CO-OP Chain

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CO-OP (Chain)

General information

Vivido has been interested in Blockchain since 2016.

Just during these current weeks, we are in the process of transforming our "Blockchain Italia" brand into an innovating start up, whose purpose is to be a competence center hosting and training developers oriented to realizing blockchain projects.

For more info: www.blockchainitalia.it

Introduction

Controlled and transparent food production chain: from the origins to the table.

The food industry has increasingly moved towards a global market where products come from many parts of the world.

Final consumers have therefore started to enquire about the origins and the quality of the food they consume. More accurately, they prefer to consume national production and products ensuring them with a good level of safety and quality.

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To guarantee that to the consumer, it is necessary to provide accurate and checked information on the history of what is purchased involving all the organizations and operators who have participated in the production process from the cultivation to the supermarket.

The information must be public, not alterable, certified and verifiable at each production step.

Where do the eggs come from?

How can I be sure and certain of the origin?

Every single egg in Europe is labeled to provide the consumer with some basic information on the provenance and type of breeding:

- Type of breeding (organic, outdoor, ground, cage)
- Country of origin
- ISTAT code of production town
- Province
- Breeding identification number

The information is not immediately retrieved as the consumer must search the various codes to know the exact origin, they are easily alterable as the label is simply printed above each egg and do not guarantee the quality of the product because they lack all those parameters which contribute to the production of the egg (feed, transportation, control of the hens).

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Food production chain: the "journey" of the eggs we find on our table

That is why it is important to involve the entire supply chain in the production of information for the benefit of the final consumer.

Below you will find the essential aspects, the individual stages of the journey, which characterize a high-quality chain.

The cultivation of the cereals and feed materials.

Feed safety is the basis of the food production chain to guarantee the safety of eggs to the consumer. Healthy food also allows the production of high quality eggs: for this reason, an excellence chain must always close monitoring this very strategical passage.

Feed production

Feed production must involve only raw materials certified in the previous stages: as this is the only way possible to be sure of the health of the animal and the consequent goodness of the eggs that will lay.

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Laying hens

Hens laying on the ground, controlled and fed according to the standards derived from the previous nodes of the process, will be in optimal conditions to lay a product live up to the hype of the consumer.

Selection and packaging

Once the eggs are laid they are moved to selection and packing centers, where once passed several monitoring and evaluation, they are finally prepared to be shipped in special containers destined to selection centers or directly at the points of sale.

Point of sale

The final stage, before arriving on our tables, include the arrival at the point of sale where the product meets the consumer who, in order to carry out a well-informed purchasing, must easily and quickly track information referring to **origin** of the egg as well as all previous stages travelled by the same.

Logistics: transport and tracking

Each of the stages described above includes a transport phase that must be traced and followed with the same attention of the production process to guarantee the genuineness, freshness and **origin** of the eggs.

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The food production chain: a technological chain at the service of the consumer.

Ensure the verifiability and traceability and the consequent transparency of a food production chain like the one previously described that involves several players, probably located throughout the national territory, and which is subject to ethical and production rules with the highest quality standards, is really a great challenge for COOP who can rely on the latest technological tools to deal with the problems that arise:

- Avoid tampering of the product during the phases of transport.
- Coordinate and standardize the activities of the players at each stage of the process.
- Allowing new players to entry into the chain in a simple and fast way.
- Tracing and guaranteeing the immutability of the data available in the different stages.
- Allow the transition to the next stage, node, only if the current player has complied with the rules of the contract.
- Provide each node with the necessary tools to allow faster digitization and subsequent distribution of information.
- Provide the consumer with a practical and fast tool to trace the origin of the eggs and follow each single step in the chain

This food production chain with its related problems to be faced and resolved can be described and, most important, resolved with benefits for

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all the players involved and especially in favor of the final consumer thanks to the **Blockchain** supported maybe by some Artificial Intelligence services that would allow to add new controls and checks in the phase of production and transport adding quality to the entire food production chain.

Why Blockchain?

The name Blockchain indicates an interconnected network of nodes, technically a peer-to-peer network, where each node actively contributes to the life of the system, in our case of the egg production chain, and guarantees the information in it, according to the rules written and described in a contract.

By design is the tool that allows us to solve all the problems highlighted in the previous paragraph in a very brilliant way, with some precautions, allowing to verify every single detail of production and to provide the final consumer with all the necessary answers verifying the needs and solutions of the various nodes that make up the production.

There are two types of Blockchain: *permissionless*, also known as public, and *permissioned*, also called private. Considering the nature of the project in question, the choice would fall on the second type where the Governance would allow guiding the process in its different phases, definitively guaranteeing, in the mathematical sense of the term, the correctness of the process that we will describe and define.

