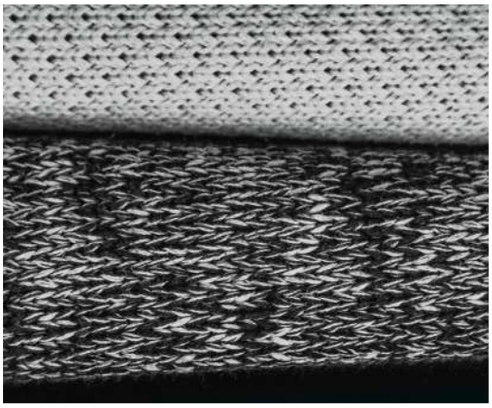


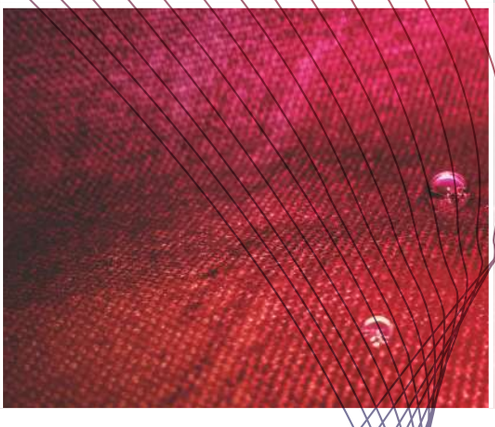
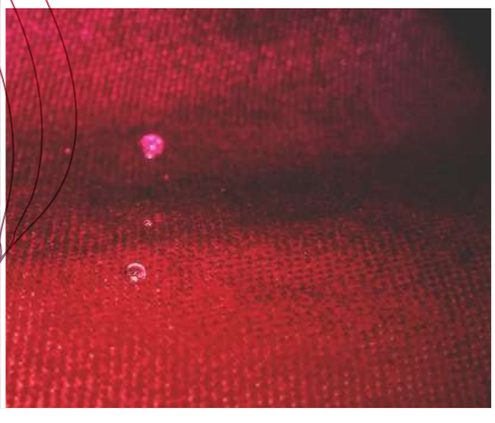

BLOCKCHAIN FOR MADE IN ITALY TRACEABILITY:

Origin, Quality, Sustainability




Case study
applied to the
Textile sector

SUMMARY

Ministry of Economic Development

in collaboration with IBM

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BLOCKCHAIN »

Ministero dello sviluppo economico

Blockchain for Made in Italy traceability: Origin, Quality, Sustainability

IBM

PREMISE: PROTECTING MADE IN ITALY WITH BLOCKCHAIN ››

This document reports on results of a feasibility study pertaining to the application of blockchain technology to one of the most significant sectors of Made in Italy, the Textile sector.
The premise shares the rationale which led to the development of an ambitious and undoubtedly innovative project. The initiative is significant not so much in terms of the numbers which characterise it, but rather due to its systematic scope, the involvement of the Ministry of Economic Development, exposure at national level and the methods used to conceive and handle it. All this has culminated in a veritable paradigmatic model for approaching issues regarding traceability, for various sectors of Made in Italy.
The idea underpinning the project is that technology in distributed registers can play a key role in improving transparency when offering Italian products to consumers.
These aspects appear to be advantageous to companies and firms operating in the country, small to medium sized enterprises in particular, which despite making up a fundamental portion of our social and economic system, often find themselves having to compete in unbalanced conditions, within complex and extensive national and international supply chains.
Blockchain technology can be a highly useful instrument for such companies, because it enables them to leverage the quality and excellence of their own production, so that they take on a more prominent role and therefore boost their negotiating power in different value chains.

A “NEUTRAL” PLATFORM

“Neutrality” is a cornerstone of this project, which has not been developed to favour or protect the interests of a single company, but rather to become a shared resource, available to the entire supply chain and, in perspective, the country as a whole.
This is why, as will be argued in greater depth in the following pages, the project developers have gone to particular lengths to define a path along which stimulation and governance actions could be calibrated, so as to create a system equidistant from the interests of big operators and the requirements of small and medium sized industrial enterprises.

AN “INCLUSIVE” APPROACH

As already known, blockchain technology has a series of intrinsic characteristics which enable it to safely and unchangeably trace transactions carried out along a certain supply chain, without requiring an intermediary entity attributed with the task of managing and certifying transactions.
A technology which does not require central trust services or intermediaries which carry out the role of guarantor between parties (trustless). When outlining the project path, an open and inclusive approach was adopted, to involve and onboard all potentially interested players.
Indeed, a further distinctive characteristic of this project is its “inclusive approach”, adopted right from the outset and not starting “from the technology” but rather “from the requirements” of companies, associations and all other players which interact in various ways along the supply chain. The aim here is to build a traceability system which is not perceived as a pre-packaged solution imposed from above, but rather something that could culminate in a pondered and shared result of a collaborative supply chain process.

> “A NEUTRAL PLATFORM DESIGNED TO BECOME A SHARED RESOURCE

This is why the entire project path was structured into a series of phases (context definition, identification of requirements, experimentation and feasibility analysis) which should not be read as the steps of a consolidated methodology, but rather as essential tools for building a shared vision of issues and priorities to be tackled, with the constant support of the Ministry of Economic Development, IBM and all companies and associations involved.
During various work sessions (meetings, workshops, design thinking sessions, etc.), the foundations were built for a new possible model for a plural work method, involving not just the promulgation of directives and guidelines, but which can also develop thanks to closer collaboration with the world of companies and professionals.
The objective of the project, the very essence of what was at stake, was more than just producing a report or experimenting with innovative technology.
The spirit of the project was to elaborate a new work model to find tangible solutions to real problems “together” and to identify the necessary infrastructures, to enable companies to compete in new ways on the international chessboard.
In this sense, irrespective of technological and operative results achieved, the project traced a new path and proposed a new work model.

> “
> A MODEL FOR APPROACHING THE TRACEABILITY REQUIREMENTS OF A COMPLEX ECOSYSTEM

RESULTS AND BENEFITS OF THE PROJECT

The following pages contain details on the objectives, activities and results achieved during the project. Here it is important to note how the advantages of the special set-up requested by the Ministry of Economic Development and the work carried out by IBM, participating companies and associations, enabled the following:

- definition of a model for approaching requirements pertaining to traceability for a complex, structured and replicable ecosystem. Various phases into which the project was articulated, developed methodologies, conceptual frameworks and analysed case studies can be easily replicated, adapted to other contexts and constitute a heritage of experiences and new collaborative project development methods which can become an element of Made in Italy value for exportation throughout the world.
- the schematisation of the supply chain elaborated during the project. This representation, extensively described in this document, contributes considerably towards the conceptualisation of cooperation and inter-chain traceability which can be easily adapted to other sectors of Made in Italy. It is important to note that one of the most significant aspects of the project is the effort which went into schematising and modelling relations and traceability needs among various players of a supply chain, which can be easily adapted to other contexts and situations.
- the actual technology developed during the project (POC), which was the subject of the conclusive experimentation, is an indisputable asset available to Made in Italy companies and can be reused, developed and enriched to make it increasingly functional to the requirements of companies and organisations and integrated with their internal operative infrastructures.
- the evolutionary process defined for the project scale-up is in turn a model for harmonious and inclusive growth which can be easily replicated and adapted to other contexts, in order to define development paths suited to different project requirements.

A NEW WAY OF CREATING A SYSTEM

Therefore, the true value of the project does not lie in its single components, but rather in how it has proven that a collective work experience is possible, useful in attempting to jointly resolve problems which can usually only be tackled by multinational companies or large consortiums.

PREMISE: PROTECTING MADE IN ITALY WITH BLOCKCHAIN

The challenge launched by the Ministry of Economic Development with this project (“understand the problems of the Made in Italy supply chain to find, if possible, a shared solution in an attempt to understand the role blockchain can play within it”), has extended beyond the technology itself.

Experimentation led to the realisation that in order to restore the competitiveness of enterprises, the correct approach is the one which enabled our country to generate the qualities of excellence which still distinguishes it at an international level: manufacturing capacity, creativity, artisan skill, competencies, culture and the ability to create a system.

In this sense, blockchain can be seen as one of the major enabling technologies for reinforcing the ability to create a system around the most profound and consolidated values of our society.

> “
> BLOCKCHAIN: A NEW WAY OF CREATING A SYSTEM AND RESTORING VALUE TO ITALIAN EXCELLENCE

EXECUTIVE

SUMMARY »

Ministero dello
sviluppo economico

IBM

EXECUTIVE SUMMARY ››

This document describes the project commissioned by the Ministry of Economic Development, developed in collaboration with IBM, associations and companies involved, to assess the applicability of blockchain technology in support of the traceability and promotion of **Made in Italy.**
Considerations reported here below come from the experience of project participants, the observation of reality and the experience of IBM.
The underlying project vision is that new technologies based on distributed registers can contributed towards improving the transparency and protection of Italian brands, to the full advantage of small and medium sized enterprises in particular, which may be interested in promoting the value of their production within the supply chain and with end consumers in the country and beyond.
In order to explore the potential of the proposed technological paradigm, the decision was made to analyse the special features of a specific sector – textiles – and to focus on the issue of traceability, based on the following fundamental dimensions: **quality, origin, environmental and ethical sustainability**.
The technology selected to respond to identified requirements is **blockchain,** which in virtue of its intrinsic characteristics, enables the tracing of transactions carried out along a certain supply chain, in a safe and immutable manner.

With blockchain, control activities are automatic: this means that all supply chain players can verify each transaction at the same time, ensuring the monitoring of overall product quality.

The use of blockchain enables various supply chain players to generate greater visibility within the production process and simplify complicated and expensive phases, providing the following advantages:

- standardisation and immutability of information;
- safety and authenticity of product information;
- optimisation of *Supply Chain* (shared access to information);
- reduction of disputes over transactions and exchanges;
- automation of processes and improvement of overall productivity (formalisation of automatisms and automatic controls).

In order to carry out an initial analysis, with the support of trade associations, a **group of companies representative of the main players of the textile supply chain** in the country was identified. Companies were involved in all project phases, enabling the sharing of knowledge and different points of view.
The project was rolled out in different phases, each one characterised by the adoption of a specific work methodology. Each phase enabled the definition and collection of requirements for successive steps, with the involvement of all identified players.

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FOCUS ON QUALITY, ORIGIN, ENVIRONMENTAL AND ETHICAL SUSTAINABILITY

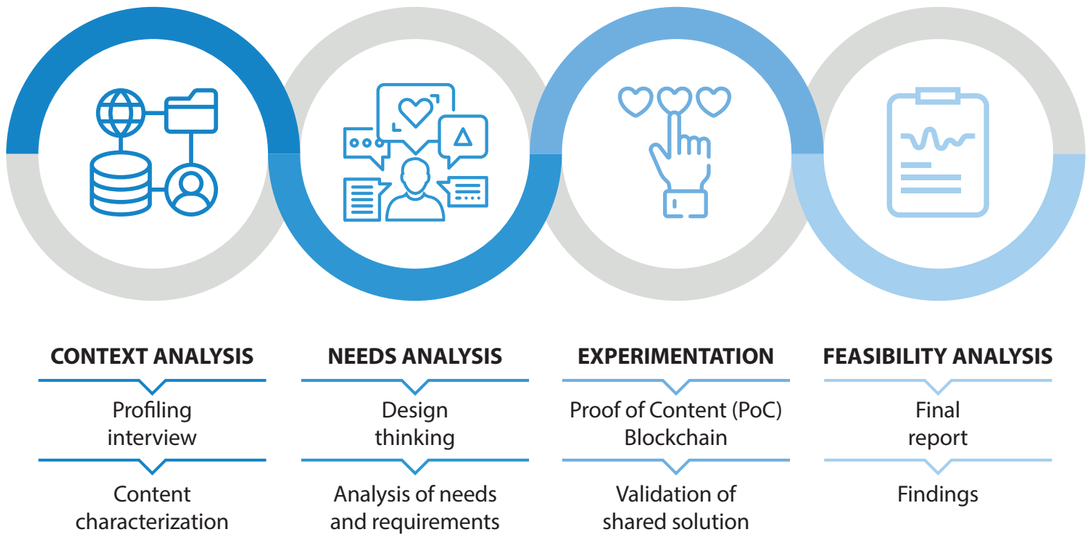


Figure 1 – The Project

PHASE 1: definition of the sector, companies and technology

Characterising the reference context is the preliminary step towards the development of any solution. In order to understand the profile of companies operating in the textile supply chain, a **questionnaire** was drawn up, collecting main reference data (number of employees, turnover, presence in the country, etc.). Companies were also requested to share their own level of knowledge of the selected technology – blockchain – with the purpose of assessing whether they were aware of its characteristics, whether it had already been adopted and whether interest in the project was high or otherwise. As completion of this phase in order to start works, a **workshop** was organised on blockchain technology, to share the most significant aspects and main benefits, analysing successful case studies on the market.

PHASE 2: analysis, definition of needs and requirements

Companies notified their participation in the initiative and the most representative ones of the supply chain were selected from among them, guaranteeing coverage of different roles of the production chain and favouring the involvement of enterprises throughout the country. Selected participants were involved in a **Design Thinking workshop** [1], with the aim of characterising the textile supply chain more effectively, not just with numbers and statistics, but by understanding difficulties and concrete needs as described by those who work in it every single day. After identifying major issues, work groups developed proposals for improvement, at process and activity levels, in order to overcome shared limits and difficulties.

PHASE 3: experimentation

The output of the Design Thinking phase was the preparation of a document containing reflections and information which emerged during the day, together with problems and hypothesized solutions. Those most suitable for inclusion in the experimentation phase were selected, based on their relevance for players and feasibility of implementation, for the creation of a Proof of Concept (PoC)[1].

[1] Also known as “proof of feasibility”: the partial creation of a certain project to prove its feasibility or demonstrate the validity of certain principles or founding principles.

PHASE 4: feasibility analysis

The methodology adopted during the project and main results of analyses carried out were collected in this feasibility analysis document regarding the potential of the technology. Before proceeding with the detailed analysis of the methodology adopted during each work phase, we present major considerations expressed by companies after testing the created Proof of Concept.

