Big data for corporate social responsibility: blockchain use in Gioia del Colle DOP

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Abstract

The traceability of the supply chain with strict compliance with the specification to demonstrate in "transparency" the production processes in compliance with legislation and from a corporate social responsibility perspective, represents a fundamental requirement at the basis of competitive advantage in the food industries (Patelli and Mandrioli, J Food Sci 85: 3670–3678, 2020). The purpose of this work is to illustrate the innovative method for the certification and protection of the production phases of the DOP food chain and specifically the Mozzarella DOP of Gioia del Colle produced by the company Capurso Azienda Casearia Srl. This innovative approach consists of several phases that will be described in detail in the following paper. Besides, the idea of the introduction of Blockchain technology in an industry like this is an important step. This technology, associated with more accurate and intelligent management of the data acquisition process (Big data approach), optimizes the productivity of small businesses such as the dairy company. Blockchain technology guarantees security in the management of large amounts of data as never before possible, an innovative and experimental approach that makes the entire path of the production chain more controlled and optimized (Giacalone et al. International workshop on fuzzy logic and applications. Springer, Cham, pp. 218–225, 2016).

Keywords Blockchain · Corporate social responsibility · Big data · Internet of things · Gioiella DOP

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1 DOP dairy products: Gioia del Colle's mozzarella cheese

Dairy goodness has always been the flagship of the south of our peninsula, and around these realities, there is an important market of raw material suppliers.

However, preserving tradition and flavors in compliance with quality standards and regulations is a primary objective to protect the image and values of the dairy company's products, in fact, more and more often producers, who fail to guarantee high standards of their products, are made way into the market thanks to misleading brands that bring to the customer's mind high-quality names (Di Vita et al. 2013).

In this regard it comes to help the protected designation of origin, better known by the acronym DOP, denomination approved the mozzarella of Gioia del Colle; however, keeping track of the quality of the entire supply chain process to remain in compliance with the DOP denomination presents some problems. With the release of Legislative Decree 231/2017 DOP of Gioia Del Colle during the year 2017, there were no platforms in the state of the art that allowed rigorous management of the advanced tracking of the product chain as represented by the US7085777B2 patent.

The platforms present in the state of the art were guided data storage systems and did not have internal modules for the interconnection of the individual phases of the supply chain via IoT and artificial intelligence modules (expert systems to support decisions) aimed at respecting the constraints envisaged by the audits and for the control of the hygienic-sanitary and qualitative production process, also in compliance with Law 231/2017.

The company Capurso Azienda Dairy, therefore, tried to find a solution following the Six Sigma methodology (DMAIC approach) applied to the workflow of the nascent supply chain through the definition, design, and experimental development of an intelligent anti-evasion system for the management of the supply chain.

The paper is structured as follows. Paragraph 2 presents the problem of transporting food with greater attention to dairy products and presents the description of DOP products showing their peculiarities and characteristics. Section 3 presents the articles of the DOP regulation for Gioia del Colle mozzarella, the starting point for the implementation of the innovative system described in the fourth paragraph, as well as the possibility of continuous improvement of the entire production chain (DMAIC approach).

In paragraph 4 introduces the DEMAIC approach through the description of its five phases: define, measure, analyze, improve, and control. Then follows, in Sect. 5, the description of the anti-elusive approach based on temporal certification through blockchain stored thanks to Big Data and the implementation of a revolutionary dynamic tracking system based on DoA technology (data over audio) alternative to the based approach on radio frequencies. All this is the demonstration of an innovative approach strongly suited to the proof of compliance with the principles of social responsibility well expressed by the ISO26000 standard.

Section 6 explains the blockchain operating process, its application in the supply chain, and the benefits it brings.

Paragraph 7 follows the definition of the excellent applications of the blockchain method also as an anti-avoidance tool. Section 8 introduces the Gioiella Filiera application the cloud software developed by SME iInformatica S.r.l.s. Last paragraph offers some conclusive remarks and final considerations.

2 DOP products: the food chain

According to article 2 paragraph 1 letter A of EU regulation 510/2006, by designation of origin we mean an agricultural or food product originating from a specific region whose peculiar characteristics and qualities are given exclusively by a particular geographical environment, including natural or anthropomorphic factors, and whose production takes place in the specified geographical area (Catanzaro and Licciardo 2006). It follows that the protected designation of origin (PDO, DOP in Italian) actually presents itself as a trademark of the legal protection of the denomination of a particular agricultural or food product, this trademark is attributed by the European Union based on certain qualitative characteristics (Belletti et al. 2007). For a product to be defined as a DOP, the stages of production, transformation, and processing must take place in a geographical area determined a priori and these stages must comply with strict rules established by a specific production specification and guaranteed by a specific control body (Germanò 2009).

Increasing globalization and a growing need for the world economy to carefully monitor production and transport for this specific category of products has led to the creation of rules and procedures aimed at protecting, during production, transport, and storage, which otherwise the characteristics of the products would vary, nullifying the work of the entire supply chain, compromising the product guarantee standards (Mancini et al. 2019).

Numerous ministerial decrees, over the years, have focused on the transport dynamics of particular fresh and perishable foods capable of altering their chemical-physical properties very easily if transported incorrectly, for example the DM 14/11/96 reports that fresh meat, after post-mortem inspection, can be transported not yet refrigerated provided that the duration of the transport does not exceed two hours and that this takes place with a refrigerated vehicle with sanitary authorization, and again the Presidential Decree 187/2001 regulates the transport of fresh pasta, stating that these must be stored, from production to sale, at temperatures no higher than 4° C with a tolerance of 3° C during transport and 2 °C in other cases; during transport from the place of production to the point of sale, they must be contained in packaging not intended for the final consumer, which ensures adequate protection from external agents and which bears the words "fresh pasta to be sold loose".

Stabilized pasta products (i.e. containing a moisture content of not less than 20%) allow transport and storage at room temperature, while pre-packaged fresh pasta must be stored, from production to sale, at a temperature not exceeding 4 °C, with a tolerance of 2 °C. Article 43 and following of Presidential Decree, 327/80 regulate the sanitary suitability and sanitary authorization provided for the means of transport, while the circular of 21 July 1998, n.64 relates to vehicles for specific transport under the controlled temperature and by vehicles for specific transport with a tank for the transport of food liquids. Ice creams fall within the scope of Presidential Decree 54/97 and they must have microbiological requirements as set out in Annex C, Chapter II of the aforementioned Presidential Decree.

The maximum temperature for the transport of pasteurized milk is set at +6 °C, however, the veterinary service can grant an exception regarding door-to-door delivery and authorize a tolerance of 2 °C during delivery to retailers. On the other hand, as regards frozen food products, during transport, local distribution in the refrigerated cabinets and counters for sale, a temperature rise of 3 °C is tolerated for short periods (defrosting).

Particular attention is paid to the products of the dairy chain as they are subject to important Physico-chemical alterations that could occur if transported with poor

standards of attention. These products, due to their composition, production, and original origin, have high deterioration alerts that can be avoided during the transport and storage phase, if specific procedures are implemented and different standards are observed.

The DPR n. 54 of 14 January 1997 is a regulation implementing Directives 92/46 and 92/47/EEC on the production of milk and milk-based products.

The aforementioned regulation establishes the health rules for the production and marketing of raw milk, heat-treated drinking milk, intended for the manufacture of milk-based products, and milk-based products intended for human consumption. Dairy products, defined as milk-based products, are identified in all those products deriving exclusively from milk with the possible addition of the substances necessary for their realization as long as they are not used to totally or partially replace any of the constituents of the milk itself and of which milk or a dairy product is an essential part.

