasks aiming at a better output as cheap as possible the search for optimization of the logistics did not exist and thus had none (ROUMY & THOMAS, 2004, p. 75)

2.1.2.2 Period of integrated logistics (1975 – 1990)

The transversal and tactical role of the logistics function is essential. It is being dissolved and gradually integrated into other functions of the company.

In a more stable economic situation and despite a continental market of new companies emerging which gave closed markets in the same segments

With production capacity surpassing demand, overproduction is quickly becoming a problem for companies struggling to empty high inventory levels and this needs to be reversed.

To keep customers who are becoming more and more demanding, companies are establishing a new production approach based on more diversified products, better quality, and especially smaller quantities, while trying to keep costs under control, some companies are using Japanese methods such as KANBAN or MRP.

To achieve this goal, collaboration and technical and informational exchanges between departments are essential. Moreover, this progressive integration and disassociation are also used by the departments to reduce and control logistics costs. Such an industrial evolution has had two major impacts on logistics:

- Minimization of product delivery time, thanks to the anticipation of customer needs...
- Delivery of products that meet customers' requirements, even with a wide and complex offer.

During this period, the transversal and tactical role of the logistics function is essential. It is gradually being dismantling its boundaries and integrated into other functions of the company. Even if it is still perceived as an internal activity of the company. (ROUMY & THOMAS, 2004, p. 76)

Figure 12 Logistics chain in the 1980s

Source: http://www.lognews.info/lognews/r166-Evolution.html

2.1.2.3 Period of cooperative logistics (the 90's)

In the 1990s, a global market economy, generates higher competition, with production always exceeding demand, the uncertainty of demand characterizes this market has caused unpredictable consumer behavior.

A shortened product life cycle and strong competition are driving companies to review the control of logistics costs while trying to satisfy and retain customers with goods that become of superior quality.

With such a context, logistics takes on major importance in the strategy, privileging transversally by mobilizing all the internal resources of the company and also the external resources of the partners with a system of interdependent collaboration.

To enter new markets, alliances are created between companies such as "MERCEDES BENZ" and "CHRYSLER" using each other's distribution networks. Alliances with customers are also created to build customer loyalty, such as cooperation between suppliers and producers with an increase in the quality of raw or semi-finished materials for a better-finished product. Companies are even looking for countries with low labor, energy, and tax costs.

The optimization of flows between partners becomes a necessity, with an integration upstream of suppliers and downstream of customers, this passing by the adhesion of the actors and the Information System. (ROUMY & THOMAS, 2004, p. 77)

Figure 13 Process-based logistics management

Source: http://www.lognews.info/lognews/r166-Evolution.html

2.1.2.4 Abstract of logistics evolution

The following table contains an abstract about the evolution of the logistics

Table 1 Logistics evolution

	Separate logistics	**Integrated logistics**	**Integrated logistics and Collaborative = Supply Chain**
Period	Before 1980s	1980 - 1995	after 1995
Horizon temporal	Court term	Medium-term	Medium and long term
Logistics manager's priority	Reducing costs logistics	Reduce costs and logistical lead times. Improve the quality of services	Reduce costs and logistical lead times. Improve the quality of benefits. Improve the service level
Information's Role	Low because the systems do not facilitate transfers of information	High because of the integration of an increasing amount of information	Strong because sharing of frequent information and searched
Relations between supply Chain members	Relationships often and aggressive and related to the negotiating strength	The balance of power is common, but other Relationships appear possible	The "win-win" logic dominates, without anglicism however

Flow speed and storage conditions	Weak, because slowed down by the multiple stocks all along with the way logistics. Importance of the warehouse	High because stocks are getting reduce and information is more fluid. Importance of platform	Strong, because the information is shared, which leads to levels of stronger reactivity. Importance of the network warehouses and Platform
Recognition of the logistics = function transversal	Weak and discouraged practically	Raised and facilitated by reporting techniques and communication	Strong. Paradigm dominant
Measurement of logistics performance	Indicators by function from the accounting	Existence of some cross-cutting indicators	The level of service is placed in the center of concerns

Source : Pierre MÉDAN et Anne GRATACAP, Logistique et Supply Chain Management, Dunod, 2008, 304p

2.1.3 Definition

The Cambridge Dictionary defines the supply chain as *"the system of people and things that are involved in getting a product from the place where it is made to the person who buys it"*, (Cambridge Advanced Learners Dictionary, 2013)

According to BALLOU *"The mission of logistics is to provide goods and services. to consumers at the right place, at the right time, and under the right conditions, while at the same time ensuring the greatest contribution to the company".* (tixier & al, 1996)

The definition of J. I HSEKETTE (1977): "*Logistics encompasses activities that control the flow of products, the coordination of resources and outlets, achieving a given level of service at the lowest cost*.". (heskett, 1997)

& the AFNOR definition *"Logistics is a function whose purpose is the satisfaction of needs expressed, at the better economic conditions for the company, and a given level of service. Needs are internal (supply, production) or external (satisfaction, etc.) in nature. clients). Logistics calls upon several trades and know-how that contribute to the management and control of physical and information flows and resources".* (AFNOR : Association française de normalisation)

2.1.4 Logistics type

Being made up of a set of actors and partners in the purchase, production, storage, and sale, the logistics chain has a typology which differs according to the properties of the actors involved:

2.1.4.1 The logistics of material goods: it is represented in the management of physical activities

A global logistics chain: When the logistics chain is made up of a set of actors from different countries in these types what needs to be taken into account are taxes, insurance, country legislation, and anything else that may be involved. Relates to import and export (pimor & fender, 2008)

An internal logistics chain: with actors within the same legal entity (same company) (pimor & fender, 2008)

An external logistics chain: An extended enterprise: this is a collaboration between several companies but with only one of them playing a dominant role, because this company is the only one represented at the customers' premises and the other suppliers or subcontractors only deal with the design, production or delivery of the finished product to the end-users. The parent company's general forecasts are communicated to the others and periodic contracts are signed between them. (pimor & fender, 2008)

A virtual company: is also a collaboration between several companies but in this case, the piloting is decentralized or semi-decentralized with a bilateral interdependence between the partners, its effectiveness lies in the capacity of the information system has integrated the various partners in the strategy. (pimor & fender, 2008)

2.1.4.2 The logistic of services

In this case, it is about processes optimizing the infrastructures of service offered for value creation. Fender and Pimor have distinguished different types of logistics, which are summarized in the following table:

Table 2 logistics typology

Logistic types	**Definition**
Supply logistics	This consists of bringing to the factories the basic products, components, and sub-assemblies necessary for production, thus it allows them to provide service companies or administrations with the various products they need for their activity.

Production logistics	Which consists of bringing at the foot of the production the materials and components needed for production and production planning
Distribution logistics	Translated by the organization and production of the routing of the goods, from the location of the supplier's withdrawal from the supplier to the place of final consumption.
Military logistics	Which is designed to transport forces and all that is necessary for their operational implementation and support to a theatre of operations.
Support logistics	Born in the military but spread to other sectors: aeronautics, energy, industry, etc., which consists of organizing everything necessary to maintain in operates a complex system, including through maintenance activities.
After-sales service activities logistics	Pretty close to support logistics, with this difference that it is exercised in a framework of a merchant by the one who sold a good, we let's use the term "service management" to designate the steering of this activity, It should be noted, however, that this form of logistics support tends to be increasingly exercised by different specialists from the manufacturer and the user.
Return logistics	It consists of taking back products whose customer doesn't want or wants to have repaired, or to treating industrial waste, packaging, products unusable

Source : PIMOR(Y) et FENDER(M), « Logistique : Production, Distribution, Soutien », 5éme édition, Dunod, Paris, 2008, p 4.

2.2 Supply-chain management

The supply chain management being a global function of the company, it represents a very important part of the costs of an industrial company between 69% and 89%, with even more important gains to be expected, hence the interest of coverage of several functions, production, storage, maintenance, flow management, even exceeding the company's purchasing, supply, sale, and follow-up of products.

In this section, we will discuss the emergence of the SCM as well as its approach, the structure of a supply chain management, the actors involved and its process, and last but not least its importance in a company and the challenges and limitations it has experienced.

2.2.1 The emergence of supply-chain

In the mid-1990s the concept of supply chain management appeared, its definition was summed up as a chain of flows and services within an economic entity aiming to satisfy and supply a customer.

Within a global market associated with an acceleration of exchanges and an ever-increasing demand from customers, companies are obliged to abandon mass marketing and show imagination in designing their products to move to box marketing, which requires them to review their supply chain.

From the supplier to the customer, supply chain management is global management of the supply chain, with a transversal approach to physical and informational flows from planning to manufacturing through research and development, distribution, and taking into account market demand. (ROUMY & THOMAS, 2004, p. 75)

2.2.2 The supply chain management approach

There is a very good distinction between SC supply chain and SCM supplemental chain management

Supply chain management has not had a precise definition despite some efforts that have given the following few definitions:

CSCMP's Definition of Supply Chain: "*Supply chains are made up of all the companies that participate in the design, assembly, and delivery of a particular product: Vendors supply raw materials: Producers convert those raw materials into products, Warehouses store that product until it's needed, Distribution centers pick up and deliver that product, Retailers, online and in-store, bring that product to you, Supply chains are the reason that the producer can provide customers what they want, when and where they want it, at the price they need"* (council of supplychain management professional , 2020)

MARTIN Christopher gives this definition of SC "*The supply chain as the network of companies involved, upstream and downstream, in the various processes and activities that*

create value in the form of products and services delivered to the end consumer". (Christopher, 1998)

James Ayers considers: *"a supply chain is the network of production and distribution facilities that carry out the tasks of sourcing raw materials, transforming these materials into semi-finished and finished products, and distributing these finished products to customers".* (ayers, 2010)

Supply chain management has not had a precise definition despite some efforts that have given the following few definitions:

CSCMP's Definition of Supply Chain Management "*Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies."* (council of supplychain management professional , 2020)

HAMMAMI Abdelkader *"Supply chain management is a set of approaches used to effectively integrate suppliers, producers, and distributors so that goods are produced and distributed in the right quantity, at the right place and at the right time to minimize costs and ensure customer service levels".* (Abdelkader, 2003)

Supply chain management, therefore, includes more than just the supply chain:

- Demand and resource management.
- The supply of raw materials and their components.
- Production.
- Inventory management.
- Order entry and order management.
- Multi-channel distribution.

- Delivery to the customer. (Cambridge Advanced Learners Dictionary, 2013, p. 1856)

2.2.3 The structure of supply chain management

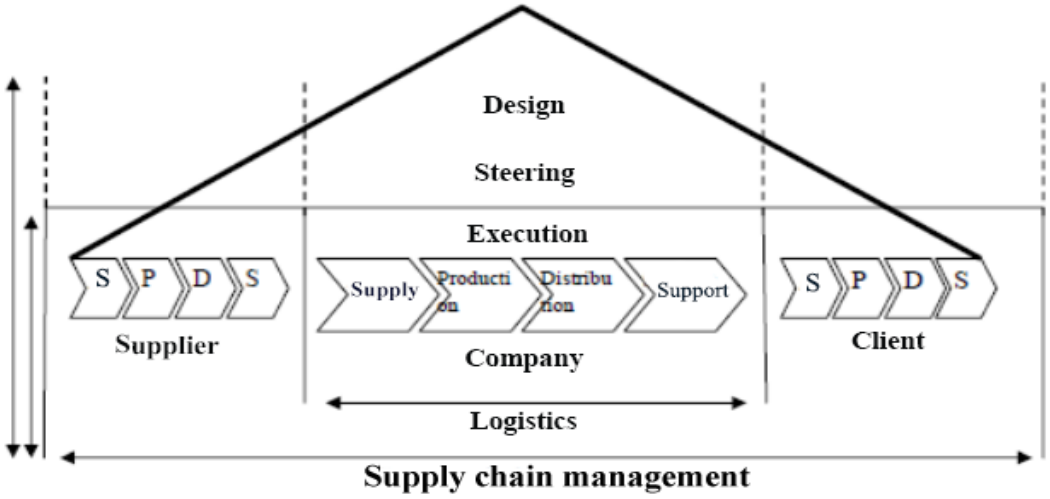
To create value, the strategic planning decisions of a supply chain pass through 3 levels:

Strategic level: with the aim of the general orientations of the company, in this level the planning is high level and long term, as an example: the search for new industrial partners, suppliers.