“

AN OPEN PATH WHICH ENABLED THE COLLABORATIVE IDENTIFICATION OF PRIORITIES TO WORK ON

MAIN FINDINGS WHICH EMERGED ››

Activities carried out to characterise the reference context resulted in the drawing up of requirements and desires of companies with reference to the functionalities that a blockchain-based solution should have in order to respond to the traceability needs and support for Made in Italy.
The development of a PoC enabled the implementation of some of these functionalities, albeit in a simplified way. The PoC was created using the framework Hyperledger Fabric [21], as chosen by the technological partner and based on their own experience. It was deemed that said technology was suitable for satisfying important requirements necessary in a market context (like enabling access only to companies who have or will have authorisation), and it was made available on a Cloud for testing by companies. The created network consists of **two nodes**, on which five types of players, identified as necessary in order to characterise the (simplified) ecosystem of the reference case, were able to act: the raw material cultivator (often not located in Italy), the certifying authority, manufacturing company, the brand and the end consumer. Project participants were requested to test the solution created. Reference cases were of a company which issues its suppliers with an order for a batch of linen, checks that the fibre is organic certified and uses it to make shirts for a particular brand. Downstream from the test sessions, considerations emerged from companies for addressing possible future developments.
Participants highlighted how the solution of the to be scenario must not be an implementation of a new management system **(ERP)** – reproducing the same sale and purchase logics as those between customers and providers along the supply chain.

> “
> **AN INFRASTRUCTURE THAT IS EASY TO USE AND CAPABLE OF INTEGRATING WITH EXISTING BASES**

On the contrary, a desire for a blockchain-based solution was expressed which simplifies interactions between companies and certifiers for the sharing of data and documents and at the same time, guarantees each player immediate access to information on product origin and quality. For this to be possible, from a technological viewpoint, the future blockchain must interface, in accordance with **integration logics**, directly with the management systems of companies, synchronising necessary information on products/processes and avoiding the duplication of management efforts.
In addition to the requirements of integration with existing databases and **simplicity of use**, participants expressed a desire for a system which enables the exchange of information almost in **real time**, so as to be compatible with company logics, without any online validation (for example, certifying authority approval) resulting in a slowing down of logistics operation due to waiting times for authorisations.
The solution must also be sufficiently **scalable** to welcome new players, like subcontractors and analysis laboratories, fundamental in the reference ecosystem.
Lastly, the **duality** of desired goals was also observed: on the one hand, the tool should present the consumers with all information on the product so that they can proceed with an aware purchase, avoiding graphics like “traffic light” indicators (perhaps resorting to holistic, recognised overviews such as the Higgs-Index[2]); on the other hand, the importance of enabling more transparent work methods was noted, to enable visibility and reward the most virtuous players in the supply chain, also with recognitions of an economic nature. From a technological point of view, this means implementing logics for the segregation of available data, distinguishing between the different roles of everyone who connects to the blockchain and between different supply chains involved in the same blockchain.
The creation of a platform based on blockchain which implements all identified requirements is achievable only through a gradual and progressive growth process of the traceability system under experimentation. A modular approach could guarantee a number of “core” services and, based on the logics of ecosystem evolution, enable the identification of a set of additional services available for activation on demand by companies involved in the ecosystem.

[2] https://portal.higg.org/

The need to adopt a **modular approach** is in line with what emerged during discussion with companies, namely the development of a long-term strategy to achieve pre-set objectives. Said structure also enables the tackling of certain structural and characterising conditions of the supply chain, requiring a necessary transition time in order to achieve the final, desired configuration.

> “
> **ALL PRODUCT INFORMATION ENABLING CONSUMERS TO MAKE AN AWARE CHOICE**

In short, what emerged from the project can be summarised as follows:

- Company **knowledge of emerging technologies** is still limited and therefore a suitable accompaniment process is necessary to facilitate the exchange of experiences and sharing of best practices.

- From a company point of view, benefits and incentives are required to favour the adoption of such technologies and the participation of different supply chain players.

- Normally **product information is distributed between different players**. An overall coordination strategy is required to boost the industry's ability to recount their story and values.

- The industry cannot be closed: it is necessary to guarantee **inter-operability between different blockchain networks** and enable access to all interested parties, by defining suitable operative methods and opportunities for differentiating various value transactions.

- **Many processes are still mostly traditional**. Guidelines, contractual standards and common languages are necessary (using and promoting those already in use in the industry, like eBIZ [2] [3] – the standardised language for the exchange of data and documents in the textile/clothing/footwear industry), not only to reduce implementation costs but also to stimulate an approach towards digitalisation, starting from major value hubs and involving interested public entities as well.

- Data are considered an asset of single companies. Therefore guaranteeing **security and privacy** is vital in the handling of information, using standards and establishing guidelines on how to share and transform them into new value for companies and the system.

- **The quality of data** available along the supply chain, considering both their completeness (requiring the participation of all players, including less technologically equipped ones) and consistency (semantics and unambiguous representations), is a decisive element of the industry's digitalisation process and the combined use of standards, blockchain and light applicative solutions can make a decisive contribution. In order to validate entered information (i.e. certifications) and process legitimisation, it is important to involve control bodies right from the outset (for example Customs Agency for Preferential Origin certification).

- Blockchain can contribute towards making the industry more efficient, on the condition that suitable **governance instruments** are created, enhancing understanding of phenomena (analytical and forecasting models) and facilitating integration with internal processes of various companies.

- The objective of a sustainable industry can **evolve over time**. It is important to understand how to enable the continuous creation of value by facilitating, for example, the development of processes and instruments by companies and start-ups (integration kit[3], smart contracts[4], etc.) and innovative value sharing methods.

In conclusion, the project process developed over these months identified blockchain as a suitable technology for supporting and promoting Made in Italy, insofar as it enables:

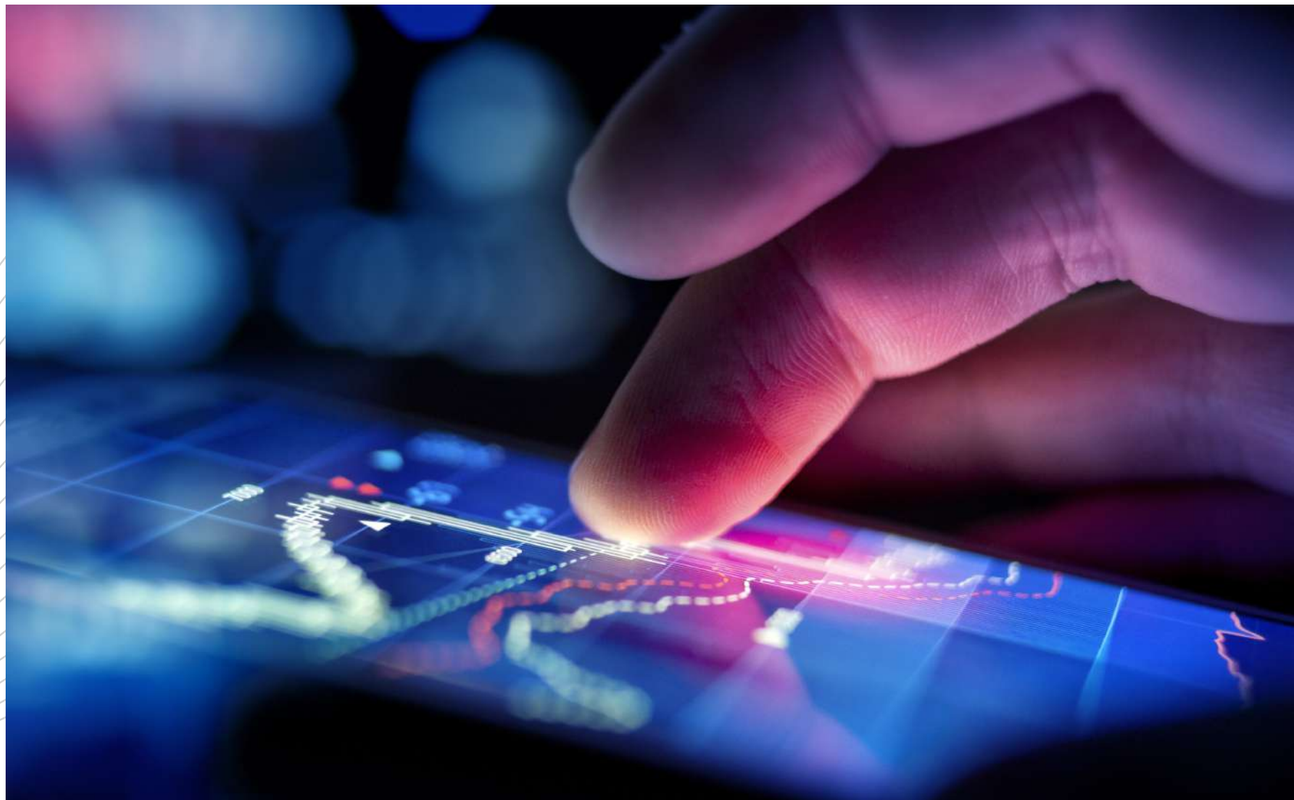
- **Democratisation** of the industry, placing all participants at the same level and favouring the creation of a veritable ecosystem as opposed to a vertical industry orientation, in which roles may be stacked in favour of the first in line.

- **Creation of trust** between participants thanks to transparency and the immutability of transactions.

- Rewarding of **transparency**, namely a willingness to provide reliable and complete information, with objective mechanisms.

- Promotion of an **'Open' system**, insofar as it is accessible to all interested players, when authorised by the network's governance models which can be designed.

[3] Integration kit: software tools facilitating single companies to join the project.
[4] A smart contract is a programme which operates on technologies based on distributed registers and whose execution automatically binds two or more parties based on predefined effects. Smart contracts satisfy the requirement of written form prior computerised identification of interested parties, by means of a process with requirements established by the Digital Italy Agency, with guidelines to be adopted within 90 days from the entry into force of conversion law of Legislative Decree (art. 8 bis).



THE ADVANTAGES
OF BLOCKCHAIN FOR

MADE IN ITALY »

Ministero dello
sviluppo economico

Blockchain for Made in Italy traceability: Origin, Quality, Sustainability

IBM

THE ADVANTAGES OF BLOCKCHAIN FOR MADE IN ITALY ››

Computerised processes adopted to date do not provide full transparency of processes along the entire supply chain, nor the exhaustive guarantee demanded by professionals and consumers regarding the origin or provenance of productions. Given that logistics and transport processes are often managed by non-automated channels (telephone, email, fax and other), or are based on hard copy documentation, as yet there is no connection between all enterprises, or a fully shared framework for the digital management of said processes. For example, the eBIZ framework for data exchange [11] is yet to be adopted by the entire industry and throughout the entire country.

To date, systems, people and processes which act and amend data, file them in different and separate archives, based on the supply chain they are part of. The fragmented, incomplete or contradictory nature of resulting information does not guarantee the reliability of every single product and hinders prompt action in the event of malfunction or irregularity. In this context, blockchain can provide a safe and distributed register of information with immediate access, reliable and of verified provenance, which can have the characteristics of impartiality vis-à-vis supply chain players, creating unprecedented and reliable connections between ecosystems, irrespective of interested product categories, which may include foodstuffs or refined fabrics.

In the following paragraph it is specified how this technology can support the promotion of Made in Italy products and as such can be applied to all sectors which represent it throughout the world – textiles, agrifood, wood and furniture, gold and jewellery, leather goods, etc.

BLOCKCHAIN IN SUPPORT OF TRACEABILITY AND TRANSPARENCY ››

Blockchain can be defined as a shared and distributed ledger which facilitates the registration process of transactions pertaining to an asset (subject of the transaction) in a business network (or ecosystem – in the case of studies regarding the industry).

As highlighted in fig. 2, all this means associating each physical object which transits from one player to another with a digital identity, thus facilitating traceability along the entire supply chain.

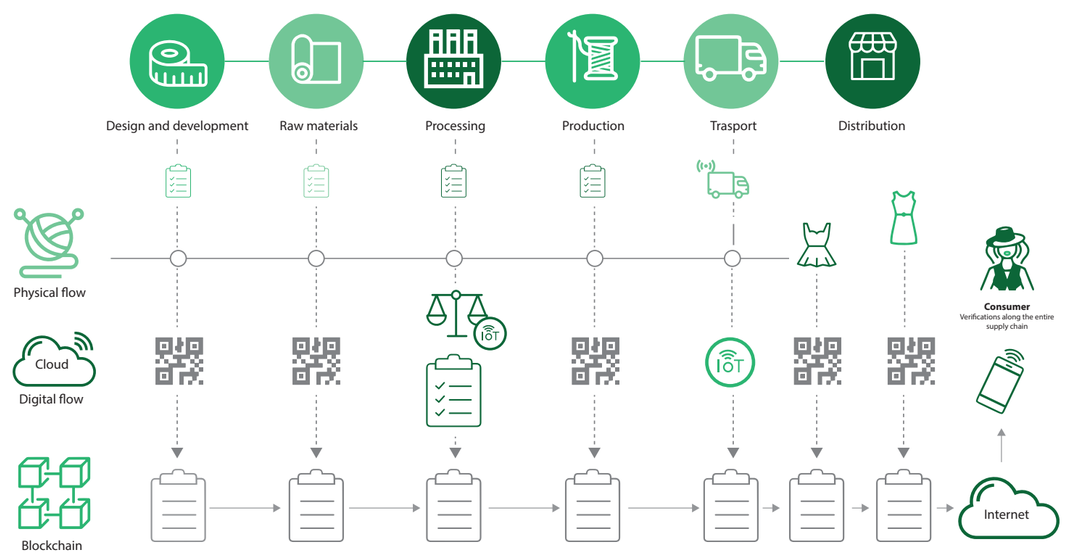


Figure 2 – Illustration of a digital flow of goods and information on blockchain for the textile supply chain

This scenario is possible thanks to the special qualities of blockchain technology:

- **Availability:** blockchain is shared, updated with each new transaction and made available to participants in real time.

- **Security and privacy:** the segregation of access and implemented encryption techniques prevent unauthorised access to the network, guaranteeing that participants are actually who they declare to be. Data partitioning techniques can also be implemented to give visibility only of information which each participant is authorised for.