Vehicle loading compartments and/or containers used for the transport of food products must be kept clean and must be regularly maintained to protect food products from sources of contamination; also, if necessary, they must be designed and built in such a way as to allow adequate cleaning and disinfection. Furthermore, they must not be used to transport any material other than food products if the latter may be contaminated. If the vehicles and/or containers are used for the transport of other goods in addition to food products or of different types of food products at the same time, the various products must be effectively separated, where necessary.

The legal literature argues that the temperature of the containers in which the dairy products must be transported must fall within the range 0 °C and +4 °C; such is the temperature range that guarantees optimal transport standards for fresh dairy products. This temperature is naturally accompanied by correct sanitation and sanitation of both the containers and the staff. As for packaged aged cheese products, the transport temperature is generally dictated by the manufacturer's instructions as it varies according to the product itself.

It thus becomes even more important to scrupulously observe all the rules, not so much to avoid sanctions, but above all, because each member of the community must now assume their share of responsibility, legally and socially relevant, in a world where technical automatisms risk to the detriment of health (Iotti and Bonazzi 2014).

3 DOP chain for continuous improvements

At this juncture, it is necessary to use the DMAIC approach which is indispensable within the Six Sigma management program and especially in quality management. This approach is generally used for all improvement activities of a particular type of process. The DMAIC already contains within its acronym the definition of the same, in fact, if the acronym is broken down it is possible to derive the definition as well as the phases that represent it.

This process is composed by five phases: Define, Measure, Analyze, Improve, and Control (De Mast and Lokkerbol 2012). The five stages are strongly linked to each other and each of them describes an important step for quality management aimed at improving, optimizing, and stabilizing a particular organization process.

The first phase, or "Define", aims to identify a specific problem to be solved as well as the resources needed to achieve the goal. The second act, "Measure", has the specific task of collecting information that can then be used as a reference to measure subsequent

improvements; the "Analyze" phase analyzes the causes and origins of a given problem. The last two phases "Improve" and "Control" respectively have the objective of identifying and implementing a solution to the problem and monitoring improvements to be maintained over time. As anticipated, DMAIC is used within the Six Sigma, which is a quality management program, based on effective control and having the purpose of making any qualitative improvement to a product or service (Pyzdek and Keller 2003).

Using the DMAIC approach (Fig. 1) for the analysis of the supply chain workflow it is necessary first of all to define ("Define" phase) the approach itself, rigorously considering the articles in the Mozzarella of Gioia del Colle specification. By reading them it is possible to deduce all the constraints to be respected to pursue the quality requirements and compliance with the product standard ("Measure" phase). It is particularly important to pay attention to some articles which show how evident the need is for technologies that allow you to keep track of the entire supply chain process to comply with the DOP denomination ("Analyze" phase).

To facilitate understanding of the context, the following is an extract of some articles of the specification:

3.1 ART. 2

The "Mozzarella of Gioia del Colle" is a fresh stretched curd cheese, obtained from raw whole cow's milk only, possibly thermalized or pasteurized, and is characterized by a production technology based on the use of native whey-graft.

Chemical composition (values on fresh product):

- lactose $\leq 0.6\%$;
- lactic acid $\geq 0.20\%$.

3.2 ART. 3

The area of production, milk processing, and packaging of "Mozzarella of Gioia del Colle" includes the administrative territory of the following municipalities in the province of Bari, in the province of Taranto, and part of the municipality of Matera in Basilicata.

D	Define	Define problem and the ideal in terms of the target to achive.
M	Measure	Collect relevant data about the process and the problem.
A	Analyse	Analyze the process to identify the cause-effect relationship between inputs and outputs. Identify the vital few root causes.
I	Improve	Determine the optium values for key contributing process inputs. Implement solutions to eliminate the root causes.
C	Control	Establish standards and controls to sustain improvements in the long run.

Fig. 1 Description of the DMAIC process. Source: Own elaboration

3.3 ART. 5

The milk used to produce "Mozzarella of Gioia del Colle" comes from farms in which lactating cows must be reared in stables that require grazing, for at least 150 (one hundred and fifty) days per year, of monophyletic or polyphite autumn grasses. -spring, composed of leguminous essences (clover, vetch, field bean, and protein pea) and cereals (oats, barley, durum wheat, soft wheat, and ryegrass), or from natural pastures of wild herbs.

The livestock feed, whose milk is used in the production, consists of grass and/or hay of polyphite grass in a percentage of at least 60% of the total dry matter. The food ration also includes cereal concentrates (corn, barley, wheat, oats), legumes (soybeans, broad beans, field beans, protein peas), and their flours/flakes, as is or in the form of complementary feeds. And again, carob and by-products of cereal processing, such as bran and small wheat bran, durum wheat in a percentage of less than 40% of the dry matter. Finally, mineral and vitamin complexes as supplements.

Of these products intended for animal feed, in order not to compromise the qualitative characteristics of the product due to the link with the territory, no less than 60% must come from the geographical area defined in Article 3.

Dairy cows cannot be fed with foods that can transmit anomalous aromas and flavors to the milk, such as to alter its chemical-physical and organoleptic characteristics; foods that represent sources of contamination or in poor condition.

Starting from the analysis of the articles, the conception, design, and implementation of the system for the management of the DOP of Capurso Azienda Casearia Srl, described below, is therefore born.

4 Intelligent DOP management system

The system conceived and designed in 2017 by the company Capurso Azienda Casearia Srl is based on artificial intelligence for the management of the audit process of the DOP mozzarella, burrata, and stracciatella of Gioia del Colle supply chain.

The goal is to provide an effective tool both in the audit phase of the raw material production (cow's milk) and in the analysis and incoming phase of the raw material, in the production phase of the product, in the distribution of the finished product for waste management and tracking (Fandos and Flavian 2006).

In the context, the object of the invention is essential to use a system that allows the monitoring and control of the entire chain of DOP dairy products of Gioia del Colle, starting from the control of the internet of things.

This type of use of this technology has already been tested in the agro-food sector and to improve marketing intelligence for a better approach to costumer demand. A great representative of this type of research in today's literature is the article written by Werenowska to analyze the possibilities of using the digitization factor in the customer relationship process to create a better and more personalized offer (Werenowska 2020).

This system can be used by the milk producer, by the dairy company, by third-party auditors, and by the final consumer.

The system preliminarily provides for the management of the service through web-server infrastructure. A data processing unit is then set up, connected to the internet via a WIFI access point or internet gateway.

By data processing unit we mean a common computer in which the database is contained. The database contains data relating to the knowledge base (relationships) that regulate the supply chain process, the requirements of 231 compliance and the mandatory legislation, the objects of the Internet of Things (livestock and lots), the knowledge base of the equipped responder of artificial intelligence, evaluations, coordinates for global geolocation. The user can therefore access the web-server platform using any hand-held device, for example, a common smartphone or tablet, equipped with internet connectivity. It is also possible to access the contents of the platform by framing an identification code (eg QRCODE), associated with each dairy cow registered in the supply chain system, to be monitored in compliance with the requirements of the DOP mozzarella, burrata, and stracciatella of Gioia del Colle supply chain, also with a view to health and hygiene control and compliance with 231 and mandatory legislation.

As regards the 231 compliance model, it indicates an organization and management model indicates an organizational model adopted by a legal person, or association without legal personality, to prevent the criminal liability of entities (Previtali 2009). Its definition is mainly provided in Article 6 of Legislative Decree no. 231 of 8 June 2001, from which it, in turn, derives its name: 231. According to this legislative decree, the company is responsible for crimes committed in his interest or to his advantage both by persons who hold representative or administrative functions and by persons subject to the management or supervision of one of the persons in top positions. The company, on the other hand, is not liable if the persons indicated have acted in the exclusive interest of themselves or of third parties (Ielo 2006).