Tactical level: to satisfy demand cost-effectively and efficiently, medium-term decisions are made at this level, they are located on resource allocation, manpower, inventory management, production...etc.,

Operational level: with minor risk and a limited scope of time they are limited to operational issues: production, scheduling ... etc (hugo, 2011, p. 41)

Figure 14 fields covered by logistics and supply chain management



Source: Philippe et Michel, la logistique globale et le SCM: enjeux principes exemples, edition eyrolles 2007 p 59

2.2.4 Supply chain functions

Sunil Chopra and Peter Meindl define the principle practices of the supply chain management as the exploration of issues and providing answers to the problem of optimizing operations in the business system, the goal of it is to increase throughput while simultaneously reducing both inventory and operating expense, to achieve that the companies make decisions in five areas:

2.2.4.1 Inventory

Inventory is spread throughout the supply chain and includes everything from raw material to work in process to finished goods that are held by the manufacturers, distributors, and retailers in a supply chain.

2.2.4.2 Operations

The operation team engages in demand planning and forecasting. Before giving raw material purchase orders, the organization has to anticipate the possible market demand and number of units it needs to produce. Accordingly, it further sets the ball rolling for inventory management, production, and shipping. If the demand is over anticipated, then it could result in excess inventory costs. If the demand is under anticipated, the organization wouldn't be able to meet customer demand, thereby leading to revenue loss. So, operations function plays a critical role in supply chain management.

2.2.4.3 Logistics

This function of supply chain management requires immense coordination. The manufacturing of products has commenced. It needs space for storage until it is shipped for delivery. This calls for making local warehouse arrangements. Let's say; the products are to be delivered outside the city, state, or country limits. This brings transportation in the loop. There will also be a need for outstation warehouses. Logistics ensures that products reach the end-point delivery without any glitches

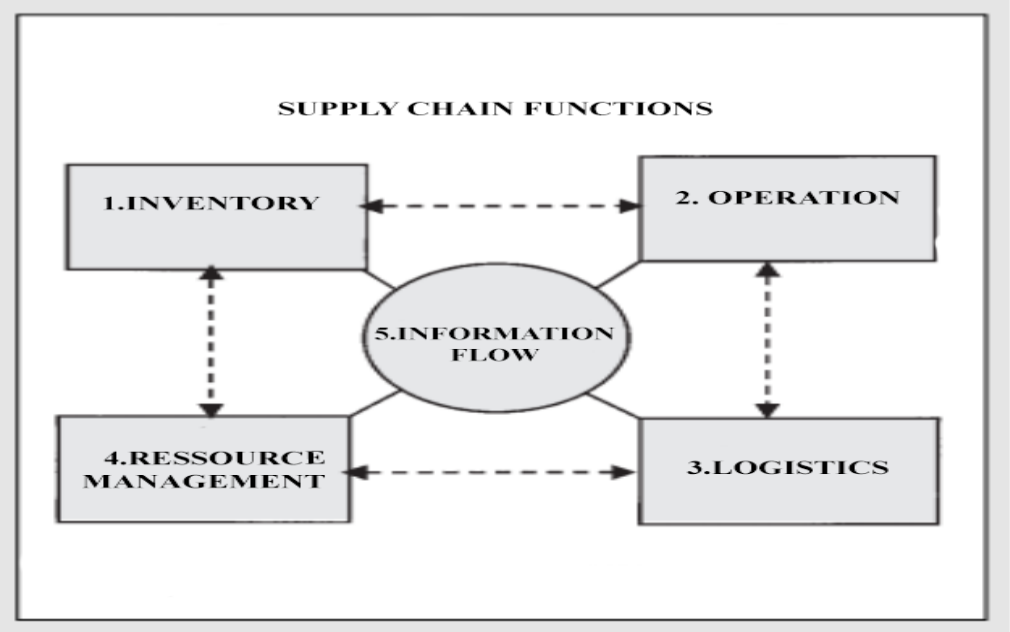
2.2.4.4 Resource Management

Any production consumes raw materials, technology, time, and labor. However, all the processes need to be efficient and effective. This phase is taken care of by the resource management function team. It decides the allocation of resources in the right activity at the right time to optimize production at reduced costs.

2.2.4.5 Information Workflow

Information sharing and distribution is what keeps all other functions of supply chain management on track. If the information workflow and communication are poor, it could break apart the entire chain and lead to mismanagement. (hugo, 2011, p. 7)

Figure 15 supply chain functions



Source: personal conception

2.2.5 Actors in the supply chain

In the supply chain they are two types of actors who participate in which are:

2.2.5.1 The internal actors (hugo, 2011, p. 23)

Table 3 internal actors of the supply chain

function	Actions
purchaser	• Referring to quality suppliers • Agree to a rounding policy • Order on time
Product Designer	• Predict delayed specialization
Packaging designer	• Designing packaging of a suitable size for the market • Adapt the size of the cardboard boxes to later apparatus. • Adapt the size of the boxes to the means of transport (road, sea, etc.)

	• Provide systems for fast opening of cartons
Manufacturer	• Being able to produce small batches (flexible workshop) • Ensuring product quality • Produce on time
Commercial	• Establish a rounding policy • Designing unambiguous catalogs to reduce returns
Transporter	• Delivering on time • Deliver in good condition
Storekeepers	• Checking receptions • Controlling inventory • Ensuring the quality of the preparations • Prepare on time
SI Responsible	• Transmit information quickly in a way that reliable • Establish an identification system automatic "universal".

Source: personal conception

2.2.5.2 External actors (hugo, 2011)

Table 4 External actors

The supplier	It is the first link in a logistics chain, it offers the basic elements essential to the creation of the company's wealth (raw materials, supplies, basic products, etc.).
The distributor	Usually represented by a distribution system. It picks up the product from the warehouse or storage location and delivers it in the appropriate quantity to the store when the retailer needs it.
The retailer	Places the product at the disposal of the buyers or consumers, this is where the final act of purchase is carried out

The consumer	Determines the future of the company, and decides the last place of the product he is going to buy. The company's goal is to maintain a relationship with its consumers, offering quality products and/or services to meet customer expectations and follow up after the purchase of its products. The consumer marks the end of the activities of the supply chain and allows the re-initialization of its processes by placing new orders.

Source: personal conception

2.2.6 Supply chain process

2.2.6.1 Planning

To organize the other processes in the chain, we always start with planning that generally covers three activities: demand prediction, stock management, and production planning.

2.2.6.2 Purchasing

This function of supply chain management pertains to procuring raw materials and other resources that are required to manufacture the goods. It requires coordination with suppliers to deliver the materials without any delays.

2.2.6.3 Production

Production refers to the capacity of a supply chain to make and store products. The facilities of production are factories and warehouses. The fundamental decision that managers face when making production decisions is how to resolve the trade-off between responsiveness and efficiency.

2.2.6.4 Storage

Trying to find a balance between reactivity and cost reduction, storage includes the quantities stored throughout the process, raw materials, components, finished products.

2.2.6.5 Transportation

This refers to the movement of everything from raw material to finished goods between different facilities in a supply chain. Between facilities, to Storage to distribution points.

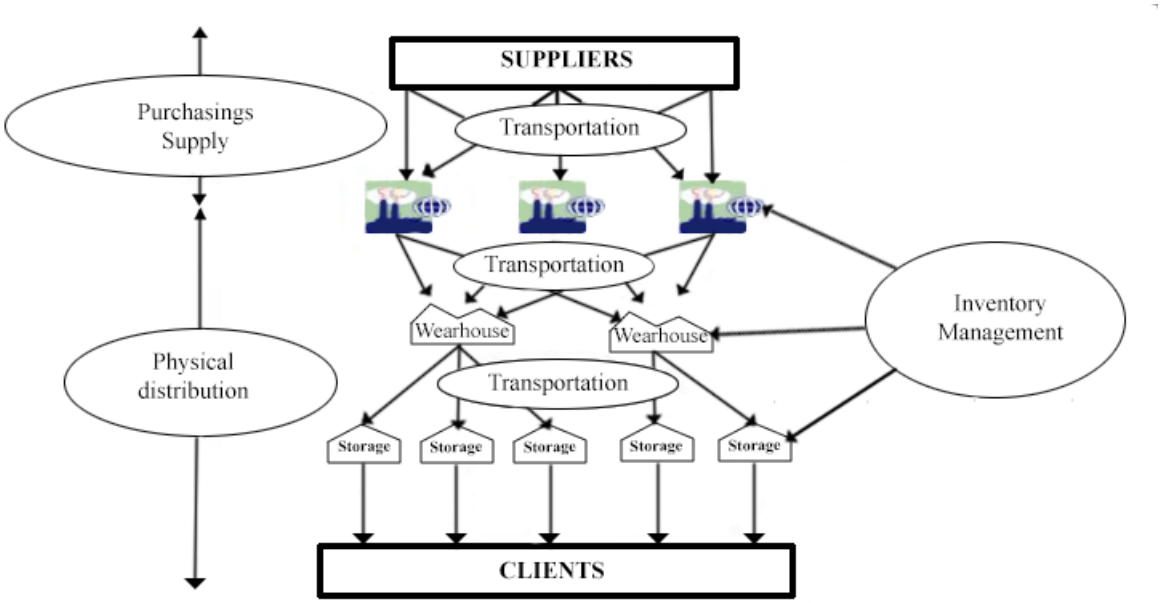
2.2.6.6 Distribution

Including delivery activities, it includes order management, transport management, and delivery to customers. Return: a recent process that manages the return of products in case of a defect, or return of a customer.

2.2.6.7 Sale

it is the final function in a supply chain aiming to generate profits, its efficiency depends on the performance of the upstream functions from where the importance of the profits varies up to even generating losses. (Zuckerman, 2002)

Figure 16 Perimeter covered by the supply chain



Source : FRANCOIS (J), « Planification des chaines logistiques : Modélisation du système décisionnel et performance », thèse de doctorat, école doctorale des sciences physiques et de l'ingénieur, Université BORDEAUX1, 2007, p24.

2.2.7 The Importance of supply chain management

As we all know, supply chain management is an indispensable part of most companies, and it is vital to the company's success and customer satisfaction:

2.2.7.1 Economic Roles of SCM

2.2.7.1.1 Improve customer service

Customers expect to repair products quickly with the correct product classification and delivery quantity. In the right location and the right delivery time. (council of supplychain management professional , 2020)

2.2.7.1.2 Reduce operation costs

And this by:

- Reduce procurement costs-Retailers rely on the supply chain to quickly deliver expensive products, thereby avoiding unnecessary expensive inventory in stores.
- Reduce production costs-Manufacturers rely on the supply chain to reliably deliver materials to the assembly plant to avoid material shortages that may cause production downtime.
- Reduce the total supply chain cost by designing a network that meets customer service goals at the lowest total cost. The efficient supply chain makes the company more competitive in the market. (council of supplychain management professional , 2020)

2.2.7.1.3 Improve Financial Position

- Increase profit leverage-the company values supply chain managers because they help control and reduce supply chain costs. This could lead to a sharp increase in company profits.
- Reduce fixed assets-Companies value supply chain managers because they reduce the use of large fixed assets in the supply chain, such as factories, warehouses, and vehicles.
- Increase cash flow – The company values supply chain managers because they speed up the flow of products to customers. For example, if a company can produce and deliver products to customers within 10 days (instead of 70 days), it can invoice customers 60 days in advance. (council of supplychain management professional , 2020)

2.2.7.2 Societal roles of SCM

2.2.7.2.1 Ensure human survival

- SCM helps sustain human life-humans rely on the supply chain to deliver necessities, such as food and water. Any failure of these pipelines will quickly threaten human life

- SCM improves human healthcare-humans rely on the supply chain to provide medicines and healthcare. In a medical emergency, supply chain performance can be the difference between life and death (council of supplychain management professional , 2020)

2.2.7.2.2 SCM protects human beings from extremes climates humans relay on the energy

supply chain to provide electricity to homes and businesses for their lighting, heating, cooling, and air conditioning. Logistic failure (power outage) will quickly threaten human life

2.2.7.2.3 Improve the quality of life

- The basis of economic growth-a society with highly developed supply chain infrastructure (modern interstate highway system, huge rail network, numerous modern ports, and airports) can exchange many things quickly and cost-effectively between businesses and consumers commodity. As a result, the economy has grown. What most poor countries have in common is that they have no supply chain infrastructure or poorly developed supply chain infrastructure.

