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An overview of terms and concepts related to the potential application of blockchain-based traceability systems as applied in seafood production

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Introduction

This report is divided in three sections, from the general to the specific, to clarify some terms and concepts related to the blockchain-based traceability systems applied in seafood production.

the first section describes some global terms and concepts of the food industry, the second defines some production's terms and concepts and the last section focus on blockchain's terms and concepts.

Those descriptions are mainly based on the European Committee for Standardization document. "Authenticity and fraud in the feed and food chain - Concepts, terms, and definitions" (CWA 17369, 2019), the report from Nofima on the "application, limitation, costs, and benefits related to the use of blockchain technology in the food industry" (Olsen, P., et al. 2019) and on the PhD thesis "Food traceability in theory and in practice" (Olsen, P., XXX).

General terms and concepts

Transparency

Transparency of a supply chain is the degree of shared understanding and access to product-related information as requested by a supply chain's stakeholders without loss, noise, delay, or distortion (Hofstede, 2004). Transparency and traceability are not the same thing. A traceability system provides information about the product, but those claims are mostly unverified. To achieve transparency, we need mechanisms to verify these information.

Authenticity

Authenticity the state of being authentic and authentic means that the product characteristics match the product claims.

When it's not the case we are talking about misdescription.

Misdescription

Mismatch between product characteristics and claims. A closed relative of misdescription is mislabeling. This term is used to describe a misdescription on the label of a product or when the product label is not aligned with the requirement or regulation asked. Lake of precision in the term used in the label ex "sea product" when the product is red shrimp is classified under mislabeling.

Misdescription can be accidental or intentional. In the last case we are talking about food fraud.

Food fraud

Intentional misdescription.

Food fraud can be classified in 3 types: implicit claim violation / record tampering / product tampering.

- Implicit claim violation: several implicit claim orbit around a product, for instance the claim: "this product produced, traded, and sold according to the relevant requirements and regulations" is typical for all commercial products. Violation of this claim include for example

nonpayment of the VAT, taxes, smuggling of the product before sale, product issued from overfishing in case of fish, etc.
We find also under that category deliberate omission of some ingredient such as water.

- Record tampering: intentional change of an explicit food production claims making it deviate from the known characteristics. As we saw above this particular food fraud can be called mislabeling.
  Some example are: changes in the product name, definition, geographical origin, species, production date, expiration date, ingredient's percentage, etc.

- Product tampering: intentional change of the product characteristics making it deviate from the known claims associated to the product. Three types of product tampering exist:
  - Exposition of the product to an unapproved or undeclared process ex irradiation of freeze without declaring it.
  - Removal of ingredients from the product without declaration.
  - Adulteration of the product by dilution (addition of an inactive of already present substance); by addition (addition of a new unapproved or undeclared ingredient); or by substitution (substitution of a declared ingredient by another).

Intention in a food fraud can be hard to prove. Investigation are often axed on the financial gain obtained as consequence of the food fraud as financial gain is the main motivation for food fraud.

Value chain

Value chain is a business management term firstly introduced by Michael Porter in 1985. It includes all the steps that add value to the product without physically handling it.

Supply chain

Supply chain in a logistical and operational term. It refers to all the production steps from the raw material until the delivered finished product to the end user (Council of Supply Chain Management Professionals, 2013).

Production terms and concepts

Batch

A batch, also called "lot" is "the quantity of material prepared or required for one operation" (Farlex, 2017). A production batch in the food industry is typically everything produced of one product type in one unit of time, e.g. a day or a shift. It can concern raw material, ingredients, production, etc. It's an internal term in the company and don't have to adhere to an external standard.

Trade item

A Trade item (TI), also referred to as Trade Unit (TU), is a quantity of material (e.g. a food product) that is sold between two trading partners. Production batches are normally large, and they are often split into numerous trade items before shipping in the supply chain. TI received by a company can be merged or mixed into ingredient batches for the next step of the chain. They have to be clearly labelled by the producing/selling company and must allow an explicit identification for the receiving /buying company. They can be identified by the batch number they belong to, which makes traceability difficult as many trade item will have the same identifier.

Traceable resource unit (TRU)

We saw that batches are internal to a company and trade item are transiting in between partners in the supply chain. The term TRU refers to both together. It's the common term for "the unit that we want to trace" (Kim, Fox, & Grüninger, 1995).

Granularity

The granularity corresponds to the level of detail (Farlex, 2017). It depends on the size and number of TRU. The smaller and numerous the TRU are, the higher is the granularity. It' a company choice when a traceability system is implemented. A fine granularity will require more workload but will result a more accurate traceability system. This will directly impact a potential product recall if something goes wrong: a rough granularity will mean more product recalled (Dabbene, Gay, & Tortia, 2014).

Traceability

It exists many definitions of traceability, most of them referring to "the ability to trace". An integrated description integrating the best of those definition is: "The ability to access any or all information relating to that which is under consideration, throughout its entire life cycle, by means of recorded identifications" (Olsen & Borit, 2013).

Traceability system

Traceability systems are constructions that enable traceability; they can be paper-based, but more and more commonly they are computer-based.

- It should provide access to all properties of a food product, not only biochemical properties that can be verified analytically.
- It should provide access to the properties of a food product or ingredient in all its forms, in all the links in the supply chain, not only on production batch level.
- It should facilitate traceability both backwards (where did the food product come from?) and forwards (where did it go?).