The sanctions provided for by law against the company as a result of the commission or attempted commission of the specific crimes are indicated in section II of the aforementioned decree and consist of pecuniary sanctions, disqualification sanctions, disqualification from exercising the activity, the prohibition to contract with the public administration, exclusion from concessions, loans, contributions or subsidies, prohibition to advertise goods or services, confiscation of the price or profit that the company has derived from the crime, publication of the sentence that can be ordered in the event of the application of a disqualification sanction (Giacalone et al. 2018b).

The sanction of the prohibition of the exercise of the activity, the prohibition of contracting with the public administration, and the prohibition of advertising goods or services, can be applied, in serious cases, even definitively. The legislative decree n. 231 defines the content of the organization and management models, providing that they must meet the following needs:

- Identify the activities in which crimes may be committed;
- Prepare specific protocols aimed at planning the formation and implementation of company decisions in relation to the crimes to be prevented;
- Identify methods for managing financial resources suitable for preventing the commission of such offenses;
- Provide information obligations towards the body responsible for supervising the operation and compliance with the organizational model;
- Introduce a disciplinary system suitable for sanctioning non-compliance with the measures indicated in the organizational model.

Liability is excluded if the company has adopted and effectively implemented an organization, management, and control model suitable for preventing certain crimes; it is appropriate, in any case, to specify that the assessment of responsibility takes place

by verifying the existence of the predicate offense and the suitability review on the organizational models adopted.

Following this approach it is possible to summarize 231 compliance (Fig. 2) as the contribution of rules, policies, and ethical code using the certification of all the transactions (using for example Internet of things and Blockchain), monitoring KPI business parameters to reach and evidence of actions on corporate social responsibility. Following this approach, the system for Gioiella DOP has been developed.

Access to the resources associated with the object of the Internet of Things can be done by all authorized users, in possession of devices with previous technologies and appropriate credentials.

Once logged into the platform, the user who owns the dairy cow can carry out the audit using a checklist, supported by multimedia content, relating to the process of the DOP mozzarella and stracciatella supply chain. The system checks livestock in real-time, by virtue of the checklist compiled over time. The system also allows you to trace the batches of milk produced, destroyed, and delivered in their management in the plant, and the production processes of DOP dairy products of Gioia del Colle. Utilizing intelligent packaging, the system also allows the geolocation of distributed dairy products to be managed to create a map of product diffusion in the world.

The entire system also uses an artificial intelligence engine that acts as a guide regarding supply chain processes, and also performs autoresponder operations. The system also makes it possible to create a communication channel with the staff of the dairy facility and to express evaluations concerning the services used. This system is highly valid for carrying out an automatic audit of the supply chain process using an expert system, and for reconstructing and verifying the entire supply chain process for third-party auditors (Asadzadeh et al. 2014).

In fact, the system lends itself to improving the process control of the supply chain, through timely intervention with the individual players involved into it.
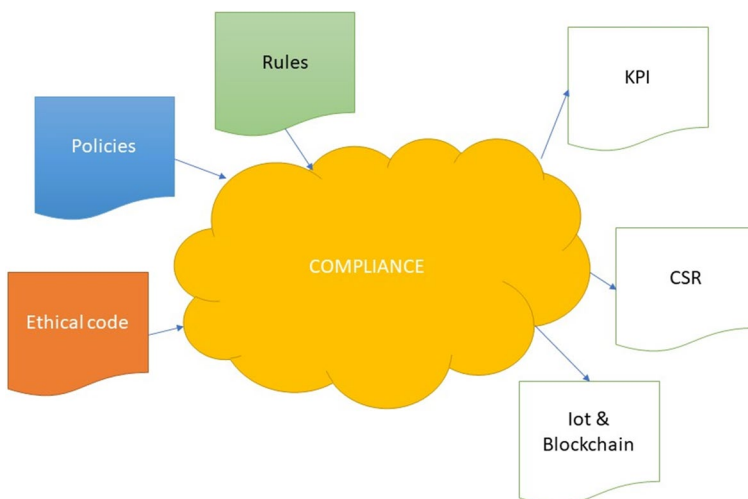

Fig. 2 Explanatory image of 231 compliance tools for companies. Source: Own elaboration

$$CF = \sum_{i=0}^{m} \frac{nc_i \times \delta}{a_i} + \sum_{j=0}^{t} \frac{nc_j \times \delta}{l_j} + \sum_{z=0}^{q} \frac{nc_p \times \delta}{pf_z}$$

The system is therefore able to determine supply chain compliance (CF):

This level is a time function given by the sum of three contributions. The first contribution is given by the non-conformities (nc) of each farmer (i) according to the seriousness of the non-conformity (delta), considering the total number of livestock managed (a). The second contribution considers the non-conformities of the lots, given the number of lots.

The third considers the non-conformities of the finished products, considering the number of finished products (pf). The more this value tends to zero, the better the supply chain compliance will be. Each weight (delta) also maps the type of non-compliance if of the supply chain, mandatory, ancillary, relating to the 231 organizational models.

The delta parameter is a fuzzy concept that considers this coding: level 1 low, level 2 medium, level 3 high.

The high non-conformities (nc_i) are related to an error on food purchase notes or an error on the GPS location of livestock. These non-conformities (nc_i) are serious and can lead to the termination of a contractual relationship with a breeder.

The medium non-conformities (nc_i) are related to a discontinuous or inaccurate use of the app (for example on the incomplete recording of the checklist).

Considering the farmer case study for the first test of system using the digital application developed we have noticed that 75% of medium non-conformity (nc_i) were related to the wrong use of the User Interface, particularly related to a difficult approach for a farmer to use digital tools. With the second release of UI that considers the conformity of the group of head of cattles, the medium non-conformity level is dropped up to 25%. The following table (Table 1) summarizes the concepts shown before.

It is also possible to carry out trends and reports of this index over time, also monitoring the non-compliance index over time for each breeder, useful for monitoring and choosing the players in the supply chain.

Considering the lots, high non-conformities (nc_j) are related to an error on fiscal documents or errors on analysis reports on lots. These non-conformities (nc_i) are serious and can lead to the termination of a contractual relationship with a laboratory or employee.

Table 1 Analysis of non-conformities on first and second UI of the system. Source: Own elaboration

TYPE of delta (nc_i)	CAUSE	Error on first UI (%)	Error on second UI (%)
High non-conformities	Error in food purchase note Error in GPS location of livestock	0	0
Medium non-conformities	Incomplete checklist Inaccurate upload of doc High delay in recording Discontinuous use of app	75	25
Low non-conformities	Slight delay in recording Connection problems	25	75

The medium non-conformities (nc_i) are related to a discontinuous or inaccurate use of the app (for example on the incomplete recording of the checklist or delay in the upload of documents/reports).

Considering the first test of the system using the digital application developed we have noticed that 75% of non-conformity (nc_j) were of low type considering the good level of digitization of operators. Medium non-conformities (25%) were related to workflow problems.

Considering the finished products, high non-conformities (nc_p) are related to an error on storage and delivery. These non-conformities (nc_p) are serious and can lead to the termination of a contractual relationship with a carrier or employee.

The medium non-conformities (nc_p) are related to a discontinuous or inaccurate use of the app (for example on the incomplete recording of the tracking checklist or delay in the upload of documents/reports).

Considering the first test of the system using the digital application developed we have noticed that 90% of non-conformity (nc_j) were of low type considering the good tracking workflows implemented in the traditional distribution chain. Medium non-conformities (10%) were related to inexperienced users.

