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Blockchain and Artificial Intelligence for quality food protection and advanced consumer services

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***Abstract*— The PIemuNt chèINa project (PININ) aims to increase the quality and quality perception of high-quality food products of the Piedmont region, introducing technologies for the traceability and authentication of agri-food products, for innovation in the marketing of products in the food chain and for the protection of intellectual property rights of agro-food brands made in Piedmont through the detection of fakes and scams. The PININ project will build a distributed and decentralized infrastructure based on blockchain that allows lot-level traceability, that is scalable throughout the supply chain. The blockchain technology will also allow the traceability of the use of European funds for breeding as regards livestock in alpine pastures to avoid fraud. The promotion of food quality in the project will involve different product chains, with different phases (from the production of raw materials to processing and distribution) and different marketing channels (from large-scale distribution to E-commerce). To validate the project in its various fields, it will be tested in four demonstrators.**

Keywords*— *Agri-food, traceability, blockchain, artificial intelligence, augmented reality, Internet of Things

I. INTRODUCTION

Traceability systems are often seen as an additional burden for compliance with legal regulations that aggravates companies due to the application of identification devices (labels or other recognition devices) and the recording of events (transport, processing, treatments, etc..). European regulations have scarcely considered the economic impact of traceability management on companies, being particularly concerned only with risk management and health protection.

Furthermore, the systems of automated collection of traceability data currently adopted by agri-food companies have mostly been designed for the internal traceability of individual companies, and are scarcely shared. There is a multiplication of different applications (apps, websites, private and institutional databases) that penalizes the efficiency of the supply chain, the accuracy of the tracked data and the experience of the individual user who is forced to use different apps or sites and copy the lot code of the product. Finally, the centralization of the traceability system undermines consumer confidence [1].

Starting from these problems, the PININ project (PIemuNt chèINa) aims to increase the quality and perception of high-quality agri-food products through the use of innovative technologies that allow to optimize and reduce the quality certification and traceability costs, as well as improve the access to traceability information by the final user. Moreover, the projet aims at protecting the intellectual property rights of agro-food brands through the detection of fakes [2]. In this way it is also possibile to avoid waste in a circular economy perspective, facilitating the management of expiring products, promoting KM0 products and introducing controls in the food chain to certify sustainability.

To reach these goals, the project will exploit disruptive technologies such as Blockchain, Artificial Intelligence, Internet of Things and Augmented Reality. They will allow the creation of an innovative food product tracking system along the entire supply chain, from raw materials to consumer, and to introduce innovative services for the consumer. These technologies profoundly change the current business model. For this reason, it is necessary not only to introduce innovations in IT systems but also to rethink the business processes of the sector.

The project is part of the "Made in Piedmont" of the S3 strategy of the Piedmont Region, in the agri-food sector, with particular attention to the rational and integral use of biological resources (Bioeconomy) as regards the waste of food products, with an interdisciplinary approach that brings together ICT companies with production and distribution companies, aimed at developing technologies not only in their respective sectors but as a result of their symbiosis, aimed at creating "circular" productive ecosystems on the regional territory [3].

The PININ project will build a distributed and decentralized infrastructure based on blockchain [4] that allows lot-level traceability and is scalable throughout the supply chain. The blockchain technology will also allow the traceability of the use of European funds for breeding as regards livestock in alpine pastures to avoid fraud. To validate the project in its various fields, it will be tested in four demonstrators: Traceability of food in large retailers with innovative services for the consumer; Traceability in the

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provision of European funds for breeding; Anti-counterfeiting of bottled products (wine and spirits); Search for food products with fake brands on E-commerce sites.

II. GOALS OF THE PROJECT

The PININ project aims to build a distributed and decentralized infrastructure based on blockchain that allows traceability at different levels of physical aggregation of the product (item-level, packages or lots), and the level of detail of the information flow: deadline, production methods, certifications, details on ethics, sustainability, requirements related to ethnic and religious group, nutritional information, composition and presence of allergens, etc., as well other information that can also be used in marketing strategies and against counterfeiting. Scalability throughout the supply chain and the multiplicity of access to decentralized archives allow the participation at a high level of security of subjects who participate by accessing, checking, viewing, processing and, in the face of pre-established rules, modifying the traced data. In details, the project has three main objectives:

Food traceability

- Implementation of a distributed IT infrastructure for food traceability based on Blockchain and IoT technologies in different contexts (beef from breeding to large retailers).

Advanced services per the users

- Realization of innovative services for the consumer, usable through AR / VR and Geoweb techniques.
- Creation of a social information product network from a Web of Things perspective, that is, starting from the product being able to access a series of information.

Anti-counterfeiting services

- Construction of an IT platform for tracing livestock in the pastures they receive European funds based on Blockchain and IoT technologies
- Development of an anti-counterfeit system for products bottled like wine and spirits based on NFC, GPS / Galileo and Blockchain technologies
- Development of a search system for false food products with brands on Ecommerce websites
- Analysis of regulatory aspects and risks with the support of IT tools

III. METHODOLOGY OF THE PROJECT

The promotion of food quality in the project will involve different product chains, with different phases (from the production of raw materials to processing and distribution) and different marketing channels (from large-scale distribution to E-commerce). The complete ecosystem of the project, with all the various components, are represented in Figure 1.

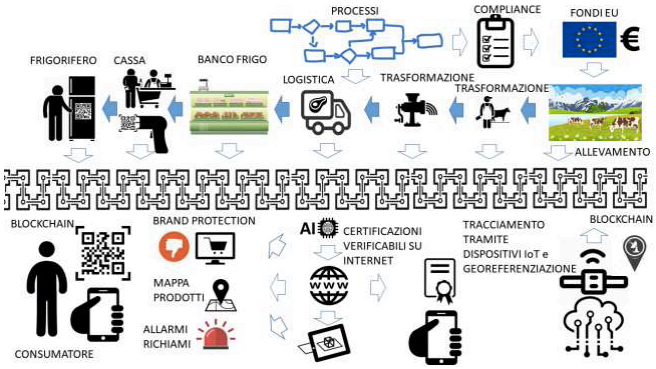

Figure 1. The PININ ecosystem

The methodology that we will adopt is twofold:

- *Ex-ante approach* with the aim of systematizing and guaranteeing/certifying quality productions/products/ brands from the beginning of the respective production or distribution cycles
- *Ex-post approach* with the aim of ensuring that agri-food products/brands that do not fall within the certified "tracks" are systematically identified, evaluated and eventually removed.

For the implementation, we will use the Turin's High-Performance Centre for Artificial Intelligence [5].

IV. DEMOSTRATORS

To validate the project in its various fields, PININ will be tested in 4 demonstrators:

1. Traceability of food in the large distribution of meat (such as La Granda - Eataly) with innovative services for the consumer

2. Traceability in the provision of European funds for cattle breeding in Piedmont for what concerns alpine pastures

3. Anti-counterfeiting of bottled products, such as wine and spirits, and analysis of data collected by tracking of interactions between brands and consumers in collaboration with Guala Closures such as end user

4. Protection of quality food product brands made in Piedmont through identification of food products with fake brands on E-commerce and regulatory compliance sites.

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