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# Traceability in the Agrifood sector: business models design options and most relevant features

MASTER THESIS IN FOOD ENGINEERING

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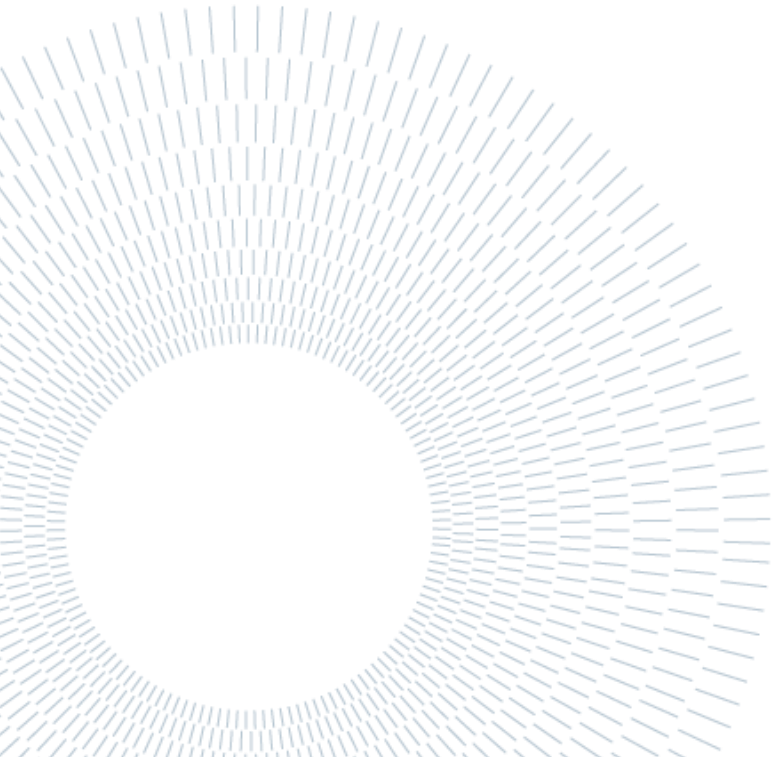

# 1 Abstract (English version)

*Traceability* is gaining attention in the agrifood sector global trends lately, and the goal of this thesis was investigating how to employ this concept in a business model (BM), determining the crucial features needed as well. Firstly, a review of the state of art exposed some theoretical spread patterns and archetypes as basis of such BM. From the theoretical results, fully resumed in a proper table filled with design options from the literature, the investigation turns towards existing companies. Firstly, the Research Question was presented, and, secondly, the Methodology for the data collection and processing was reported. To select existing companies to be analysed, a two sections database was scanned. In the first section, companies adopting *traceability* as core business aspect were picked (two companies). In the second section, six additional companies were picked by excluding the ones operating in a specific food sector and outside the EU. The eight companies were investigated to obtain the minimum requirements and nice-to-have features for a BM. On the other hand, specific design options related to *traceability* were presented. The relevance of these two outputs should be meant as the identification of a structure (possible BM design options) basing on four main dimensions (Value Proposition, Value Delivery, Value Creation, and Value Capture) to be adapted to the specific focus of this thesis which verts on *traceability*. In addition, these results were discussed to identify propositions providing guidelines for the design of possible BMs adopting *traceability* as core aspect, minding the features obtained from the research. Therefore, a BM should a) deliver of *traceability* services through user friendly platforms together with mobile versions to allow more and more personnel to use them; b) be strategically address to meet the requirements of the customers to consequently create a need to be satisfied, as the concept of *traceability* is still emerging in the market; c) exploit the strong benefits for the logistics section from proper tracking records by a network optimization, avoiding useless shifts of goods; d) exploit the customers' perception boost of the products from the sense of transparency; e) offer customizable subscription packages and fees to the customers, and fees should be proportional to the income generated by the services themselves. Practical and theoretical implications were offered, together with limitations of this work which suggest potential further research.

