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Using the Transparency of Supply Chain Powered by Blockchain to Improve Sustainability Relationships with Stakeholders in the Food Sector: The Case Study of Lavazza

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Abstract: Food product safety and quality are considered to be of the utmost significance on a global scale. Highly publicized food safety incidents have significantly increased public interest in food traceability, defined as "the ability to track any food, feed, food-producing animal or substance that will be used for consumption, through all stages of production, processing, and distribution" (European Union). The World Health Organization (WHO) suggests that governments, producers, and consumers work together to ensure food safety, which calls for the dissemination of pertinent information throughout complex food value networks. Therefore, it is in the best interest of profit-driven businesses to implement information systems for tracking food goods, a significant byproduct of which is the likelihood of increased profitability. This paper aims to explore the ample possibilities for such implementations that are now available thanks to blockchain technology. In particular, the goal is to explore the dynamics of this technology and identify how it helps to create good customer relationships. For this purpose, the case of Lavazza, an important Italian roasted coffee company that has recently introduced a blockchain-tracked product to the market, is analyzed in detail, including all the steps that made the application of the technology possible and how it was finally communicated to the consumer. The case study offers a concrete example that resulted from both stakeholders' internal need for greater traceability and consumers' external need for greater transparency regarding the company's sourcing processes. In this pilot project, collaboration among all the entities that are part of the chain was essential to delivering a formative, customized, and ultimately, easy-to-understand experience to the end consumer. Finally, Lavazza is an example of a company that decided to challenge itself by following a trend that will be increasingly present in future socioeconomic scenarios.

Keywords: blockchain; food; supply chain; Lavazza

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1. Introduction

Food product safety and quality are now considered to be of the utmost significance on a global scale. According to the World Health Organization, foodborne illnesses impair national economies, tourism, and trade and obstruct socioeconomic progress. Highly publicized food safety incidents, such as tainted milk in China or peanut butter infected with bacteria in the U.S., have significantly increased public interest in food traceability. The World Health Organization suggests that governments, producers, and consumers work together to ensure food safety as a potential remedy for the current situation, which calls for the dissemination of pertinent information throughout complex food value networks. Article 3, paragraph 15 of the Regulation 178/2002 of the European Food Safety Authority defines food traceability as "the ability to track any food, feed, food-producing animal or substance that will be used for consumption, through all stages of production, processing, and distribution" [1]. Given the growing need for improved food traceability, it is in the best interest of profit-driven businesses to implement information systems for tracking food goods, thereby reducing information asymmetries and decreasing health hazards by providing customers with information on the manufacturing and shipping processes for their products. Finally, increased openness can aid customers in evaluating a product's attributes more accurately. This study aims to explore the ample possibilities that blockchain technology provides for such work. This technology has provoked a lot of disruptive changes, starting with cryptocurrencies in the financial world. However, the goal of this study is to explore the dynamics of this technology in terms of its functioning and application in the most complex and discussed sector of today's food and beverages industries: the supply chain. We argue that the blockchain's immutability and shared data access among supply chain players can facilitate information transparency along the supply chain. Even though it is still unclear how this evidence may be effectively communicated to the target audience and how much of an influence it will have on their views and behavioral intentions, the benefits that it can bring to today's system are promising. Indeed, one of the most complicated characteristics of the supply chain is the lack of instruments and the technology to fully trace it. Therefore, with the goal of greater trust and transparency, applying the blockchain to the supply chain could be a turning point, as blockchain technology provides transparency, allowing information to be shared with confidence within a trusted network. In all industries around the world, this technology is helping to transform business. Greater trust leads to greater efficiency by eliminating duplication of efforts. After introducing the main features of blockchain technology, this study focuses on its applications in the food and beverage sector, analyzing the case of Lavazza, which appears to be particularly significant.

The Characteristics of Blockchain Technology

In general, businesses rely heavily on information, so it is critical to make sure that all information is as accurate and timely as possible [2]. The blockchain is a data structure that consists of growing lists of records, called "blocks", securely linked together using cryptography [3,4]. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data. Since each block contains information about the previous block, they effectively form a chain, with each additional block connecting to the previous ones. As a result, blockchain transactions are irreversible; once recorded, the data in a particular block cannot be changed retroactively without affecting all subsequent blocks [5].