- Improve living standards-a society with a highly developed supply chain infrastructure (modern interstate highway system, huge rail network, numerous modern ports, and airports) can quickly and cost-effectively exchange many goods between businesses and consumers. As a result, consumers can use their income to buy more products, thereby improving social living standards

- Create job opportunities – supply chain professionals design and operate all supply chains in society, and manage transportation, warehousing, inventory management, packaging, and logistics information. As a result, there is a lot of work in the supply chain field (council of supplychain management professional , 2020)

2.2.7.2.4 Opportunity to reduce energy use

Supply chain activities involves the transportation of people and products. As a by-product of these activities, scarce energy is consumed. (council of supplychain management professional , 2020)

2.2.7.2.5 Protect cultural freedom & development

- Defend human freedom-citizens of a country rely on military logistics to defend their way of life. Military logistics personnel ensure the safety of soldiers and other citizens to the greatest extent strategically. Also, superior logistical performance can bring military victory.

- Protect the delivery of essentials – citizens of a country rely on supply chain managers to design and operate food, medicine, and water supply chains to protect products from tampering (council of supplychain management professional , 2020)

2.2.8 The supply chain challenges & limits

Simply break down a part of the supply chain to stop the ability to deliver products and make money. For example, if you cannot obtain consumables, a machine fails, a sales website crashes, you cannot find inventory in a warehouse or a transport truck fails, you may have to shut down the entire operation to prevent bottlenecks. If you outsource a part of the supply chain (such as materials, production, sales, or transportation), the supplier may accidentally destroy your business when you are in trouble, or increase by holding the price you have not paid or taken the price as a hostage What the supplier wants. (Monczka & al, 2009)

Chapter 02: a methodological approach

This chapter will be divided into two parts. The first will focus on the methodological approach and epistemology used, as well as the different techniques used in collecting and processing the necessary data.

Our second part will be a brief presentation of the TAPHCO spa's field of study.

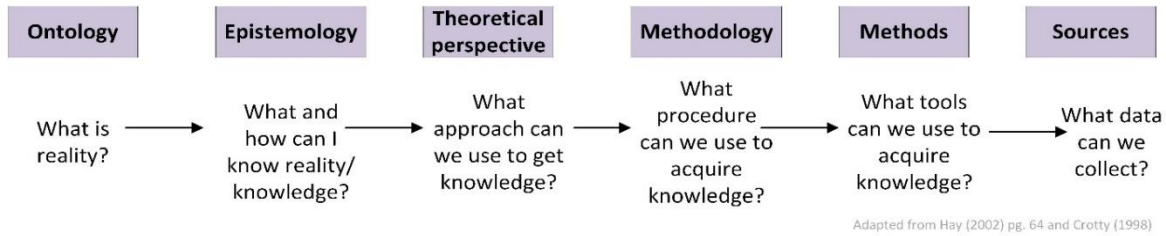
1 Research Methodology

Epistemological paradigm: definition + types (constructivist - interpretive)

A research paradigm is Guba (1990) characterized the research paradigms as "the set of common beliefs and agreements shared between scientists about how problems should be understood and addressed" (Kuhn, 1962)

The Epistemological reflection can clarify the presuppositions and justify the choices made at these different stages of research, surpassing the simple search for coherence between the analysis and the objects of this analysis.

Figure 17 Building a Basis for Better Research



Source: https://link.springer.com/article/10.1007/s40670-019-00898-9/figures/1

Ontology – What is reality?

Epistemology – How do you know something?

Methodology – How do you go about finding it out?

1.1 Ontology

In our case, as we have to adopt new technology in an environment where it doesn't exist yet there is no single reality or truth the reality is created by individuals in groups, in this case, we have to study it as modeling to see if the conditions are appropriate for it

1.2 Epistemology & theoretical perspective

constructivist interpretive our research will be based on an objective collect of knowledge, which means we have to work on the field with personal interaction with managers of the different department in TAPCHO to interpret reality needs, and to discover the underlying meaning of events and activities, and to provide the quality information needed to the thesis.

1.3 Methodology & Method

aiming for a set of objective responses, we considered it necessary to use the qualitative method with its tools. That Mays and Pop define that: "*The goal of qualitative research is to develop concepts that help us understand social phenomena in natural (rather than experimental) contexts, focusing on the meanings, experiences, and perspectives of all participants"* (Mays et Pope, 1995)

1.4 Data collection tools

To define the characteristics of our territory which was TAPHCO'S SUPPLY CHAIN we decided to include the tools that are usually used in a qualitative method, we have elaborated 2 guides associated with documentary research.

1.4.1 Documentary research

The documentary research was a valuable step that we had to carry out before embarking on our empirical study. It allowed us to collect informative data through the study of documents provided by the company.

"Documentary research aims to identify and locate information resources already processed, either by individuals or by machines. Documentary research is accompanied by the qualifier "computerized" when this activity involves the interaction between two systems, one human (i.e., the user) and the other computer (i.e., a database) via software and an interface". (Dinet and Passerault, 2004).

Our research is mainly based on books, dissertations, scientific articles, web site, and theses in French and English languages dealing with supply-chain and blockchain provided by the company or the blockchain experts.

1.4.2 The interview

in the absence of a supply chain manager, we have conducted several interviews with the managers of various TAPHCO supply chain departments, **Mr. Abdelmouman**, Purchasing and Supply Manager, the production manager **Mr. Kadri**, and the quality manager **Mrs. Said** to collect a maximum of information on the supply chain process within the company, as well as blockchain experts for the technical side of the implementation of blockchain technology within a supply chain with the help of a maintenance guide.

The structure of the interview guide: In our case, we opted for two types of interview guides:

Interviews for TAPCHO supply chain personnel: our goal in this study carried out within TAPHCO SPA was to study the information system and the information flow as well as the possibility of integrating the blockchain technology into it.

The inductive part: which was based on our presentation as a student of strategic management and information systems and the presentation of our study topic to facilitate the exchange of ideas.

The first part: this part was an introduction of the interlocutors to present their position and the missions and responsibilities entrusted to them within TAPCHO SPA.

The second part: This part concerns the information system used in the company and the information flow between the different SC departments, as well as the identification of potential risks and problems already encountered in the transmission of information.

The third part: is dedicated to the contribution of the blockchain as a solution in the traceability, transparency, and security and facilitation of information flow concerning the accomplishment of their missions and tasks.

1.4.3 Interviews dedicated to the blockchain expert

The inductive part: which was based on our presentation as a student of strategic management and information systems and the presentation of our study topic in order to facilitate the exchange of ideas.

The first part: this part was an introduction of the interlocutors to present their profiles, their experiences in the IT field in general and blockchain in particular

The second part: is devoted to the presentation of the blockchain with its components and technical advantages and differences with other technologies.

The third part: this part concerns the role of the blockchain in the business domain and in particular in the supply chain as well as the challenges and constraints of its implementation.

1.4.4 Field observation

The field investigation is a fairly common research method with which we entered the field ourselves to collect data. "What can we expect, more generally, from a reflection on the field and on-field practice? A beginning of reflection on the link that is created in the place of the meeting and on its consequences on the researcher's posture and the conduct of his work of investigation, information gathering, and analysis of situations". (Steck, 2012)

In our situation, we entered the supply chain of TAPHCO to follow the production process of a drug KORTIKAN from the supply of its raw material to the commercialization of the finished product.

2 Company

2.1 Presentation

TAPHCO Spa (Tassili Arab Pharmaceutical Company), is the result of an Algerian - Jordanian - Saudi joint venture between the SAIDAL Group, the pan-Arab pharmaceutical financing company ACDIMA, the Saudi pharmaceutical and medical device company SPIMACO and the Jordanian pharmaceutical production company JPM.

2.2 Partners

2.2.1 The SAIDAL Group

Pioneer of local pharmaceutical manufacturing in Algeria, with a share capital of 2.5 billion Algerian Dinars, i.e. 22.7 million USD. Listed company covering a significant part of the Algerian market.

2.2.2 SPIMACO

Specialized in the production of pharmaceuticals and medical devices, created in 1986, with a share capital of 784,375,000 Saudi Riyals, i.e. 209 million USD.

2.2.3 ACDIMA

Constituted by capital contributions from 12 Arab countries and its share capital is set at 90 million Kuwaiti Dinars, i.e. 295 million USD.

2.2.4 JPM

Jordanian Pharmaceutical Manufacturing, established in 1978 with a share capital of 20 million Jordanian Dinars, or USD 28 million.

2.3 Main objective

TAPHCO Spa has a manufacturing and control unit that complies with international standards of good manufacturing practice, particularly in the areas of production, quality assurance, quality control, and environmental performance.

TAPHCO Spa's ambition in the short term is to make its factory a reference manufacturing site and to bring out of its culture the search for the highest level of performance, it will have as its main activities

- The manufacturing for human use and the marketing in Algeria of TAPHCO specialties.
- Provision of product shaping on request of partners and others.

2.4 Composition of the company

THAPHCO SPA is composed of 130 employers devised as shown in the following table:

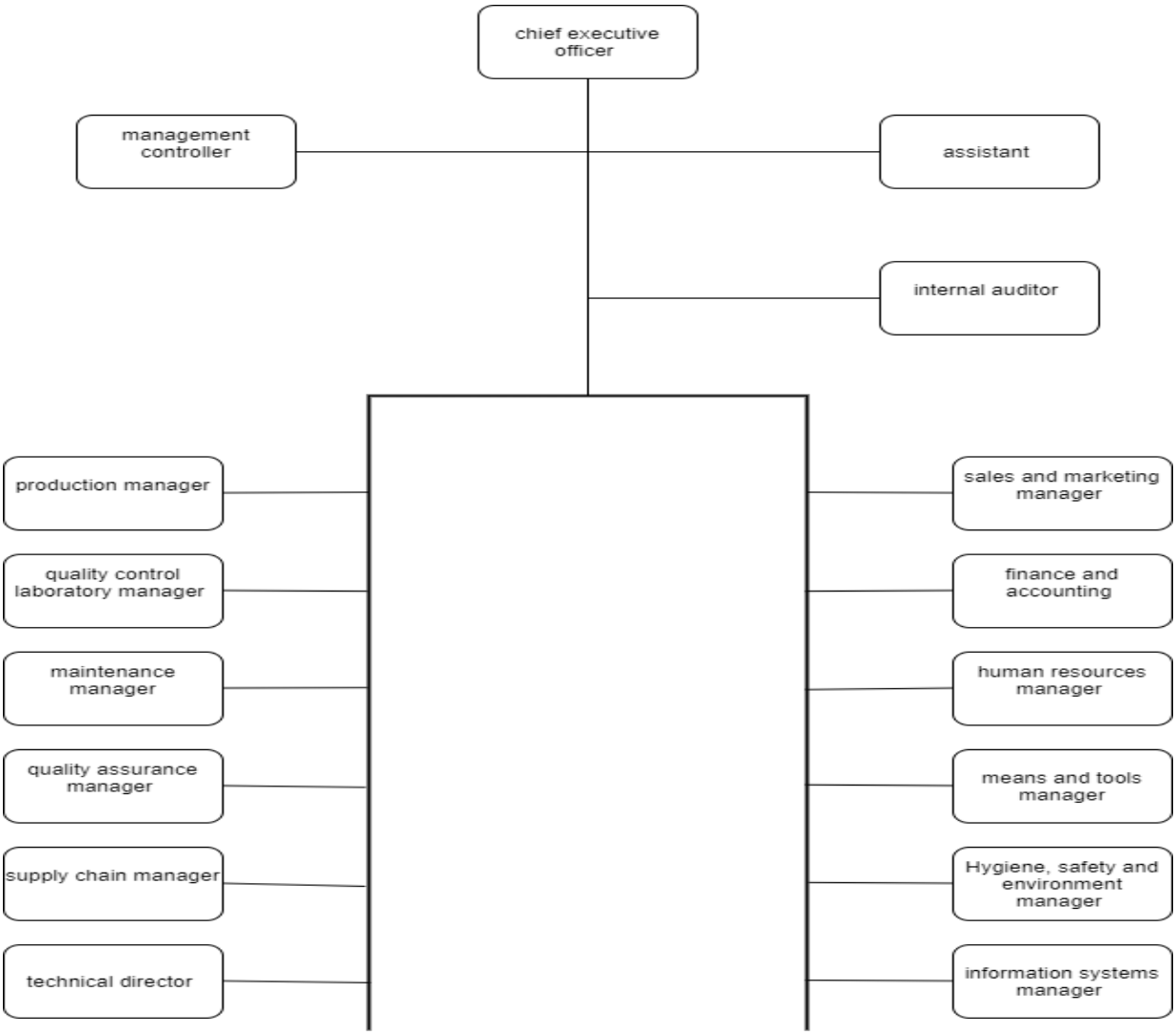
Table 5 Staff composition

Department	**Staff**
General direction	4
Technical	3
Production	18
Marketing & Sells	33 / 22
Maintenance department	12
Quality assurance department	5
Information system	3
Finance & accounting	5
Human resource	4
Supply chain	8
Hygiene & Security	19
Means and tools	4
Total staff	130/117