**Key-words:** traceability; business models; design options; value proposition.

# 2 Abstract (Italian version)

La *tracciabilità* sta recentemente guadagnando attenzione nei trend globali del settore agroalimentare, e l'obiettivo di questa tesi era analizzare come impiegare questo concetto in un modello di business (MB), determinandone anche le caratteristiche cruciali necessarie. In primo luogo, una revisione dello stato dell'arte ha esposto alcuni modelli e archetipi teorici diffusi come base di tali MB. Dai risultati teorici, interamente ripresi in un'adeguata tabella riempita con opzioni di design provenienti dalla letteratura, l'analisi passa a aziende esistenti. In prima istanza, è stata presentato l'obiettivo della ricerca e, in seconda istanza, è stata riportata la metodologia per la raccolta e l'elaborazione dei dati. Per selezionare le aziende esistenti da analizzare, è stato esaminato un database in due sezioni. Nella prima sezione sono state selezionate le aziende che adottano la *tracciabilità* come principale aspetto di business (due aziende). Nella seconda sezione, altre sei società sono state selezionate, escludendo quelle operanti in un settore alimentare specifico e al di fuori dell'UE. Le otto aziende sono state analizzate per ottenere i requisiti minimi e le caratteristiche utili per un MB. Inoltre, sono state presentate delle opzioni di design specifiche relative alla *tracciabilità*. La rilevanza di questi due output dovrebbe essere intesa come l'identificazione di una struttura (possibili opzioni di design per un modello di business) basata su quattro dimensioni principali (Value Proposition, Value Delivery, Value Creation e Value Capture) da essere adattata al focus specifico di questa tesi, cioè la *tracciabilità*. Inoltre, questi risultati sono stati discussi per identificare proposizioni che fornissero linee guida per il design di possibili MB che adottano la *tracciabilità* come aspetto centrale, tenendo conto delle caratteristiche ottenute dalla ricerca. Pertanto, un MB dovrebbe a) fornire servizi di *tracciabilità* attraverso piattaforme di facile utilizzo insieme a versioni mobile per consentire a sempre più personale di utilizzarli; b) essere strategicamente indirizzato per rispettare i requisiti della domanda e per creare di conseguenza una necessità da soddisfare, dato che il concetto di *tracciabilità* è ancora emergente nel mercato; c) sfruttare i forti benefit nel ramo logistico dati da un corretto tracciamento per un'ottimizzazione del network, evitando spostamenti di merce inutili; d) sfruttare il miglioramento della percezione dei prodotti da parte dei clienti data dal senso di trasparenza; e) offrire pacchetti di abbonamento modulabili ai clienti, il cui costo dovrebbe essere proporzionale ai guadagni generati dai servizi stessi. Implicazioni teoriche e pratiche, insieme a limiti e possibili future ricerche sono infine presentate.

**Parole chiave**: tracciabilità; modelli di business; opzioni di design; proposta di valore.

# Contents

# 3 Chapter one

## 3.1. Introduction

*Traceability* is gaining more and more attention lately, mainly in a green view of the industrial agrifood sector. It is one focal concept for the transition towards eco-friendly and sustainable economic systems. The interest is on its effectiveness in capturing value and generating income. Indeed, given that social and environmental benefits of sustainable innovations are relevant, a key feature of such concepts (and *traceability* as well) should be a concrete economic potential. To convert such potential, related and correctly designed business models (BM) must be studied and developed. These tools allow a company to set their targets, chase them in the most efficient way and be effective in creating value. Therefore, this thesis focuses on the BM perspective of *traceability*. On one hand, this concept was assumed to be the core aspect for such BM, as a constraint on which the model must be developed on. On the other hand, all the relevant features needed to accomplish this goal were investigated and critically proposed. The research question to be answered for this paper dealt with the most important design options for a BM which adopts *traceability* as core aspect, and its focal features. Concretely, options for possible BMs were detected, with the goal of making *traceability* a consistent element for successful businesses.