With no claims to completeness and exhaustiveness, which go beyond the objectives of this work, we suggest that blockchain technology presents a series of characteristics that allow information to be managed in an unambiguous and transparent way [6]. First of all, due to the immutable register that is only accessible to authorized network members, blockchain technology is the ideal way to communicate information because it does so instantly and with full transparency [7,8]. Additionally, due to the specifics of an end-to-end transaction, only a single version of the truth exists, automatically creating trust and new, more efficient business opportunities. Among the principal elements that create a blockchain network, we find distributed ledger technology—i.e., a log to which all participants in the network have access, as well as the immutable record of all transactions that it contains. In this register, transactions are noted only once; therefore, no duplications of the same task are registered, which differs significantly from the typical networks of traditional businesses [9]. Secondly, one of the most singular features of this technology concerns the fact that users cannot in any way modify or tamper with transactions once they have been noted in the shared ledger explained above. Indeed, if a transaction record contains an error, it will not be deleted, but another transaction will be added to correct the wrong one. Consequently, all transactions remain visible. Finally, this process is made even faster by smart contracts, the main purpose of which is to accelerate transactions thanks to a set of rules that are stored on the blockchain and executed automatically [10]. An example that highlights the significance of these smart contracts is the vending machine. If one enters the right amount of money and selects an item, the vending machine dispenses the item they have chosen. The terms of the contract are clear, and the transaction takes place on its own.

When a transaction is made, it is recorded as a "block of data". These transactions can be of different types, both tangible (such as a product) or intangible (such as intellectual assets) [11]. This data block reports the relevant information, which might include who, what, when, where, how much, and even specific conditions—such as, for example, the temperature of a shipment or the duration of time a product travels between two places. Every block is interconnected, meaning that one block is connected to both the one that precedes it and the one that follows it. Indeed, these form a chain of data, hence the so-called blockchain, which is the asset protagonist of the network that moves from one place to another, at times changing owners. Moreover, the blocks certify the exact time and sequences of all transactions and are securely connected to each other so that they do not alter, preventing one from mistakenly being inserted between two already existing blocks. Each block that is added reinforces the verification of the previous block and, consequently, of the entire transaction or blockchain.

Thus, the blockchain is a tamper-proof technology thanks to this key element of immutability. Transactions are locked together in an immutable chain: a blockchain. This eliminates the possibility of tampering by malevolent actors and creates a record of transactions that all members of a network can trust. Since only participants are part of the blockchain network, we can always be sure to receive accurate and timely data, and we also have the assurance that the data recorded on a blockchain are completely confidential material to which only members have access.

The characteristics of blockchain technology, briefly described above, make it particularly attractive for production chain stakeholders [12]. Businesses and customers look to brands to ensure the veracity of their goods, while supply chain participants need increased transparency and responsible sourcing to minimize disputes. Therefore, using the blockchain as a solution for significant supply chain issues might help executives use data to better control possible disruptions in the present and create a strong resilience for the future. It takes collaboration and coordination to move products and services between suppliers, manufacturers, banks, regulators, logistics service providers, and retailers [13], but the challenges facing firms in the modern world are more significant than ever. Disruptions in the supply chain increase costs and cause considerable revenue losses. The fact that these disruptions are worsened by inefficient processes that rely on slow and inaccurate data only further troubles the situation.

For all of the aforementioned reasons, businesses today are looking for transparency, resilience, and agility in their supply chains. The blockchain, a component of supply chain technology, encourages agreement, trust, and transparency among all parties. It guarantees flexible business outcomes while giving each member benefits, but it is not as easy as it seems [14].

With the blockchain, control processes are automatic, allowing all supply chain participants to simultaneously verify every transaction, which is advantageous for tracking overall product quality. The use of the blockchain enables the various supply chain participants to increase visibility throughout the production process and streamline difficult and expensive steps, providing the following main benefits: supply chain optimization through shared information access, security, and authenticity of product information as a result of immutability; reduction in disputes over transactions and exchanges due to traceability; and, finally, improvement in productivity.

As previously stated, regardless of the type of product an organization produces or sells, a reliable supply chain network is critical to keeping contemporary customers satisfied and achieving financial goals. Still, the blockchain does not bring only advantages; there are also some potential challenges that must be taken into consideration. Among its main disadvantages, blockchain technology requires a significant amount of energy. The process of integrating all of the actors in a company's value chain can be complex and highly expensive; therefore, scalability is not easy to reach. Moreover, the fact that the information stored in a blockchain cannot be changed can be considered both a positive and a negative aspect. Finally, since the blockchain is a new technology, it still has to be explored and studied in order to fully understand all of its potential and risks [15].

It is important to implement a blockchain-based solution that aims to streamline the interactions between the company and the certifier for sharing data and documents. This would guarantee that each actor would have immediate access to the origin and quality information related to the product [16]. From a technology standpoint, the future blockchain will need to interface with several stakeholders to make this viable. In order to synchronize the essential data on goods and processes and prevent the duplication of management efforts, this technology would have to interact directly with businesses' management systems. It is important to have a system that allows information to be sent practically instantly in order to be compatible with the logistics of current businesses in addition to connectivity with existing databases [17]. This objective must be accomplished without the use of any online validations (such as certification authority approval), which would slow down operational logistics due to the timeframes required to obtain authorizations. The solution must also be sufficiently scalable to support additional participants, such as subcontractors and analysis labs, which are essential to the reference environment. Being part of a relevant ecosystem means that every actor can benefit from the application of blockchain technology since it is based on the principle of creating a network plurality between companies that share a business [18]. Therefore, as a first point, it is essential to define which actors can be part of this ecosystem by tracking their mutual relationships and existing processes, the geographic areas in which they operate, and the regulatory constraints they must comply with [19,20].