Source: General HR direction of TAPHCO

the previous table composes the following Organigram:

Figure 18 TAPHCO's Organigramme

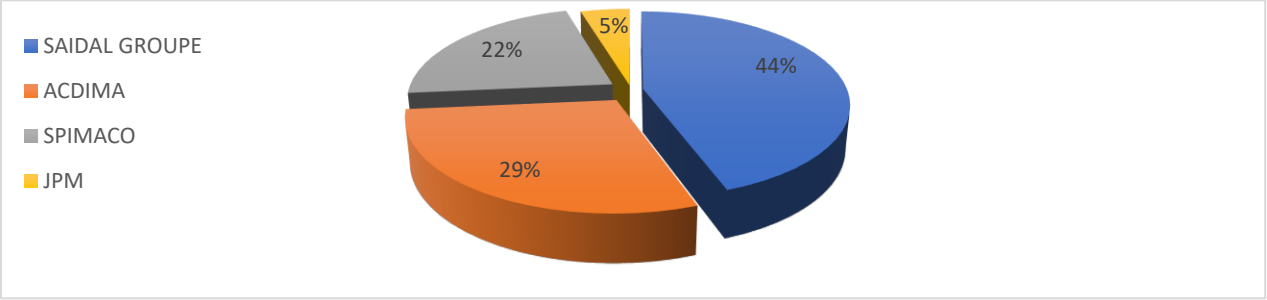


Source: General HR direction of TAPHCO

2.5 Social capital

The share capital of TAPHCO SPA is 1,083,482,400 Algerian Dinars, distributed among the shareholders as follows

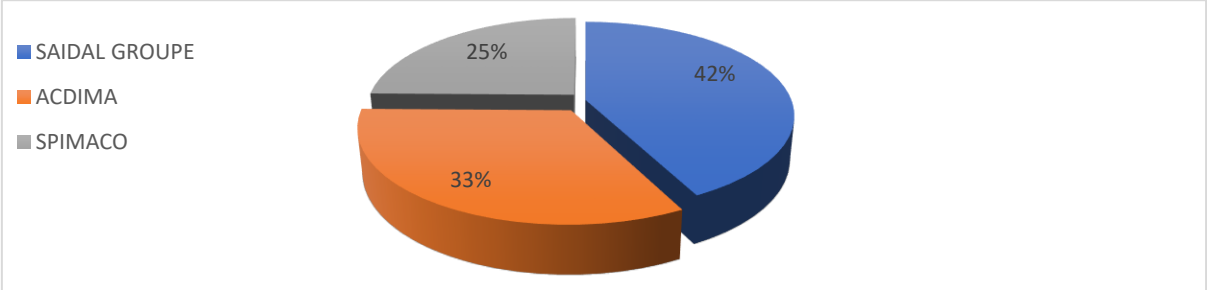
Figure 19 Distribution of the capital



Source: General HR direction of TAPHCO

Distribution of associated current accounts of around 20 million euros

Figure 20 Distribution of associated current accounts

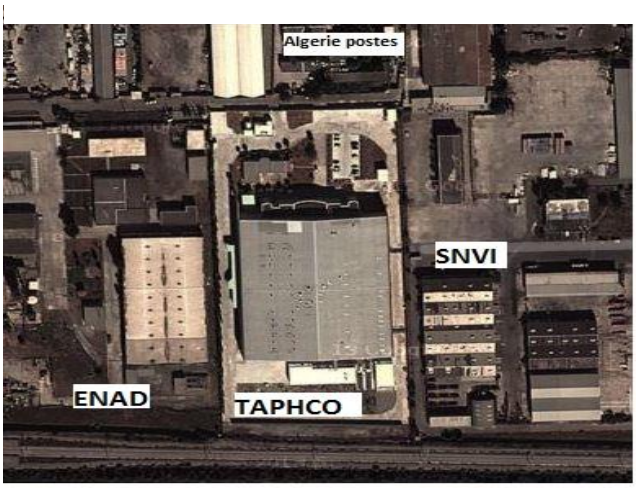


Source: General HR direction of TAPHCO

2.6 Geographical location on the site

TAPHCO SPA is located in the Industrial Zone of Rouiba, east of Algiers, located on a plot of land owned by the company. The global surface of the site is 29 224 m²

Figure 21 Geographical location



Source: General HR direction of TAPHCO

2.7 The main supplier

TAPHCO SPA has many suppliers we mention the main of the suppliers in the following figure.

Figure 22 the main supplier

Source: General HR direction of TAPHCO

2.8 Quality control laboratory

TAPHCO SPA has a quality control laboratory with a surface area of 600 m² and future extensions that allow real-time physicochemical and microbiological conformity analyses of raw materials, packaging items, and finished products.

2.9 Production capacity

To concretize its manufacturing program and meet the needs of the national drug market, TAPHCO SPA has a production capacity in its first operational phase of:

- 12 Million-unit sales per year with a single shift.
- 30 Million sales units per year with three shifts.

To achieve its production and sales objectives and to offer patients quality products at competitive prices, TAPHCO Spa has brought together all the material and human resources, especially technological ones.

2.10 Storage capacity

TAPHCO SPA has a storage warehouse covering an area of 3900 m² which is the equivalent of 3294 pallets. This warehouse is equipped with all the storage conditions of:

- Finished Products(goods),
- Semi-finished products,
- Packaging items
- Raw material.

2.11 Therapeutic portfolio

The products of TAPHCO are mentioned in the following table:

Table 6 Therapeutic portfolio

CLASSE THÉRAPEUTIQU	NOM (*DCI*)	Forme/Dosage/ Conditionnement	Date	PHOTOS PRODUITS
Cardiologie	**DAGHTAN 50 (*ATENOLOL*)**	**comprimé pelliculé /50 mg/30 cp**	**Estimation de l'obtention de la DE fin Avril 2017**	
Gastrologie	**EMETIKAN 10 (*DOMPÉRIDONE*)**	**Comprimé pelliculé/ 10 mg/40 cp**	**Estimation de l'obtention de la DE fin Juin 2017**	
Cardiologie	**IRBé 150 (*IRBÉSARTAN*)**	**comprimé /150 mg/30 cp**	**Estimation De l'obtention de la DE en Mai 2017**	
Cardiologie	**IRBé Plus (*IRBÉSARTAN - HYDROCHLOROTHIAZIDE*)**	**comprimé /150mg-12,5mg /30 cp**	**Estimation de l'obtention de la DE Aout 2017**	
Antifongiques	**MYCODAN 50 (*FLUCONAZOLE*)**	**Gélules / 50 mg / 10 gél**	**Estimation de l'obtention de la DE en Juin 2017**	

CLASSE THÉRAPEUTIQU	NOM (*DCI*)	Forme/Dosage/ Conditionnement	Date	PHOTOS PRODUITS
Autres médicaments du rhume	**IBIPSO 200/30 (IBUPROPHÈNE/PSEUDOEPHEDRINE)**	**Comprimés pélliculés/200mg-30mg/20 cp**	**Estimation de l'obtention de la DE Novembre 2017**	
Anti inflammatoires	**KORTIKAN 20 (*PRÉDNISOLONE*)**	**Comprimés orodispersibles/20mg/ 20 cp ODT**	**Estimation de l'obtention de la DE en Juin2017**	
SNC	**SULAN 50 (*SULPIRIDE*)**	**Gélule/ 50mg/ 30 gel**	**Estimation de l'obtention de la DE fin Juillet 2017**	
Urologie	**TALAN 20 (*TADALAFIL*)**	**Comprimé pelliculé/20mg/ 4 cp**	**Estimation de l'obtention de la DE Septembre 2017**	

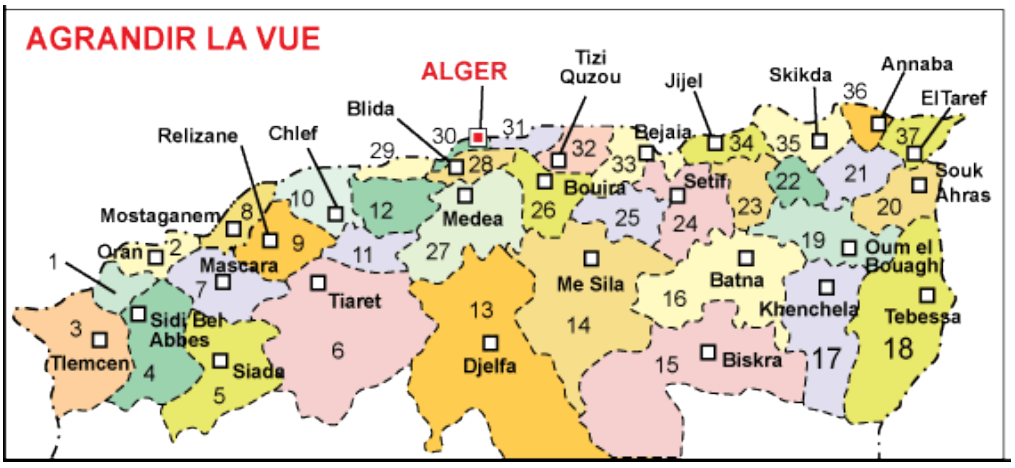
source: General HR direction of TAPHCO

2.12 Mapping force

The salesforce went through 2 stages the 1st stage was a foray into the market by targeting the 3 large regions center, east, west

1st Phase:

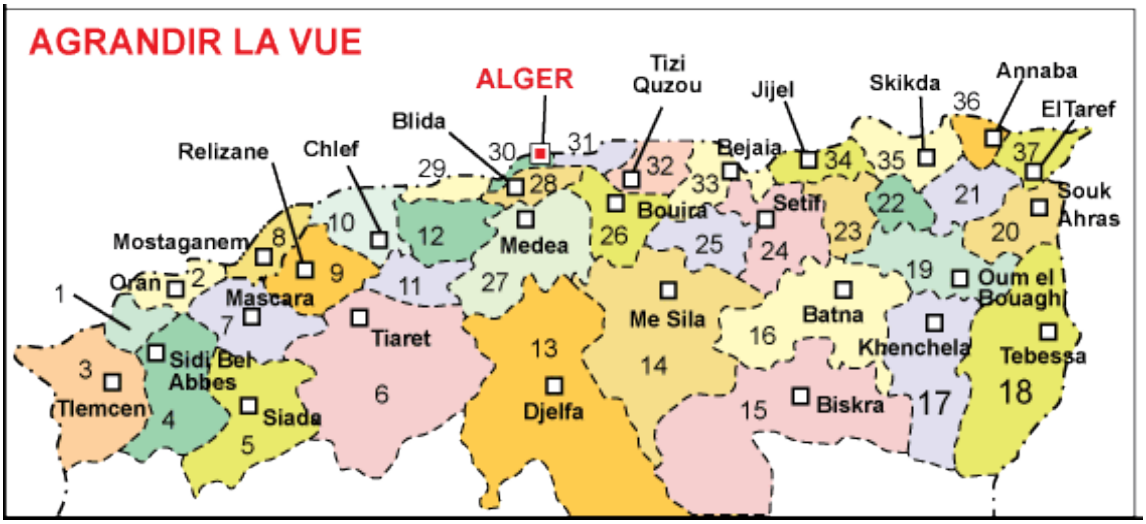
Figure 23 1st stage mapping



Source: General HR direction of TAPHCO

2nd Phase:

Figure 24 2nd stage of mapping



Source: General HR direction of TAPHCO

Chapter 03: Result & Discussion

The pharmaceutical industry is distinguished from other industries by A manufacturing authorization system, which also guarantees that all medicines authorized on the European market are only manufactured/imported by authorized manufacturers - whose activities are subject to regular inspections by the competent authorities - who implement the principles of quality risk management, these standards are defined as GMPs

Definition of GMP: One of the elements of quality assurance, ensuring that products are consistently manufactured and controlled according to quality standards appropriate for their use and specified in the marketing authorization, GMP regulations require a quality approach to manufacturing, enabling companies to minimize or eliminate instances of contamination, mix-ups, and errors.