- **Consent:** for a transaction to be valid, all network participants must agree on its validity. This occurs by means of consent algorithms which implement requirements set forth in Smart Contracts regulating interactions among players. The existence of consent over a transaction also forges a climate of trust among all parties. For example, it could be guaranteed that inspection certificates are authentic, as once uploaded and available for viewing on the network, it will no longer be possible to change or falsify them.

- **Transparency and control:** transaction participants have access to the same records, they can validate transactions and check identity or ownership without third party intervention.

- **Provenance:** information blockchains can be retraced from the last added block right up to the first, thus enabling the identification of the provenance of assets and their complete history. This helps to ward off any counterfeiting phenomena of goods, thus enhancing product quality.

- **Immutability:** no participants can amend a transaction once it has been registered. If a mistake is made, a new transaction must be carried out to correct it. In this way both transactions remain visible, guaranteeing the existence of a Ground Truth in the event of any disputes between parties.

- **Irrevocability (finality):** executed transactions are final and cannot be contested insofar as each is considered as the invocation of the rules of a contract (terms and conditions) expressed in computerised code (Smart Contract) and shared by both parties.

- **Flexibility:** given that business rules and contractual conditions can be directly defined on the platform, they can evolve as business processes they support evolve.

In a context in which many small players compete and collaborate through a supply chain which extends beyond national borders, the application of blockchain may have a positive influence on small and medium sized enterprises, because it simplifies interactions and transactions between players, including control bodies, certifiers, clients, manufacturers or subcontractors. Furthermore, the availability of an updated chronology of executed operations is a foundation upon which each network member can build their "reputation", insofar as they are responsible for recorded information. Consequently, companies can reinforce their position and visibility in the industry, both at a national level and vis-à-vis international competitors. Lastly, downstream from the production chain, improved traceability throughout the entire industry would make it simpler to develop applications enabling greater transparency for the end customers, so that they can make more aware purchases.

THE ADVANTAGES OF BLOCKCHAIN FOR MADE IN ITALY

> "AN INSTRUMENT FOR SMALL AND MEDIUM SIZED ENTERPRISES TO REGAIN THEIR COMPETITIVE EDGE, EVEN IN LARGE INTERNATIONAL VALUE CHAINS

TEXTILE SECTOR

USE CASE »

TEXTILE SECTOR (USE CASE)[5] ››

In order to concretely understand traceability issues, analyses were undertaken considering **the context and specific qualities of the textiles sector** insofar as it is historically representative of **Italian manufacturing excellence**.
The Textile-Fashion sector is extremely important for the Italian economy, both in terms of generated value and employment [5,6,7,8]. With a turnover of € 54,074 million (2017, up 2.4% compared to the previous year) and 400,100 people employed in 46,073 companies, the industry contributes approximately 9,6 billion towards the advancement of the sector, 9.9% of the total national manufacturing industry. Textile and tanning industries guide both internal growth and export; the latter grew over 3% from 2016 to 2017, totalling € 30.6 billion. Italy has confirmed itself as the world's major exporter of wool yarns and fabrics, the second biggest exporter of silk fabrics and the third biggest for hosiery.
Considering the importance of Italian product at an international level, promoting Made in Italy is a priority. At a time in which the volume of the counterfeit goods market is on the rises (estimated as totalling € 2.2 billion in 2015 [9]), companies, bodies and institutions must ensure that Made in Italy is synonymous with high quality.

[5] Data source: Sector Report 2017/2018 – The textile-fashion sector in Italy, edited by the Confindustria Moda study centre.

BILLIONS OF EUROS	2016	2017	2018*
Turnover	52.85	54.07	55.48
% change		+2.3%	+2.6%
Textile Turnover	approx. 19.82	approx. 20.1	approx. 20.54
% change		+1.4%	+2.2%
Turnover Clothing-Fashion	approx. 33.05	approx. 34	approx. 35.02
% change		+2.8%	+3.0%

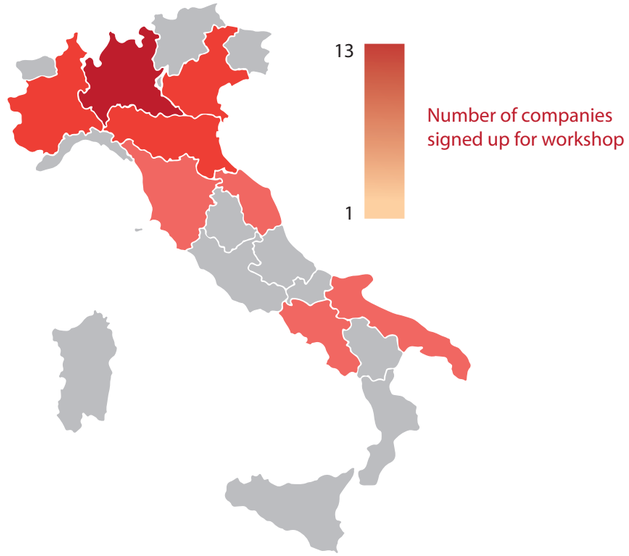
Table 1 – Revenue of the textile and clothing industry in Italy, years 2016 - 2018

BILLIONS OF EUROS	2016	2017	2018*
Exports	29.6	30.6	31.5
% change		+3.5%	+3.1%
Imports	20.6	21	21.5
% change		+1.9%	+2.4%
Trade Balance	9	9.6	10
% change		+6.2%	+4.8%

Table 2 – Data on imports and exports of the textile and clothing market (*forecasts)

THE REFERENCE MARKET

In order to understand the requirements of the textile industry in Italy more thoroughly, a survey was carried out involving a sample of selected companies (approximately 30) evenly distributed up and down the country (adjacent figure).
Those interviewed mainly work in the clothing industry, focused in particular on textile production: family-run businesses, with an average turnover of € 21 million and less than 100 employees each.
Companies were asked to specify what aspect of traceability was most important for their business, among the following:



- Supply Chain Certification; Environmental Impact; Quality of Production;
- Fight against Counterfeiting; Intellectual Property Control;
- Transparency for Consumers; Production Ethics; Brand Protection.

Interviewees were more oriented towards the issues of transparency for end consumers and product quality, followed by environmental sustainability and ethics.
The identified common need is the development of a traceability system which can become a reference point for all players in the supply chain and consumers in particular. Said system would enable the commercialisation of products with easily determinable origin, quality and sustainability, with attributes deriving from reliable and certified evidence.

Improving traceability along the supply chain will enable the reduction of negative impacts linked to the phenomenon of counterfeiting, while also supporting the textile industry to handle growing demands from consumers who are increasingly sensitive to environmental sustainability and ethical production issues.

NATIONAL AND INTERNATIONAL EXPERIENCES

This initiative is a collaborative project, to which companies have contributed with their experience and knowledge of the sector, embracing a front-line role. Over the last few years there have been numerous initiatives at a global level, promoted by bodies and enterprises, with the aim of supporting exponents of the textile sector, in the field of traceability processes for guaranteeing the quality of sold products. The table below contains information summarising major projects undertaken at national or European level:

BODY	INITIATIVE
TABORELLI	The project is called E.T.I.C.: European Textile Identity Card, and aims to give visibility to places in which spinning, weaving, fabric ennoblement and the creation of a garment, take place.
UNIONFILIERE	TF – Traceability & Fashion is the voluntary Traceability system promoted by Unioncamere (Italian Union of Chambers) and Italian Chambers of Commerce, managed by Unionfiliere. The system is operative in main Made in Italy production chains in order to guarantee maximum transparency for consumers, with reference to where main production phases take place and main product characteristics in terms of salubrity, environmental sustainability, corporate social responsibility.
ENEA	eBIZ, common language for the Textile, Clothing and Footwear industry, is a permanent initiative conducted by EURATEX (European Apparel and Textile Confederation) with the technical support of ENEA. eBIZ models exchanges of information in the fashion industry with collaboration processes and data formats, the specifications of which are published and available to companies.
CITTADELLARTE	Cittadellarte Fashion B.E.S.T. (Best Ethical Sustainable Trend) is an operative hub which since 2009 has been dedicated to the development of bioethical sustainability in the textiles sector. Therefore B.E.S.T. is a project for sustainable fashion, bringing together dozens of companies which manufacture fabrics, yarns and ecosustainable accessories [12].
CUSTOMS AGENCY	A project by the Customs and Monopoly Agency, blockchain for the tracing of the production chain in the alcoholic beverages sector – Genepì Piedmont.
UNIC	UNIC was promoted by a certification framework developed with ICEC (Institute of Quality Certification for the Leather Sector) to guarantee high traceability standards of leather [13].

Table 3 – Examples of initiatives regarding traceability for the Italian textiles industry

There are important international experiences which focus on the issue of traceability in the field of textiles, by exploiting advantages provided by blockchain. Some of the most interesting examples can be seen in table 4:

BODY	INITIATIVE
World leader of commercial and technological solutions for agrifood The Seam®	The Seam has established a consortium for the world cotton industry in order to create and use blockchain for registering and tracing the exchange of cotton in real time, along the supply chain [14].
Partnership between Provenance and the fashion designer Martine Jarlgaard MARTINE JARLGAARD	Partnership between Provenance and the fashion designer Martine Jarlgaard to keep a record of the journey of raw material along the entire supply chain up to finished garment [15].
Fair Fashion Center of Glasgow Caledonian GCNYC THE FAIR FASHION CENTER	The Fair Fashion Center of Glasgow Caledonian uses blockchain technology to document data flows between all supply chain participants, creating an efficient, transparent and verified system [16].

Table 4 – Example of international initiatives for the application of blockchain to the textile industry

CERTIFICATIONS

Along the production chain, companies are requested to certify the conformity of products and production processes with regulations and standards in force (as well as specifications requested by customers). Such conformity certifications are structural and functional requirements of the system which must be noted and acknowledged when developing a blockchain-based solution (specifications which can vary extensively are a different matter). In practice, they can impact rules included in the Smart Contract signed by network participants, binding for example the types of documents to be uploaded on the network. There are different plans for compliance with market regulations and standards.

1) THE REGULATORY PLAN

There are legal obligations which entrepreneurs must fulfil in order to commercialise their products in different countries.

In Europe for example, compliance with regulations set out as follows, is compulsory:

- Product safety (General Product Safety Directive GPSD 2001/95/EC).
- Contents of chemical substances (REACH – Regulation (EC) 1907/2006 and Persistent Organic Pollutants (POPs)), both for garments, leather and accessories.
- Labels and names of fibres (Textile Regulation (EU) No. 1007/2011). All products containing at least 80% textile fabrics or products made from them must have a label bearing the name of fibres used.
- CITES regulations for all products which use animal or vegetable fibres (transposed by the EU with Regulation 338/97).
- Intellectual property (product, brand, design, etc.).

2) VOLUNTARY CERTIFICATIONS

It is requested of certifying bodies from the single businessman, prior presentation of necessary documentation for required inspections. This category includes product and process certifications, such as quality and sustainability certifications ISO, OEKOTEX, GOTS and many others. These certifications are of limited duration over time, 1-2 years generally, and must be renewed.

3) QUALITY AND SUSTAINABILITY STANDARDS SET FOR CUSTOMER BRAND SPECIFICATIONS

In response to requests from the market and end consumers, a brand may require its suppliers to satisfy specific quality requests (for example the use of organic or recycled raw materials), although certifications of entire production chains are rare. Often such requests are subject to variation over time and according to orders. It is not unusual for a brand to request the *Scope and Transaction Certificates*, from own direct suppliers and sometime from their subcontractors[6].

As highlighted, a knowledge of the standards and regulations which govern (mandatory or otherwise) the exchange of goods along the production chain is a prerequisite for the correct design of the final blockchain solution.

[6] In general, if the type of processing carried out by a subcontractor is "core", such as ginning, spinning or weaving, then subcontractor certification is requested. In the case of minor processes, there is no need to specify the name of single subcontractors in the scope certificate. (source: https://textileexchange.org/wp-content/uploads/2017/02/Cert-Toolkit-Basic-Package.pdf).

METHODOLOGY: ANALYSIS AND EXPERIMENTATION ››

The initial project phase focused on understanding and analysing the context and most significant issues. First of all the players were selected – companies and bodies – for involvement in the project process. It was important to gain an understanding, from stakeholders, of which mechanisms regulate exchanges within the production chain and what the main references are in terms of regulatory context and certifications in force.
During a preliminary workshop, the characteristics of blockchain were discussed, potential benefits were examined through the analysis of main use cases on the market. This was followed by a Design Thinking session in which identified parties were divided into five work committees, to identify and share main critical issues of their day-to-day work and start configuring possible solutions. Collected inputs were used to draw up an extremely detailed analysis document which was the starting point for the successive experimentation phase, when identified needs were translated into requirements in an initial Proof of Concept (PoC). The construction of a feedback mechanism enabled the collection of participant inputs and comments. Opportunities for sharing were organised with remote calls, during which generated material was presented to participants, leaving them with time to reflect on possible improvements, which were successively integrated in the final version of the document. Methodologies applied together with results which emerged at the end of each project phase are described further on.

> “
>
> **THE STARTING POINT: ANALYSIS OF THE CONTEXT AND PROBLEMS OF THE SECTOR**

PLAYERS INVOLVED ››

Involved players were selected on the basis of their role and importance, to ensure the best possible representation of the textile supply chain and national context.