5 Livestock wellness, social responsibility and biocompatibility monitoring

Underlying the mission and values of the Capurso Azienda Dairy company, represented by Filippo Capurso, are the concept of "animal welfare" and that of Social Responsibility. CSR (Corporate Social Responsibility) or Corporate Social Responsibility (CSR), is by definition, anticipating the concept that will then be widely discussed and analyzed, "The voluntary integration of the social and environmental concerns of companies into their commercial operations and relations with interested parties ".

CSR is not limited to simply respecting the laws but identifies a series of practices and behaviors that a company adopts autonomously and on a voluntary basis, in the belief of obtaining results that can bring benefits and advantages to itself and more generally to the context in which the company operates.

An efficient summary of all the literature on this topic can be found in Del Baldo's article, where both the main achievements in the sector and the criticisms of visions no longer suited to the everyday needs of industries and customers are exposed (Del Baldo 2015).

The goal is, therefore, to take particular care of the relationship with its stakeholders: collaborators, suppliers, customers, and partners, carrying out concrete actions for them. This takes shape in a company policy that can reconcile the economic objectives with the social and environmental objectives of the reference area, with a view to future sustainability (McWilliams et al. 2006).

Knowledge about the use of technologies such as blockchain in the CSR theme was also fundamental, especially in understanding what was the biggest obstacle encountered today and what to focus on this research; it is in fact demonstrated through text mining analysis that the most recurring problems are food waste and customer confidence in the use of products from large companies (Goloshchapova et al. 2019).

CSR is therefore the application of several specific principles such as sustainability, voluntariness, transparency, quality, and integration (Sinha and Panda 2018).

As far as sustainability is concerned, it consists of conscious and efficient use of environmental resources as common goods and therefore the ability to enhance human resources while also contributing to the development of the local community in which the company operates. It is also described as the ability to maintain the company's economic development over time. Voluntariness, on the other hand, is expressed as actions carried out beyond legal obligations. Transparency is defined as listening and dialogue with the various direct and indirect business stakeholders.

Quality is described in terms of products and production processes, while integration is expressed as a vision and coordinated action of the various activities of each direction and department, horizontally and vertically, on shared goals and values. CSR suggests and proposes different perceptions and various operational declinations based on the cultural context, the existing business culture, the emergencies to be addressed, the economic and social actors involved. It basically means offering a positive contribution to business development and managing its impact on the economic and institutional environment in which it operates (Banerjee 2008).

The distinctive element of CSR is to combine economic responsibility with social responsibility, which creates tangible and intangible values for everything around the company itself. Winning values for the company, for people, for the territory, and for the environment. The various stakeholders must be able to pursue their own interests but to pursue the broader principle of the lasting economic life of the company as a whole; therefore this can only be achieved through approaches of economy and efficiency through the logic of comparison and balancing of interests. Surely CSR has a greater impact in large companies, especially in multinational companies whose production is also carried out in developing countries where fundamental human rights are often not respected and working conditions are not guaranteed (Visser 2008). CSR, however, is above all of great importance for SMEs, which can make the most of its various opportunities.

In the new competitive challenge of globalization, it is the latter that must integrate the concerns of customers, employees, and environmental criteria for a higher quality of the final product with the ultimate aim of improving their reputation and staying on the market (Conti et al. 2019). CSR has the function of bringing out hidden costs linked to waste and management inefficiencies, both from the point of view of the use of resources and the inadequate enhancement of the company profile and therefore sets itself the goal of systematizing investments and promoting added value created for the various business stakeholders.

Unlike what one might think, this offers the possibility of being applied with flexibility and creativity in consideration of values, mission, sector, size, and companies. It certainly starts as a basis from compliance with regulations concerning companies, in the social and environmental fields, but it qualifies for a principle of voluntariness in promoting actions that go "beyond the law" in order to strengthen the achievement of its mission and vision of the company.

The main Italian reference is the National Plan on Corporate Social Responsibility 2012–2014. The National Action Plan is implemented under the direction of the two lead administrations, namely the Ministry of Labor and Social Policies and the Ministry of Economic Development, in compliance with the autonomy and prerogatives of the public administrations (central, regional and local) and entrepreneurial subjects, trade unions, third sector organizations and civil society who contribute to the achievement of its objectives.

This guiding role is part of a broad action of national public administrations, at a central and local level, which are flanked, accompanying public action, business activities,

and stakeholder initiatives. Given the multidisciplinary and integrated nature of CSR, it is necessary to proceed with synergistic action between the institutions at different sectoral and territorial levels. Of course, companies play a key role, but also stakeholders (trade unions, workers, consumers, third sector organizations, civil society) who, through active involvement and sharing (so-called multi-stakeholder approach), can favor processes in progress. Similarly, the involvement of the financial sector is necessary to facilitate the access of businesses, especially SMEs, to capital and credit.

In the definition and implementation of the Plan, particular attention is paid to SMEs which often do not have sufficient financial resources and knowledge but are essential for the achievement of the Government's objectives given their number, their roots in the communities companies in the supply chain and the growing role they play in the internationalization of production. The contribution of social enterprises and third sector organizations is also recognized, for their attention to the territory and the direct relationship with citizens.

As the CSR affects the sectors in question, the agri-food and livestock supply chain, in the same way, the emerging technologies, as already extensively described, embrace these ancient economic fields.

An interesting word cloud about terms of CSR is provided in Fig. 3.

As regards the IoT technology applied to the field of zootechnics, it is of fundamental importance for breeders so that they can achieve multiple and important objectives, first of all, animal health and that of consumers (Herrera and Blanco 2011). Another main objective of the combination of IoT and livestock is that of the efficiency of the animal production chains and their safety. Each farmer, therefore, has the possibility, thanks to the IoT, to monitor the quantity and quality of animal production, as well as the ability to optimize the consumption of water and feed, track the position of livestock, identify the position of the means used for their transport, check the health of the animals, prevent or intervene promptly in the event of diseases, always with a view to social responsibility (De Soete 1984). There are many advantages that nascent IoT technology can bring to traditional livestock:

- Control of production, quantity and quality;
- Optimization of the use of primary goods for the health and sustenance of livestock;

Fig. 3 Our Word map about CSR concepts. Source: Own elaboration

- Food safety for consumers;
- Welfare and health of livestock;
- Traceability of animals;
- Control of the position of transport vehicles, as well as control of the entire supply chain.

The dairy cow is the heart of the workflow; therefore, it must be suitably protected. Tracking systems via IoT are based on the declarations of the farmer and of individual supply chain operators. However, thinking of a further robust automatic tracking for monitoring the "welfare" of the individual head of cattle represented a very important goal to pursue.

Monitoring systems from a "smart-tattoo" perspective involves the use of chips/circuits based on radiofrequency systems that are "tattooed" on the animal's skin. These RFID-oriented systems, therefore, require the installation of important UHF infrastructures inside stables and fences.

However, radio frequencies are particularly attentive due to their problems relating to biocompatibility, long-term exposure to these could lead to non-negligible damage to humans and animals. The development of "green" technologies based on visible light (VLC communication) and via audio signals (Data over Audio) therefore represented a fundamental input for the design of an alternative system. However, VLC communication is feasible only in the absence of external light sources (during the night or in dark environments), while during the day only DoA is feasible.

The joint use of thermochromic polymers also makes it possible to verify the well-being of the animal by monitoring the temperature not through thermometers but through "smart tattoo" characterized only by thermochromic polymers and without the use of chips.

These are photochromic and luminescent inks that react to different wavelengths by activating under UV rays. Some types of inks such as variochromatic and "white" polysprectal ones, although very difficult to find, guarantee a high degree of control of the products on which they are applied. UV sensitive inks are mainly used for valuable documents but are applied to all types of media. Fluorescent polymers are usually inserted in the printing ink of security documents and when a document is scanned, the ink reacts to a certain wavelength of the polymer, which is measured precisely, thus ensuring the authenticity of the document.