The GMP guideline is divided into three parts and. Part I presents the GMP principles applicable to the manufacture of medicinal products while Part II applies to active substances used as starting materials. Part III contains GMP documents that clarify certain regulatory expectations.

This allows the finished product to be of high quality, and this protects the consumer from dangerous products or ineffective ones

1 TAPHCO spa SC

1.1 The principal part of the SC of TAPHCO spa

1.1.1 Technical direction and legal affairs

This sector links the legal obligations in force in countries and the sale and production of medicines. Indeed, it is imperative to have an excellent knowledge of the laws of the Public Health Code, to produce the drugs legally, otherwise, the market authorization (AMM) will not be obtained. This is where everything is put in place to ensure that the drug's marketing authorization file respects and meets the legal requirements to ensure the safety and efficacy of each drug.

1.1.2 Supply

to ensure the supply of Raw Material (active principle, excipient) and Article of Conditioning (Aluminum, blister, leaflet, and cases) according to the programs already predefined by the

technical director and the person in charge of production and to make a forecast of supply according to the forecast defined by the technical director for a determined duration.

1.1.3 The quality control laboratory

Each holder of a manufacturing authorization must have a quality control department.

The quality control department as a whole has other duties such as establishing, validating and implementing all quality control procedures, supervising the control of reference samples and/or models of raw materials, packaging items, and finished products where applicable, checking the labeling of raw material containers, packaging items, and finished products, monitoring the stability of products, participating in investigations carried out following complaints about product quality, etc.

All such operations shall follow written procedures and, where appropriate, shall be recorded.

1.1.4 Quality assurance

Quality assurance: the role of the quality assurance department is to ensure the realization of the product with the required quality, to establish and maintain a state of control and monitoring for process performance and product quality, to facilitate continuous improvement. process performance and product quality), Thus ensure the quality, efficiency, and safety of the products by respecting good manufacturing practices

1.1.5 Production

It is the parent department of the SC since it is where the RMs are transformed into finished products through several different processes depending on the product, it ensures the safety, efficiency, and conformity of the product from the reception of the RM and AC to the finished product by issuing the finished product order

1.1.6 The warehouse:

the warehouse is where the products are stored, it is divided into two parts, the storage of RM and AC and the storage of finished products,

The first is the receiving area for the RM and CA which is evenly divided into three parts quarantine area for the RM to be analyzed by the CQL and accepted area for compliant products, and rejected area for non-compliant products.

The second is the finished product area, which is divided into two parts the quarantine area for finished products to be analyzed by the CQL and the accepted area for verified finished products.

1.2 SC process of TAPHCO spa

1.2.1 Forecasting

The forecast is done by the TD and the production whether it is for a new product never launched (validation batch) or a product already launched (routine batch), to know the quantity of RM and ACs used for a limited time most of the time it is done on an annual basis.

1.2.2 Supply

The real first chain of the SC it is divided into four phases

- Supplier selection: it differs according to the nature of the product in the case of a new product there is a consultation of existing suppliers to confirm the availability of the Product Monograph at their premises in the case of unavailability a prospecting of new suppliers
- After the selection of the supplier, a proforma invoice is sent with technical datasheets, certificates of analysis to confirm the origin of the product and its prohibition, finally, an invoice is sent containing the type of packaging of RM with its weight and customs documents.
- The transport: of the RM is done with service providers and the tracking of the products is done with a tracking number on the site of the last ones ensuring the history of places and dates with the transport conditions of the RM

Once arrived at the dock (port or airport) a forwarder receives the RM files with an import program made by the TD to the company.

1.2.3 Warehouse (reception area)

The RM arrives at its destination and is put directly into the reception airlock and then sent to the quarantine area of the warehouse's reception area, the quality control laboratory takes a sample from this RM to ensure compliance and prepares an analysis report and transfers it to the store manager.

Two scenarios are to be expected:

- If the Product Monograph does not comply with the standards and requirements requested, it is sent to the rejection room or the SUPPLIER the TRANSITOR, and the service provider is contacted to determine the origin of its non-conformity and send it back.
- If the RM is compliant and accepted it is transported to the acceptance room for storage pending the request of the production department and start the batch.

1.2.4 Production

This stage of the SC is the most important because it consists of the transformation of the RM and the ACs into the finished product, following three stages which are:

1.2.4.1 Weighing:

This is the 1st stage of the production which consists of weighing the RM (active principle and the excipients) for a batch according to the quantity requested by the production manager.

1.2.4.2 Manufacturing:

This is the most important step in the production process and consists of transforming the RM and the excipients into a semi-finished product. It is differentiated according to the required product.

1.2.4.3 Packaging:

Is the final part of the production, it consists of putting the semi-finished products in ACs to protect them as soon as they are made available?

1.2.5 Warehouse (finished product area)

After packaging the finished product is sent to the quarantine part of the finished product area of the warehouse where it remains pending release from the lab.

The QCL will still take samples of the finished product to ensure the conformity of the finished products and the quality department still 2 more cases are to be expected:

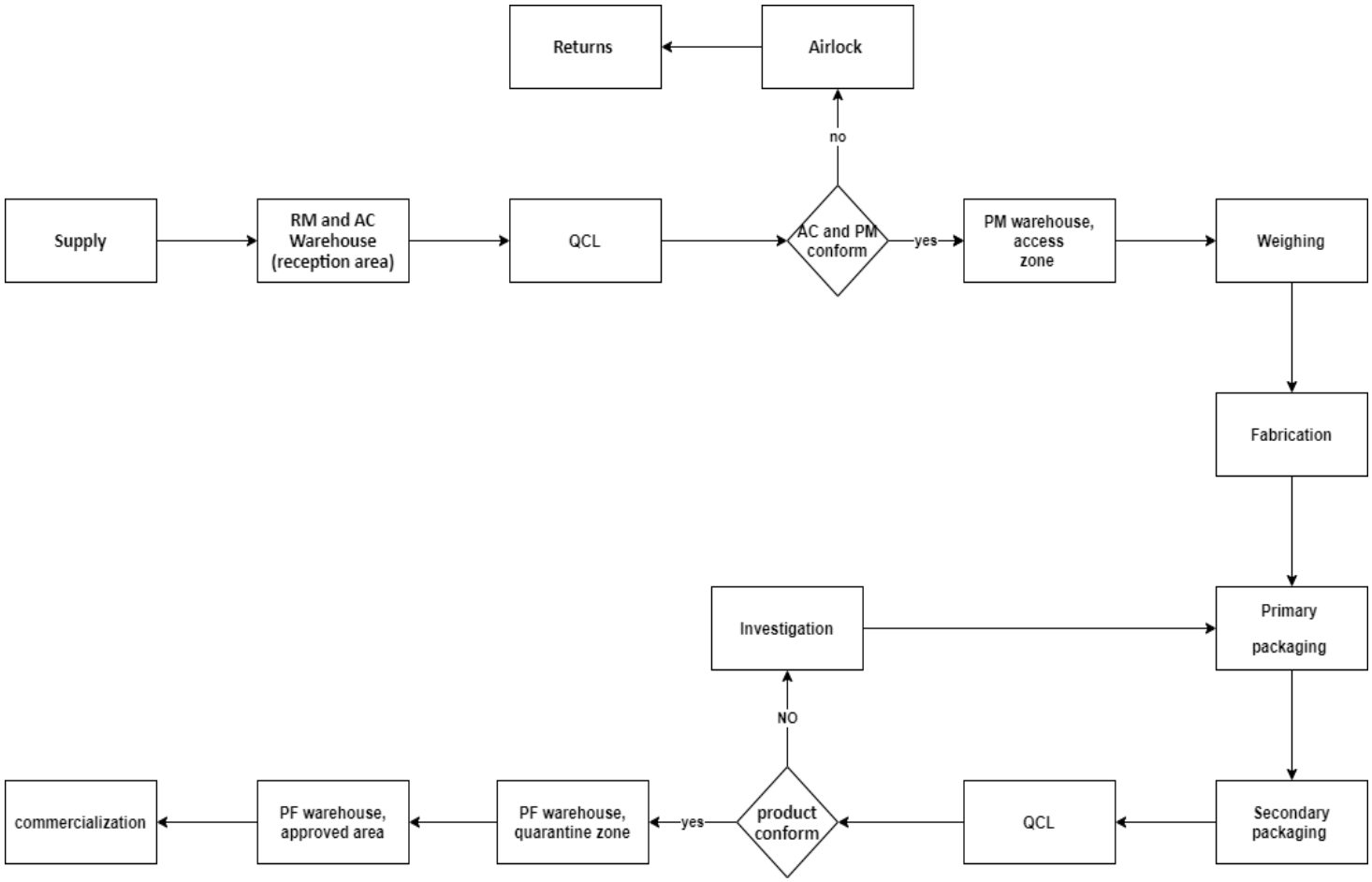
- In the case where the product is not in conformity, an investigation will be established.

- In case the product conforms it is sent to the product ready part and stored before the product is shipped.

1.3 SC cartography of TAPHCO spa

In the following figure, we made cartography of the whole process of SC.

Figure 25 SC cartography of TAPHCO spa



Source: made by us

2 Interview about the IS of TAPHCO spa

In our case, TAPHCO does not have an IS as being a company planning to purchase an ERP as an IS, we were allowed to follow the information exchange process within the SC to study which module of an ERP is compatible with the Blockchain technology.

Table 7 List of Interlocutors in TAPHCO spa

name	function	Time during interview
KADRI MOHAMED	Production manager	20min
SIAD KENZA	Quality assurance manager	30min
AMINE ABDELMOUMAN	Supply manager	58min

Source: made by us

During our field observation and interviews, we noticed that in the absence of an IS the different departments of TAPHCO SPA use simple means for all that is information and data transfer.

Table 8 Observation of SC in TAPHCO spa

topic	observation
Information exchanges with partners	first of all, the informational exchange between the supply department and the suppliers, the service providers, and the forwarding agents is done via telephone and the documents are sent via email as for the original documents they are hand-delivered via the forwarding agents or bank channel to release the necessary funds and the payment of the transactions. As far as purchase orders are concerned, they have to be signed by the person in charge of procurement and the CEO.
Information exchanges within the SC functions	As for the exchanges between the different departments within the company itself, they also take place via e-mail for all requests or by telephone via an internal telephone network with codes corresponding to each department, As for the original documents for all the manufacturing procedures and batch file follow-up and even for the identification of equipment or premises, they must pass through the quality assurance department and be approved before being issued and then signed by the person in charge of the department requesting the document before being signed by the user with the date of use and finally after using these documents are stored and kept in the archives

Meetings between functions and with staff	Adding also oral communication via meetings of less than 30min each morning between the different SC department heads to define daily objectives and briefings between department heads and their subordinates.
Difficulties and problems of their current IS	This kind of communication had an undesirable effect and problems arose that are a waste of time just as the information itself is sometimes considered unreliable and incomplete and finally, feedbacks are always late leading to delays in reacting to problems.
Expectations from an IS	the three managers explained their expectations of an information system that can be summed up as having transparency and traceability of information flows with decentralization without this being altered to keep its reliability, which will facilitate the control of product quality with suppliers and forwarding agents as well as the control of compliance with GMP pandering production, and after explaining their expectations of a blockchain on an information system, their appreciation was positive with a rating of 4.7 out of 5.

Source: made by us

Table 9 answers of TAPHCOS's interlocutors

topic	**Person interviewed**	**answers**
Information exchanges within the SC functions	**Siad kenza** **Quality assurance manager**	every demand should be done by mail, then documents are provided and certified by the quality assurance function, without a quality assurance certification the document is invalid and won't be recognized by other functions
Meetings between functions and with staff	**Mohamed Kadri** **Production manager**	every morning we do an oral meeting within the managers of differents functions followed by a briefing with our staff about the characteristics of the batch programmed for the day

Difficulties and problems of their current IS	**amine abdelmouman** **Supply manager**	Delay of the information, The IS at TAPHCO Spa is average due to the absence of ERP
Expectations from an IS **And appreciation of the blockchain as an apport**	**amine abdelmouman** **Supply manager**	we expect a system able to make verification of the product before it reaches the company, I would rate the blockchain with a 4
	Mohamed Kadri **Production manager**	we need an ERP to gain time and being able to react at the right moment, I would rate the blockchain without lying with a 5
	Siad Kenza **Quality assurance manager**	we need a system able to make the verification of the right information and to gain time, I would rate the blockchain with a 4

Source: made by us

3 Interviews dedicated to Blockchain expert

In this interview, we have asked for Blockchain expert to give us the opinion and technical view about the technology implemented in the supply chain and what are the advantages and limits can face to the Blockchain,

The interviews were open with a question not limited to gather the maximum of information they can give. It was also reparteed on three parties as mentioned in the methodology section.