The whole research was split in two main sections: firstly, a literature review was conducted to present the state of art regarding BM and *traceability* definitions, and BMs in agrifood sector specifically. This review's results offered theoretical archetypes and patterns for BMs, and some design options based on four dimensions (Value Proposition, Value Delivery, Value Creation, and Value Capture). Such dimensions stood also for the second main research section, which dealt with existing companies, selected through precise criteria. The companies to be selected were contained in a database. Firstly, an assigned section of this database was analyzed to spot companies adopting *traceability* as core aspect. This led to two companies. Then, some selection criteria were applied to the other section of the database. Such criteria excluded companies working in a specific food sector (to pick versatile brands) and companies operating outside the EU from all the ones

which matched the keyword "*traceability*" in their captions. This led to a pool of six extra samples, added to the ones previously picked. Keeping the same four dimensions mentioned (Value Proposition, Value Delivery, Value Creation, and Value Capture) both for the literature research and for the companies' investigation aimed at validating this pattern as an analytic tool, potentially useful also for further works. Comparing the results from the investigations on the eight selected companies, some minimum requirements and nice-to-have features were detected and proposed. Such elements should stand as design elements for BMs. The identified requirements were data certification, awareness of customers, transparency, reaching smaller customers, networking, attention on sustainability, management improving, smart decision making, and employment of user-friendly tools. On the other hand, the nice-to-have features (which by definitions would set a recommended higher quality standard for the company) were personalized interfaces, economic KPIs, no physical devices, mobile apps, customized offers. In the meanwhile, design options based on the same four dimensions and exclusively related to *traceability* were delivered. Such options represented a deeper dive into the design of a BM and were identified after the companies' investigation.

The discussion upon the results highlighted the theoretical and practical contributions, the limitations and eventual further research as well as some propositions to be intended as guidelines for the design of BMs. Such propositions derived both from the data found and from critical assumptions. Therefore, a BM should a) deliver of *traceability* services through user friendly platforms together with mobile versions to allow more and more personnel to use them; b)be strategically address to meet the requirements of the customers to consequently create a need to be satisfied, as the concept of *traceability* is still emerging in the market; c) exploit the strong benefits for the logistics section from proper tracking records by a network optimization, avoiding useless shifts of goods; d) exploit the customers' perception boost of the products from the sense of transparency; e) offer customizable subscription packages and fees to the customers, and fees should be proportional to the income generated by using their own services. On the other hand, further research could vert on a deeper collection of economic data from companies in this specific sector regarding their income flows, and a wider literature review since the state of art offer limited number of sources as of now. This aspect underlines the contemporaneity of the topic and the consequent interest and potential.

## 3.2. Thesis structure

The thesis was divided in two chapters: chapter one contains the introduction and the literature review including preliminary definitions regarding BMs, *traceability*, and BMs in the agrifood sector.

Chapter two begins with the presentation of the Research Question, continues with the Methodology, dives into the Results related to the companies' investigation and ends with the Discussion section.

Lastly, Bibliography, Sitography, List of Figures and Tables are reported.

## 3.3. Business Model Definition

In a first general definition, a BM could be identified as a useful framework to synthesize and represent a company logic to create value and subsequently capture it. Therefore, a BM should include some key features which are usually shared regardless of the industrial sector of the brand considered. On the other hand, a BM should not be confused with the strategy adopted by the company to make profit out of their market. Both these two aspects are interestingly discussed by Shafer et al. [1].

The authors offer a clear distinction between a strategy and a BM. Despite defining univocally these terms could result tricky, they associate a strategy to the decision-making activities, with a usual forward-looking view. Once this direction is stated, the company can formulate and design a BM which will reflect the strategic choices mentioned. The BM allows an analysis and a validation of the strategy and the consequent effects of the strategy itself. Obviously, the results of the actions dictated by the strategy are the most important feedback which must be considered.