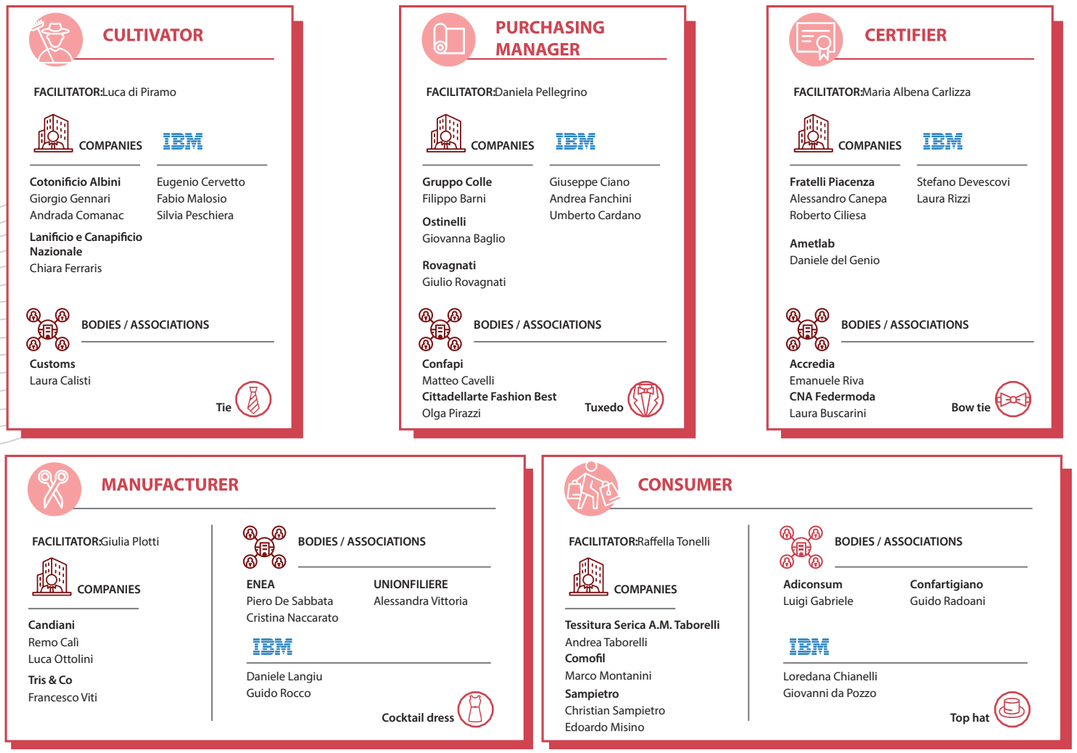


Figure 3 – Work Committees at the Design Thinking Workshop

THE DESIGN THINKING SESSION ››

The Design Thinking approach is intrinsically cyclical and iterative: moments for analysing the current situation are followed by practical prototyping in which the characteristics of imagined solutions to critical issues identified during the analysis phase are penned down. Lastly, playback and sharing sessions enable the discussion of obtained results which are critically assessed, thus generating inputs for a successive analysis phase, resulting in a continuous "loop".
Design Thinking develops around three methodological pillars:

1. Principles of the framework, constituting the way in which problems are discussed and resolved.

2. The "loop", the model of conduct and action which guides the series of actions and analysis phases, reflection and creation as previously described.

3. The "keys" enable the adoption of a framework on a vaster scale, at a company or supply chain level, for the resolution of complex problems. This is actualised by identifying veritable declarations of intent on the new experience of identified players, called hills, which are focused on defining aspects and concrete functionalities. The latter are then discussed, feedback is collected on occasion of Playback sessions scheduled in advance.

Once the case study and problem to be tackled are identified, the Design Thinking session is held, typically lasting one or two days consisting of a series of activities, each a prerequisite of the preceding one. Said activities are carried out by groups, often in silence initially; each person is called to provide their own individual contribution (divergent moment) and then similar ideas are grouped together in order to build successive phases up (convergent moment).

> "A COLLABORATIVE APPROACH FOR IDENTIFYING THE NEEDS AND PRIORITIES OF COMPANIES

Figure 4 – The three pillars of Design Thinking

Within the scope of the project, a subset of activities were selected which belong to the Design Thinking framework[7].

ACTIVITY	PURPOSE
Ecosystem Map	Characterisation of relations between production chain players (including those not directly represented by work committees) and above all, information exchanged between them.
As-Is Scenario	Definition of daily activities together with assets and technologies used, to identify intervention areas with the greatest added value.
Big Ideas	With respect to identified areas of analysis, participants imagined innovative solutions to mitigate critical issues identified during process description.
Prioritization Grid	Ideas which emerge are prioritised, based on their impact and cost (expressed in terms of feasibility) of creation.
MVP & User Stories	The selected idea is "actualised" by imagining user stories, namely functionalities and actions which the end user must be able to execute once the final solution is implemented.

Table 5 – Activities carried out during the Design Thinking Workshop

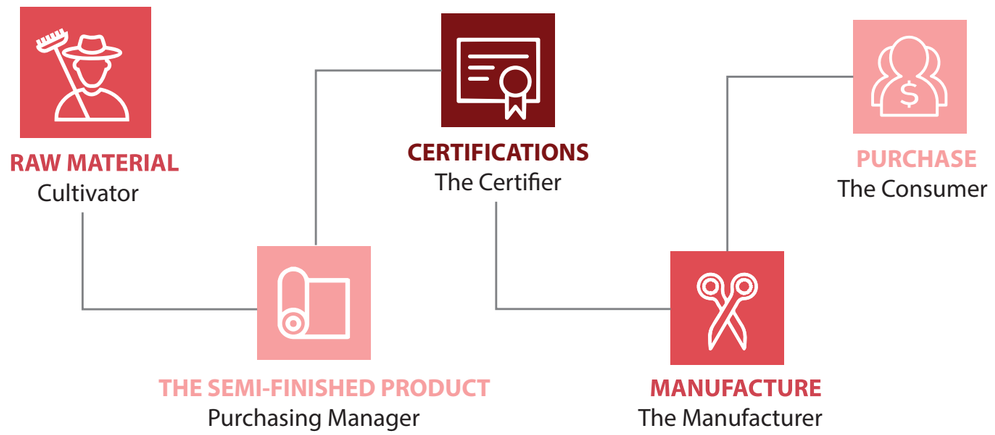


Figure 5 – Players of the Design Thinking Workshop

[7] https://www.ibm.com/design/thinking/

The objective at the outset, shared by companies and associations, which delimited the field of the study, is as follows: *how to help players of the textile supply chain to simplify the exchange of information useful for traceability, with the help of blockchain, along the value production chain of a high quality garment*. Participants were allocated into different work groups, each focused on one of the production chain players. The team identified five users: the linen cultivator, the person in charge of purchasing semi-finished products, the certifier, the maker of the finished product and the end consumer. Identified players only cover a subgroup of all possible interested parties, but they represent the professions active along the entire supply chain and as such provide a solid starting point for analysis.

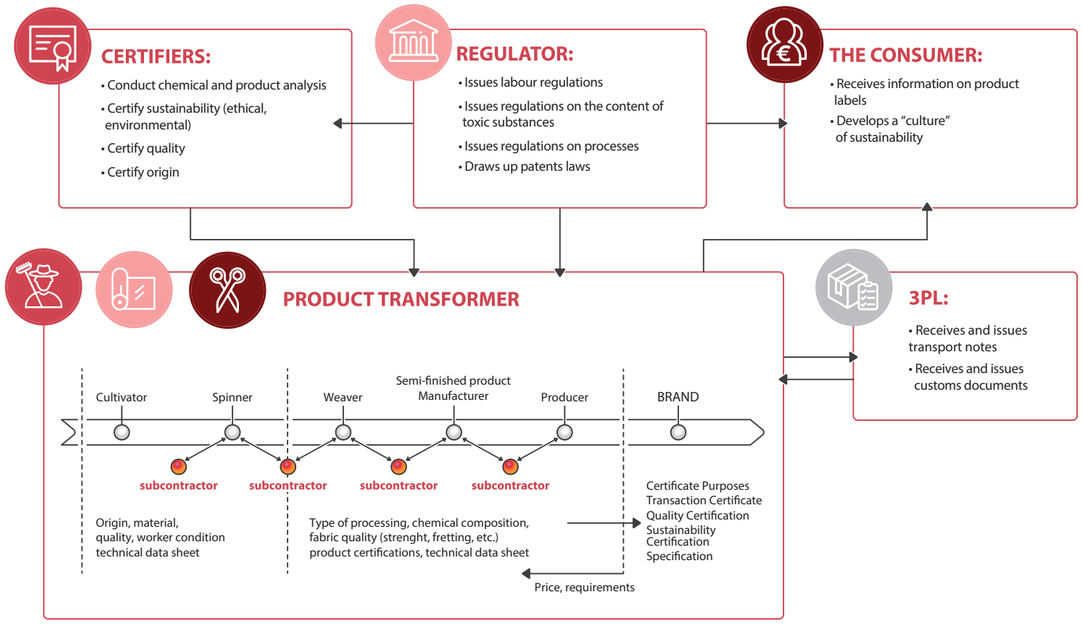


Figure 6 – Ecosystem of the textile industry, as characterised during the workshop

The participants' knowledge of the sector enabled the outlining of the characteristics of the reference ecosystem. Figure 6 shows the presence of different subject categories, whose interactions are often based on the exchange of data and information which is not fully traced:

1. The first group of identified players are *transformers of the textile product*: said group includes cultivators, transformers of textile materials (spinners, weavers, manufacturers of semi-finished products and makers of apparel) and the brand which commissions suits and yarns. In each process phase, supply chain players must fulfil requirements set forth in specifications defined with their own customer and/or directly with the brand. In addition to compulsory certifications, players can obtain voluntary certifications, guaranteeing the quality of the product and processing.

2. Players of the supply chain rely on a broad network of subcontractors for processes such as dyeing and finishing (e.g. stitching, repair, the ironing of garments and semi-finished products). The management of interactions with subcontractors – the sending of the raw product, management of logistics and orders, arrangement for quality checks on the processed product – may lengthen delivery times and require re-processing in the event of poor product quality.

3. Certifying bodies issue documents to ensure conformity with environmental sustainability, ethics and quality (limits on presence of chemical substances, fabric quality). These certifications confirm compliance with legal restrictions and specifications stipulated between a player and its customer downstream along the production chain. Currently it is not easy for a player to promptly find out what types of certifications have been obtained by players upstream and above all to which part of the product these apply, as there are few documents which travel in hard copy along the supply chain.

4. The exchange of information is not clearly modelled and uniform (however there are reference models of data flows – GS1 and eBIZ as well as others which companies may decide to join on a voluntary basis).

5. Often there are regulatory differences between countries regarding the compulsory nature of certain certifications.

6. There is a widespread need for greater certainty regarding sustainability, ethical production and the quality of products. This means that brands demand that suppliers guarantee high standards and present documents regarding production processes and produced batches (*Scope Certificate and Transaction Certificate*).

The causes of critical issues which emerged during the workshop derive not only from the structure of the business ecosystem – undoubtedly fragmented – but also from the difficulty of retracing products and information along a significantly articulate and changeable production line.
To date, the availability of processing data and the process traceability fail to satisfy the needs of entrepreneurs. This results in an economic cost and a business risk for companies. There are also insufficient incentives for suppliers to provide complete and prompt data and to acquire additional certifications and standards in terms of quality and sustainability, also due to the scarce recognition of the price[8] incurred by more virtuous companies.
Therefore not only is product and system information difficult to obtain, the supply chain itself is characterised by weak integration, heavily populated by subcontractors and sub-suppliers and is also vast, extending to international level. In this sense, facilitating the process for the codification and conveyance of information on product processing is one of the objectives for successive project development.

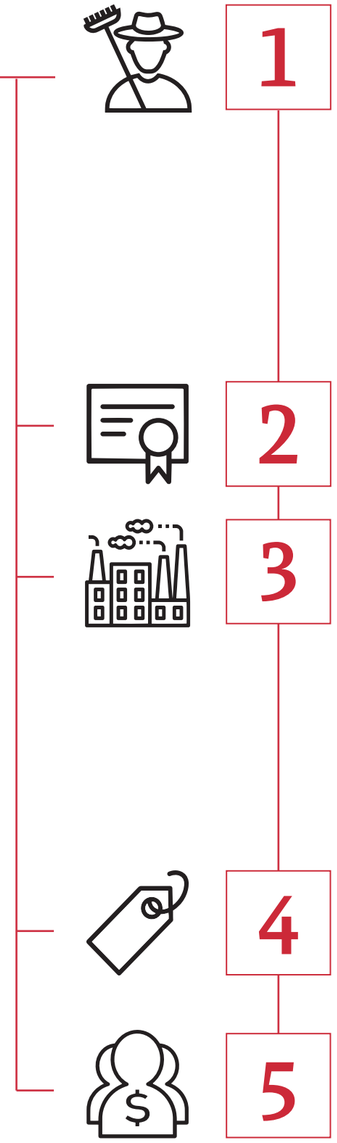
EXPERIMENTATION

Given the findings which emerged during the Design Thinking session, the purpose of the experimentation phase was to understand how product traceability could be improved along the entire supply chain, with the application of a blockchain solution. Experimentation had a dual purpose: on the one hand, to enable the end consumer to view major information on the processing phases of a garment, to verify quality, sustainability, ethics and provenance; on the other hand, to support Made in Italy, promoting the quality of products and processing.
Experimentation develops around a use case which simulates the product life cycle along the entire supply chain, involving main players characterising the reference ecosystem. It is hypothesized that **a manufacturing company** requests a batch of raw material from the **cultivator** which must be certified organic. **A certifying authority** can validate (or otherwise) the batch of raw material and enclosed information, before the batch is sent to the manufacturing company for successive processing and shipment to the **brand** for sale to the **consumer.**

IMPLEMENTED FUNCTIONALITIES

Blockchain experimentation consists of two nodes: the cultivator and the certifying authority operate in the first one, whereas the manufacturing company, brand and end consumer operate in the second one. Two nodes are the minimum number for simulating interaction between different players, however in a production scenario it is recommended that the network of blockchain nodes is designed to respond to the sector's needs (such as associating a node with each player or a consortium of players with similar processes or requirements in common). Faced with the most valid alternatives, it was decided to develop the PoC on the Hyperledger Fabric framework, a technology which enables the implementation of an access segregation logic, so that users acting on the network can carry out actions based on the role they play, on which it is possible to know which organisation executed a specific operation. This scenario responds to privacy and security needs which companies expressed in Design Thinking. The possibilities offered by the Hyperledger framework make it particularly suitable for the purposes of experimentation, although it should be noted that obviously there are alternative solutions which can be taken into consideration.
In particular, implemented functionalities enable:

> “
>
> **A SYSTEM FOR IMPROVING PRODUCT TRACEABILITY ALONG THE PRODUCTION CHAIN**



The **cultivator** of raw material to send documentation to the certification authority, to obtain approval, responding to the demand for more streamlined interactions with certifying bodies. Chosen certificates can be uploaded (many are available) for each of the pre-selected fields of action: ethical and environmental sustainability (CTW, OEKO-TEX, GOTS, ISO14001, SA8000), quality (ISO9001), origin (Certification of Origin)[9];

The **certifying authority** to view the cultivator's requests for certifications, so that they can view them and therefore approve or reject;

The **manufacturing company** to accept or refuse a batch of inbound raw materials and if approved, to associate it with a product or enter information on origin of the manufacturing phase (within the scope of PoC, as a simulation, information was promptly entered on the manufacturing phase only; for the other phases values were associated automatically);

The **brand** to have visibility of raw material processing phases (spinning, weaving, ennoblement and apparel making), the origin and any available certification;

The end **consumers** to obtain succinct information (origin, quality, sustainability, ethics) on the product they are buying.