3.1 Introduction of the experts

The first one was to introduce the interlocutors who are:

Table 10 List of Blockchain Expert Interviewed

name	function	Time during interview
HALOUANE IBRAHIM	CTO & cofounder of CorpSense	1h15
NASSIM BELOUARE	CEO Transfonum	This interview was made via google form as the person live in Paris and due to COVID 19

Source: made by us

Nassim BELOUARE (CEO TransfoNum, blogger, and Blockchain consultant):

Digital project manager and passionate about teamwork, I had the chance to develop my skills within the company TransfoNum: agile scrum method/ Blockchain/ ICO/ Speaker/ Blogger.

He has given more than fifty pieces of training/conferences in France and abroad in the democratization of the Blockchain universe: ICO/ Smart-contract/ Cryptomonnaie/ Bitcoin and accompanied the company NoLimitCoin in its development in Europe. He has also published more than a hundred articles on digital technology in general and its impact on the economy, which he publishes on his blog and also on the website of the World Economic Forum, bitcoin.fr, governance magazine ETC.

Ibrahim HELOUANE (CTO é Cofounder of CorpoSense)

From a management background and bachelor accountancy, He has been creating and maintaining business software and management dashboards; for better data reporting and business analysis, which results in better managerial decisions. He has been working in different fields: business & industry, pharmaceutical, education, and mostly in a Telecom Company. He used to coach developers and teach them the best practices which allow them to improve their productivity and security in different subjects: database, development, reporting. He has used different technologies and tools depending on project requirements:

- Software Architect (Java, Python)
- Reporting and Business Intelligence (SAP WebI, Open source solutions...)
- Database Administration and Maintenance (Oracle, SQL Server, MySQL, PostgreSQL)
- Web & Android coding, hosting, and maintaining (Java, Python, PHP, other CMS...)
- System and Administration (Linux, MS Windows, VPS Admin)
- Data Analytics & Data Analysis, Data Science
- Decentralized Technologies and Blockchain.

The second was about the Blockchain technology and the technical view of it and limits. In the following table, we took the two interviews of the experts and resume the results got from them in the table.

Table 11 answers of Blockchain experts

topic	expert	Answer
About Blockchain		We saw from the theoretical section that exists too many definitions so we chose to ask experts we met, how they define the Blockchain to see if there is a difference but we didn't mention any difference. We can take this as a mutual definition between them.
	Nassim BELOUARE	"A blockchain is a database that contains the history of all the exchanges carried out. between its users since its creation. This database is secure and distributed: it is shared by its various users, without an intermediary, which allows each one to check the validity of the chain.",

	Ibrahim HALOUANE	The blockchain is a book that allows the recording of data, information, a fact, to secure and transparent way. We can think of the blocks as interrelated pages of the book and if we want to change a line on a page, you will have to change the line on the page the whole book and its history...
Characteristics	**Mr. Nassim BELOUARE** **&** **Mr. Ibrahim HALOUANE**	**Security:** Blockchain technology is considered to be the most secure technology today. Two aspects make the blockchain more secure than traditional databases: the blockchain by definition is a string of blocks. Each block is linked to all previous and next blocks. In fact, in case an unhealthy person tries to change the data in a block, it will be necessary to change the data in the block. all the previous and next blocks. The second aspect that makes the blockchain secure, is the fact that the blockchain is a distributed registry on all members of the network. This means that if a copy of the registry is hacked, it is will remain several tens of thousands more to change. Since the existence of the blockchain, no blockchain could not be hacked even though there have been hackings of the trading platforms of crypto money or others. Hacking in the world of digital marketing is a serious threat. If we only take emailing, no less than 700 million email addresses were hacked in 2018 according to the media LCI. Thus, the blockchain can provide solutions to improve security in advertisers, publishers, and users.

		Decentralized: The revolution brought about by the blockchain is to allow a group of people to carry out transactions without having intermediaries, as is the case with the use in crypto money, where thousands of people exchange digital assets without the need for a bank or other intermediaries. The security and validation of transactions are done automatically using one of the methods such as Proof-of-work, Proof-of-Stake, or Consortium. This enables a new model of collaborative and community-based management. Moreover, thanks to smarts contracts (smart contracts, which are executed once the conditions are validated) and Dapp's (decentralized applications), allow anyone to duplicate a traditional service such as insurance in a decentralized format. The blockchain can therefore eliminate intermediaries in online advertising or other forms of advertising. services that require a regulatory body.
Integration of Blockchain in Business	**Both of Mr. Nassim & Mr. Ibrahim the mentioned technically the same points.**	• Data reading: when two parties need to see information simultaneously. • Data sharing: when two parties need to send data to each other. • Data certification: when we need more reliability and validation of the quality of the data. • Complex activities by intermediaries: to fluidify processes and reduce intermediaries. • Activities that require speed of execution: to reduce delays and save time. • Interaction activities: a mass of interaction between Men and Machines.

		The use of Blockchains will not be limited to the financial world only, they will bring to the market numerous solutions in different sectors.
Blockchain value in the Supply chain	**Nassim BELOUARE**	If the Blockchain technology allows us to track more securely and transparently all types of transactions, imagine the opportunities it presents across the supply chain each time a product changes hands, the transaction can be documented, creating a history of the transaction of a product, from manufacturing to sale. This could significantly reduce lead times, costs, and time to market, additional costs, and human errors that plague transactions today. Some supply chains are already using technology, and according to experts, the Blockchain could become a universal "supply chain operating system" soon.
For the pharmaceutical Industry	**Nassim BELOUARE**	**Elimination of counterfeiting** The Blockchain can save lives in some cases! Indeed, in the pharmaceutical industry, the number of counterfeit products is impressive. The consumer does not have any means to verify the authentication of the information. Traceability allows us to track the location of production as well as the components emitted in this product by using bar codes on the drugs in the supply chain. These codes are scanned and entered into a register. decentralized which is immutable. As drugs are exchanged between each other, the codes are scanned again and recorded in the register. This makes it possible to track the drugs as they move through the supply chain to the patient. final consumer. Counterfeit medicines are thus much easier to detect and the guilty parties are much easier to apprehend. This could save the lives of millions of people in the world

Type of Blockchain needed		It depends on the need. But usually, it's a private Blockchain. Because companies don't have the infrastructure to create public blockchains.
	Ibrahim HALOUANE	This technology can secure the administrative file for medicament if we can preserve these documents in a secure database that we can prove that this document is transferred from company A to company B in a secure way and that allows also to fight to counterfeit a
Technical Challenge	**Nassim BELOUARE**	**Massive and complex adoption:** The blockchain brings together several technologies that have existed for several decades, including the asymmetric cryptography, distributed registers, hashing, and blockchain. The understanding of all of these technologies and the way they work requires knowledge of the following preliminary techniques. It is this technical complexity that makes the democratization of the concepts related to the blockchain slower than other innovations. **Scalability:** The Blocks of the blockchains are limited to a storage capacity like that of the blockchain, this limit is one mega per blockchain. At scale, this storage limit makes projects linked to the blockchain not very scalable. Knowing that the majority of startups have the ambition to become scalable, these technical constraints can demotivate companies, which will then turn to similar solutions. more scalable.

	Ibrahim HALOUANE	**Non-homogeneity of laws:** For a startup that offers solutions for the international market, using blockchain solutions can be a brake in some countries. Indeed, some countries prohibit the use, promotion, and sale of crypto money and the blockchain.

Source: made by us

It exists a challenge that has been mentioned by Nassim Belouar about laws in Europe in the following point

Incompatible with the principle of RGPD

One of the major principles of GDPR (General Data Protection Regulation) is to allow users to delete data that is recorded at any time. However, on the blockchain, we cannot delete the data recorded, which means that the blockchain is not compatible with data protection laws European personnel. This could hinder certain marketing uses of the blockchain soon. This complexity is despite the existence of turnkey solutions such as those offered by Ethereum, does not allow companies to develop blockchain-based services because of both the cost of development that it requires and because of the lack of qualified human resources to develop on languages dedicated to the blockchain.

This point is to discuss after in Algeria if it will exist a special law for the Information and technology in this case

4 Description of the production part of TAPHCO spa

4.1 Weighing

Weighing of raw materials must be carried out in a separate weighing room designed for this purpose.

Weighing must be performed following the procedure for weighing raw materials to ensure the proper functioning of raw material weighing operations in compliance with a good manufacturing practice.

4.1.1 Responsibility

- Weighing personnel are responsible for the application of the raw material weighing procedure and must follow the instructions motioned on the batch record.
- The production manager must check the weighed portion of the batch record.

4.1.2 Hardware

- Four models of scales
- PE alimentary bags have different capacities
- Tamper-evident fasteners
- STAINLESS STEEL shovels and congestions
- Pneumatic pump with alimentary hoses

4.1.3 Rooms

Different rooms are used in this procedure, either for the weighing itself or in the storage or even airlock doors for receiving and sending the RM, these rooms are:

- Airlock 107: reception and control of the RM
- Room 108 where there is a laminar flow cabin where the weight is weighed by itself.
- Room 114: storage of the RM after the weighing
- Airlock 109: the return of the surplus of RM to the warehouse

To guarantee good progress of the operations a check of the rooms is always carried out by the person in charge of production.

This verification consists of the validity of the cleaning of the rooms used by the company.

The conformity of the ambient parameters (temperature, pressure, relative humidity) must be checked before starting the weighing of the RMs

4.1.4 Reference documents

It exists many documents which are

- Room identification form:
- Room cleaning form:

- Manufacturing order
- Batch folders:
- Labeling in the production area
- Scales Operation Document

4.1.5 Weighing process

4.1.5.1 Receiving the RM

The reception of the RM coming from the warehouse is done in the airlock room 107 in a wooden pallet, in this airlock, the weighing staff checks the conformity of the raw material designations with the article code, the internal batch number of the PM, the expiry or re-checking date and the quantity of RM supplied concerning the manufacturing order received.

4.1.5.2 Preliminary operation

Before starting the weighing operation, the person in charge of the weighing has to perform some tasks, which can be summarized as preparation by collecting the cleaning forms of the rooms to be used, fill in the identification form of the room, and put it at the entrance of the room, prepare and check all the material necessary for the weighing and put the laminar flow cabin into operation 30 minutes before the beginning of the operations.

4.1.5.3 During weighing

Once the room and the RM are cleaned and identified and ready, the RM is transferred from the wooden pallet to a blue PE pallet and then to room 108 to start the weighing operations.

Once in the laminar flow cabin, the RM is unpacked and visually checked, the balance is set to zero before use and, depending on whether the stainless-steel congee or the PE bags are prepared to receive the RM, the weighing is done and a ticket is issued containing the following information:

- Date and time of weighing,
- Product: designation and dosage of the product to be manufactured
- Lot: batch number of the product manufactured
- Material: designation of the material to be weighed

- Code: article code of the material to be weighed
- Batch: internal batch number of the weighed materials
- Expiry Date: expiration date and control date of the material to be weighed
- Once the ticket is issued, it contains a stamp from the person who issued it and is checked by a second person of the weighing company and is also stamped before being stuck on the weighing bag containing the weighed material.

4.1.5.4 At the end of weighing

Once the weighing is finished and the bags are packed, they are placed in wire mesh carts or identified and sealed pallets, these are grouped in room 114 waiting to be transferred to the production.

The remaining raw material is stored in the airlock 109 to be taken back to the warehouse.

4.2 Fabrication (dry)

The manufacturing process differs according to each product

Kortikan®20 is a product manufactured at the TAPHCO spa where the active ingredient is prednisolone. The fabrication of the product follows three general steps which are:

- **Sieving:** Industrial sieving eliminates undesirable particles, thus avoiding problems that could lead to litigation.
- **Mixing:** The purpose of mixing is to obtain a homogeneous final product from the different initial compounds whatever the sampling, one must be able to find the same percentage of the initial constituents at any point of the mixture.
- **Compression:** This step allows us to dense the powder and to shape it into a tablet. Thanks to a sinking, by a load or a displacement, imposed.

Between each step, there is a reconciliation (weighing before and weighing after q1, q2) to know the losses in grams of the material.

4.2.1 Responsibilities

- The personnel in charge of manufacturing must follow the procedures dedicated to these manufacturing steps and must respect the instructions mentioned on the batch records.