The number will then vary depending on the use case, sector, production stage, and level of mutual trust. It will then be necessary to define the target ecosystem of the key segments that will constitute it, each of these segments referring to the role that the organization will play within the network [21]. In addition, the identification of participants should include all those actors that will determine the success of the ecosystem, i.e., the actors needed to provide capabilities such as industry credibility and financial, human, physical, and intellectual resources. Once the target ecosystem has been identified and understood, it is then necessary to define the future business model based on the key benefits of the blockchain (consensus, provenance, immutability, and purpose) and their impact on the network, identifying areas of cost savings or process improvement for each ecosystem component.

Such a model is fundamentally built via the combination of three main models: the business model, the governance model, and the incentive model. The definition of the asset (also known as a token) that is exchanged among business participants is the starting point for the construction of the business model. By its nature, the blockchain is a distributed, decentralized, and collaborative structure that allows actors to interact equally. However, to allow a business to be built in a scalable way over time, the network has to be constructed in such a way that the number and type of participants justify the investment. One of the ways in which it is possible to incentivize new players to join the network is to establish mutual trust among the participants: they must be reassured about the security of the data exchanged and agree on the rules that guarantee the validity of the information shared [22].

Once the ecosystem and, more precisely, the various business models have been identified, policies and procedures that characterize the ecosystem must be developed; in other words, its governance model must be described [23,24].

The success of a blockchain solution depends on its ability to create value recognized by all participants in the ecosystem [25]. The benefits that occur from joining the network must be clear before the technological development of the solution because such a thing has the goal of incentivizing stakeholders' participation. Different types of incentives can be analyzed. Some of the most common ones include the increasing of operational efficiency that leads to cost reductions and new revenues opportunities thanks to the acquisition of new customers, the improvement in the end consumer experience [26], the strengthening of brand image, and leadership gain on the market, and, finally, better operational risk management, which can also reduce costs. Therefore, it is essential to create an incentive model that changes over time and is based on what participants hope to gain from using the solution.

In light of these considerations, the following paragraphs will explore the dynamics of this technology, explaining its functioning and its application to the most complex and discussed sector of today's food and beverages industries: the supply chain. The work starts from the idea that information transparency along the supply chain may be facilitated by the blockchain's immutability and shared data access among supply chain players. Even though it is still unclear how this evidence may be effectively communicated to the target audience and how much of an influence it will have on their views and behavioral intentions, the benefits that it can bring to today's systems are promising.

2. Applying Blockchain Technology to the Food Supply Chain

Food product safety and quality are now of the utmost significance on a global scale. Recently, consumers have become increasingly aware of what they eat, starting from the choices they make when purchasing food. Questions such as "where does this food come from?", "how was it cultivated, processed?", "what materials were used to produce it?", "how respectful to the environment are all the actors that made it possible for me to purchase this food?", and many more are becoming central to the purchasing intentions of today's consumers [27]. Therefore, contemporary companies need to find a way to answer these questions, and they must do so in the most credible way possible. Sustainability, traceability, and transparency must be tangible aspects. Consumers are asking for more. Good storytelling is not enough at this point. Now, it is a matter of facts, of being able to actually see and "touch" the sustainability premises that brands promise their consumers [28].

Added to this is the need to access healthy, genuine food that is guaranteed safe, in order to avoid global health crises. The World Health Organization (WHO) suggests that governments, producers, and consumers work together to ensure food safety as a potential remedy to the serious health problems we have witnessed in recent decades [29], which requires the dissemination of pertinent information throughout complex food value networks. Therefore, it is in the best interest of profit-driven businesses to implement information systems for tracking food goods, which, as a significant byproduct, can also lead to greater profitability [30,31]. Finally, increased openness can aid customers in evaluating a product's attributes more accurately [32].

The growing attention to all aspects of the production and distribution chain makes blockchain technology particularly attractive [33].

The food industry has given blockchain technology a lot of attention, but a step-by-step plan for incorporating it into food supply chains has yet to be developed due to the lack of successful blockchain initiatives and industry-specific studies. Future research prospects should address current blockchain problems, including scalability, rules, privacy, and incentivization. Specifically, in the food chain, a conceptual framework has been created in three phases for the implementation of the blockchain using innovation adoption theory [34]. The suggested framework is innovative and is anticipated to help food chain managers determine if the blockchain is appropriate for their business and/or a larger supplier network [35]. Practitioners are required to identify influencing variables, case studies, and implementation stages to guide them as they create a roadmap for using the blockchain in the food business. Research that focuses on the food supply chain is appealing because food items have qualities such as perishability, temperature sensitivity, and seasonal availability, and they are dependent on the natural world for production [36].