Given that the ratio lying under the strategy should include all the possible aspects to avoid weaknesses, the BM should be as comprehensive as possible as well. Shafer and his team [1]identified four main components of a BM in their paper (Fig 1). Firstly, the strategic choices, including the definition of the target market and the scope, of the value proposition, of the competitors, and of the mission: these concepts should be cleared as the very first step for the brand. As anticipated, the strategic choices of the company will be reflected from the BM, which will make the path to the revenue possible practically, starting from the overall strategy. This first cluster, therefore, refers to the most general overview, and will be very peculiar for each company, differentiating them between one another. As the very initial orientation of the productiveness of the brand, these are crucial steps which will

deeply affect all the following ones of this cascade. In the second block, which is related to the value network, belong the aspects regarding the suppliers, the relationships with the customers and the information flows. Once that the overall strategic direction is stated, the concrete actors of the whole network must be detected. Thus, the selection of such actors takes place at this point. Obviously, the criteria for the mentioned selection are dictated from the strategic choices features block, and are coherent with them. Even the relationship with the customers is crucial, more than ever when it comes to innovative BM which strongly rely on long and stable relations with consumers. Soon after the identification of the actors, the management of the products and information flows becomes relevant. Indeed, the role of the actors aims to the best delivery of goods and services in the various stage of the network, in all the directions. Specifically, in the innovative BMs, information carry value as well as the products. The "create value" component is about the resources employed, the assets considered, the processes and the activities performed. Starting from the resources and assets and through the processes and activities, values is created. As already mentioned, products and processes should be considered also as related to information, digitalization, and relationships management. Therefore, value creation assumes more and more possible paths nowadays, as will be clarified in a while. Finally, the block about capturing value comes, including all the features regarding the costs, financial and profit analysis. This fourth component is related to the concrete steps the incomes go through before becoming the effective revenue. Disregarding the sector of the company of interest, these generic concepts are always shared by all the BMs, and become specific for each brand depending on the business and the market.

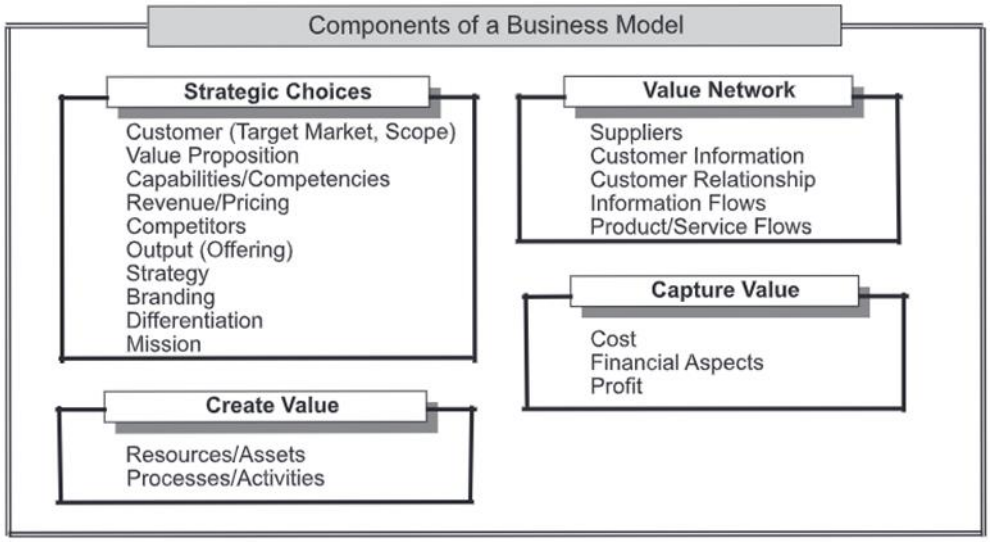


Figure 1. Components of a BM. [1]

On the other hand, some criticalities are highlighted. Particularly, a BM could face some problems when it comes to key steps and/or stages of its definition among the components just analyzed given that they are the more crucial ones. The main element on which the attention of this work will be put is the one related to value creation and value capture. The reason behind this selection from the author lies in the practical role this features have, since they are the final conversion of all the stage upstream and the effective realization of the company in an economic perspective.