Thermochromic inks and paints have the peculiar characteristic of losing their original tone following a temperature change; in the event that these should be of the reversible type, they will then regain their original tone when the temperature returns to the original threshold again.

In some cases, they are composed of microcapsules that change color becoming colorless when the temperature exceeds a certain range of values, then finding the primordial color when the temperature drops back to the original standard. The opacity of thermochromic inks generally depends on the temperature, color, concentration, and thickness of the tint. The intensity of the color is about 10–20% of classic dyes and by toning temperature, we mean the point where the thermochromic paint or ink reaches 95% of its colorless state. The standard color change temperatures are between 6 and 31 °C. The loss of original hue following a temperature change can also be irreversible and, in this case, they are irreversible thermochromic inks.

The fields of application are many and nevertheless, it is necessary to take into account the thermochromic characteristics of these inks and paints, it can undergo alterations until it disappears in the case of prolonged exposure to high temperatures above 50 °C. Excessive exposure to sunlight for several days can also damage the colors of the pigments up to completely canceling the phenomenon of color change.

In the aforementioned context, the object of the invention of the year 2019 was to carry out an innovative method and related biocompatible device for the control of livestock. It involves the use of a thermo-chromic marker for monitoring the body temperature of livestock and a biocompatible device via DoA (data over audio) communication.

For localization within a delimited area (e.g. fence, park) it is necessary to have appropriate DoA receiving devices consisting of microcontrollers equipped with an appropriate sensor for audio reception, distributed along the perimeter. Through a gateway interface, it is possible to transmit the signals acquired via DoA to the outside, in order to record the relevant transactions in a public blockchain (Fig. 4).

The device placed on the cattle is instead constituted by a microcontroller powered by batteries which allows through a special DoA (data over audio) interface, consisting of a speaker for transmission and an acoustic sensor for reception, geolocation of the head of cattle and communication of the detected signals.
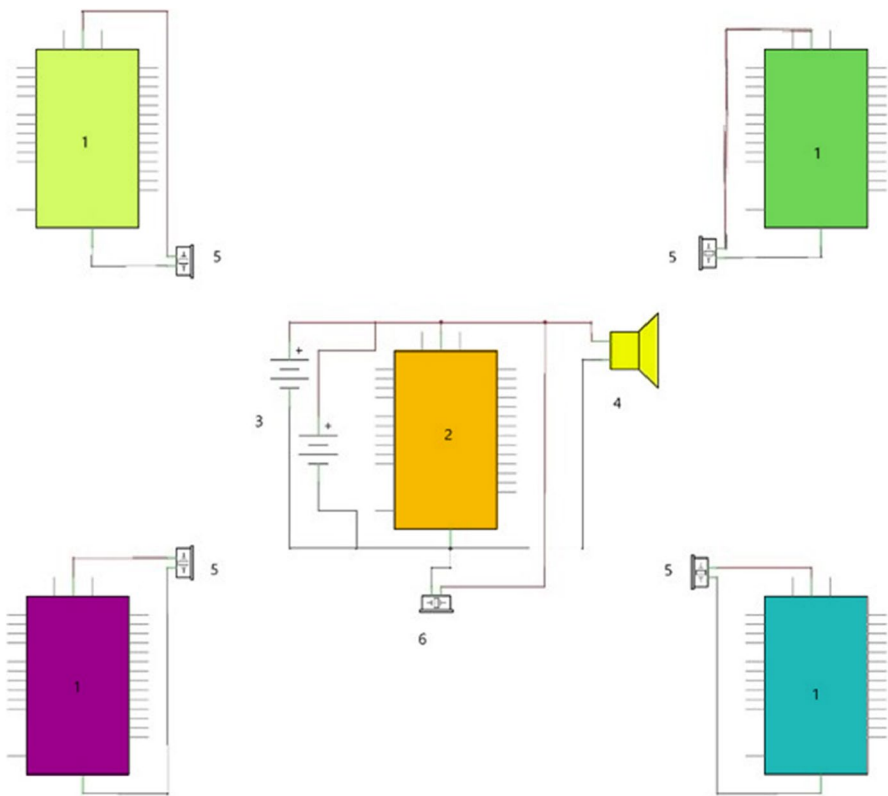

Fig. 4 DoA device for livestock monitoring. Source: Own elaboration

The method involves a phase of definition of the thermo-chromic marker according to the body temperature to be monitored; a phase of application of the marker on livestock for a biocompatible visual control of body temperature; a step of placing the biocompatible device on livestock; a phase of discrete time localization of the cattle and reception of the data detected by the sensors via DoA controller; a phase of certification of the temperatures of the livestock through visual control of the markers and finally a phase of registration in blockchain.

This tool therefore allows the operator to carry out a check on livestock at any time (Ali et al. 2019). This allows us to pursue excellent standards of control and quality of the environment in which the cattle reside as a dairy company.

In order to assess the level of electromagnetic pollution decrease compared to the use of smart-tattoo with the use of RFID, it is therefore possible to monitor the EPD (electromagnetic pollution decrease) parameter at a defined time t is defined by the following easy formula:

$$EPD(t) = sum\,(polluting\,sensors\,level\,for\,each\,head\,of\,cattle)/sum\,(head\,of\,cattle)$$

From the analysis of the EPD it is possible to carry out an analysis of the level of biocompatibility of the tools used and therefore of the improvement of the quality of the environment in which the livestock resides.

The pollution sensor level is described in a fuzzy level. The high level of pollution is 3, the medium level is 2 and the low level is 1. The level is related to quality (in function of the number of hours of exposition) or health limits. The quality limit is considered not respected because of the use for over 4 h in a same day.

For example, considering a head of cattle is characterized by a smart tattoo with RFID, the level associated to an smart tattoo characterized by active RFID is 3. The level associated to a smartband BLE device is 2. The level associated to a DoA emitter device is 1.

Considering a single head of cattle with smart tattoo with RFID the result of the EPD is high. Hence, EPD value is equal to three, which represent an high level.

Considering a DoA emitter device the EPD (t) would be 1 (low).

Considering 20 head of cattles with RFID smart tattoo the EPD (t) value is 3*20/20 = 3 (high).

Considering 10 head of cattles with RFID and 10 with DoA emitter EPD ($t+1$) value is 1*10 + 3*10/20 = 2 (medium).

A possible revolutionary contribution to livestock tracking systems without environmental impact.

The above, in addition to pursuing the main purpose of effective and certain control of the supply chain, has an ethical declination identifiable in the rules and principles of social responsibility set out above. The latter has a natural evolution in containing the risks that workers may encounter during the performance of their activities; in the context of the food chain of dairy products, biological risk becomes the main problem to be contained and addressed (Tiozzo et al. 2019).

As regards biological risk, also called bio-risk, it refers to substances of biochemical origin that are potentially harmful to the health of any living being and these risk factors include microorganisms, viruses and toxins. Biohazard naturally affects every environment and sphere of human daily life including, of course, work environments which can represent a more or less significant biohazard which in turn entails more or less serious consequences for the workers who work there. As regards the biological danger in dairies, this is mainly represented in critical points of the production chain:

- Supply and storage of milk;
- Laboratory analysis of milk;
- Seasoning of the cheeses;
- Treatment of water discharges.

The effects on health can be different and highly specific based on the type of risk with which one comes into contact and the physiological predisposition of the individual. Among the main health effects are asthma and rhinitis, infections by pathogenic microorganisms potentially present in milk (salmonellosis, tuberculosis, brucellosis), infections by pathogens present in the sewage treatment plant (hepatitis A, tetanus, typhus, leptospirosis).