Collaboration and coordination among the various entities that are part of a supply chain are two key aspects for ensuring end customer satisfaction. In fact, the main players in this network are all those entities whose interdependent work enables us to consume the products we want; they include manufacturers, regulators, suppliers, banks, logistics companies, and retailers. A single ingredient that is produced by one company can end up in thousands, if not millions, of finished products that go to the end consumer. The problem really stems from the lack of a standardized industry-wide system that provides guidelines for tracking each of these segments that create a food supply chain. As a consequence, the very thing that is lacking in this system is traceability; therefore, it is necessary, and now urgent, to conduct research and develop technologies that will allow each stage of the production chain to be traced [37,38].

According to studies [39,40], supply chains can be transformed by blockchain technology, which is characterized by linked timestamping, digital currency, proof of work, byzantine fault tolerance, asymmetric cryptography, and smart contracts. The blockchain is fundamentally a peer-to-peer network that employs complex consensus methods to maintain decentralized records of digital assets [41]. This characteristic distinguishes the blockchain from conventional databases, which are centralized when used in a supply chain, for instance. In addition to preventing risk occurrence, reducing the impact of supply chain disruptions, increasing companies' flexibility in dealing with supply chain disruptions, and altering business-as-usual attitudes, the blockchain has the potential to eliminate or at least mitigate a number of sources of risk [42]. Retailers must collaborate closely with suppliers, exchanging specific information about the product's origin and transportation, to remain profitable in a highly competitive environment [43].

Companies in the food sector can become more competitive by improving customer relations [43]; however, a lack of information sharing can have negative consequences and raise worries among consumers about the quality of food [44,45]. An unprecedented degree of traceability is now achievable thanks to the immutability of the data and the distribution across many nodes, each of which has an exact copy of all recorded transactions. This level of traceability was not conceivable before the advent of blockchain technology [46]. Data that have been saved can scarcely be changed, and any effort to do so can usually be identified quickly. The combination of all these qualities has the potential to lead to solutions that can promote supply chain resilience, even while the blockchain is far from flawless and has been proven to only be somewhat hacker-resistant [47].

Despite the advantages of a blockchain-based traceability system as described in the current literature, little is understood about the drivers behind applying blockchain technology in supply chains. For example, a recent study reveals that traceability is the key factor influencing the adoption of the blockchain in the agriculture supply chain [48]. Other authors have pointed out that the adoption of blockchain platforms in supply chains is influenced by the three criteria of traceability, transparency, and trust. Previous studies have shown that its implementation may increase supply chains' traceability and transparency, as well as the level of quick trust that exists in temporary organizational structures [49]. Retailers are urged to highlight the benefits of the blockchain in their marketing communication strategies, while research clearly advises the adoption of the blockchain for items with high traceability awareness (i.e., worries about a product's safety and quality) from a profit maximization standpoint [50]. As a result, people get more confident in a certain institution. Customers can feel confident in their purchasing selections when given information about a product's provenance, including its origin, legitimacy, integrity, and custody. By offering traceability, certifiability, trackability, and verifiability, the blockchain can aid in establishing each of these [51]. Yiannas [52] provided a theoretical example of how blockchain technology might improve food traceability and transparency. Real-world data, which include the fact that well-known food merchants have already begun deploying blockchain-based systems, support the conclusions of academic research and attest to the potential of the blockchain in food traceability systems. The blockchain is already used by several companies in the food sector. For example, Barilla uses the blockchain to avoid the counterfeiting of its products. JBS Foods, America's largest meat producer, uses it to assure customers that animals are not being grazed in the Amazon rainforest, and Walmart uses it to track down mango and pork products [53].

A primary goal of consumer product organizations is the improvement in provenance tracking solutions. As we saw earlier, recalls of noncompliant food products can be a very expensive process and might create significant reputational risks [54]. In fact, this very aspect is driving some of the most important players in this consumer goods industry, such as Nestlé, Unilever, and Golden State Foods, to start piloting blockchain projects.

The main opportunities that consumer products companies are pursuing by adopting the blockchain are as follows [55]:

1. Tracking provenance: The blockchain allows businesses and consumers to track the origin of a product, its attributes, and any changes in ownership.
2. Tracking critical parameters: For products that are sensitive to storage conditions, blockchain coupled with IoT can help companies track conditions such as temperature during transit.
3. Asset condition monitoring: The blockchain collaborates with other entities that can monitor the conditions of assets that are in other locations.
4. Regulatory compliance: The blockchain ensures product compliance because it allows relevant authorities to determine whether that product was manufactured and operated in a manner that complies with regulations.
5. Providing assurance: The blockchain can help establish and secure ownership of a product. This means that organizations can extend the warranties that are given to a customer at the time of purchase, thus ensuring an original product and avoiding losses due to fraud.