Coherently with the introductive part, this thesis aims to the Agrifood 4.0 environment. Before deep diving in the specific sector mentioned, the step along the review will be related to innovation and sustainability. Such features are shared in the overall concept of Industry 4.0, therefore Agrifood 4.0 shares them as well. Indeed, innovation and sustainability are key factors for the largest portion of companies currently. Thus, for this paragraph, interesting BMs are the ones strongly related with sustainability principles, circular economies and, consequently, BMs which went through some sort of innovation as well as the companies employing them. Indeed, as a matter of fact, a BM should be designed in a versatile manner, or, at least, it should offer versatility when it comes to a need of adaptation from the brand due to -usually- external forces. Surely, all the features of the BM are required to adapt and innovate at the same pace of the BM itself, and the capturing value capability is included as well. An interesting case study of capturing value from innovation is offered from Chesbrough et al. [2]: even if this case study does not refer properly to Industry 4.0 company, it is a nice example of transition from a differentiation of the vision switching from the relevance of the product sold to the affiliation of the customers creating a strong relationship through a good service delivered. Somehow, Xerox lived kind of a revolution for that time, anticipating what is much more spread nowadays in terms of overall strategies and conceptual application of innovation. Indeed, Xerox managed to achieve success with a technology which was considered with no potential from other important firms by changing its BM. This brand had to overcome the issue often related to discovery-oriented research in this sector, which is the lack of a clear path through the market, in a technology push situation. Xerox BM should have to deliver value to the customers from the technology inventions they made, despite the uncertainties related to the product itself and the economic domain faced (Fig. 2).

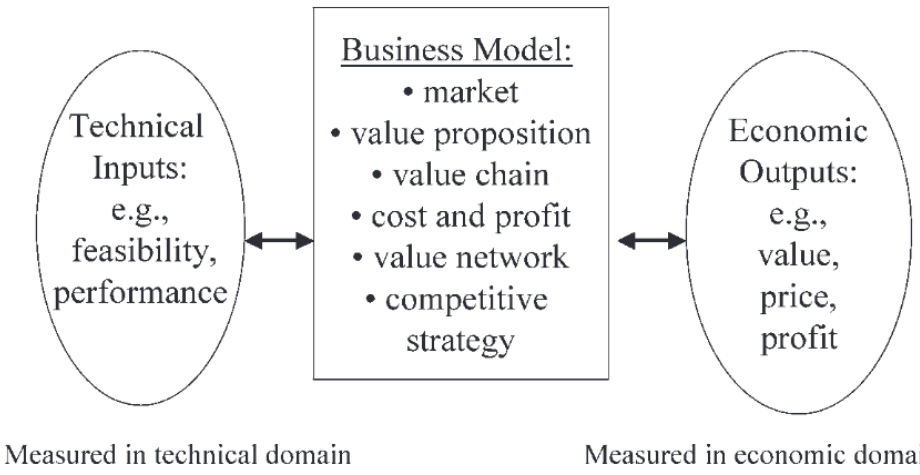


Figure 2. The mediative role of the business model, between the domains of interest, through some key components. [2]

To do so, Xerox CEO switched the brand capturing value structure, passing from selling the equipment (old strategy) to offering a lease to the customers (new strategy). This meant a strong trust in the product, since the main revenue was then coming from consumables and supplies instead of the machines. Offering this value proposition to the customers, together with a high-quality machine and the service and support included, was the game winner. According to Chesbrough et al. [2], a successful BM should map between technical and social domains, and managers should design appropriate BM to realize the value latent in the innovative products and capture value from them.

Ibarra et al. [3] conducted a review about BM innovation as well, when it comes to application of such models to industry 4.0 which is the main global trend nowadays. Specifically, some key features are identified to convert the classic approach in a new one that would fit this transition:

- **Service – orientated approach**: industry 4.0 is pushing to a shift from product orientation to service orientation. This shift would allow brands to compete also out of the only manufacturing costs, introducing the so-called product-service system (PSS).
- **Network – oriented approach**: new actors are appearing and old roles are changing all along the classic value chains, as well as the opportunities to create, deliver and capture value for the stakeholders.