- The person in charge of production must check the manufacturing part of the batch record.

4.2.2 Hardware

During the process, there are tools to use

- BIN: The machine is mainly used for transport and a solid loading of materials in the pharmaceutical industry.
- A sifter
- Scales
- A Mixer
- A disaggregation tester
- A pharmaceutical compressor

4.2.3 Rooms

Different rooms are used in this procedure, either for the weighing itself or in the storage or even airlock to receive and send the RM, these rooms are:

- Room 07: where the sieving operation takes place.
- Room 06: where the mixing operation takes place
- Room 13: where the BINS are stored
- Room 14: where the compression operation takes place
- PSO room: where the semi-final product is stored after the fabrication.

4.2.4 Reference documents

It exists also many documents which are :

- Room identification form:
- Room cleaning form:
- Manufacturing order
- Batch folders:

- Labeling in the production area
- Scales Operation Document

4.2.5 Fabrication process

4.2.5.1 Preliminary operation

As well as the weighing before the beginning of the operations some tasks are carried out, we start with a checklist of the line gaps of the rooms N°07, N°06, and N°14 in case of change of products, as well as the temperature, humidity, and pressure norms, are in norms, then a test and a verification of the materials is also made to avoid any risk.

4.2.5.2 Sieving

The RM is conveyed from room 114 where they were stored to room 07 and a bin is also stored, all the RM (excipient and active principle) are introduced and mixed manually and then introduced into the sieve shaker via a metal grid), the bin is positioned at the exit of the sieve shaker or the product is poured into it.

At the end of sieving, the BIN is transferred to room N°06.

4.2.5.3 Mixing

The bin having been transported to the room N°06 is fixed to the mixer and the door of the room is closed, at the door of the room the control command of the mixer is fixed, the person in charge of manufacturing enters the information specific to the product based on its manufacturing order (speed of rotation, mixing time,).

At the end of mixing the bin is discharged to room 13 where it is weighed in a scale mentioning the net mass and the mass of the waste the printed ticket is stuck to the back of the sheet of the batch record of the product.

4.2.5.4 Compression

The bin is then transported to the room, N°14 where the compression is done,

The compressor is adjusted to obtain the tablets with characteristics according to the standards indicated in the batch record of the product, the compressor is started at vacuum for 15min for its running-in, then the BIN is installed in the compressor and the compression is launched, the tablets coming out of the machine are stored in storage drums labeled with PE bags for

preservation. During compression, IPC tests are carried out to ensure the properties of the tablets (weight, hardness, thickness, brittleness).

The end of compression marks the end of the manufacturing process. The storage drums are transported to the PSO room while waiting for packaging.

4.3 Packaging

It is described as a set of items surrounding the pharmaceutical form from its manufacture to its use.

In the pharmaceutical field, the packaging operation goes through two stages:

- **PRIMARY PACKAGING:** This consists of elements in direct contact with the pharmaceutical form and which cover it to protect it. Examples: Blister packs, bulbs, vials...
- **SECONDARY PACKAGING:** Which is made up of elements containing the primary packaging without direct contact with the pharmaceutical form, usually consisting of a cardboard box containing the instruction note and may contain accessories (spoons, dropper...).

4.3.1 Responsibilities

- The packaging staff is responsible for the application of this procedure.
- The production manager must ensure that this procedure is applied.
- The quality manager is responsible for ensuring that the standards are respected in the procedure.

4.3.2 Hardware

The tools used are

- Blistering machine
- aluminum coil
- or PVC (differs according to the type of product)

4.3.3 Rooms

- Primary Packaging room

- SECONDARY PACKAGING room

4.3.4 Reference documents

The documents are

- Room identification form:
- Room cleaning form:
- Manufacturing order
- Batch folders:
- Labeling in the production area
- Packaging order

4.3.5 Packaging process

4.3.5.1 Preliminary operation

After a check of both rooms, the conformity of the material, the storage drums are transported from the storage room to the primary packaging room or their identification labels are checked as well.

An aluminum coil is transported from the warehouse to the primary packaging room, and case labels and notes for grouping boxes and cartons are transported to the secondary packaging room via a packaging order.

4.3.5.2 Primary packaging

The information according to the products are introduced to the blister machine, the drums are opened and emptied in the vibrant, and the aluminum coil is also placed, a forming station via plates or suction cups gives the shape to the tablets stored in the blister, and the vibrant places them, the staff makes a manual check to avoid the repetition of pills or its absence in the blister, then passing to the sealing station with a cooling system before cutting and a belt where there is a scale checking the weight of each blister pack in case weight of blister pack is irregular this defines a lack or an excess of tablet the machine stops automatically and the blister pack is ejected.

4.3.5.3 Secondary packaging

In this part, four machines are used and are all linked to each other a carton, a check weigher, a grading machine, and a case packer, all linked to the blistering machine of the primary packaging via a conveyor belt.

Before the beginning of the operations, a functional test is made, then the carton is filled in the dedicated place with boxes and information notes, the labeler is filled with labels, and the case packer with red type boxes of a height of two floors.

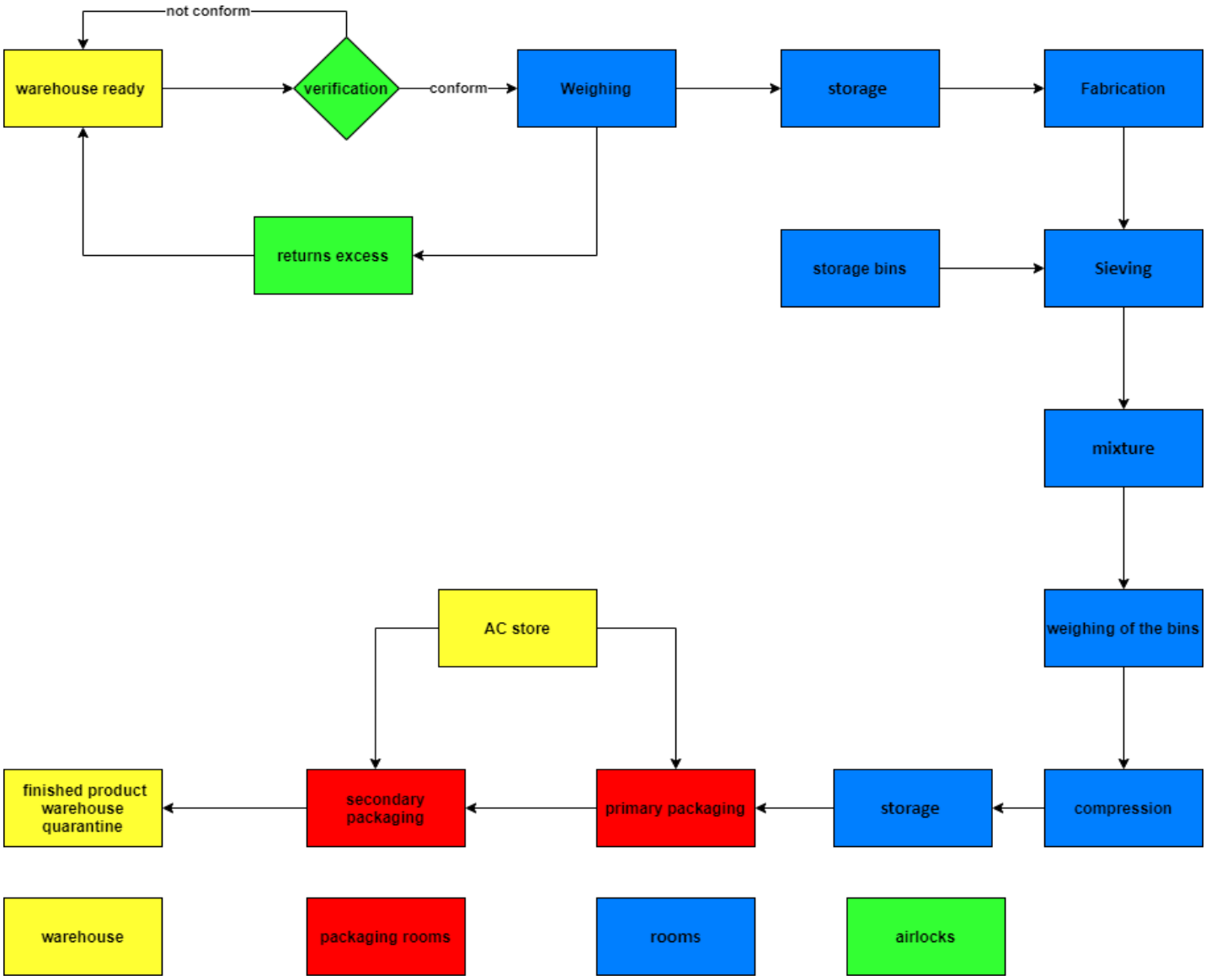
Product information such as date of manufacture, expiry date, and batch number are fed into the carton and printed on the cartons. The blister belt transporting the blister packs from the blister machine to the carton where the blister packs are aligned with each other in pairs and then placed in the cartons with the notes, then the filled boxes are transported to the check weigher or a scale tests their weight in case one of the boxes is out of the weight standard it is automatically extracted and sent to the shucking machine, the regulations are sent to the labeler or the labels are stuck to the boxes, finally the boxes are transported by the belt to the case packer where they will be stored in red type boxes on a width of 6 boxes and a length of 13 and a height of 2.

Finally, the outgoing crates are lined up by the packaging staff on wooden pallets and will be transported to the warehouse.

4.4 Cartography of the production part in TAPHCO spa

In the following figure, we are making a cartography of the process of production in the production department

Figure 26 cartography of the production part



Source: made by us

5 Blockchain technology in TAPHCO spa

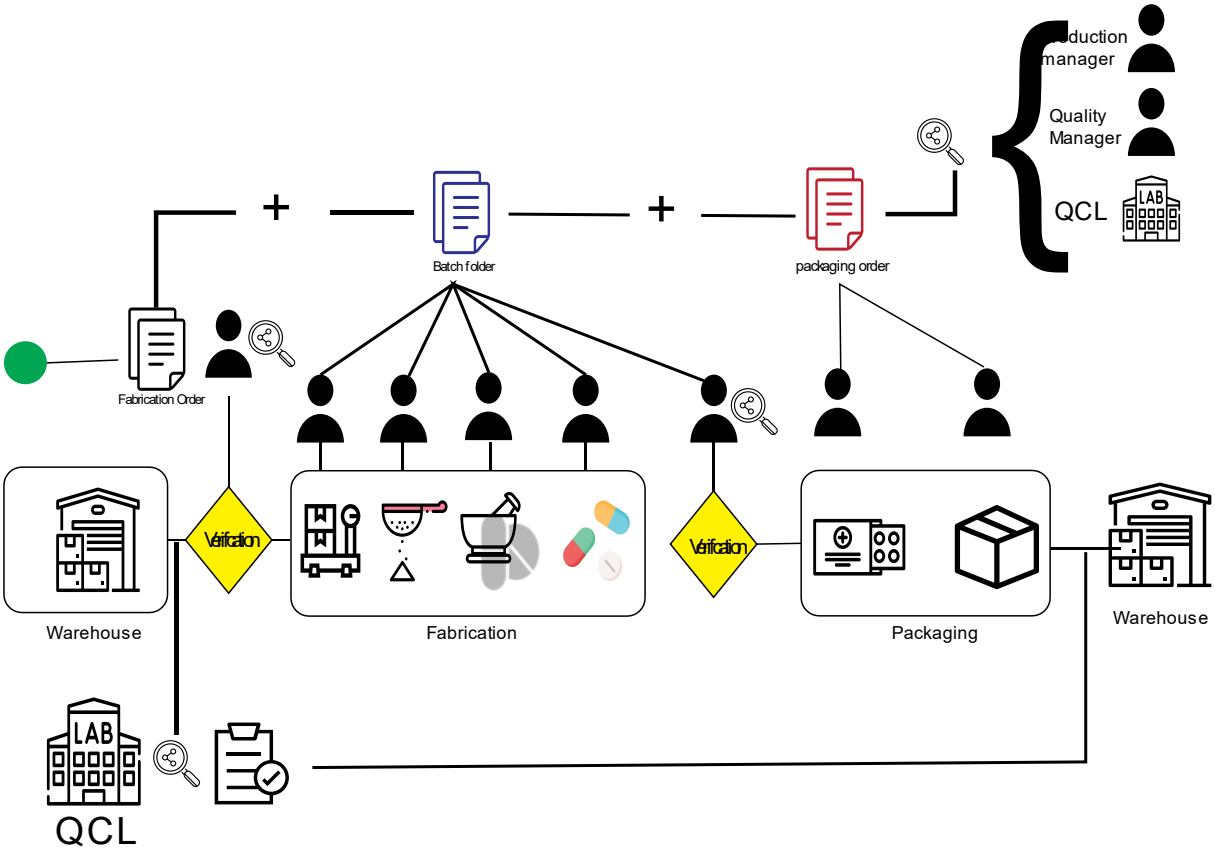
To guarantee the absence of data alteration it we decided to make a blockchain consortium between several functions of the same department. In our case the weighing, fabrication,

packaging, and storage functions of the production. The blockchain being replicated at the same time in the departments, no entity can modify data without the other one noticing it. There are two choices for the stored data

The blockchain is shared between all production functions. But we only give to the production function the access to stores the production data. As the manufacturing steps progress, it sends a printout of the data to the blockchain. In the event of an audit, the production manager can compare the footprint of the audited data with the data sent during manufacturing.

so here we only store the data from the batch folders directly on the blockchain. However, if the company has to store all the batch records of all the products manufactured in the company, this would represent a huge amount of data over the long term.