[8] A price higher than the market one, based on the principle according to which a higher price is associated with better quality of sold product.

[9] The depicted process is a simulation of activities between main identified players of the supply chain and the following is specified:
- to date there is no certification authority for Certification of Preferential Origin (it is a self-declaration)
- Certification of Origin is issued by the Chamber of Commerce (process not digital yet)
- the product Certifier (like OEKO-TEX), can only digitally confirm that it has issued the certificate for the product in question or, following the execution of tests on physical samples, issue a new certificate.

Experimentation aimed to represent the ecosystem as a whole, rather than focus in detail on specific players of the production chain. This decision is in line with what emerged from the workshop, namely a need for a solution for the industry rather than for single players and also enabled all companies involved in the initiative, regardless of the part of the supply chain they directly operate in, to contribute towards a critical analysis of proposed solutions.

OPERATIVE HYPOTHESES

Given the prototype nature of the solution, functionalities made available are not exhaustive in terms of all possible interactions between production chain exponents. Hypotheses were made regarding two fields: the **ecosystem** and the **production process** of apparel.

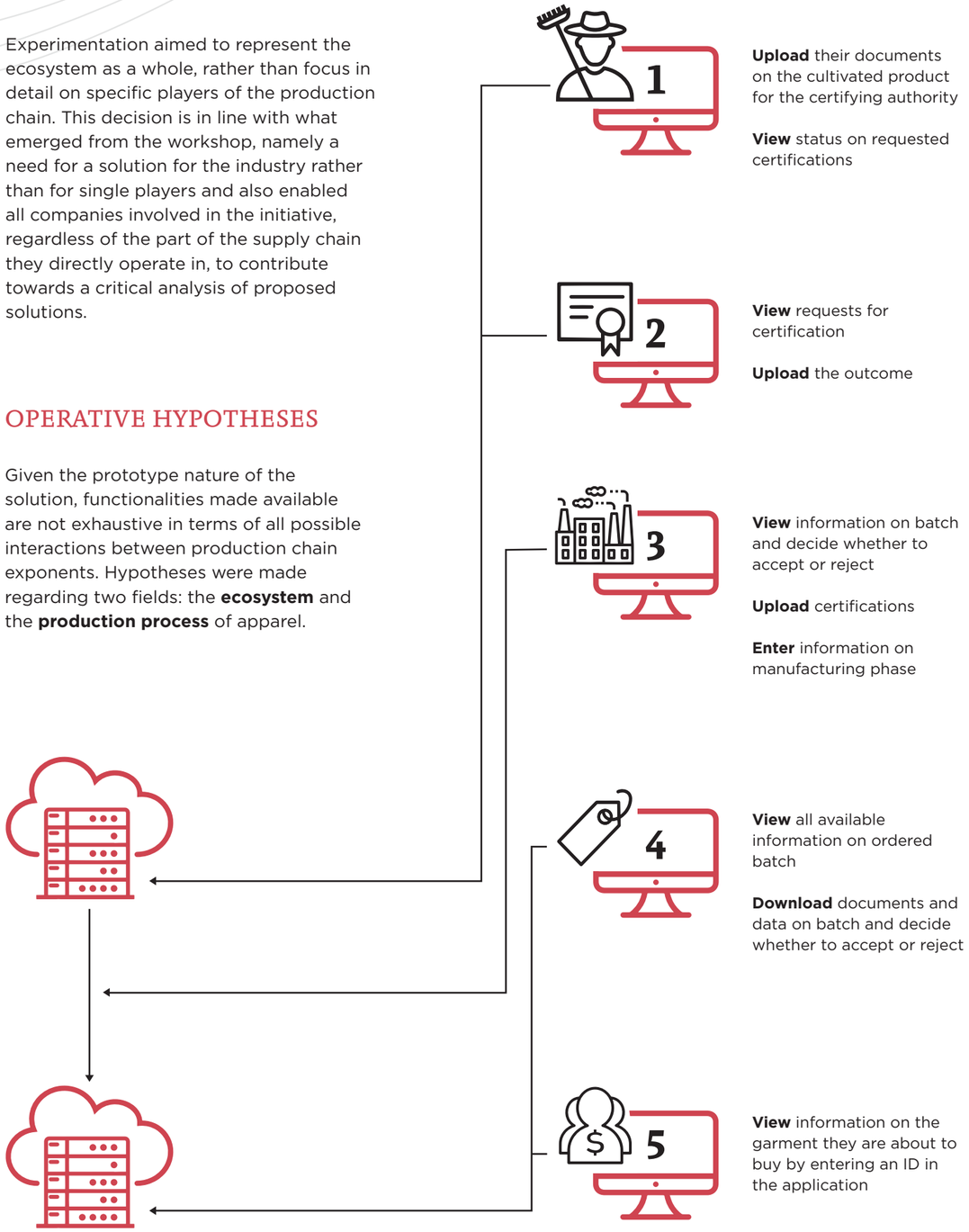


Figure 7 – View of solution structure as developed during experimentation phase

With reference to the ecosystem, the following considerations are valid:

1. In this context the certification authority can only view and control documents uploaded by the cultivator and the manufacturing company, whereas in reality they may intervene in all processing phases;

2. All the players of the textile production chain were not taken into consideration; for example, analysis laboratories are missing, they contribute by verifying materials processed along the production chain and subcontractors;

3. The manufacturing company exemplifies the role which raw material transformers could have in a blockchain system, including spinners, weavers, apparel makers or subcontractors;

4. The current network consists of just one player per type, whereas in reality all players, cultivators for example, may engage with several players upstream or downstream, spinners for example.

With reference to interactions between players and the implemented processing flow, it was assumed that:

1. The cultivator regularly sends raw material batches to the manufacturer in an automated and ongoing manner.

2. Only one raw material can be associated with each producer. In a production scenario it would be necessary to implement a *one-to-many* ratio[10].

3. The certifier must approve raw material documentation uploaded by the cultivator before the latter can make batch information available for viewing by the manufacturing company. This is restrictive, as in production conditions there isn't always time to approve each batch prior to shipment.

4. All certification documents are hard copies and can be authenticated, dematerialised and registered on the blockchain. This clashes with the supply chain's current level of digitalisation.

5. Certifications are an attribute of the exchanged asset, be it raw material or the finished product. However, some certifications are to be considered "systemic", namely regarding the company: ISO9001 quality certification is one such example. Any future developments will be able to differentiate between product certifications – which will continue to be an attribute of the exchanged asset – and system certifications – regarding single players. It was also hypothesized that certificates do not have a limited period of validity, whereas in reality they must be renewed every one to two years.

6. Each asset can only be sent to a single body: in a production scenario, a one-to-many logic should be implemented to enable each company to interact with a multitude of players up and/or downstream.

7. There is no "return" or re-processing logic of goods, rather only non-acceptance from the player immediately downstream.

8. In the event an asset is associated with several certifications and one of these is false, the certification authority can only reject the entire asset and not the single document.

These hypotheses for operation are simplifications adopted to carry out experimentation which aims to achieve pre-set objectives, but they can be revised and issued in any successive phases, based on the production scenario to be created.

[10] In IT a "one-to-many" ratio means that it is possible that an entity – for example, an item of clothing, has a relationship with a multitude of factors of another entity, such as different materials used to make it, from the linen of the fabric to the bone in buttons.

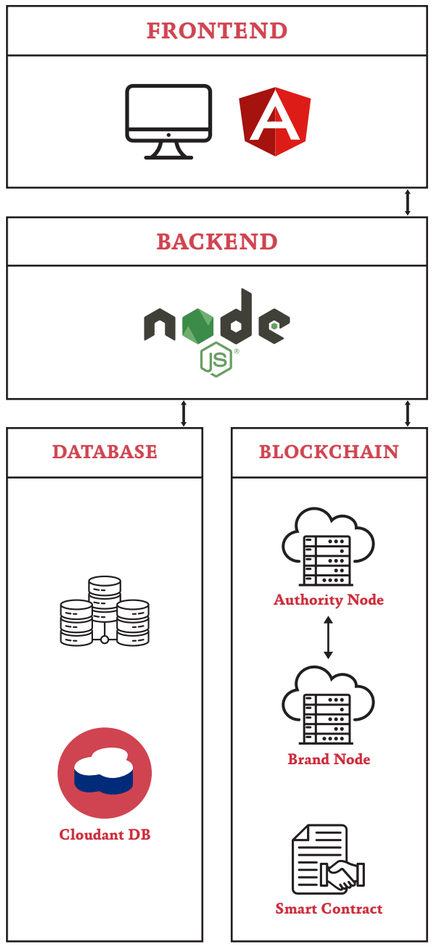


Figure 8 – Blockchain architecture implemented in experimentation

THE ARCHITECTURE AND DATA MODEL

As already mentioned, Hyperledger Fabric was chosen as a development framework. However, blockchain nodes make up only a part of the overall architecture of the application created for the study [fig. 8].

It consists of a front-end developed in Angular.js, which communicates with a back-end application implemented in node.js language. This application also acts as an orchestrator between the database – a Cloudant database – and actual blockchain nodes. The database contains all information on users and their profiles. A single database was used for both nodes in the study, however in a production context distinct databases are recommended for each node, to guarantee the security of information. The entire application was made Cloud available, to enable companies to access it during the testing phase.

In spite of its simplicity, the proposed architecture includes all the components of a blockchain-type application, including the definition of a *Smart Contract* containing consent logics which enable the validation of transactions carried out by users. Said logics are also reflected in the structure of the implemented data model. All controls guaranteeing the integrity of exchanged information are codified in the *Smart Contract* and must be verified for players to reach consensus for each transaction carried out. The currently implemented *Smart Contract* establishes the following restrictions:

1) the univocal nature of exchanged asset ID (batches of raw material of finished products);

2) the existence of asset ID prior to any amendment, to prevent the entering of erroneous data. This implies that the cultivator must start the process, by entering an ID for the raw material batch, which will be successively associated with a product ID;

3) for each process phase, check the asset in question has all validation *timestamps* for all previous steps. For example, before sending to the manufacturing company, it is verified that the raw material batch has been associated with a production, blockchain asset creation and certification authority validation timestamp;

4) verify each actor only executes operations for which they are authorised, based on their role (for example, the certifier can only accept or refuse documentation presented by other players, but cannot amend content).

The rule described in point 4) here above is a requirement for the *Smart Contract* and is binding at a data model level. Data model refers to all attributes which can be attributed to the "entities" constituting the blockchain; examples of entities include transactions, exchanged assets or registered network users.

The data model requires each user to be associated with a personal information sheet containing their name, user password and role: when they login on the platform, the application verifies the role of the actor and said information is used in input to verify compliance with limits set forth in the *Smart Contract*. Lastly, in order to guarantee the security of exchanged information and verify user identity, namely to ascertain that everyone is who they say they are, each role was associated with a certificate necessary for accessing the application (together with aforementioned credentials).

TEST AND RESULTS

In order to verify the veracity of the hypothesis and choices, companies tested the created solution. During the test period, companies were provided with credentials to access the application in Cloud. Initially companies tested implemented functionalities for the cultivator and certifying authority, in order to materialise information on the raw material batch in the blockchain. Then, each company played the part of the manufacturing company, brand and end consumer. Once tests were carried out, observations and suggestions for improvement of the proposed solution were collected from companies. Suggestions were organised into topics, as presented here below.

LOGIC OF THE SOLUTION

1) The platform shouldn't reproduce an ERP on a small scale, it should be able to be recalled from it and should be scalable and open to external players (e.g. subcontractors and foreign customers);

2) it is necessary to verify that requests for real-time availability of information are reconciled with supply chain times which are sometimes long (e.g. certification approval may be too lengthy for delivery deadlines);

3) PoC hypotheses on the number of bodies to which an asset can be sent, or the possibility to associate several materials with a single product, need to be extended;

4) the need to establish governance and a relationship between different supply chains using different applications (based on the same blockchain or otherwise).

Previous points imply the need to revise the consent rules set forth in the *Smart Contract* implemented during the experimentation and/or the underlying data model.

FUNCTIONALITIES OF THE APPLICATION AND USER INTERFACE

1) A credential recovery procedure needs to be provided;

2) the possibility to search, order and filter the IDs of assets handled or viewed by a single user;

3) the chance to pre-populate some fields (e.g. existing certifications);

4) the solution should provide the end consumer with aggregate data on certifications associated with a product and not details of single processes;

5) the previous point leads to the need to distinguish between information which when traced, facilitates interaction between different supply chains and information which provides the end consumers with visibility on the characteristics of the product they are buying. At full-scale, such information should be segregated at a data model level, so as only authorised persons can access available information.

CERTIFICATIONS AND CERTIFIER'S ROLE

One of the functionalities of experimentation is to enable users to upload documentation necessary for voluntary and non-voluntary certification. Considering that only a sub-set of available certifications was included, the following suggestions for improvement were collected:

1) with reference to environmental certifications, it was noted how entering data like CO2 emissions or water consumption only can be misleading. This focuses on negative aspects rather than on the true environmental and ethical sustainability of processing;

2) all certifications and information necessary for participating in national tender notices (like CAM) should be included;

3) other certificates to include are Sales Documents (e.g. Invoice), REACH Compliance Declaration, Handling Certificates (A. TR, EUR.1, EUR Med), ZDHC, OCS, FSC, PEFC, GRS Certificates. All certificates of origin of all 4 major phases (spinning, weaving, ennoblement, making) were included, together with the "Test Report" which accompanies semi-finished products;

4) the introduction of a company sustainability index was suggested, like the Higgs-Index[11] or PEF/OEF methodology[12];

5) the solution should also include which ethical and social sustainability requirements are satisfied by companies.