- **User – driven approach**: this trend will lead the companies closer to their customers, creating new types of relationships and partnerships. Flexibility is a key characteristic for this innovation, which would allow a customization of the PSS.

Moreover, according to the model discussed from Osterwalder and Pigneur [4], Ibarra et al. [3] report four main possibilities to complete the transition towards an Industry 4.0 approach. These tangible paths are illustrated in Fig. 3.

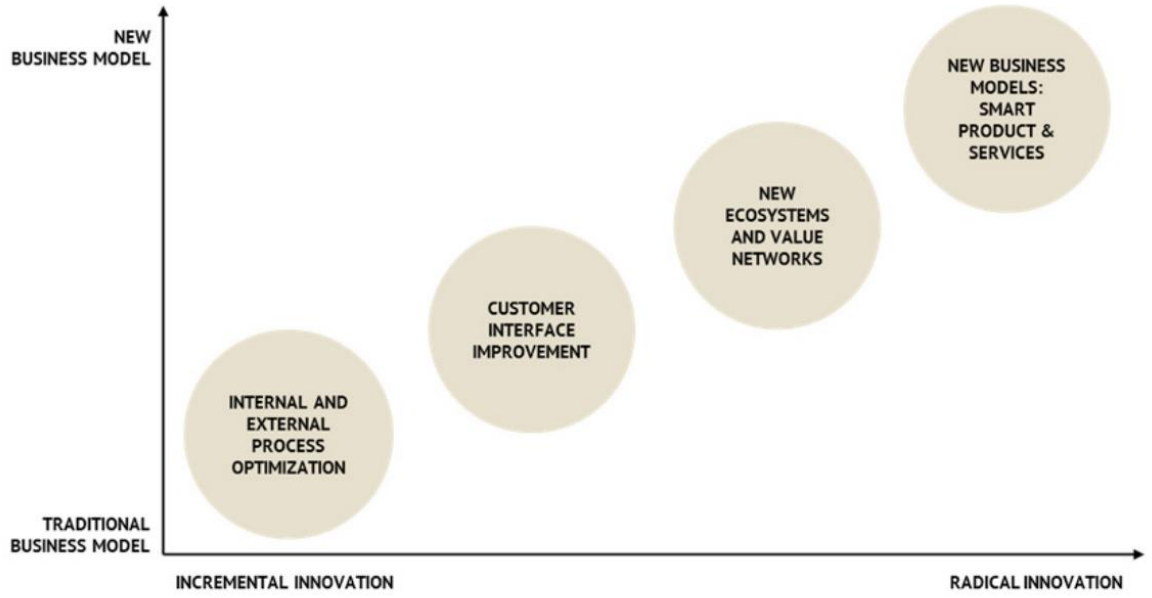


Figure 3. Four trends to conduct a digital transition in manufacturing companies. [3]

The authors offer a detailed description of the way such paths impact the mentioned transition, which are briefly reported below.

Internal and external process optimization: this first step refers to optimization (in terms of an increasing efficiency and an improved performance) thanks to some spread technologies as Big Data, Cloud Computing, Additive Manufacturing, etc., which expose the companies to a low risk. Specifically, product and resource traceability, machine to machine connection and employees training would be facilitate. Moreover, a more transparent management and more flexible offers would be delivered.

Customer interface improvement: this step is value delivery driven, linked to the technologies mentioned. It allows a better understanding of customers' needs,

improving their experience. Here, the focus is about a segmentation based on data analysis, more direct and long-term relationships, and improved digital sales.

New ecosystems and value networks: based on an attention towards the core business, this model represents the concrete radical innovation. This way, the focal brand's value creation processes are bound with the ones from the stakeholders. The perspective changes from the chain to the network. New capturing value systems need to be designed, and sharing information and skills with all the actors becomes now crucial.