Consumer goods companies can rely on the blockchain to ensure the safety and authenticity of products [56]; this means that for products whose safety is paramount, such as baby food, meat, dairy products, or pharmaceuticals, the blockchain will be critically important. In addition to these markets, it could certainly have great opportunities in markets where there is a high level of counterfeiting, such as the electronic appliances trade. Thanks to the blockchain, consumers can know if the product they are purchasing was actually manufactured by the brand that it is marked as.

3. Materials and Methods

This study employed the case study methodology developed within the social sciences [57,58]. This methodology is common not only in the social sciences, such as psychology, sociology, anthropology, and economics, but also in practice-oriented fields, such as environmental studies, social work, education, and business studies. Case study research excels at bringing greater understanding to a complex issue or object and can add experience and strength to what is already known through previous research. Case studies emphasize detailed contextual analysis of a limited number of events or conditions and their relationships.

The aim of this paper is to gain a deeper understanding of the topic in question and explore the case study of Lavazza, an important Italian roasted coffee company that recently introduced a blockchain-tracked product to the market. All of the steps that made the application of the technology possible and how it is finally communicated to the consumer are analyzed in detail, including how the company set up the whole process of blockchain implementation thanks to an important collaboration between different stakeholders. As an innovation that will surely mark an important change for the company, this creation will most likely pave the way for new collaborations and interactions with suppliers and a new way of communicating values to the end consumer.

In the coffee sector, the use of the blockchain represents a trend that is increasingly consolidating, as evidenced by the recent literature on the subject. Thiruchelvam et al. [59] and also Alamsyah et al. [60], for example, analyze the blockchain considering the technical aspects more. Trollman et al. [61] based their research on the ecological point of view of the blockchain. Other papers consider not only the technology but also the organizational point of view [62]. Bager et al. [63] introduce a novel event-based modeling framework for supply chain networks that includes production processes. The consumer perspective is analyzed by Dionysis, Chesney, and McAuley [64]. They investigate the consumer purchasing intentions for blockchain traceable coffee and their psychosocial antecedents.

The majority of the authors give more importance to the traceability and transparency of the blockchain [65,66].

The element that characterizes the novelty of our study is the integration of the blockchain into a broader set of tools used by the company to convey trust to the consumer and disseminate the founding values on which the corporate vision is based, above all sustainability. In fact, in the coffee sector, knowledge of the entire production chain is generally poor, especially as regards cultivation and processing; Miatto and Amado [67] also agree with the necessity to close this gap.

For these reasons, Lavazza works with its commercial partners so that they have an in-depth knowledge of the product they use and, through storytelling, can tell the consumer how the blends are made and their origin, processing, and extraction methods. In this way, the company aims to transform the consumption of classic espresso coffee into a new experience that enriches and satisfies the consumer. It is a complex path for which the company makes use of the contribution of several players starting with the Training Centers active on the Italian territory. Their primary objective is to convey the culture of sustainable coffee, accompanying the consumer and the commercial distributor on a path of growth and greater awareness.

The sustainability-oriented path is also implemented in the "Piacere Lavazza" app launched in 2020, a platform through which the final consumer can have rewards from domestic and away-from-home consumption, thus promoting loyalty to the brand and its founding values.

On the product front, the company increased its range of sustainable blends over time with a series of projects that have the primary objective of improving the working conditions of farmers and protecting the environment. To spread the values of sustainability and build consumer trust, Lavazza also created the Coffee Defender community, made up of knowledgeable baristas and coffee-loving customers, united to spread the culture of sustainable coffee.

In this broad framework of corporate strategies oriented towards sustainability, the use of the blockchain, the subject of this study, stands as a transparent tool aimed at transmitting the changes implemented on the sustainability front to all players in the supply chain (from farmers to consumers). Thus a virtuous circle is created, which allows the transfer of experience, knowledge, and trust between all the actors involved.

The insights on Lavazza's case study were possible due to the collection of primary data made available by the company, as well as the direct experience within the team that provided an in-depth understanding of how the blockchain was developed and integrated into their systems.

4. The Lavazza Case Study

Lavazza proposed using the xFarm platform and supplementing it with blockchain technology (xFarm is a platform designed by farmers for farmers that enables users to fully and easily enter the world of digital agriculture. Due to the fact that each agricultural business is unique from the others, xFarm offers individualized solutions on a single, modular, non-dispersive platform). Lavazza's chosen partners on the ground are Fazenda Primavera and Fazenda Matilde, which also represent the starting point for Lavazza's blockchain journey. The objective of the pilot project was to launch a fully traceable, block-chained specialty blend from Lavazza's new specialty coffee brand, 1895 Coffee Designers, in Q3 2022. This 100% Arabica blend was to be further supported by a highly interactive consumer interface that enabled consumers to trace their cup of coffee from bean to cup.

