

Blockchain technology in sustainable supply chain management: from theoretical expectations to application perspective. Case of the fisheries sector.

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Abstract — The development of the supply chain between the requirement of competitiveness and the imperative of sustainability, induces the supply chains and the companies that support them to engage in a sustainable development approach. Nevertheless, to achieve this end, new devices have been adopted, among which we find sustainable technological innovations. Therefore, this research highlights the blockchain technology considered as a real lever for the anchoring of sustainable development. However, this ambition of sustainable digitization encounters many obstacles in terms of acceptance of technology, its use and its compatibility with the sustainable development strategy. Through the analysis of the literature review, we have identified the main factors that influence the adoption of blockchain technology that can improve the sustainability of a supply chain. The exploratory study with actors in the fisheries industrial supply chain allowed us to analyze the feasibility of implementing this technology in the sector.

Keywords: *Blockchain – sustainable development – supply chain – fisheries industrial sector*

INTRODUCTION

Sustainable development has become a crucial concern for civil society. To achieve this end, many systems have been put in place by companies as well as new technological innovations have been adapted throughout the supply chain, such as eco-technology or sustainable technologies which take into account the requirements of sustainable development (Tempri, 2010). The 4.0 industrial revolution and digitalization can constitute an alternative and a key solution for anchoring sustainable development, provided that the innovation policy is in perfect harmony and connection with the sustainable development policy (Depret and Hamdouch, 2009).

No one can deny that sustainable technological innovations can have an impact on sustainable development. However, these innovations require more than adoption or implementation, but scientific, technological and institutional management accompanied by overall performance monitoring at the end of this process (Gundolf et al, 2007). Among the revolutionary digital technologies, we find the blockchain which seems to be a solution and a tool to help anchor sustainable development (Kouhizadeh and al, 2021)

It is in this perspective that our problem lies: what are the determining factors that influence the adoption of blockchain technology? And to what extent does this technology contribute to improving the sustainable performance of a supply chain?

To achieve this objective, we will first present a state of the art on the particularities of sustainable technological innovations and the factors that determine the perceived importance of the impact of blockchain on the sustainable performance of a chain. logistics. Then we will present our conceptual model which brings together all the research proposals and its application in the fisheries -industrial supply chain.

II. LITERATURE REVIEW ANALYSIS

A. *The contribution of technological innovations to sustainable development*

Since their appearance, technological innovations have been a major lever for socio-economic development. However, the industrial revolutions and the technological innovations that accompany them have had a negative impact on the environment.

Indeed, technology represents the main cause of the overexploitation of natural resources and the degradation of the ecosystem, nevertheless for some researchers it can become an alternative and a key solution for the anchoring of sustainable development (Djellal and Gallouj, 2009 and 2018).

Sustainable technological innovations are defined by Hamdouch and Depret (2009) as: “a set of alternatives making it possible to meet the objectives of sustainable development. Sustainable innovations can be of 4 types: technological, organizational, managerial or institutional”. For our case study, we will retain technological innovations. Gasmi and Grolleau (2003) consider environmental or sustainable innovations as any innovative action that reduces the negative impact on the environment (Temri and Fort, 2010).

Sustainable development has become a major concern for civil society but also for the scientific community. To achieve this end, many tools and approaches have been put in place as well as new technologies have been adapted such as eco-technology which consists of using ecological techniques during the production processes but also during the supply chain (Temri et al, 2015).

The issue of the impact of technological innovations in anchoring sustainable development has been little studied (Pavelin and Porter, 2007). It is clear that most researchers focus on the study of the determinants of social and sustainable performance, without worrying about the means and devices for maintaining this sustainable performance. Beyond this first observation, other complementary results emerge in this study. First of all, sustainable technological innovations could contribute to economic growth, however it requires an innovation policy in perfect harmony and connection with the policy of sustainable development. In this movement, Hamdouch and Depret (2009), note that sustainable development policies are conservative, they do not encourage companies to invest in integrated technologies that respect the constraints of sustainable development. Indeed, companies opt to integrate the cost of sustainable actions in the cost of production instead of investing in the research and development policy which remains a policy underestimated by companies..