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The following are its peculiar characteristics:

- Immutability of the information included in it: for example, in our case the analyses on feed, on hens, on fields where raw materials are produced to produce feed.
- The data written on the *Blockchain* would be public and guarantee transparency.
- Presence of private channels for the communication of the various players with the owner of the process or perhaps between interconnected players: local analysis laboratory with external analysis laboratory.
- Speed in the exchange of information and writing and availability of the "immediate" data.
- Reachability and availability of the instrument (Always On).
- Simplicity in the entry of a new player.
- Process standardization via contracts (Smart Contract).
- Security: data is encrypted and accessible only to members or specific roles.
- Democratic tool that adds a very high social value to the whole process because each player, node, actively contributes to the achievement of objectives and goals.

By putting all these aspects together, we can easily ensure the complete digitalization of the entire production process.

The basis of the decision that leads to the use of a *Blockchain Business*, permissioned, is the presence of a business network, this is to say more actors involved, otherwise it would be sufficient a system based on traditional databases.

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What we are describing is a case study for which the *Blockchain business* is undoubtedly the most appropriate solution.

Another important aspect in the use of a *Blockchain* architecture is that it is not "imposed" by the "stronger" actor present within a food production chain, but its decentralization, and therefore the fact that each participant can hold one or more nodes of the system, making it by its **participatory nature, eliminating the sense of compulsory**.

Analysis of the operation of the new supply chain

Considering the Blockchain and the previous considerations made, we see the operation of the egg production chain by describing the individual nodes and how the processes involved would be managed.

The process we are going to review involves a complete digitalization of the information produced in each of its individual step and will essentially use three tools:

- The *Blockchain* to guarantee and collect information produced by each node (traceability).
- A single Mobile App for players that will interface with *BlockChain's* read / write services and which will be differentiated according to the role of the node, its task in the chain and of course to the signed *Smart Contracts*.

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• A Mobile App for consumers that can be used directly in the stores to be able to find, by reading a specific code on the packaging QR codes, all the information related to the package of eggs to be purchased (**traceability**).

These three software tools will be joined by a "hardware" tool to ensure that the product that is transported from one node to another in the food production chain cannot be tampered with or counterfeit: we thought of tamperproof stickers to be used on the existing packaging read by the App of the players before unpacking in order to ensure the authenticity of the product received.

Initial considerations

To fully understand the organization and structure of this chain revisited in key *Blockchain*, we need to specify some point:

• Each of the sections described below represents a player and each player could be involved in more than one node: it means that for example regarding the production of feed, there could be one or more suppliers that would undergo the same contract, *Smart Contract*, and that could communicate with the chain's Governance or with any additional nodes via private channels.

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• Private channels are necessary since some communications and / or certain documents cannot be in the public domain but are strictly for use and consumption of the parties: for example, contracts, the results of certain types of analysis, some considerations or why not communications about the incorrectness of certain actions.

• Each single node, identifiable as a single supplier, will use to interact with the Blockchain a profiled application during the membership phase, when the node becomes part of the Blockchain, so that it has the necessary functionalities to honor its contract and can be completely autonomous with its "slice" of interaction with the system.

• Any software and Artificial Intelligence systems will interact with the "*EggChain*" through read / write services on the Blockchain.

• We will refer to artificial intelligence software such as AI (IBM Watson, IBM Watson IoT and IBM Watson Supply-Chain).

Cultivation of cereals and raw material for the feeds

The land used for the cultivation of raw materials to produce feed could be kept under observation through hardware tools (IoT - Internet of Things) that periodically and automatically detect some significant data relating to the state of the soil and crops in it: the PH of the soil, the quantity of irrigated water, the climate and send the result of

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the measurements, which would become single transactions, on the Blockchain, linking the data to the grower.

The data will be processed by an artificial intelligence software to promptly identify anomalies and warn the farmer and the operators involved to intervene to restore or continue to guarantee high quality standards.

All the data processed will be headed by the *Blockchain* and will be triggered notification events to the Mobile App of the node in question. The data would therefore be the heritage of the food production chain, deciding up to what detail to allow the final consumer, during the traceability, to use it.

There was talk of the heritage of the food production chain: indeed, the spirit of the *Blockchain* is to share and use simple data and analytics that can be pulled out by all the participating nodes that would find themselves sharing experiences to ensure the standard of the product but also to optimize costs and production.

Periodically, the AI will provide an overall and simplified assessment of the surveys available to the supply chain and the consumer, with the aim of qualitative transparency.

Shipping and tracking (sourced food)

Honored the conditions of the *Smart Contract* (qualitative, quantitative, etc.), the cultivator node, will proceed to send the raw material delivering to the logistics company the batches previously packed and supplied with anti-tamper stickers. Honoring all the conditions of the *Smart Contract* is

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the only way that allows to move to the next step of the chain (with exceptions defined on *Smart Contract*).