Naturally, the competent bodies propose and suggest some prevention and protection measures such as adequate maintenance of air conditioning systems, to prevent mold from accumulating, containment of dustiness, periodic sanitation of the environments, individual supply of specific PPE, periodic cleaning of the forms to avoid the accumulation in the environment of mites and fungi, vaccine prophylaxis (if available), adequate information and training of personnel on biological risk and health surveillance for laboratory workers.

Reasoning with a view to social responsibility, these risks are foreseen by the manufacturing company which implements specific operations and procedures aimed at safeguarding the physical health of its employees. Of course, regardless of the adoption of CSR, each company follows specific prophylaxis for the prevention and containment of specific biological risks (Singh et al. 2020).

The most immediate and current formula to implement social responsibility policies is the one that today saw the national and global epidemic of COVID-19 as the protagonist, which has pushed all Italian and foreign companies to adopt strategies that guarantee, in all possible ways, work continuity in safety for their workers.

From the sanitation of the plants to the shifting of staff, from the implementation of smart working to the large quantities of PPE, each company has been deeply shaken to awaken its most sensitive and responsible part.

At an international level, some references show the possibility for companies to adopt market crisis reaction schemes for any damage caused by the pandemic, which is clearly exposed in Y. Wang's paper, which shows the reactions to companies in case of market stress and shock caused by the virus (Wang et al. 2020).

The spread of the virus in the production chain is in fact an aspect not to be underestimated; safety during business processes is of primary importance (Rizou et al. 2020). The emergency dictated by COVID-19 has attracted the entire Italian and foreign production fabric, which has long been sensitive to issues of sustainability and corporate social responsibility, to commit to achieving a general profit that mainly involves safeguarding employees and third parties (He and Harris 2020).

The security to guarantee employment for workers must be considered as included in CSR and some companies are also moving towards the creation of intertwined supply networks (ISN), with great elasticity that allows them to undergo major changes without serious damage (Ivanov and Dolgui 2020). The conversion change and acceleration of entire production plants, which have changed shape and format to adapt to the fight against the virus, are unequivocal signs of an awakening of consciences in the field of social responsibility (Mollenkopf et al. 2020); reaching the awareness of a restructuring of the design of the product chain to predict the possible impending risks and to analyze how to behave in cases where these situations may occur again, analyzing pandemic supply risk mitigation measures and potential recovery paths (Ivanov and Das 2020). There is also the possibility

of a creative push on the part of companies for the centralization of production processes thanks to low cost technologies to face the shocks of the production chain, such as 3D printed technologies with special printers (Armani et al. 2020).

The choice of certain strategies by small and large companies will turn, in the long term, in terms of reputation for the company itself, in numerous economic and financial advantages as well as in greater loyalty of the end customer who will see them as a bulwark of reliability and safety.

Although different national directives already oblige each company to pay greater attention to the safety of employees, workers, and third parties in this moment of high criticality, each company has shown great sensitivity and attention to the problem in question aimed not only at the continuity of production but also and above all to the growth of an awareness, from the point of view of social responsibility, that stakeholders, employees and end customers are the backbone for general profit and effective continuity of work activities.

6 The blockchain as a security guarantee

The technology called "blockchain" (literally in Italian "chain of blocks") is a shared and immutable data structure and is defined as a sort of digital register whose entries are grouped in blocks linked in chronological order and whose integrity is guaranteed by the use of encryption.

It can be imagined as a concatenation of blocks consisting of the set of verifiable transactions, with a vertical or tree structure, capable of connecting different nodes, which are used by subjects to take part in the decision (Fig. 5). One of the fundamental characteristics of the blockchain is that of being comparable to a ledger in which each operation is recorded in the system and cannot in any way be changed, modified, or tampered with (Nofer et al. 2017).
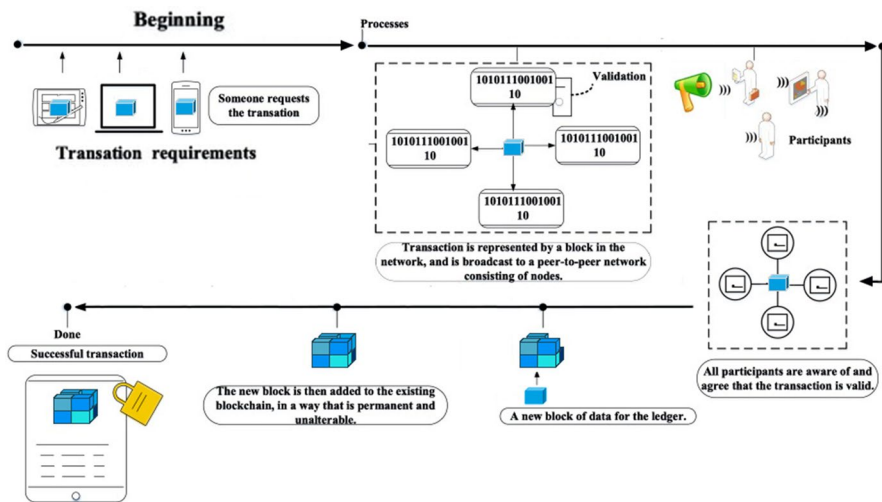
Fig. 5 Blockchain operation process. Adapted from Feng et al. 2020

Before the advent of the blockchain, in relation to systems that already allowed the exchange of transactions and information, the concept of centralized logic was prevalent, in which everything referred to and was managed by a single unit or authority (Wang et al. 2019).

With the concept of decentralized ledger, we are witnessing a phenomenon of decentralization of information, that is, it is no longer guarded by a single central unit but moves to the peripheries, becoming increasingly important in the transaction. The real innovation, however, is represented by the transition from the concept of decentralized ledger to that of distributed ledger (Fig. 5).

This is the point that most characterizes the advent of blockchain technology (Ozdemir et al. 2019). The concept of ledger distributed in equal copies of information to a multitude of people allows to evolve in a logic of governance.

The primary logic thus becomes that of trust between all the subjects for which the decision-making process passes through the construction of consensus among all the participants, each of whom has the same information as the others. The first real blockchain was introduced in 2008 and implemented the following year to act as a ledger, or register of all transactions, of the nascent digital currency bitcoin (Crosby et al. 2016).

Specifically, a blockchain is an open and distributed digital register, capable of storing data records securely and permanently which, once written in a block, cannot be retroactively altered without all subsequent blocks being modified and this, due to the nature of the protocol and the validation scheme, it would require the consent of the majority of the network. A node, after verifying the entire blockchain, collects and collects the new transactions generated yet not validated and suggests to the network what the new block should be (Drescher 2017).

All transactions on the ledger are digitally signed by the holder of an account on the network and this provides three key properties of the ledger, namely authentication, integrity, and non-malleability (Fig. 5). Each clause is discussed and approved by both parties before being entered into the chain, and once approved, it is inserted into the first block and transformed from natural language into an encrypted language that can be understood by the system.

Thanks to the "backup" system, it will not be possible to find yourself in a situation where one party boasts the existence of a contract with some clauses and the other boasts the same type of contract but with different clauses; the blockchain is also equipped with a data saving system. In addition to the saving system, the contract is also duplicated so that it is always clear which original is shared by the parties themselves. A copy of the entire register is stored on each device-node of each participant so that each information record contains both the copy of the transaction and the block containing the transactions performed in chronological order; then protected by a Hash code.

The table above (Table 2) shows the processes of the production chain and the consequential benefits that this can derive from it, giving an overview of how rich this topic is and how many discoveries and applications it is still possible to make. In this research, however, the issue of safety is addressed, one of the most important steps for customer safety and for the transparency of products arriving at the end of the food chain.