Figure 27 actual information flow process



Source: made by us

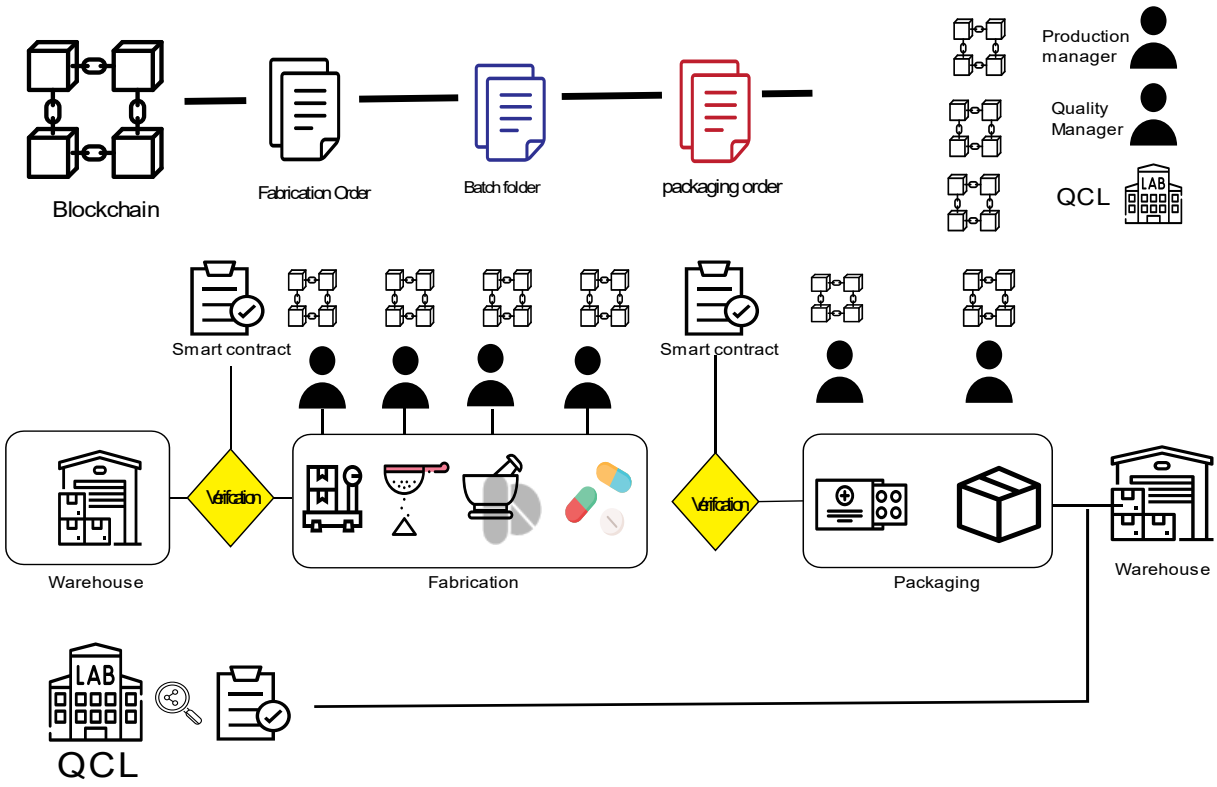
Our second choice would be to host only the hash print of the data in the blockchain as shown in this figure. We give the access to The manufacturing function to declare in the blockchain the creation of a new batch, then as production progresses, the data constituting it would be stored by the other departments, and a hash print sent to the blockchain with the reference of the document it refers to.

To check the integrity of a data, we simply calculate its hash fingerprint and compare it with the hash fingerprint that was sent in the blockchain when the data was issued. If there is a discrepancy, it means that the data has been modified.

By choosing this we, first of all, allows the production manager, when checking a batch, to make sure that the data has not been altered. In this way, he is certain to base his judgment on reliable data.

And finally, in the event of an audit, we give the health authority and the QCL pharmacist responsible for the establishment of the certainty that there has been no alteration of the data presented.

Figure 28 Information flow after Blockchain proposed solution



Source: made by u

Conclusion

Pharmaceutical companies consider that their internal quality system meets their needs in the face of the requirements of drug manufacturing set by the government drug agencies.

To guarantee this quality and conformity of high demand, they need to rely on a high-performance information system providing total control and reliable information.

TAPHCO spa being a new company on the market, and planning to obtain a quality IS in order to develop its SC, we proposed to the company to rely on the blockchain technology, so we had the task of conducting a study on "the possibility of integrating the blockchain technology in an IS and more precisely in an ERP".

First, we made a complete analysis and tracking of physical and information flows in the CS, modeling, and mapping them, and we found administrative complexity in the information flow with an excess of documents to follow the qualitative recommendations of the GMPs to the letter.

Then, with the interviews done with the managers, we made a description of the information flow between the different functions of the company in the absence of an information system, and we observed the difficulties encountered in the transmission of information between the departments of the company or between the company and its partners.

Then we did interviews with blockchain experts to study the possibilities and models of integration of blockchain technology in an ERP controlling an SC function.

Finally, we proposed a blockchain technology as a solution for the difficulties encountered, after having chosen the most essential function of an SC in the pharmaceutical field which is manufacturing, we decided to model a way of integration.

The decentralized nature of the Blockchain makes transparency an overriding principle. While the importance of transparency in financial transactions in the blockchain was stressed and Its value in the supply chain is equally crucial. Transparency is fostered by the availability of all parties. All data recorded on a Blockchain that is authorized, which nurtures trust.

A shared, indelible logbook with codified rules could potentially eliminate the verifications required by internal systems and processes.

The Blockchain-based supply chain can help participants to note price, date, location, quality, quality, price, and certification, and other relevant information to manage the chain more effectively of supply. The availability of this information within the Blockchain may increase the supply chain traceability, reduce losses due to gray and fake markets, improve visibility and compliance of sub-contracting contracts and improve the position of a leading manufacturer responsible.

As a type of blockchain, we decided to go for the Consortium Blockchain with the integration of the Smart contracts which have been revolutionary and are transforming many industries, such as insurance and legal services. The supply chain in the pharmaceutical industry benefits, with smart contracts making autonomy a reality. The supply and distribution industry has tedious processes that delay even the most meticulous activities for hours.

And finally, to eliminate counterfeiting because, in any supply chain, there is always the danger of being introduced into the system by particular when the goods change hands. Especially in the pharmaceutical industry, this is extremely dangerous and may result in loss of life.

Blockchain-based systems help reduce this toxic behavior by using codes to bars on medications in the supply chain. These codes are scanned and entered into a decentralized register that is immutable. As drugs are exchanged between each other, the codes are scanned again and recorded in the register. This makes it possible to track medications as they are taken. and as they move through the supply chain to the end consumer

In conclusion, we can say that this end-of-study project experience allowed us to put into practice our theoretical knowledge acquired during our postgraduate studies and to acquire new skills concerning IS modernization.

We recommend the company TAPHCO spa to implement and integrate a blockchain technology when acquiring an ERP system as a solution in their current state and as a method of modernization.

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Annexes

Interview with Production manager

1. Introduction and introduction of their functions
    a. Could you briefly introduce yourself?
    b. Could you please explain the tasks of your position?
    c. Describe the production process you go through.
2. Description of IS in TAPHCO spa and its limits
    a. What is your method of the informational transaction with your different departments within the production department?
    b. What is the process of information flow in your department with the other departments of CS
    c. What are the problems you encounter in the information flow of your supply chain? or the risks you identify before each production launch?
    d. What problems do you encounter in the information flow of your supply chain?
    e. What do you think of TAPCHO SPA's IS?

3. Contribution of the blockchain as a solution and their appreciation of it
    a. Do you think decentralization can help solve its problems?
    b. Do you think this transparency will facilitate your transactions with your different departments?
    c. Do you think that decentralization with transparency can make it easier for you to control the quality of your products?
    d. For you, what are the requirements of a system that manages production?
    e. According to the information you have been given, to what degree do you think that the BlockChain will be beneficial to the smooth running of your process? on a scale of 1 to 5
    f. Do you have anything to add or suggestions?

Interview with supply chain manager

1. Introduction and introduction of their functions
    a. Could you briefly introduce yourself?
    b. Could you please explain the tasks of your position?
    c. Describe the procurement process you go through.

d. How do you choose your suppliers?

e. What are the risks you can identify in this choice of supplier?

2. Description of IS in TAPHCO spa and its limits

    1. What is your means of the informational transaction with the supplier?
    2. How do you make sure that the quality of the products in the cold chain is monitored?
    3. What problems do you encounter in the information flow of your supply chain?
    4. What is the process of information flow in your department with the other departments of the SC?
    5. What problems do you encounter in the information flow of your supply chain?
    6. What do you think of TAPCHO SPA's IS or at least of the current way of transmitting information?

3. Contribution of the blockchain as a solution and their appreciation of it

    a. Do you think that decentralization can help to solve these problems?

    b. Do you think that this transparency will facilitate your transactions with your suppliers?

    c. Do you think that decentralization with transparency can make it easier for you to control the quality of cold chain products?

    d. For you, what are the requirements of a system that manages the supply chain?

    e. Based on the information you have been given, to what degree do you think the BlockChain will be beneficial to the smooth running of your process?

    f. Do you have anything to add or suggestions?

Interview with Quality manager

I. Introduction and introduction of their functions

1. Could you briefly introduce yourself?
2. Could you explain the mission of your position?
3. What is the importance of quality assurance in the pharmaceutical industry?
4. What do you think about the GMP?
5. How do you ensure that they are respected?

II. Description of IS in TAPHCO spa and its limits

1. What is the process of information flow in your department with the other departments of the SC?
2. What problems do you encounter in the information flow of your supply chain?
3. What is reliable and secure information in quality assurance?
4. What do you think of the TAPHCO IS or at least of the current means of information transmission?

III. Contribution of the blockchain as a solution and their appreciation of it

1. Do you think that decentralization can help solve its problems?
2. Do you think that this transparency will make it easier for the LNCPP to give you a marketing authorization?
3. Based on the information you have been given, to what extent do you think that the BlockChain will be beneficial to the smooth running of the CS process?
4. Do you have suggestions to add?

Interview with Blockchain Expert

I. Introduction and introduction of their functions

1. Could you briefly introduce yourself?

II. Blockchain technology presentation

1. What do you think Blockchain technology is?
2. What is the difference between a blockchain and a traditional database?
3. What are the main characteristics of the blockchain?
4. We know that the Blockchain is a recording technology, so what kind of record is stored on the Blockchain?
5. What are the types of Blockchain technology?
6. Can a block be removed from the blockchain? If so, how?
7. what are the steps of blockchain implementation?
8. what are the technical challenges of this implementation?
9. do you have any suggestions for solutions to these challenges?

III. The role of blockchain technology in the business domain

1. what do you think about the integration of this technology in business? and what can it bring?
2. could you explain the concept of using a blockchain in supply chain management?
3. do you have examples of use to give us?
4. how can a blockchain solution be integrated into an ERP system?
5. Is decentralization a strong point in a supply chain?
6. What are the opportunities of the blockchain in the pharmaceutical industry and what is the role of digital identity?
7. What type of blockchain can be used in a supply chain project? and why?
8. what are the implementation tools?
9. as an expert, if you have any suggestions added for us these in this theme, we are all yes.