B. How blockchain technology works in a supply chain

The current trend requires the integration of smarter, automated, digital but also sustainable technologies in order to achieve a more efficient supply chain (Yadav and Sign, 2020). Among these revolutionary technologies is the blockchain. Exposing the dawn of a new era, blockchain technology is based on a ledger or register of information composed of several blocks, each of which has an identity, address and specific information (Abeyratne and Monfared, 2016)

Among the specificities of this technology, that it allows the storage and transmission of information, which is characterized by transparency and data security. Generally the blockchain is a decentralized database where data and information are stored in several nodes of the chain in order to avoid possible hacking or loss of data, while preventing the modification or deletion of its recorded transactions (Azaria et al, 2016). Because of this quality, supply chain transparency and auditing has become more impactful (Steiner and Baker, 2015). The implementation of blockchain in a supply chain improves transactions between two or more actors in this

chain in terms of confidentiality and transparency (Kosba et al, 2016))

C. The impact of Blockchain on the sustainable performance of a supply chain:

Although blockchain technology ensures the traceability of the supply chain, its preponderant role and its impact on sustainable performance has been raised by several authors (Sabeti et al, 2019; Rogetzer et al, 2019; Bhat et al, 2019; Swan, 2015; Chapron, 2017; Korpela et al, 2017)

On the economic side: the blockchain ensures the disintermediation of the supply chain while guaranteeing the security and authenticity of the data as well as the transparency and reliability of the company.

On the social side: blockchain technology reassures the consumer about the ethics of the products purchased and thus contributes to strengthening food safety by reducing contamination problems thanks to the digitization of the monitoring and storage of records and information, while improving traceability and consumer confidence.

On the environmental side: it traces the carbon footprint of products throughout the supply chain, and thus contributes to the reduction of carbon emissions in the delivery of the product by providing the bases for mapping the chain

D. The success factors of blockchain adoption for a sustainable supply chain

Through the analysis of the literature review, we have deduced that the main factors influencing the adoption of blockchain are:

• F1: The robustness of the system

The three criteria of the robustness of the information system (transparency, security and trust) are recognized as key success factors for the adoption of blockchain in a supply chain. On the one hand, the blockchain provides verifiable and auditable transactions and data without being able to be modified, which establishes the transparency of this system (Nugent et al, 2016). On the other hand, this technology provides the security of its transactions which are protected from hacking or modification or even deletion (Kshetri, 2018). In this respect, an environment based on the transparency, visibility and security of its transactions induces a relationship of trust between its partners, which has an impact on the performance of the supply chain and its sustainability (Sabeti et al, 2019). This situation applies to the blockchain when it is implemented in a supply chain.

• F2: Accessibility

For the evaluation of this factor, we opted for 3 explanatory variables (Kouhizadeh and al, 2021):

- Traceability: globally, the blockchain ensures the traceability of physical and information flows, which has an impact on product quality. Nevertheless, it contributes to the sustainability of a supply chain through the optimization of natural and energy resources.

- Simplification: blockchain technology encourages and promotes digital operations, which considerably reduces paperwork and redundant work. Similarly, technology facilitates financial and commercial transactions and plays a

significant role in simplifying the work of certain data entry operators (Belchior and al, 2021).

- Availability: according to Liang et al (2017), what characterizes blockchain technology is the availability of data on the network, which allows transactions to be carried out at any time.