Blockchain technology allowed Lavazza to provide data transparency about product origin and production processes that can then give coffee aficionados better insight into who produces their coffee, how they produce it (sustainability is a key concept here), and the journey it takes before it ends up in their cups. The following concepts are the foundation of Lavazza's goals:

- Proof of origin + Proof of quality = Enhancing the consumer experience;

- Proof of quality = Ethically sourced raw materials and taste profile.

4.1. Data Collection and Presentation to the End Consumer

Highly accurate data fed into the system and accessible at several stages of the coffee supply chain provide Lavazza, farmers, agronomists, and ultimately food lovers with trustworthy information about the origin, production processes, resources, safety, ingredients, and quality of the coffee they choose, manage, distribute, sell, purchase, and consume.

This, in turn, supports all of these actors to make more informed decisions that allow them to create greater value: production processes will be environmentally aware, products will be developed with higher health and safety standards for consumption, and the consumer will have the information needed to make informed purchase decisions.

To provide consumers with the information collected in an easily understandable and digestible manner, an interactive consumer interface was developed by a cross-functional team consisting of Lavazza departments, information technology providers, blockchain developers, and project managers. The selection of Key Performance Indicators (KPIs) was essential given that the average consumer is not yet well informed about the supply chain structure of coffee [68].

4.2. xFarm and Visit in Brazil

The xFarm team sent two people to Brazil in January 2021 to set up the sensors and devices to gather different parameters of the local climate's air and soil that were to be used in the calculation of some of the KPIs. Moreover, the visit was also an opportunity to deeply analyze all of the aspects of the selected KPIs impacting the quality of the process. Moreover, xFarm was introduced, and training for their platform, including all of the aspects that could support the Fazendas in their daily work and in gathering data for the KPIs, was provided. The Fazendas were already using an SAP tool to trace farm and coffee processing activities. Moreover, they had an irrigation sensor (tensiometer), but it was not connected to any platform; however, their meteorology station had IoT (Internet of Things) capability. Cellular connectivity was problematic, and international SIM roaming had issues; therefore, a local IoT SIM provider, VIVO Brazil, was selected. Nevertheless, the Fazendas only had cellular connectivity coverage in a few areas, which made the setup more challenging than expected.

4.2.1. Device and Equipment Installed

Lots of different equipment and devices were installed and tested, such as rain measurement sensors, air humidity, and temperature sensors, cameras to record features of the different plantations, and more.

Moreover, given that 1895 Coffee Designers had not yet decided which variety it was going to buy for the development of the blockchained blend, sensors were installed in the most promising fields where the best performing and highest scoring lots were to be grown. The final decision was made once the harvest of the different lots had been completed, around September 2021, and the green coffee samples had been tasted by Cristiano Portis (Coffee Designer 1895). The blend was to be composed of two differently processed varieties, Catucai and Araara. This underlines the importance of full traceability of activities, which is a down-top tracing process.

4.2.2. XFarm Platform

The xFarm platform is a complete and powerful farm management system that simplifies the management of agricultural companies. Different functions dedicated to the cultivation, logistics, bureaucracy, and agricultural machinery are completely integrated. The sensors' data can also be accessed in the app or webapp of the xFarm platform. Moreover, the app has been translated into Portuguese, since most of the farm workers do not speak English. In the xFarm platform, all of the fields of both Fazendas were created with the goal of tracking not only the agreed-upon KPI of coffee quality but also an overview of the fields modeled on the Fazenda Primavera.

A new irrigation tool was given to the farm as part of an experimental model for coffee irrigation and is available through the xFarm platform. The tool can predict when and how much water the coffee plants in different zones need. It combines the data from the soil moisture sensor, the current weather recorded by the meteorological station, and the weather forecast for the next five days; given this input, it calculates the water needed in millimeters. The tool has the potential to reduce the use of water, thus optimizing the Fazenda's operating costs. To make the xFarm interface simpler and more intuitive, a new Control Center interface was developed. It allows all of the fundamental parameters of the farm, including tractors and other machinery, sensors, fields, local weather conditions, crops, and more, to be monitored from one unique interface. The application has also evolved to make it more useful and accessible. The loading time has been reduced by 90%, making it much faster, and use in areas with a reduced internet connection has also been guaranteed [69].

4.3. Analysis of the Coffee Processing

The coffee processing was analyzed deeply by the quality manager of the Fazenda to design and develop a dedicated interface in the xFarm platform to track the process. Given the measurements of the sensors and the tracking of the process activities in the platform, it will be possible to automatically calculate the quality KPIs defined by Lavazza.

There are two main types of KPIs:

1. Periodic indicators automatically measured by the installed sensors;
2. One-shot indicators derived by the coffee processing parameter entered in the xFarm platform.