Although blockchain technology was almost exclusively associated with the world of bitcoin, today, worldwide, we are witnessing an affirmation of this technology in the most diverse sectors.

One sector of use of the blockchain is that of cybersecurity; in fact, while consisting of a publicly accessible register, blockchain technology uses cryptographic keys that allow data to be verified and sent internally, ensuring that the information arrives correct from

Table 2 Possible blockchain applications in supply chain. Adapted from Rejeb et al. 2019

Inventory management and warehouse operations

Enablers	Processes
Smart racks	Route optimization, elimination of in-process collisions
	Fast, cost-efficient, and flexible operations
Smart glasses	Better handling of items that are hard to reach or 'dark assets' (i.e., items that are difficult to detect on the shelf or racks)
Monitoring cameras	Real-time visibility of inventory levels
Smart forklifts	Avoidance of stockouts
Smart warehouse management system (WMS)	Agility and fast responsiveness to inadequacies (e.g., misplacement of items)
	Workspace monitoring (e.g., for security purposes)
	Stock keeping units (e.g., pallets) recognition and localization
	Simultaneous threat detection and scanning for imperfections

Production and manufacturing operations

Enablers	Processes
Embedded machine sensors	Real-time condition monitoring
	Remote maintenance
	Predictive maintenance: Detection of physical stress levels, pile-ups, and prevention of failures
Machine analytics	Improved measurement of throughput, setup-time, and overall productivity
	Enhancement of both machine-to-machine and machine-to-human interactions

Transportation operations

Enablers	Processes
GPRS sensors	Continuous visibility of products along the supply chain
	Real-time shipment tracking
	Remote product sensing (e.g., temperature, humidity, vibrations)
RFID sensors	Protection and preservation of product quality
Routers	Improve activity bottlenecks and outdoor traffic, transport mobility, road and driver safety
GPS satellites	Maximizing fuel efficiency and optimize routing strategies
	Improved service delivery

the source to the recipients without the risk of interception and manipulation during the transmission process. Another sector of use is that of the electoral vote or, even if it may be somewhat surprising, the musical field.

Regarding the relations between blockchain and the EU, an official paper was released on the benefits of introducing this technology in various areas and a European Blockchain Observatory was then established in February 2018 to which numerous states joined and, on 28 September 2018, Italy has also become part of the European "blockchain partnership".

As anticipated, a fundamental factor of the blockchain is the absence of a hierarchy between nodes, aimed at ensuring maximum transparency, and at the same time secrecy, of the data. These are in fact a real numerical series accessible to all but encrypted.

Starting from this assumption, the concept of Big Data can be introduced, that is a very extensive collection of information data in terms of quantity, speed, and variety, which increases exponentially every time any operation is carried out (Giacalone et al. 2018a).

Each movement of any user leaves a trace that increases the already extensive amount of data, information, and at the same time of algorithms that then allow us to interpret and identify what we are looking for in an infinite numerical sequence.

This large amount of data often, depending on the contexts, needs to be made available and shareable, think for example of information shared between hospitals or banking information. During the sharing of such amounts of data, however, these could be lost, altered or out of date, or even acquired by unauthorized third parties.

The close link between Big Data and blockchain is revealed above all in this aspect and in the resolution of this problem (Giacalone and Scippacercola 2016). In fact, this could give the possibility to share and make a large amount of data accessible to all users of the chain, eliminating or minimizing the possibility of error and corruption.

Chain sector, although it represents a great innovation, should not be considered as something incompatible. In the international literature, there are other examples of a use contextualized to rural or food sectors of the blockchain that have given us hope in the construction of this paper and thanks to which it is possible to extricate in the immense existing literature. The possibility of digital optimization in the development phases of a product is confirmed to bring numerous benefits (Fig. 6), regarding the safety of the production process and the guarantee of traceability that can meet the needs of the consumer (Rejeb et al. 2019). The benefits also extend to the identification of operational disruption or disruptions in the production chain that are re-traced and managed before a system collapse occurs (Suhail et al. 2020).

Feng and Wang wrote an article about blockchain-based solutions for addressing food traceability concerns, traceability systems implementation by proposing an architecture design framework and suitability application analysis flowchart of blockchain based food
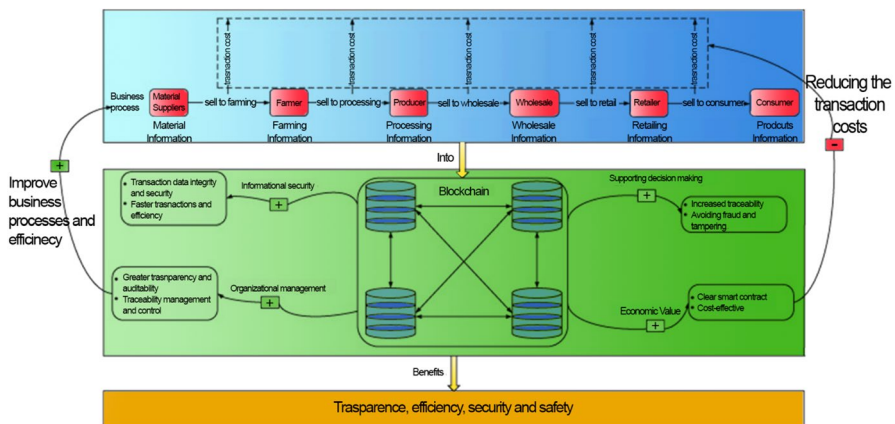

Fig. 6 Blockchain benefits in supply chain. Adapted from Feng et al. 2020

traceability systems (Feng et al. 2020). In a similar way, the article by Demestichas also deals with the topic of traceability in terms of the Internet of Things and Blockchain, but also gives a great vivacity to the existing literature (Demestichas et al. 2020). A more stable and adaptable approach is given, again in this sector, by Patelli and Mandrioli. They suggest a logical scheme in order to favor the identification of the BC structure that is more appropriate for each agrifood supply chain (Patelli and Mandrioli).

There are also numerous testimonies of use of services by third parties, such as oracles, whose use in the production system is addressed by Caldarelli in his paper, also the great starting point for the observations made in this article (Caldarelli et al. 2020).

Furthermore, the growing maturity of the concept of Big Data itself underlines the differences with business intelligence, especially in terms of data and its use (Ruoto et al. 2017).

7 Blockchain consortium as an anti-avoidance solution

The system based on the Internet of Things and artificial intelligence, while being an excellent solution for the "improve" phase in terms of DMAIC, nevertheless encountered the problem of possible avoidance of the same. In fact, this problem was based on chains of normal, organic, or DOP products. Tracking, in fact, was carried out through paper registers or digital platforms.

However, these systems were easily circumvented as they did not allow the individual phases of the supply chain carried out by the various operators to be certified at a temporal level. This certification can also be particularly useful for the bodies in charge of control and third-party quality control bodies.

In the aforementioned context, the object of the further conception, design, and implementation (in 2018) was essentially that of carrying out a blockchain-based system for the certification of a dairy product chain (normal, organic, DOP) including a network of markers unique associated with the individual dairy cows to be monitored via HMI interface (Germanò 2009).

The HMI interface is used by the operators of the supply chain (eg producers, auditors). All the phases carried out on the individual head of livestock and the subsequent batches produced are tracked in the distributed database module (ledger) which records the time of the supply chain activities in accordance with the supply chain regulation (McWilliams et al. 2006) managed by a semantic knowledge base. (knowledge base) present on computer (Pyzdek and Keller 2003) equipped with web-server.