The certifier's role should be differentiated to reflect the presence of bodies which issue fixed-duration certificates (e.g. 1 year) and test laboratories for the verification of the quality of goods. The former certify

[11] https://apparelcoalition.org/the-higg-index/

[12] PEF/OEF methodology has been officially adopted by the EU for indicating the environmental impact of each production activity (with reference to products or the company), scientifically measured, calculated in a standardised way and presented to the end consumer in a concise and accurate way.

the company as opposed to single batches (incompatible with supply chain dynamics), whereas the latter receive batch samples. This also implies the introduction of a notion of validity for certifications entered in the system and present in the blockchain.

SUPPORT FOR ITALIAN MANUFACTURING COMPANIES AND INTERNATIONAL VISIBILITY

1) In order to consolidate the reliability and visibility of the industry, players need to define rules on requirements, standards, minimum and common certifications for all supply chain exponents, which characterise processes and products in terms of: quality, origin, environmental and ethical sustainability;

2) simultaneously, requirements determining "variable geometry" supply chain characteristics can also be established, characterising a few segments only (for example, certification of some raw materials like cotton);

3) the platform must give greater visibility to the work carried out by Italian producers and manufacturers, adding missing roles to modelled ones and/or enabling access to international companies and actors as well;

4) a non-monolithic scenario is required, in which different solutions and different supply chains can coexist within the sector.

INVOLVEMENT OF INSTITUTIONS

1) In order to validate entered information (i.e. certifications) and process legitimisation, it is important to involve control bodies right from the outset (for example the Customs Agency for Preferential Origin certification);

2) collaboration with such bodies may lead to the development of mechanisms which speed up checks carried out on companies, perhaps also facilitating the issuing of authorised exporter certification;

3) lastly, companies highlighted the need to increase the level of digitalisation of documentation exchanged along the supply chain (involving relevant bodies), for example enabling the use of digital versions of documents currently only accepted in hard copy.

All suggestions from initiative participants are a starting point for evolving the developed prototype solution and are an added value for creating a supply chain approach, of benefit to all players involved.

FEASIBILITY ANALYSIS ››

Discussion with companies and bodies which participated in experimentation enabled the collection of functional requirements for a blockchain-type solution in support of Made in Italy in the textile sector. In addition to this analysis, the sustainability of the proposed approach was also verified, from a technological, organisational and business point of view. The aim is to understand how it is possible to shift from a single-company vision to a holistic supply chain approach, with the creation of a scalable solution that is advantageous for participants in commercial terms. Therefore the following paragraphs contain details of the business network concept, namely the characteristics of the ecosystem designated for blockchain solution application. Different business and governance models are characterised, along with incentives and technologies which can be developed in similar contexts.

> “
> FROM A SINGLE COMPANY VISION TO A HOLISTIC PRODUCTION CHAIN APPROACH

THE CONCEPT OF BUSINESS NETWORK

During the entire project, participants were asked to distance themselves from their role as single players and embrace a view point of the entire supply chain. The use of blockchain technology requires a shift away from a logic centred around a single-company reality, to a plural approach based on a network of companies which share business. It is evident that each player can benefit more from a blockchain-type application because they are a part of a reference ecosystem.

There are different network configurations for the development of a blockchain solution[13]. Within the project, in an initial analysis the textile industry could be comparable to a *Founder Network*. It is characterised by the differentiation of business between different network participants; the main advantages of blockchain use are linked to the improvement of existing processes.

The evolution of the initial ecosystem may lead towards an *Industry Utility Network* model in which the solution is extended to a supply chain, including partners and companies, or to a *New Market Network*, in which players of different Industries collaborate for the creation of new services and business models.

Irrespective of the reference network structure, the starting point is to define which players operate within the ecosystem, mapping their reciprocal relations and existing processes, geographical areas of operation and regulatory restrictions they must abide by. In short, the **minimum viable ecosystem (MVE)** must be established, defining how many organisations should participate in a pilot network. The number may vary according to the use case, sector, production phase and level of mutual trust.

The recommendation is to identify key segments of the target ecosystem, whereby a segment refers to the role of an organisation within the network. The identification of participants must accommodate all players which would determine the success of the ecosystem, namely players necessary for providing capacities such as sector credibility, financial, human, physical and intellectual resources.

The following were identified as key players during analysis: **cultivator, certifier, manufacturing company, brand, consumer**.

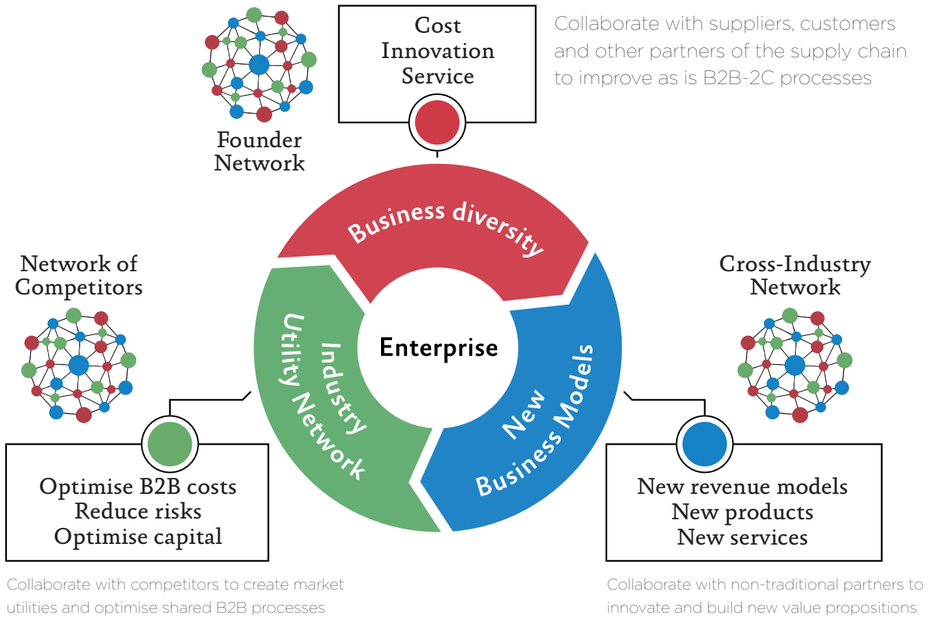


Figure 9 - Collaboration models in blockchain

Based on initial discussions, the starting ecosystem could be extended to the Customs Agency (holder of criteria for Made in Italy verification), laboratories examining the quality of fibres and fabrics, right through to subcontractors. Beyond the borders of the supply chain, other potential actors could also be assessed (for example, Banks, Insurance Brokers and logistics operators), which could provide specific products and services for the textile industry. In order to make the network more efficient and usable, additional players can be considered in support of the network, such as Accredia (as a body guaranteeing certifiers) and trade associations.

[13] https://www.linkedin.com/pulse/building-business-cases-Blockchain-blog-number-1-andy-martin-1?trk=portfolio_article-card_title

THE BLOCKCHAIN BUSINESS MODEL

Once the reference ecosystem is characterised and understood, it is necessary to define the future business model based on key benefits of blockchain [17,18,19,20] (consent, provenance, immutability and purpose) and their impact on the network, identifying areas of saving on costs or process improvement for each component of the ecosystem. This model is structured around three axes: the business model, the governance model and the incentive model [fig. 11]. Details on what each of these components entail are provided here below, before describing the suggested technological model.

THE BUSINESS MODEL

The starting point for the construction of the business model is the definition of the asset (or token) to be exchanged among business participants. By its very nature, blockchain is a distributed, decentralised and collaborative structure which enables players to interact on an equal level. However, this result is only possible if a network effect is reached whereby the number and type of participants justifies the investment and enables the construction of scalable business over time. One of the best ways for incentivising the entry of new players in the network is to establish a climate of mutual trust among participants, for reassurance as to the security of exchanged data and agreement on rules – Smart Contracts – which guarantee the validity of shared information. In other words, if the primary objective is to support Made in Italy, promoting excellence and local products, companies, bodies and associations must converge towards a common model of exchange and tracing of information which increases purchased product value for the end consumer.

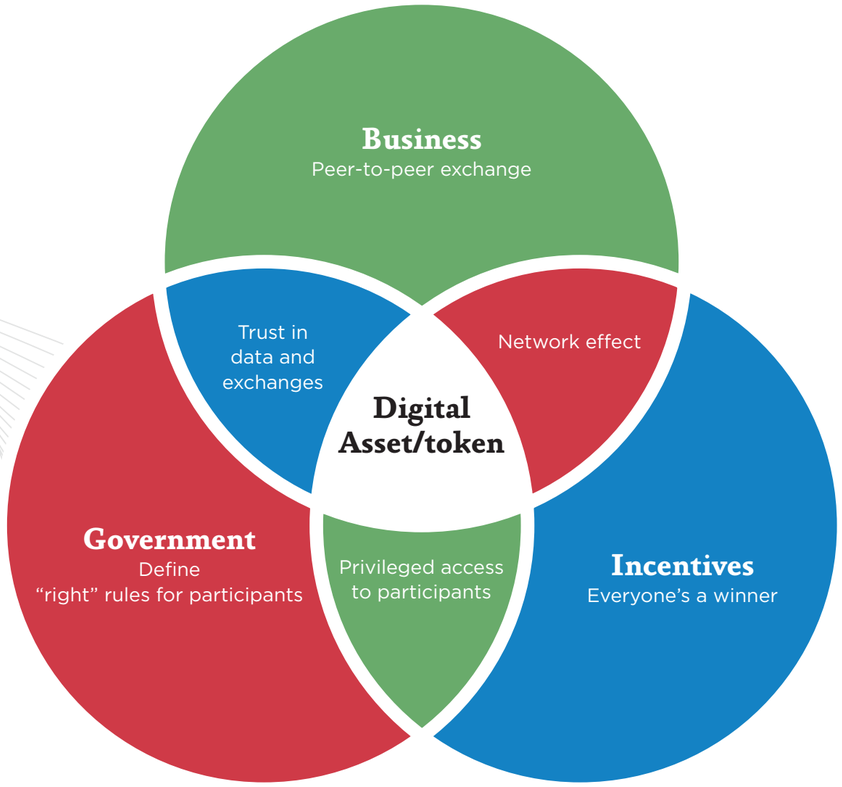


Figure 10 – Base elements of the blockchain business model

THE GOVERNANCE MODEL

Once the ecosystem is defined, with the specific business model, characterising rules and processes must be defined, namely the governance model. The term governance indicates two complementary aspects to take into consideration:

1. *Governance of solution*. Refers to all rules which determine how organisations using a solution interact with each other.
2. *Blockchain Governance*. Refers to the structure and process which determine how blockchain technology is maintained and evolves over time. This category includes entry/exit methods for new players over time, the federated management of access to information, etc.

In both cases there are two critical components which give shape to the governance model: incentives, presented here below, and a mechanism for coordination between parties.

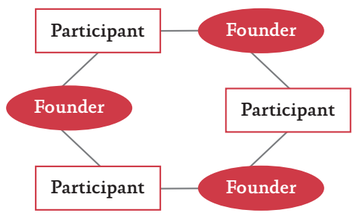
The latter must be prepared whenever the incentives of participants fail to align, giving rise to a need to define a process for convergence towards common objectives. As highlighted in the diagram on the right, the Governance of the solution may be a network based on different models:

- Consortium: if the network is of an Industry Utility kind, it may be useful to create an equal consortium, in which all participants can join the initiative upon payment of a fee, monthly for example, given that costs and benefits are distributed and tangible for everyone (for example in relations between a bank and its customers and other banks). For the blockchain solution to be sustainable, all market players must join it (for example, the advantage of reduced transaction costs between players is due to greater transparency guaranteed by blockchain and is reduced by the presence of a third actor, another credit institute, which has not joined and thus must be approached with traditional business logics.

- Founder: this model is particularly suitable when there is a very strong player in the supply chain, which can involve companies up and down stream. The founder becomes a guide within the network and can decide to implement an access fee or otherwise, based on expected benefits. This governance configuration can be adopted in the context of a Founder Network.

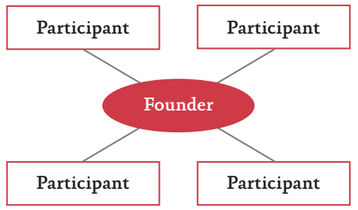
- Community Network: created in contexts in which there may not necessarily be a pre-existing business, or for the creation of new interaction opportunities among players involved. Plastic Bank is an example in this sense, which incentivises the collection and recycling of plastic, with the distribution of tokens in the form of economic incentives, thus creating an "inverse" supply chain which complements the traditional one of plastic material processing.

NETWORK BASED ON CONSORTIUM



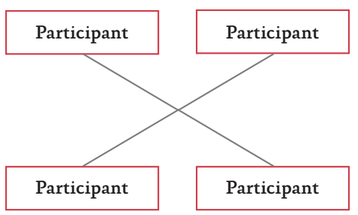
In this type of network founders are equal to other participants, a legal entity can be included, established by founders (e.g. -JV)

NETWORK BASED ON FOUNDER



Sole founder capable of giving direction to network

COMMUNITY NETWORKS



Network guided by sector standards or owners of existing networks

THE INCENTIVES MODEL AND AVAILABLE MEASURES

When a blockchain solution is built, its success depends on its capacity to create value which is recognised by all ecosystem participants. Advantages of belonging to the network must be clear and evident before the technological development of the solution and should incentivise the participation of players. Five main types of incentives can be identified:

1. reduction of costs to increase operative efficiency;

2. improvement of end user experience;

3. new opportunities for earning thanks to the acquisition of new customers;

4. improved management of operative risks, with consequent reduction of associated costs;

5. reinforcement of image and leadership on market.

It is essential to create a model of incentives which changes over time and is based on what participants hope to achieve from using the solution.

To analyse the **model of incentives**, the following considerations can be shared, in more general terms regarding the economic and/or financial feasibility of an initiative, based on four analysis directives:

1. The characteristics of business network participants. For the initiative to be able to yield sustainable benefits, capable of justifying creation and operating costs over time, it is important that participants live up to certain criteria:

- representation of main players of the production chain (customer-provider relations) to cover the most important information flows and value;

- focus on quality production with industry certifications;

- involvement of a supply chain head, capable of promoting the attributes of quality, origin and sustainability in the eyes of the end consumer;

- involvement of at least one actor that is sufficiently structured to act as a guide for the implementation of governance and funding best practices.