• F3: Pressure from external stakeholders:

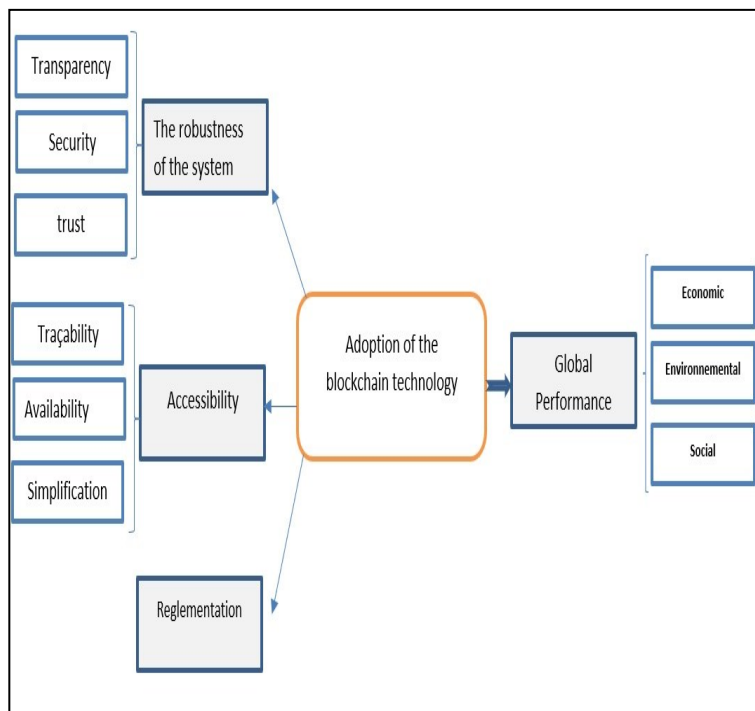
According to Luthra and Mangla (2018), government policy has an impact on the adoption of blockchain by actors in the supply chain in order to discover a possible fraud or scam by one of the actors during transactions carried out or during an inspection.

III. CONCEPTUAL AND METHODOLOGY MODEL OF WORK:

A. Proposed conceptual framework:

Our conceptual model is based on the coupling of the model of key success factors for the adoption of blockchain proposed by Yadav and Singh (2020) and the sustainable supply chain model of Baumann (2011).

Fig1 : the structure of our conceptual model



B. The theoretical approach to the adoption of blockchain technology in a supply chain:

In our study we have identified the theoretical framework of blockchain technology according to the technological approach. This approach is based on the technology-organization-environment interactionist theory developed by Tornatzky and Fleisher (1990). This approach focuses on the factors that influence the adoption of a technological innovation, which are: the technological, organizational and environmental context (Bohas, 2013) [4].

In our model, the technological context is represented by the robustness of the system while the accessibility of the technology represents the organizational context. The environmental context is represented by the regulations put in place to support the adoption of technology in the supply chain.

VI. PRESENTATION OF THE CONTEXT OF THE STUDY :

The fish product processing and valorization industry represents an important outlet for the fish industry and the agri-food sector, which transforms Morocco into a continental platform for the valorization and export of fish products. This success is due to the consideration of sustainable development requirements and the implementation of digital technological innovations, including sensor technology and the Internet of Things, cloud computing, as well as the cyber-physical system in the value chain. fisheries -industrial products in consultation with the challenges of the Halieutis strategy, which has made it possible to improve the performance and competitiveness of the sector. At the level of the fisheries -industrial sector, Morocco has implemented the cyber-physical system SAMAC implemented with other internet of things (IT) in a perspective of quality assurance and traceability of the entire sector.

A. State of play of existing digital technologies:

The exchange of information between the actors of the supply chain is the key to the success of any supply chain management. Aware of the importance of digital technological innovations to cope with the increased agility of the fishing sector and the volatility of regulatory changes; the Moroccan government under the direction of the Department of the Ministry of Fisheries (DPM) has established the "Samac" system, which constitutes a platform open to all operators in the agro-fisheries logistics chain, thus covering all operations from fish capture to to its export.