The anti-tampering stickers will have a code, a QR code, that once read by the App will cause a key to be generated that will be written on the *Blockchain* and will only be available, via the Mobile App, to the only consignee of the shipment.

Any attempt to tamper with and / or open it from unauthorized will be traced on the Blockchain and will give rise to reports to the Governance and / or any other node in charge.

The identified forms of irregularity will be managed via *Smart Contract* and may generate concrete actions by the Governance.

The same "courier" will have to identify himself, using the App cut on his profile, before the withdrawal in such a way that the event can be "traced" on the *Blockchain*.

The successful start of the shipment will include in the *Blockchain* the reference to the lot on the shipment date and to the courier.

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Delivery of raw materials (sourced food)

The supply discharge handler verifies that there is no tampering in the packaging, reads the QR code, through the Mobile App, on the sticker and then certifies the receipt by entering a data on the Blockchain.

Also, in this case any anomaly will be signaled through a transaction on the *BlockChain*.

Animal Feed production

At this stage it is important to verify the processes and use of raw materials that lead to the creation of the finished product and ready to become the nourishment of the hens.

Manufacturers will periodically perform tests on the feed samples and the results will be entered on the *Blockchain* associating them with the product batch.

For each lot, will be provided information on the production date, substances and raw materials used.

Producers will be able to use testing laboratories and / or on-site or geographically dispersed production laboratories: each of these additional elements will constitute a node of the *Blockchain*, there may be private channels for communications and *Smart Contract* may exist which will guide this phase of the process.

In this case too all the information will pass on the *Blockchain* and you will be able to interact with the system only through the services offered by the Mobile App.

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Shipping and tracking (feed)

The manufacturer certifies the delivery of goods to the courier and it is again entered a new data on the *Blockchain*.

Same system with anti-tampering adhesive and opening allowed only to the node that will receive the key on the App.

Feed delivery

The supply discharge handler checks that there is no tampering in the packaging and then certifies receipt by reading the QR code that will trigger the inclusion of data on the Blockchain.

Thanks to the previous steps checked and certified, the farmer has the certainty of having received a quality product that meets the standard imposed by the contract.

Breeding hens

The farmer, now is completely sure about the great quality of feed certified by the previous steps on the chain, now he must ensure the welfare of the hens in such a way that the eggs laid are qualitatively and ethically, impeccable.

Every egg produced, even in the current supply chain, is labeled and it is therefore possible to trace the lot and the breeder. This information using IoT technologies, such as a simple camera at the bottom of the conveyor

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belt that "scans" the eggs that pass, would be written on the Blockchain enriching the information assets collected up to now.

As already mentioned, considering the importance of animal welfare both from a qualitative and a strictly ethical point of view, the environment in which hens are raised must absolutely respect precise parameters. The IoT technologies, sensors and cameras, would allow the automatic verification of some environmental parameters within the breeding: the quality of the air, light, temperature, state of the ground. These data would then be analyzed by the AI which will provide a simplified and public result, inserted on the Blockchain, in the logic of continuous improvement.

Therefore, to each batch of eggs produced, in addition to being already associated with all the history related to the data of the cultivation of raw materials and the production of feed, will be added all the information collected in the breeding including vaccines and treatments used on hens during the production of eggs in addition to data on environmental quality detected.

The breeder, using the Mobile App profiled on his role, having obviously respected all the standards described by his Smart Contract, will certify the delivery of eggs to the logistics by entering the data on the Blockchain and generating the key that will be used by the next node. This is one of the most important steps regarding the shipping phase of the entire supply chain: in the subsequent phases, combined with the date of arrival at the supermarket, it will guarantee the freshness of the eggs.

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Shipping and tracking (eggs)

Also, in this case the anti-tampering adhesive will allow us to certify that the eggs are exactly the same of the farming.

Selection / Packaging (eggs)

In this step, the responsible, through the Mobile App, will certify the integrity of the packaging by reading the QR code on the sticker. Here an additional check be triggered by *Smart Contract*: the time elapsed from the starting of the breeding to the opening of the packaging is enough to ensure the freshness of the eggs?

If it was not on the *Blockchain* it would be sent a complete report of time data that would invalidate the *Smart Contract* on that specific lot by stamping the delivery as late and excluding the same lot from the production line.

In case of the adequacy of the time spent between the two phases, the eggs would pass through other controls and all these data would be written on the *Blockchain* enriching the information baggage in favor of not only the final consumer but the entire production chain.