Players involved during experimentation, despite not being directly in an organic customer-supplier relationship, enabled the in-depth exploration of the initiative's importance for all players necessary for covering aforementioned needs. Therefore it is possible to express a preliminary **positive evaluation** regarding the capacity to attract the necessary players to build a minimum ecosystem which guarantees the economic and operative sustainability of the initiative.

2. The sizes of the addressable market and the tipping point of the initiative. In 2017 the textile and fashion sector generated a turnover of 54.1 billion, 30.6 billion of which in exportation, up 3.5% compared to the previous year[14]. In order to finalise a feasibility assessment, it is recommended that the minimum market shares of each ecosystem participant are mapped out to determine the tipping point in terms of minimum market shares necessary for scaling the network.

[14] Confindustria Moda on ISTAT data, Movimprese

In order to determine this threshold value and to plan necessary actions for reaching it in a time compatible with funds available for the initiative, the use of the Value Design blockchain methodology is recommended, once the set of participants is determined. In line with what has been achieved within the scope of the initiative, this methodology suggests starting from the mapping of business processes and interactions between players, to understand which blocks and difficulties have been identified and shared to date by the network, (for example with the Design Thinking methodology). The entity of expected benefits, contextualised according to reference market size, will then stimulate the ROI of the initiative.

Starting from the exact figure of expected ROI, a key factor in reaching the tipping point is the active involvement of a promoting body capable of exercising an aggregative and incentivising role, to support actions undertaken by single parties. The active involvement of industry and district associations is crucial.

Good representation of such entities already in the experimentation and PoC phase generates a favourable preliminary assessment regarding economic feasibility.

3. Categorisation and estimate of attainable benefits. Attainable benefits can be divided into 3 categories:

1. increased turnover;
2. reduction of costs;
3. intangible or indirect benefits.

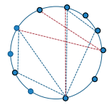
Increased turnover can substantially be attributed to three phenomena:
- reduced counterfeiting;
- greater commercial success (volumes) of characteristic products through quality, provenance, sustainability and ethics attributes.

1 Business process

High level identification of business process.

2 Business network participants

Business network participants are mapped using a “circle” to identify types of participants and the nature of relations between them.

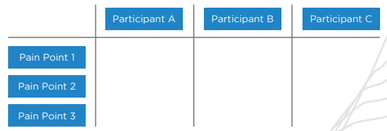


3 Market

Once the use case and types of members participating in the process are identified, the reference market and market quota per participant must be identified.

4 Shared Pain Points

Definition of pain points by business network participants.

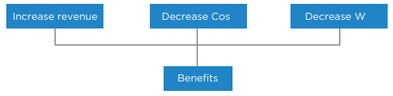


5 Benefits

The identification of main pain points needs to be followed by considerations on how blockchain can resolve such critical issues and what the expected benefits are (each benefit needs to be associated with a KPI).

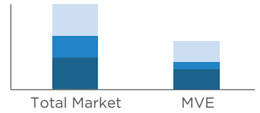
6 Value Tree

Division of benefits into 3 types “Turnover” “Costs” and “Operating Capital” and identification of factors of the solution which influence said dimensions.



7 Sizing the market

Identification of minimum viable ecosystem (MVE), total market size and tipping point for scaling the solution.



8 ROI estimate

Estimate of profit the new solution can generate and relative costs for its development, governance and maintenance.

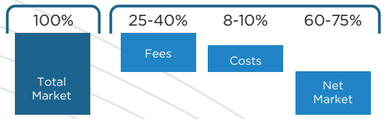


Figure 11 – Definition of Ecosystem and main dimensions

- the biggest price premium obtainable through the characterisation of intermediate and end products.

The reduction of costs is correlated with two main principles:

- the simplification of communication processes between players involved, with a relative reduction of burdens of reconciliation and management of exceptions;
- dematerialisation of document flows.

Lastly, the main intangible benefits can be categorised as follows:

- image, visibility and brand perception;
- increased intermediary brand visibility in the supply chain in the eyes of the end consumer;
- promotion of a sustainable and quality Made in Italy production model.

The entity of said benefits, coupled with an estimate of their value, varies according to the type, quantity and field of application of a blockchain-type solution and is difficult to quantify beforehand. Based on opinions and preliminary findings collected by companies participating in the experimentation phase, it is still possible to express a favourable assessment regarding the attainability of said benefits to such an extent as to justify investments necessary for the start-up and growth of the initiative.

4. Incubation, incentivisation and funding tools.

Incentive tools which can be made available to companies in order to support the initiative in economic-financial terms can be divided into four categories:

- Measures usable by single companies to improve own competencies and performance and to buy innovative equipment and technologies.
- Measures usable by companies for the development of aggregation projects, based on "systemic" technologies or which in any case aim to favour complex transformation processes of business systems.
- Possible enterprise participation and aggregation mechanisms.
- Instruments in support of venture capital which may partly focus on project purposes to further support potential evolution.

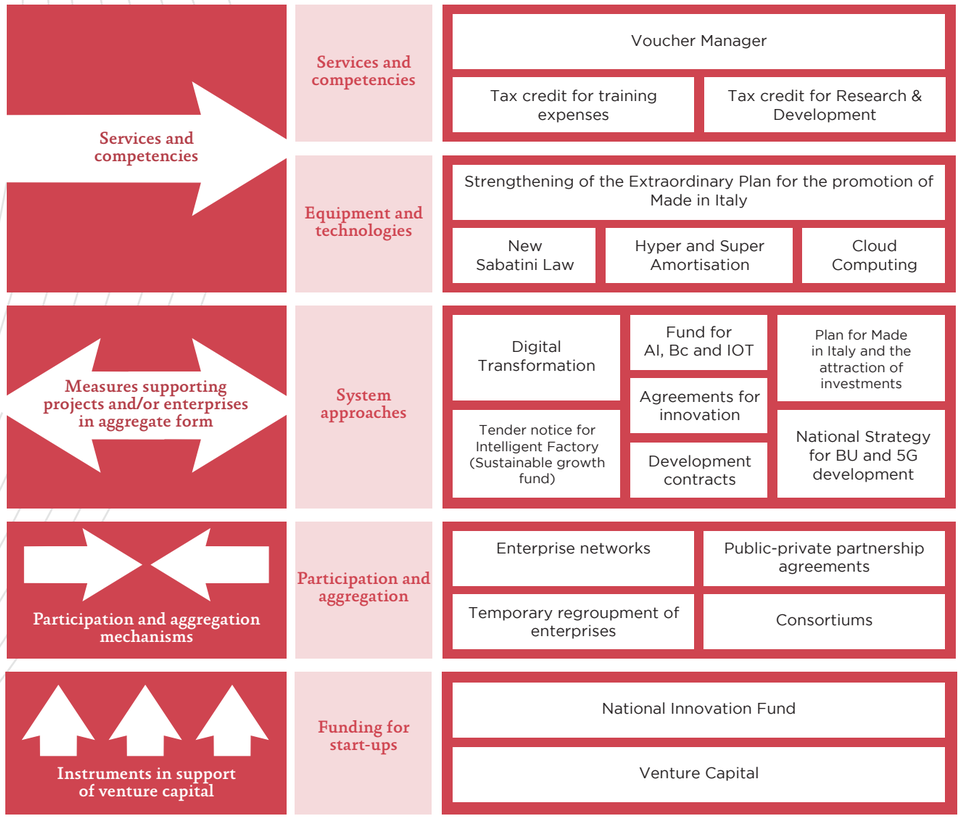


Figure 12 – Main measures usable for any project evolution (source: project team)

In this analysis we will focus on the first two classes of measures, which appear to be most closely tied in with the case at hand.

1. Measures usable by single companies, to improve own competencies and performance as well as to purchase innovative equipment and technologies.

Former ones include:

- **the purchase of specialised consultancy services** to support technological and digital transformation processes through technologies specified by the National Enterprise 4.0 Plan and the modernisation of enterprise management and organisation structures (voucher manager – art. 1, paragraph 228, Budget Law 2019);

YEAR OF ISSUING		YEAR OF IMPACT FOR PUBLIC FINANCE				
	Measure	**2017**	**2018**	**2019**	**2020**	**2021**
2017	Super and hyper-amortisation	0	1,131	1,923		
	New Sabatini Law	28	84	112		
	Tax credit for R&S expenses	0	727	727		
	Competence centre	20	10	0		
	Total 2017	48	1,952	2,762		
2018	Super and hyper-amortisation		0	903	1,712	
	New Sabatini Law		33	66	66	
	Tax credit on 4.0 training		0	250	-	
	ITS growth		5	15	30	
	Intelligent Factory Tenders		328	-	-	
	Total 2018		366	1,234	1,808	
2019	Super and hyper-amortisation			0	535	1,010
	New Sabatini Law			48	96	96
	Tax credit on 4.0 training			0	250	-
	Temporary manager for innovation			20	25	25
	Amendment R&S tax credit			0	-300	-300
	Development contracts			1	16	45
	IPCEI microelectric funds			25	50	60
	Blockchain IoT funds			10	15	15
	Total 2019			104	687	951

* Corresponding with the reference year of the Budget Law or the year of emanation of Ministerial Decrees.
Resources issued following the multi-year European financial structure 2014-2020 were not included.
Source: Technical report on Government provisions

Figure 13 – Public resources in support of the Industry 4.0 project (source: Confindustria Study Centre)

- **support staff training** in subjects pertaining to technologies of the Enterprise 4.0 Plan (Tax credit for 4.0 training expenses - art. 1, paragraphs 46-56, Budget Law 2018);
- **support Research and Development activities** to innovate processes and products and improve future competitiveness of company (tax credit Research & Development – art. 3, Legislative Decree no. 145, 23rd December 2013, converted by Law no. 9, 21st February 2014);

The latter include:

- **facilitate access to credit** to buy or lease machinery, equipment, plants, instrumental goods for productive use and hardware as well as software and digital technologies (new Sabatini Law - art. 2, Legislative Decree no. 69, 21st June 2012 as amended.);
- **support investments** in new instrumental assets, material and immaterial goods (software and IT systems) functional for the technological and digital transformation of productive processes (hyper and super amortisation - art. 1, paragraphs 90-94, Budget Law 2016 as amended.);
- **make infrastructure costs flexible**, facilitating the adoption of new access and consumption paradigms of new technologies, through the possibility of using super-amortisation for the purchase of cloud computing services (from CAPEX to OPEX) for (cloud computing - art. 1, paragraph 229, Budget Law 2019).

2. Measures usable by companies for the development of aggregation projects, based on "systemic" technologies or which in any case aim to favour complex transformation processes of business systems. Examples include:

Note: When discussing measures supporting single enterprises it may also be useful to mention those regarding the "Strengthening of the extraordinary plan for the promotion of Made in Italy and the attraction of investments in Italy" - art. 30, paragraph 1, Legislative Decree no. 133, 12th September 2014, converted by L. no. 164, 11th September 2014 as amended), which provide various forms of support, including:

- *training and communication initiatives*
- *support for Italian trade fair events;*
- *promotion of products of excellence and protection abroad of brands, quality and origin certifications;*
- *support for penetration of Italian products on different markets;*
- *creation of a unique distinctive sign;*
- *creation of strategic promotion campaigns on the most important markets to fight against the Italian sounding phenomenon;*
- *support for the use of e-commerce tools by small and medium sized enterprises;*
- *creation of innovative promotional types for the acquisition and loyalty of demand on foreign markets;*
- *organisational reinforcement of start-ups, micro, small and medium enterprises using vouchers;*
- *support for investments in Italy, with accompaniment and assistance actions for foreign investors in Italy.*

- **Funds for interventions with the aim of favouring the development of AI, Blockchain and IoT applications** (art. 1, paragraph 226, Budget Law 2019) – drawn up to favour the development of artificial intelligence, blockchain and internet of things technologies and applications, the Fund aims to fund research and innovation projects to be carried out in Italy by public and private entities, including foreign ones, in strategic areas for the development of said technologies, functional for the country's competitiveness.
- **Digital Transformation** (Art. 29 Law no. 58., 28th June 2019 Conversion into law, with amendments, of Legislative Decree no.34, 20th April 2019) - drawn up to favour the technological and digital transformation of SMEs, the Digital Transformation measure grants financial concessions for projects for the implementation of enabling technologies identified in the Enterprise 4.0 plan (big data, augmented reality, advanced manufacturing solutions, additive manufacturing, simulation).

N.B. at the time of publication of this study, the procedure for defining fund management methods was not yet defined. However, its specific allocation for projects based on AI, Blockchain and IoT technologies makes the fund particularly interesting for a project like the one on which this study is based. Therefore it is hoped that the definition of relative management regulations includes suitable reward mechanisms which can stimulate the development of big initiatives for country-level transformation, at the same time facilitating the involvement of companies and other stakeholders.

- **"Intelligent Factory, Agrifood and Life Sciences" Tender** (Ministry of Economic Development Decree, 5th March 2018) – a concession further increased in February 2019, for favouring the creation of research and development projects in all three fields mentioned here above. Concessions are granted in the form of financial funding or contributions towards costs incurred. Enterprises of any size and which pursue business in industry, agroindustry, craftsmanship, services for industry and research centres can all benefit. Said entities can present projects, also jointly with others.
- **Agreement for innovation** (Ministry of Economic Development Decree 24th May 2017) - a measure which aims to fund industrial research and experimental development projects for the creation of new products, processes or services or the significant improvement thereof, by means of the development of one or more technologies defined by the "EU Framework Programme for research and innovation 2014-2020 - Horizon 2020". Research and development projects eligible for this measure must set out a cost of between € 5 million and € 40 million, with a duration of less than 36 months. Applicant enterprises can present projects jointly and/or in conjunction with research bodies, for up to a maximum of 5 co-applicants. In such cases, projects must be rolled out by means of network contracts or other collaborative contractual forms like partnership agreement or consortium.

N.B.: The specific perimeter of application of the measure may mean it is not immediately applicable to supply chain projects in view of their intrinsically multi-organisational nature.
However, if the concept of "intelligent factory" could be expanded to the broader one of "intelligent supply chain", the measure may be particularly interesting for supporting projects oriented towards the integration of several entities which interact, with reference to purposes of common interest.

- **Development contracts** (art. 43 Legislative Decree no. 112, 25th June 2008) - a facilitating tool dedicated to supporting large-sized investment programmes, including industrial development programmes, also regarding the transformation and commercialisation of agricultural products. Development programmes can be created by one or more enterprises, Italian or foreign and of any size.