This digital technology has facilitated the traceability of the fish product through the computerization of catches as soon as the boat docks at the quay. Indeed, the descriptive data of the fish products landed and declared by the captain of the vessel and which concerns the quantity of fish landed by species, are digitized through their integration into a mobile input terminal (Personal Digital Assistant: PDA).

Once entered in the database, the PDA generates the catch declaration (DC) with QR code delivered to the master of the vessel. This DC allows him access to the ONP fish marketing platform. The data entered in the DC is automatically sent to the Bigdata represented by the central server of the DPM as well as to the national network of the Samac system. The DC is presented to ONP agents to access the marketing platform for fishery products (Halle and CAPI). The latter carry out the optical reading of the DC to restore the data from the central server of DPM to the ERP of the ONP (MAIA).

All fish marketing transactions carried out at the ONP level are digitized in the MAIA system. At the end of the marketing

circuit, the ONP generates a purchase traceability report (ETA) for each wholesaler allowing the assurance and monitoring of the traceability of fish products, which is then transferred to the DPM network.

From an environmental point of view: the Samac system allows downward traceability (fish wholesalers) and upward traceability (fish wholesalers) of the commercialization flows of fish products, and thus contributes to the assurance of the control of the certification of catches. This digital technology remains an opportunity for sustainable fishing by promoting the verification, monitoring and follow-up of commercial transactions in the fishing sector and contributes to the valuation of the fish product by expelling the informal from the agro-fishing value chain. Digitization is a real challenge in order to ensure efficient and sustainable fishing by generating for processing industries a fish product that meets the requirements of health and quality standards.

From a societal point of view: the Samac system provides and improves the traceability of the fisheries -industrial product and contributes to reassuring the industrialist on the quality of the halieutic product and its origin. In addition, the system makes it possible to trace the batch of products and their origin in the event of contamination (histamine) or pathogenic problem declared by the customer or the consumer. Digitization has facilitated the procedure for exporting the fisheries -industrial product and has contributed to considerable time saving and facilitated the certification tasks for the industries involved in the valorization of the halieutic product.

The implementation of the Samac system in internal logistics has enabled manufacturers to improve their manufacturing process and to overcome certain challenges encountered in the fisheries -industrial sector which relates to the traceability of fish products and food safety. In this context, this digital technology ensures transparency which leads to greater accountability of the actors through the recording and monitoring of each stage of the life cycle of the fisheries -industrial product from the ship to the manufacture of the box, canned or semi-canned.

However, financial transactions are restricted just for upstream logistics, which can be seen through the payment of shipowners, which is ensured under the control of the ONP, while other financial transactions are not ensured by this technology. Similarly, the Samac system has enabled fish product processing industries, in the event of detection of a defective product by ONSSA or by the distributor, to easily identify the offending batch and remove it from their warehouses or even from the market instead of destroying the entire batch, which leads to an optimization of resources and waste for industries registered in a framework of ethical and responsible practices.

B. Blockchain Technology Application Perspective

In this regard, Blaha and Katafono (2020) consider that among the most debated digital technologies in recent decades, we find Blockchain technology.

At the global level, the blockchains most commonly used for the management and traceability of the fisheries -industrial supply chain are Ethereum (considered a pioneer) and the hyperledger (Blaha and Katafono, 2020).

Unfortunately Morocco is not yet able to implement blockchain technology in the fisheries -industrial supply chain. Unlike other countries, this technology has enabled the traceability of the fisheries -industrial product by the consumer and to ensure the origin of the product and even its eco-labels and certifications at the time of purchase on the shelves of large surfaces by simply scanning the QR label of the can with the application that is in the consumer's smartphone. Certainly the current Samac digital system has provided many advantages, but the current trend requires integrating a smarter and more sustainable digital system in order to obtain an efficient and sustainable supply chain. For this, we are going through our study to study the feasibility of integrating blockchain technology and its future impact on the sector.