4.4. Goals Achieved

In the proof of concept, the environmental KPIs were already loaded onto the blockchain every two weeks (roughly 12 recordings) from May 2021 to October 2021, which allowed the team to construct a graph of the average temperature, humidity, wind speed, etc. During the growing period of the coffee, sensors were installed prior to harvest, and they started capturing data immediately. The objective from a marketing perspective was to directly associate the timings of the blockchain recordings with the growing of the coffee to give consumers the possibility of actively participating in the growing process of their cup.

4.5. Lavazza Project—The Blockchain Solution

The new-gen, Pure Proof-of-Stake (PPoS) Algorand was selected for Lavazza's blockchain initiative. Algorand is recognized as the first blockchain to have solved the blockchain trilemma, which means that it can achieve security, scalability, and decentralization simultaneously. Both periodic KPIs and one-shot KPIs are recorded in the blockchain. The periodic KPIs are recorded automatically every 2 weeks, while the one-shot KPIs are recorded manually when triggered by the app.

The following are examples of some KPIs that are periodically registered: rain meter sensors, air temperature sensors, air humidity sensors, wind direction sensors, wind speed sensors, and leaf wetness sensors.

4.6. The Relationship with the Consumer

The last phase of this project involves developing the user interface for the consumer, who must be able to comprehend all of the traceability and transparency information that this technology places at their disposal. This project was developed in cooperation with the graphic design firm Publicis Sapient. Consumers must first enter the batch ID found on the back of the package in order to have access to the information. The number of batches changes with each production; therefore, the information about the roasting period will always be different depending on the type of coffee being consumed at the time. The interface was constructed with a modern, youthful design to target the 1895 consumer and communicate the coffee's journey in an easily understandable yet creative way. The following six sections walk the consumer through each step of how the coffee's beans are made:

1. Growth shows the type of harvesting, the geographic coordinates of the location, the start and end dates of the harvesting period, and more. This section includes details on the temperature, humidity, rainfall, and wind speed that were relevant to a particular harvest season for the two farms in Brazil where the beans were grown. The Fazenda Matilde is in Angelândia, in the Brazilian state of Minas Gerais, where the Catucai variety thrives in the rich soil and mild environment. Farmers manage moisture and regulate irrigation using information from sensors in the soil to ensure beans are capable of producing a great cup of coffee. The second farm is located in the highlands of Minas Gerais, Brazil, where Fazenda Primavera has devoted generations to cultivating the coveted Arara variety. Thanks in part to technology, farming while maintaining the integrity of the soil remains possible here. Electronic sensors installed especially for the blockchain 1895 project help farmers keep track of changes in the soil's moisture and surrounding air temperature;

2. Harvesting covers the cherry harvesting process, including how many cherries were picked, when they arrived at the sorting station, and the average Brix level of the kernels. In actuality, hand harvesting is the only method to guarantee a uniform and high-quality crop since only excellent, perfectly delicious kernels from the Arara and Catucai varieties may advance to the following stages;

3. Drying: After harvest, the beans are dried in one of two ways: natural for Arara and honey for Catucai. For the natural method, the cherries are placed on the threshing floors in the sun, where they are rotated many times a day by on-site workers to guarantee uniform drying. For the honey method, only a few cherries are depulped and put out to dry. The next phase is fermentation, a natural alteration of the coffee that is meticulously managed;

4. Quality: At this step, the process of essence control officially begins. A rating is provided to the coffee's quality, and the 1895 coffee designers reassess it to create the ideal specialty coffee. Coffee from Lavazza's partner farms in Brazil is of the finest quality due to stringent controls and respect for each stage of bean processing, and that is confirmed one final time by a tasting that occurs after the beans arrive in Italy. The company's rating of the coffee, the number of beans chosen, their size, and the total kilos of green coffee are all revealed in this section;

5. Transport follows the beans' voyage, which is a crucial element in making sure that the quantity of coffee chosen matches the amount reported at the transport stage. Early quality checks guarantee the consistency of the coffee's attributes and guarantee that the quantity in dry milling and storage matches the quantity declared at the transit stage. Thus, the name of the ship that performed the transfer is listed here, together with the geographic coordinates of the departure and arrival points, the arrival and departure dates, and the overall duration of the journey. Here, the average temperature and humidity that were measured throughout transportation are also included;

6. Roasting: This is the final process our beans go through before they reach us. Modern machinery is used to roast the grains, which turn from green to a shiny brown color and release a potent aroma as they do so. In fact, the beans undergo several changes at this stage, most notably the release of their aroma. They also change color, gain volume, and lose moisture. The best instruments are used to verify roasting temperature and time. The type of roasting equipment used, the kind of roastery, and the location where it all happened are all provided here. In this section, consumers can find information about the quantity of coffee that was roasted, the temperature used, and the average length of roasting time.

To conclude, given that most consumers now navigate the internet via smartphones and use them to scan QR codes, a mobile-first solution was developed to enhance the digital journey [70].