N.B.: the size of eligible projects appears to be particularly significant and application may be difficult for an initiative which, as previously mentioned, needs to grow gradually and focus on progressively involving players and stakeholders.

N.B.: an interesting aspect of development contracts is that beneficiary entities are divided into applicant entities (namely the enterprise promoting the development programme and responsible for it) and participant enterprises, which create investment projects within the programme. From this viewpoint, the model defined by development contracts may be interesting for creating an evolved development model of the project, which may attract other interested subjects thanks to an initial action by an entity promoting the programme.

- **National strategy for Ultrabroadband and the development of 5G technology** (DEF 2019) – as already known, the Economy and Finance Document 2019 (DEF) provided for the use of incentivisation and support tools for the use of services and products based on fibre, by companies and individuals.

N.B.: incentivisation tools in support of the measure also include the possibility to resort to "zero bureaucracy for innovation" experimentation and partnership models, in specific areas of the country. This set-up could also be useful for the supply chain traceability project as conceptually placing initial project phases inside a sort of "regulatory sandbox", may simplify the identification of the most suitable models for regulation and legislative support, in a continuous discussion between public and private.

- **Support programme for emerging 5G technologies** (Ministry of Economic Development Decree, 26th March 2019) - the aim of the Programme is to create experimentation projects, pursue applied research and technological transfer, based on the use of emerging technologies like Blockchain, Artificial Intelligence (AI), Internet of Things (IoT), linked to the development of new generation networks. The Plan is funded by resources of the Development and Cohesion Fund 2014-2020, as provided for by the Investment Plan for the spread of ultrabroadband, as per CIPE (Inter-Ministerial Committee for Economic Planning) Resolution no. 61/2018.

THE TECHNOLOGICAL AND COMPETENCIES MODEL ››

The choice of technology is fundamental for the blockchain governance model as most available blockchain models are managed by distributed groups of developers. Governance should ensure that platforms evolve according to logics capable of satisfying the evolution dynamics of the ecosystem (including market dynamics). The creation of a network requires numerous decisions to be made, such the format used for saving data, resources and transactions, the type of network, governance and transaction validation rules. One of the most important decisions is the **choice of blockchain technology**, namely the software providing the implementation of the shared database and the execution framework for the smart contract. Network participants must adopt the same technology to validate information. As yet there is no universal interoperability standard for blockchain technologies, although work on standardisation is ongoing.

The selected blockchain technology must be able to integrate different suppliers and different IT environments which are typically present in companies and this means that the opening of blockchain technology is essential. In general, it doesn't make sense to adopt a proprietary blockchain technology as it would require all present and future participants on the company network to adopt the same provider, thus increasing the risk of lock-in, increased costs and lack of innovation.

In order to prevent malevolent intrusions in the goods production network and therefore control participants, while maintaining the privacy of transactions and alignment with basic characteristics, the blockchain must:

- enable the monitoring of network activities, for audit and verification purposes;
- prevent the anonymity of participants, while still providing diversified membership services;
- enable private and confidential transactions for exchanges using digital certificates and message encryption algorithms;
- enable governance which is in line with sector policies agreed in advance by main stakeholders, like a members consortium, a regulator or a market maker. Rules can be multi-dimensional and may, for example, describe how consensus is achieved, how future amendments to adhesion are decided, or who is responsible for any errors in Smart Contracts.

By way of example, **Hyperledger Fabric** is a technology which may best address highlighted needs, developed as part of the Hyperledger project.[15]

[15] As with other projects by Linux Foundation, Hyperledger is a consortium for the development of open software, therefore in line with the guidelines of the Digital Italy Agency. At the time this paper was written, more than 260 organisations from different industries are registered in Hyperledger and such an enormous community of developers has resulted in more than 10 open standard software developments.
One of the most advanced Hyperledger projects is Hyperledger Fabric, which provides an implementation of a shared register and a framework for the execution of Smart Contracts built around the principles of security (to reflect the requirements of regulated businesses) and modularity (to enable innovation). It is developed by a global team which represents dozens of organisations, with numerous examples in production. Hyperledger Fabric is considered enterprise-ready. This Readiness for companies is enabled by services (number of transactions in units of time) suitable for a production process, high levels of security and consent algorithms configurable according to network necessities.

Here follow the technical characteristics of the application which could be based on Hyperledger Fabric to trace the production chain of Italian textiles in particular and of Made in Italy in general. The application consists of a series of services distributed on two applicative components, Client and Server, and it integrated with participants' IT systems, if present. The component may have application customisations based on necessary functions of each type of participant. Client side applications can be web applications and mobile applications. The purpose of the Server application is to render process operations congruous with blockchain use.

With *client side* applications, the application regarding the consumer should also be considered.
Typically made for mobile devices, the application will enable the consumer to view product history and quality.

In the solution's architecture, client side applications (Mobile and/or Web) can be hosted on a Cloud Service Provider available on the public internet network.

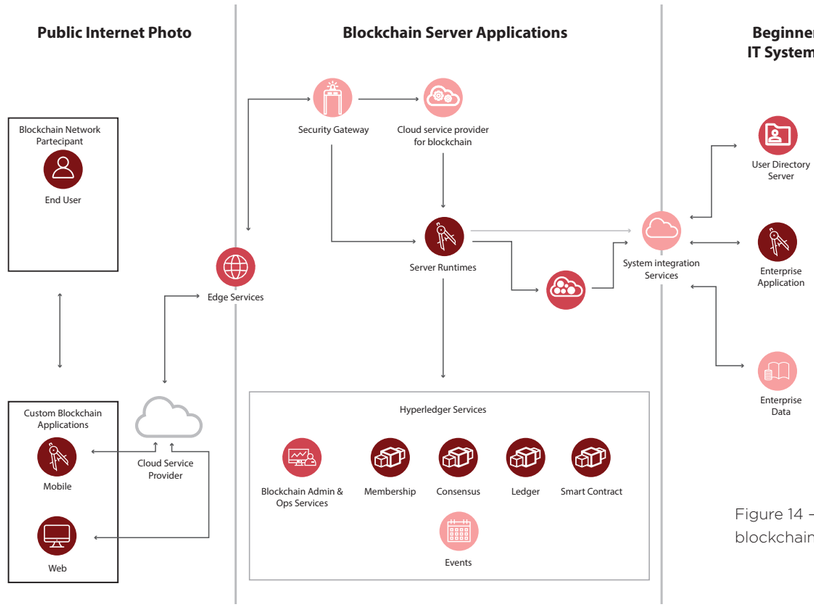


Figure 14 – Architecture proposed for blockchain application for Made in Italy

Client applications hosted on the external cloud interact via Edge Services with the Server application. Edge Services are network services capable of distributing contents on the internet. Typical examples of network services include: DNS, CDN, firewall, load balancer. The Blockchain Server application contains access logics to the shared register and is the node of the blockchain, all textile production process participants must obtain it.

The node is protected by a Security Gateway which manages accesses to the application, in Single-Sign-On eventually, with the Client component.
Blockchain nodes can be hosted on the computers of network participants or in general on Cloud Service Providers used by blockchain participants to fulfil IT needs In the described architecture, a host environment provided by a Cloud Service Provider is hypothesized.

On this Cloud Service Provider, the Runtime Server is the logical server onto which services of the Hyperledger Fabric blockchain are installed, described in the following table:

SERVICE	DESCRIPTION
Blockchain Admin & Ops Services	Blockchain administration service. Provides the console through which among other things it is possible to verify the status of transactions and blocks entered in the ledger.
Consensus	It is the mechanism which enables network members to approve proposed transaction which in turn modify the register. Consent mechanisms must support transaction performance and confidentiality. Hyperledger enables members to specify the policy of consent associated with the execution of a Smart Contract.
Events	System of notifications on significant operations carried out on the blockchain. For example, can notify of the execution of a Smart Contract or the creation of a new block in the chain.
Ledger	Contains current register status and the blockchain.
Membership	Manages the identification and certificates used by transactions and authorised access aspects. This service can be connected to an external certificate authority.
Smart Contract	Contains register amendment transactions (software code). Transactions are triggered by end user operations.

Table 6 – Blockchain Hyperledger Fabric: services

Through a System Integration service, the blockchain is bi-directionally integrated with external systems like:

- ERPs of participants, their accounting systems or in general management applications used by the participant (Enterprise Application);
- databases (Enterprise Data) which in the case at hand may contain information (certified) on the participant's specific production process, which can be referenced with hash keys by blocks contained in the ledger;
- user directory server containing information on company staff participating in the blockchain, for example authentication and authorisation profiles. This integration service is created as a web service whose functionalities are expressed with API (Application Programming Interface), made available on the API Management service.

The previously described applicative architecture must scale on a number of nodes equal to the number of participants belonging to the textile consortium managed by this blockchain network. From a technological viewpoint, scalability also becomes synonymous with infrastructure shaping. This implies providing a reserved space in the Cloud which guarantees access to information to a large number of players simultaneously, providing suitably sized databases for collecting all necessary information and coverage of internet connectivity to immediately and rapidly access the solution.

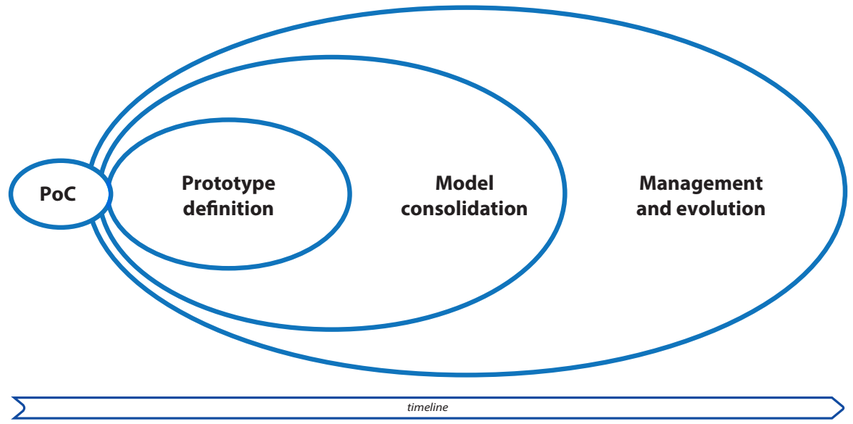


Figure 15 – Typical phases of a blockchain project

FINAL CONSIDERATIONS ››

The analysis and experimentation carried out highlight how blockchain technology appears to be particularly suitable for supporting the promotion of Made in Italy, insofar as it enables the resolution of issues which typically arise in traceability processes currently in use.
Across its different phases, the project also enabled the identification of some scenario elements which could be addressed with a series of accompaniment actions in order to favour the progressive participation of interested players and the model's long-term sustainability.
The experimentation carried out is ideally positioned at the start of a project development procedure worthy of exploration, by means of a continuous public-private dialogue, to understand how to favour the engineering of the system and ensure full project viability. The following diagram shows the three main phases in which a blockchain project is usually developed:

With respect to the three phases represented here above, the project demonstrated the effectiveness of blockchain regarding problems which emerged for the identified field of application. The Proof of Concept (PoC) demonstrated that processing steps can be traced using blockchain, making them transparent for all players of the textile industry (including any Certifiers) and providing all information relevant for the consumers, so that they can make an aware purchase.

Here follow key aspects which emerged during analysis:

- **Lack of a homogeneous perception and knowledge of blockchain:** As of yet there is no widespread knowledge of blockchain technology among enterprises of the textile system. The path unrolled with the project raised awareness as to its value, however in order to enable massive knowledge of this technology and its adoption along the entire supply chain, specific actions are required, for example: a communication plan to promote awareness, facilitate the disclosure of experiences and the sharing of best practices.

FINAL CONSIDERATIONS

- **Balancing the role of the market and the role of the State:** the creation of a "neutral" blockchain, equidistant between the interests of large groups and SMEs, does not occur spontaneously and requires a series of support and accompaniment actions which can facilitate the involvement and participation of all interested entities. In this sense, an interesting element emerged during works: the opportunity to evolve the Enterprise 4.0 programme in an even broader and transversal programme (e.g. Supply Chain 4.0) which could facilitate the convergence of incentives, accompaniment and training measures towards large infrastructure projects in support of Made in Italy.

- **Participatory and inclusive approach:** in conducting the project, it was decided to follow an inclusive and participatory bottom-up approach which enabled the identification of priorities, thanks to the direct experience of companies. A key element which emerged during meetings is the need to guarantee a holistic method for digitalisation, starting from major value nodes around which the supply chain is organised, for the progressive involvement of all interested private and public actors.

- **Successive focus and extension:** in looking to ensure the gradual development of the traceability system, it may be useful to favour the creation of a "minimum viable ecosystem" (MVE), built on actors and contiguous supply chain segments, on which the evolutionary path towards the target ecosystem can be built. In this phase, players responsible for system governance should facilitate the joining of different companies, according to various forms of participation (autonomously, or in aggregate form, in different business networks). Another important element could also be to include functionalities and services calibrated around the needs of all these players in the development plan which can improve model sustainability. This may also require the creation of a balanced involvement model, capable of satisfying the requirements of different players in different phases of project evolution.

- **The key element of competencies.** Obviously the creation of a supply chain traceability system requires the use and availability of technological and process competencies which can accompany companies in various integration and management activities. Therefore to this effect, there should be particular focus on defining suitable paths and training credits for all professions and competencies which may contribute towards project development (e.g. blockchain experts, integration specialists, specialists of IoT technologies, security experts in distributed environments, etc.) and which could be acquired temporarily through facilitating measures such as voucher manager or tax credit for training activities.

- **Supply chain data vision:** Supply chain processes are still strongly based on hard copy documentation. Therefore it would be useful to stimulate progressive digitalisation in this sense, facilitating the recovery and sharing of information among companies, the supply chain should be the main enabler for the activation of such processes for change. Currently, product information is distributed between different players. Therefore it may be useful to define an overall strategy for the management and coordination of supply chain data which enables the construction of the product story and the values it upholds.

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Compared with the numbers of the supply chain (45,000 companies, 400,000 workers, etc.), the freshly concluded traceability project may seem like a small step.
However, we are convinced that it is paving the right kind of path because blockchain can give renewed cohesion and recognition of the deepest values of our country's creativity and artisan knowledge.

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