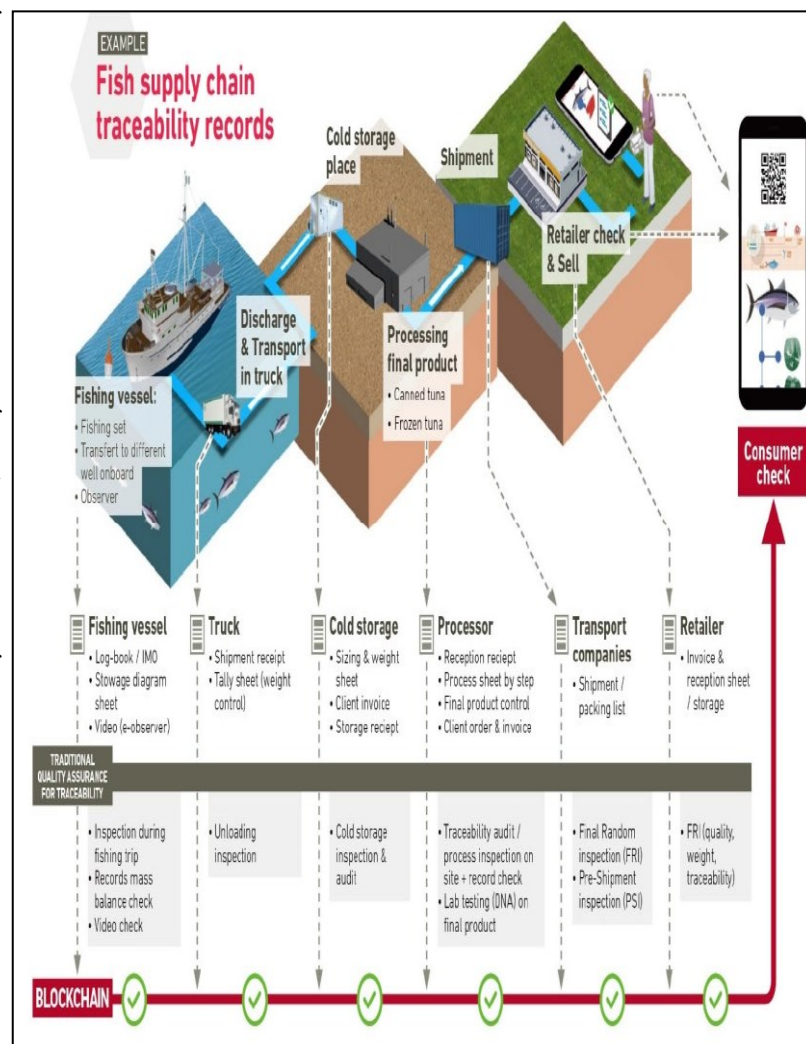


Fig 2 : The traceability of the industrial fish supply chain by Blockchain technology (Blaha et Katafono, 2020)

➤ *Futur impact on the on the environmental component:*

The application of blockchain technology will be able to enable seafood processing industries to record, display and share data across the entire supply chain, which will provide better transparency and traceability. fisheries -industrial product. This results in better management of the cold chain, enhancement of the fish product and optimization of waste and resources used, while ensuring the sustainability of resources.

➤ *Futur impact on the on the social component:*

The application of blockchain technology in the fisheries - industrial sector may offer promising social characteristics. On the one hand, it will provide better assurance and guarantee of the safety and quality of the fisheries -industrial product in order to protect the health of the consumer. On the other hand, it will provide assurance on the rights of seafarers and fair labor through the acceptance of regulatory commercial transactions declared by the DPM and the rejection of all other transactions resulting from illegal and undeclared fishing (IUU).) that denigrate workers' rights.

More broadly, blockchain technology associated with RFID technology can provide quality managers in processing industries with a real-time fish product tracking system ensuring mastery of the HACCP system, and therefore facilitate their task of control and monitoring which can produce for possible certification (saber et al, 2019).