4.7. Final Result: The Fully Traceable Blockchained Blend, Noble Volcano

The final product of this journey is a combination of two different arabica varieties: Catucai and Araara. Fazendas Primavera and Matilde are located in a mountainous region, at 1000 m altitude, in Chapada da Minas, Brazil. The farms' vegetation is a mix of savannah climate and Atlantic Forest, having a lush and diverse biodiversity. With high relative humidity, a climate quite similar to that of Central America, and clay soil, the Primavera farm's climate intersperses dry and rainy periods, where coffee is planted in both flat and soft undulations and has streams and rivers through all its length. Throughout the farm, there are mahogany trees intercropped at coffee trees to produce a shaded fruit. The benefits of this type of plantation are reduced temperature and temperature range, reduced demand for irrigation water, reduced winds, and increased organic matter on the ground, which causes slower grain maturation and more homogeneous sugar consolidation, giving the coffee greater sweetness and unique flavors. Besides the weather, the coffee is harvested ripe and prepared in quality stations with the utmost care. The pleasant climate, altitude, and relief offer special characteristics to the coffee, but the post-harvest drying in African beds, rigorous quality, and people management processes make Primavera a Farm of Excellence, with upscale coffees and unparalleled taste. The quality and special consistency of their coffee have been confirmed by awards in recent years. The farm won the Cup of Excellence in 2018 with a coffee of the Geisha variety, and they received second place in 2019. The two varietals, Catucai and Arara, and their respective processing methods, black honey and natural, give the specialty blend Noble Volcano a full-bodied, velvety crema and an intense aroma of macadamia with notes of chocolate, hazelnut, and caramel.

The graphics of the package were designed to communicate what sets this product apart from all of the others in 1895's market range. In fact, as can be seen in the figure below, the package represents the coffee's entire journey from left to right, and the figures are colored with squares to represent the blocks that make up the blockchain.

To conclude our analysis of the Lavazza case study, a SWOT analysis is a useful tool for summarizing the highlights of applying blockchain technology to this business.

STRENGTHS Data integration Tangible traceability Transparency Immutable information	WEAKNESSES Manual input of roasting data Impossible to run more than one batch ID at a time High implementation costs Hard to escalate Possible falsification of internal Lavazza data
OPPORTUNITIES Consumer education Enhancement of transparency Amplification of final consumer experience Incentive for all stakeholders to implement good practices Possibility to address new customers	THREATS Old software Security attacks Not suitable for every process Lack of internal expertise

5. Conclusions

Today's supply chains have major shortcomings, and the current system is no longer suitable for the world we live in. Both consumers and the socio-political scenarios that characterize today's society are forcing companies to innovate, digitize, and find solutions to problems that are becoming more and more of a priority.

In this context, the application of blockchain technology to innovate supply chains represents a key to solving major problems related to lack of transparency and complexity. Certainly, this technology is not easy to understand, and it is even less easy to apply to a business context characterized by traditional business logic and processes. While few companies have yet to apply blockchain technology to different projects, many are studying its benefits and disadvantages. However, as early adopters show, once the initial hurdles are overcome, important advantages can be gained from an organizational and strategic point of view for the company. First of all, this technology represents a tool for building stable and trusting relationships with all stakeholders, in particular with the final consumer.

Consumers' reactions to a product having or not having a traceability label were also analyzed in order to understand whether or not they had more or less incentive to purchase. The results of this analysis showed that the presence of a blockchain label on a product increases a consumer's propensity to purchase it; however, there are other aspects that can prevail and influence purchase in the opposite direction. Such aspects are a consumer's familiarity with a brand and the more premium appearance or positioning of one brand over another [71]. This shows that the market for traced products exists and will continue to expand, especially when we consider consumers' increasing demands to know the origins of a product and the methods and actors who took part in its production.

This paper offers a concrete example of the application of blockchain technology to increase traceability for stakeholders and transparency for consumers. All the entities that are part of this chain need to collaborate in delivering an experience to the end consumer that is formative, customized, and easy to understand. Furthermore, Lavazza represents an example of a company that decided to challenge itself by following a trend that will be increasingly present in future socioeconomic scenarios. The collaborative approach underlying the blockchain is configured as a tool for achieving sustainability and the pillars that make it up, in line with the objectives of the 2030 Agenda.

6. Limitations and Future Research

Despite its contributions, this paper does have some limitations. This analysis aims to be illustrative, rather than exhaustive or definitive. One limitation is that this paper only considers a single case study, albeit a significant one. Future research providing advancements in the field should include other contributions on the topic, such as identifying other companies that have decided to develop new relationships with their stakeholders using blockchain technology. Another interesting research perspective concerns long-term observation in order to verify the evolution of blockchain technology and how it impacts businesses' relationships with stakeholders in the long run.

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