Blockchain terms and concepts

Blockchain

Olsen and al (2019) describe blockchain as the following: "A blockchain is type of database that contains a digital recording of the history of some transactions. While databases and database systems come in a wide variety of structures and architectures, the blockchain data structure is more narrowly defined and blockchain systems have several features that set them apart from traditional digital ledgers or relational databases. Blockchain systems are normally distributed across a network of computers, thus not centrally managed, and the transactions within a blockchain are shared among all the participants of the blockchain network. The transactions are checked and validated through a consensus mechanism before they become part of the blockchain, and consensus is required so all the blockchain participants agree on the 'truth' of the blockchain, that is, the blockchain that contains all the valid and executed transactions. By linking transactions cryptographically to previous transactions, data immutability is secured; meaning that changing or tampering with the data becomes (practically) impossible. One of the main advantages of a blockchain is that transactions can be traced back all the way to the start of the blockchain, so that it can provide info of an asset on the blockchain and inform how this asset has originated and changed over time."

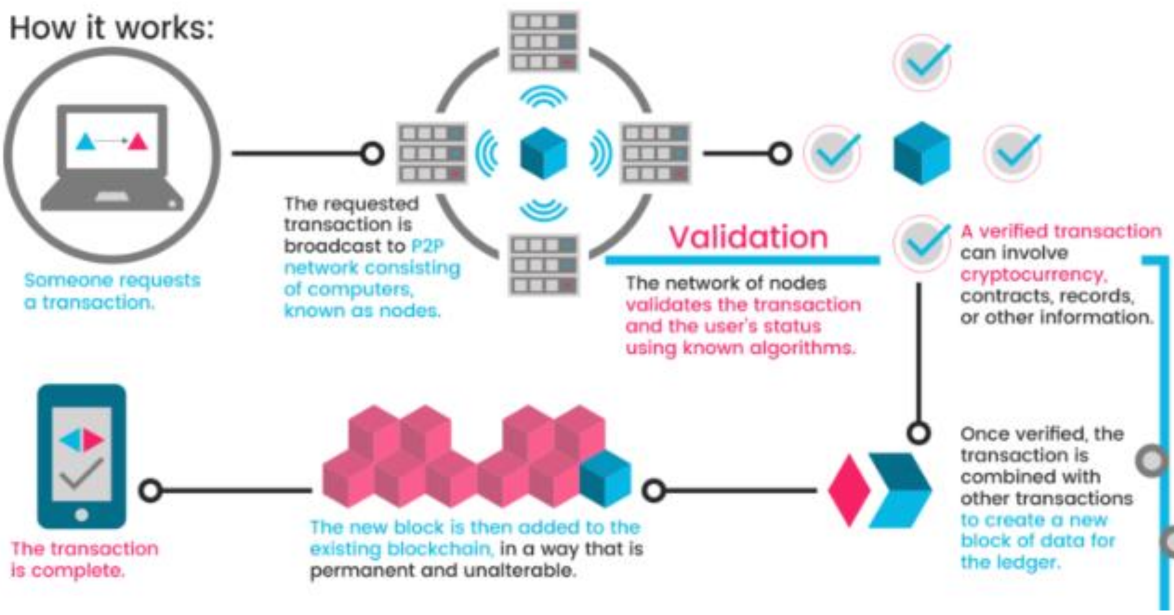

FIGURE 1: SCHEMATIC REPRESENTATION OF A BLOCKCHAIN SYSTEM (BLASETTI, 2017)

Blockchain characteristics

Four main characteristics of a blockchain implementation are decentralization, persistency, anonymity, and auditability (Wang et al., 2018).

Decentralization: in a blockchain system the transaction's validation don't need to pass by a central server, it can take place simply between 2 users. This allows to avoid performance lost due to potential bottleneck effect and reduce the server cost.

Persistency: each transaction is recorded in the blockchain as a block. Those blocks are distributed through the whole network meaning that each block have a copy of the blockchain. With that system, any other nodes verify the block and the transaction it contains making falsification almost impossible and easy to identify.

Anonymity: blockchain users enter the network by a generated address. They can create as many accounts as wanted. This leads to a high level of privacy.

Auditability: once an information enters the network it can never be overwritten or lost. In addition each transaction is recorded with a timestamp which make easy to generate the history of transaction up to the first block.

Blockchain type

Currently, the blockchain system can be categorized into three types: public, private and consortium/federated.

Public blockchains are open source and not permissioned meaning that the access is not under request but directly accessible. Anyone can access the blockchain network from his computer; enter a new block which, if validated, will be stored permanently in the blockchain; have access to all the transactions present in the blockchain; validate transactions within the network.

Private blockchains are controversial to be called blockchain because they are controlled by one organization which make them be a centralized network. They are almost always permissioned meaning that to access the blockchain you need to be invited and approved by the organization who control it or the already members of it.

Consortium/federated blockchains are managed by entities, trusted authorities or group of people. The access to the blockchain is permissioned and allowed only to specific set of nodes. The right to read the blockchain can be public or limited to the participants. Like the private blockchain there is controversy about classifying it as blockchain system due to its limited access and its partially centralized mechanism.

Immutability

Immutability is the ability to tamper the transactions or values present in the blockchain. A public blockchain have a high degree of immutability as each node contain each transaction, alteration of a value or transaction is then almost impossible and would be easily spotted. For private and consortium blockchain on the other hand, immutability is low as the validators are group of people or organization, they can choose to modify a record if they validate the change in between them.

Efficiency

The efficiency corresponds to the time the data take to spread throughout the network. In a public blockchain, the efficiency is low due to the number of nodes and validators that is more numerous compared to the consortium and private blockchains who are, for the opposite reason, more efficient.

Summary of the three blockchain types with their different characteristics:

	Public	Consortium/Federated	Private
Consensus determination	everyone	selected (few)	single authority
Read permission	public	public, partly public, restricted	public, partly public, restricted
Immutability	nearly impossible	possible with majority of validators	possible
Efficiency	low	high	high
Centralised	no	partially	yes
Consensus process	permissionless	permissioned	permissioned

FIGURE 2: (OLSEN, P ET AL., 2019)

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