V. TESTING OF THE MODEL IN THE FISHERIES - INDUSTRIAL SECTOR:

Pour répondre à notre problématique de recherche, nous avons carried out an exploratory study in the fisheries -industrial supply chain of the Agadir region in order to test the success factors of blockchain technology resulting from the literature review on the currently existing digital system (Samac system)

A. Proposition 1: the robustness factor of the system influences the adoption of blockchain in a sustainable supply chain.

Through the exploratory study with the actors of the fisheries - industrial supply chain, it turns out that since the implementation of the Samac system, there is an increased transparency of the transactions carried out within this network. Indeed, blockchain technology ensures **transparency** through the declaration of the origin of the fish, its scientific name, its compliance with regulations and its passage through the formal circuit (market or Capi). This was achieved thanks to the control and monitoring carried out since the boat left the sea through the VMS system which traces the circuit of the boat and monitors its catches and records it in the Data of the Ministry of Maritime Fisheries.

The emergence of traceability technologies for fish products generate greater food **security**, as is the case with the current Samac system. Indeed, thanks to this technology, it is possible to trace the routing of the product from its origin to its export and facilitates the work of the inspectors to control the conformity of the product to the standards which increases the food safety of the halieutic product. On the one hand, it is easier to detect a defective batch and remove it from the market or from the stock of fish product processing industries than to destroy the entire batch. In this regard, the Samac system reflects a high degree of **confidence** that the fish product comes from responsible fishing that complies with food safety standards, since all transactions recorded in the system are regulatory. On the other hand, the users of the system are reassured of the security of the data which cannot be modified or erased in any way, which generates a climate of confidence for the commercial transactions carried out by the system.

From the above, we deduce the preponderant role of the technology of the Samac system in the participation of the respect of sustainable development issues in accordance with the Halieutis strategy, and thus provides a favorable framework for a possible application of blockchain technology in this sector. .

B. Proposition 2: the accessibility factor influences the adoption of blockchain in a sustainable supply chain

The fisheries sector in Morocco has a national fish traceability system, it is the Samac system which ensures the monitoring and traceability of the fisheries -industrial product throughout its supply chain. The implementation of this digital system is part of Morocco's new approach to sustainable development in order to preserve and enhance fisheries resources for national and international markets, as well as ensuring the health safety of these products.

The Samac system is an online **traceability** platform that ensures the permanent storage of transactions but also the sharing of data. Thanks to this quality, each player in the fisheries -industrial supply chain manages to consult and carry out certain digital transactions but also to quickly ensure the certainty and legality of operations. If it is clear, the growing usefulness of this digital technology which contributes to the economy of travel and transport costs for professionals to recover or carry out commercial transactions but also certain financial transactions which leads to the **simplification** of their work tasks .

On the other hand, the Samac network provides these users with access to the recorded data available on the network. In this network, smart contracts for supplying factories to wholesalers or fishing boats can be made using this technology. This quality of **availability** provides better visibility and traceability of fish products which contributes to the valuation of this product within the framework of the valuation and optimization of fish resources, the main pillar of the sustainable development strategy.

C. Proposition 3: the regulatory factor influences the adoption of blockchain in a sustainable supply chain.

The integration of the blockchain is the result of a consortium of actors and stakeholders involved in the fisheries -industrial supply chain in a secure, transparent and legal framework. However, the success of the implementation of this technology comes down to the establishment of a favorable regulatory framework that accompanies the operations carried out by this system so that the blockchain technology is widely adopted by all the links in the chain.

V. CONCLUSION

Faced with the requirements of sustainable development, supply chains must put in place new systems to improve their sustainable performance. The emergence of digitalization and the appearance of sustainable technological innovations can help transform a traditional supply chain into a sustainable supply chain. However, supply chains in their transformation process face several challenges that can impact the adoption of sustainable technological innovations.

The main contribution of this study is to analyze the determining factors of the adoption of blockchain technology and to analyze the impact of this technology on the sustainable performance of a supply chain.

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