Shipping and tracking of selected eggs to Point of Sale or storage

Also, in this phase the anti-tampering adhesive would have the dual purpose of certifying the Origin of the product and guarantee, "verifying" the dates stamped on the Blockchain, the freshness of the product.

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In case the eggs were directed to a storage center and no further unpacking / packing was necessary, the verification of the lots, having the Blockchain date of departure from the previous node, would be periodic and any exceeding of the maximum times would be automatically reported to the Governance and at the center itself so that the necessary actions can be taken.

Logistics and transport

We have seen how logistics and transport are absolutely vertical concepts to the entire production chain and how certain situations described due to delays, lack of supplies, simple misunderstandings can lead to a loss of the actual value of the whole production and consequently to an economic loss by not only of the COOP customer but also of the various players involved in the process.

Given the amount of data written on the *Blockchain*, the alignment of a specific supply chain AI could be an important step: the optimization of these phases of the process that are not to be considered secondary would add a great value and would allow significant savings of time and money to the various players.

Let's think for example of transport and how an efficient calculation of the route and the means to be used would bring advantages to all players and possibly also to the environment with minor emissions into the atmosphere. Naturally the data collected in these phases would be available for consumer use and consumption.

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Withdraw any unsuitable lots

Should any anomalies and problems not found during the process have to be experienced, for example the incorrect analysis taken for good due to any problem in the laboratory, tracing every information and passage on the *Blockchain* allows us to intervene very quickly and identify the person responsible of the step, each lot involved and the point in the chain in which to make the possible withdrawal.

The reporting of non-suitability would be traced on the *Blockchain* and if the eggs of the lot had landed at the point of sale, actions could be taken to safeguard the consumer:

- If during registration of the Mobile App the reference point of sale was requested and if it is this last one to be involved in the withdrawal, you can immediately notify it. One could also think of a "silent" profiling that instructs the App on the points of sale based precisely on the points of sale in which it was used.
- When the consumer uses the App to "trace" the origin of the eggs by reading the QR code on the package, the App indicates that the package belongs to a non-consumable lot.

Point of sale

The final destination and last node of this chain is the sales point where the eggs will meet the consumer.

Each sales point or each person / responsible of the deliveries will, using the Mobile App, set on the specific profile, the key necessary for the

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opening of the packaging containing the egg packs: the first verification that will be carried out will concern the freshness checking the departure and arrival dates. If there are already reports on the Blockchain and / or if the timelines do not comply with the rules, the batch will be tracked as unsuitable on the Blockchain and possibly also rejected. The information collected from these checks will be printed on the Blockchain.

At this point, the word goes to the Consumer...

What does the consumer gain?

At the beginning of this discussion we saw what are the main questions that we as consumers ask ourselves before purchasing any product coming from breeding and, in this specific case of eggs:

- Where do the eggs come from?
- How can I be sure and certain of their origin?

Now we can respond fully and in detail to these questions: the entire food production chain has been **drawn**. The information of every analysis, every step, every delivery, every batch and every single egg is on the *Blockchain* which at this point becomes a common good, a reservoir of unchangeable and incontrovertible data, to be consulted to verify the value of the eggs and the entire food production chain.

By simply reading a QR code on the packaging, we consumers receive the gift of **traceability** and the absolute security of what we are going to bring to our table. And **transparency** is invaluable.

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If there was no Internet connection available?

Surely this is one of the most frequent questions when it comes to systems that are strongly connected and geographically dispersed: the absence of "connection" would be an absolutely limiting factor and in some cases blocking.

The total absence of connection is not taken into consideration in this discussion as it would compromise the whole approach described.

But we can discuss the "momentary" absence of connection: we find ourselves without a data line in a specific passage. In these cases, we would have off-line data transactions: in practice, the information to be written on the Blockchain would be encrypted and would reside on the device only for the time necessary for automatic synchronization to the "return" of the line.

If instead of writing it was instead necessary to read in the worst case, for example the key to open a package, you could set up a backup system in which the data, encrypted, necessary for the transaction would be available on the latest Mobile App contacted, in the case of the key on the mobile app of the courier, which at that point appropriately questioned would provide access at the beginning.

Each of these possible off-chain actions would be treated as anomalies on the Blockchain and their use regulation and authorized by the Governance.

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Implementation appendix

The following are the software tools that would be used to realize the project

Blockchain: Hyperledger Fabric

Cloud and SaaS Blockchain Service: IBM Cloud BlueMix

Artificial intelligence software (AI): Watson AI and Watson IoT

Artificial intelligence software specific for supply chain: Watson Supply Chain

App for the players and the nodes of the chain: Android app since probably the players will be equipped with specific work devices, made with Xamarin and Visual Studio (C #)

App for consumers (available on the Stores): App in double version iOS and Android made with Xamarin Forms and Visual Studio (C #)

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