The interaction between the computer and the HMI requires the use of an Internet connectivity interface (Visser 2008) by means of a WIFI NETWORK or Internet Gateway.

The processor is also able to verify the data acquired by the distributed ledger system, generating the related alerts. The HMI interface is also used for the management and monitoring of the entire supply chain process.

Writing in the ledger can concern both the suitably coded content, a hash of the single-phase, a hash of the dump of a series of transactions (e.g. daily transactions).

To ensure the robustness of the system, it is also possible to send this hash by certified e-mail, but it is only useful in the Italian context (Giacalone et al. 2019). This alternative is more advantageous in economic terms than the use of the timestamp, which represents

a valid alternative in the Italian context. The blockchain has international validity and ensures remarkable standards with limited costs.

A single transaction in the blockchain is therefore defined as T_F (ledger tuple):

$$T\_F = (set\,(T\_F\_prev),\, reference\,garment/batch,\, \sup ply\_ref,\, user,\, temporal\_ref,\, action,\, blob,\, outcome)$$

where we consider the head of livestock or the reference lot, the reference to the supply chain, the user, the time reference, the action performed, a multimedia type blob field (for information in the form of audio, video, photography), and the outcome of the operation carried out.

The set (T_F_prev) represents a vector of hashes that guarantee the connection to the previous blocks of both the blockchain and the reference item/lot. The verification of the correctness of the phases of the supply chain is implemented thanks to the semantic knowledge base.

From the monitoring of supply chain transactions, it is possible to find anomalies and generate compliance reports (certified by the temporal guarantee of the transactions) useful for controls or audits.

This certification can be implemented both from a permission-less blockchain perspective (through a public ledger) or from a consortium perspective, where the individual nodes of the blockchain are the individual operators of the supply chain.

All to pursue the principles of transparency, respect for interests, ethics and develop the issues of the environment, consumer protection, good management practices, involvement, and community development at the basis of the social responsibility of the ISO 26,000 standard.

8 Gioiella chain app

The software implementation carried out on the system described by the two invention patents is the Gioiella Filiera application developed by the innovative SME iInformatica S.r.l.s., an experimental cloud platform created based on the new technique covered by the invention patents of the Capurso Azienda Dairy. This platform combines the technology of the internet of things and the blockchain, thus enabling the supply chain process to be implemented.

Since the application uses artificial intelligence modules, it is very simple and intuitive. The modules based on verifying the compliance of the geolocation with the supply chain requirements are performed transparently by the app (with the consent of the operator).

In Fig. 7 we can see the main menu that allows us to access the various sections of the app.

By accessing your livestock menu (Fig. 7) there is therefore complete management of all information on livestock, in fact, it is possible to search for any dairy cow by name, code, or QR-code and view the information on it, including weight, variety and other information, it is also possible to compile new audits and view the audits carried out, a fundamental part to remain in conformity with the DOP denomination. By accessing the audit screen, you can:
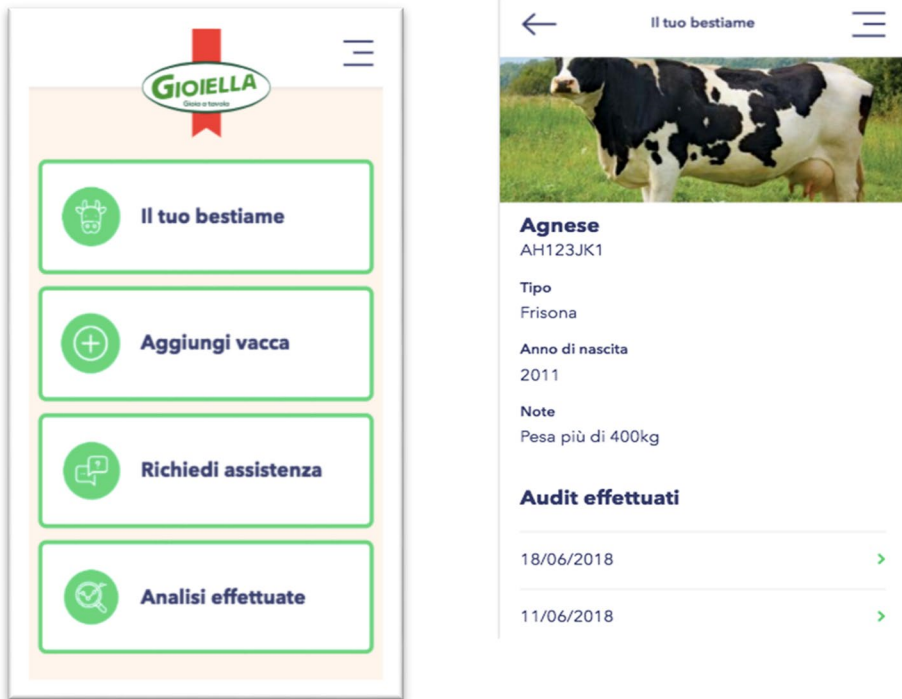
Fig. 7 Gioiella App (in Italian language). Source: Own elaboration

1. Carry out the audit using a checklist (Fig. 8), supported by multimedia content.
2. View the audits carried out over time having very easily a report on the production quality relating to the dairy cow taken into consideration thanks to targeted questions that provide a clear idea of the quality and compliance with the DOP denomination, but more importantly the system will have available all the information that will allow him, thanks to the artificial intelligence inside the software, to determine the trend and compliance of the entire cattle in real-time.

The section carried out is also available where you can have a summary of all the analyzes, with the possibility of tracing the batches of milk produced, destroyed, and delivered and their management in the plant.

9 Final remarks

The above described and articulated represents the three-year path of industrial research and experimental development that has effectively demonstrated how much innovation and continuous improvement are of fundamental importance in the contemporary age for increasing the competitiveness of each company (Giacalone et al. 2016).

Fig. 8 Gioiella Filiera compliance checklist (in Italian language). Source: Own elaboration

A similar path, of course, can be declined in contexts different from that of dairy production. Capurso Azienda Casearia S.r.l., a historic company in southern Italy, has put in place, during this three-year course, excellent and different skills that embrace multiple fields of knowledge; in fact, the company know-how varies and oscillates from high technological skills, such as DoA and VLC, to ethical-legal skills, such as CSR and 231 compliance.

The invented method has allowed us to achieve important milestones to enable monitoring and control of the supply chain. Through this approach, it is able to synthesize numerous compliance in a quick and accessible way to all accredited users, allowing the planned control of the livestock, the tracking of the entire supply chain, and to build a communication system with the dairy staff.

An important innovation is that we have implemented social responsibility under a different aspect from its typical use, we do not use it merely from the point of view of compliance with the laws, but, according to a series of behavioral practices that are implicitly adopted by companies according to an assessment of the possible benefits that these practices generate to itself and to the area in which the company operates.

Therefore, strong synergy has been created between the various components (Fig. 9) such as to direct and enter the company in a much wider panorama, opening up new economic opportunities and growth opportunities in ethical, professional, and financial terms.

The attention paid by the company, during the performance of its activities, to the key principles of corporate social responsibility, further increases the identification of Capurso Azienda Casearia S.r.l. as a reality inspired by the territory and devoted to the same which, wanting to maintain high standards of Gioia Del Colle DOP mozzarella, has not neglected the strong link with the territory to which it belongs, encouraging, even more,

Fig.9 Illustration representing the DOP by Gioiella supply chain (IoT, AI, Blockchain, DoA, CSR). Source: Own elaboration

the possibility of an all-round development not far from the reality of the south. On the basis of the conducted research, we can finally state that corporate social responsibility involves practices aimed at having a positive impact on the community in which the analyzed company operates and even at creating a positive brand image for the some company.

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