New business models - smart products and services: this last step is achieved after a radical and complete innovation. Companies' markets could be diversified or expanded. On the other hand, there is no need to abandon the old models, since they can coexist (allowing a valuation of the new ones). A great new feature is the co-creation of the value with the customers themselves and, therefore, direct relationships.

Also, Dijkman at al. [5] define a useful framework about the BMs for IoT applications, which are effectively related to the Industry 4.0. This team recognized some spread and main components of this models, which can be seen as "building blocks" – as they are called in the mentioned report. Figure 4 is presenting the main contents of the review. Such Figure can be considered as a more specific framework of with respect to Figure 2, since it cites many detailed elements. Moreover, the reader now got in touch with block specifically related to Industry 4.0 BMs: it is therefore coherent that some features will be different now, strictly linked with digitalization and informatic. Indeed, the elements of the blocks which primarily deal with innovative BMs are included in the ones colored in grey. This is evident right from the first block, which mentions hardware and software producers (with the latter highlighting a technological transition even more). Likewise, the key activities will follow this trend, through the need of developments of sales platform (another new element proper coming from Industry 4.0), for example.

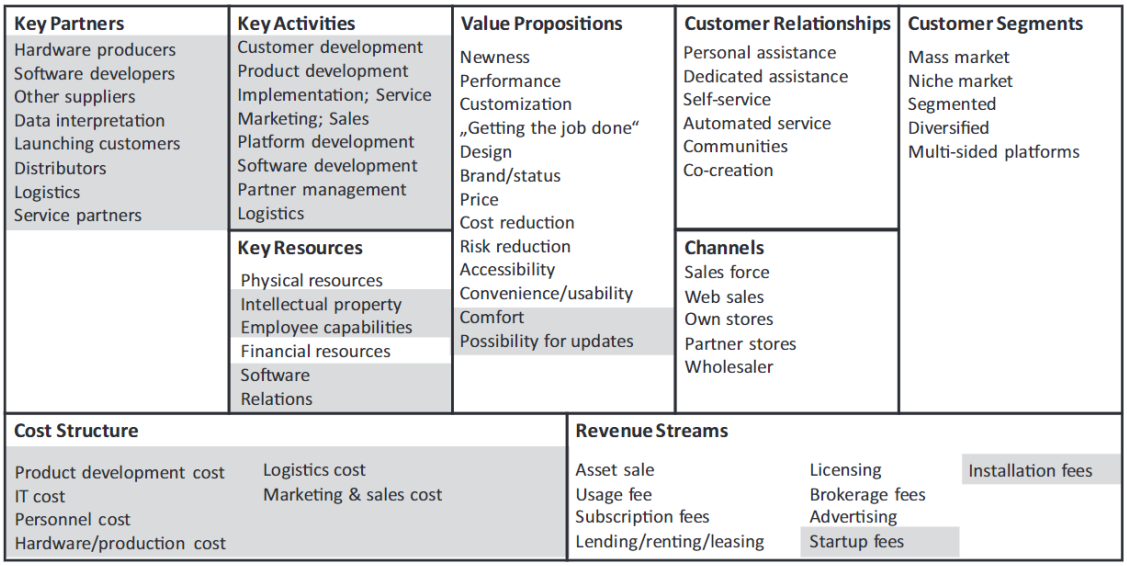


Figure 4. Main building blocks for BM in IoT applications. [5]

An interesting and new combination of values proposition is offered by the comfort, always more and more demanded nowadays as main and versatile quality in each sector, and the dynamic of the products themselves. "Comfort" should be interpreted as the ease of accessibility and usage of the products/services: from this, the opportunity of updating them, avoiding the need of new purchases is a key trend. As such, it is coherent with a circular economy flow and sustainability concepts as well. The cost structure should be revised and adequate as well, since the economic frameworks of such innovative BMs evolved with them. At the same point, the revenue streams deeply change, with some new elements upcoming.

The following focal concept, which is *traceability*, will be introduced and presented in the next paragraph. Consequently, since the BMs description and innovation and *traceability* frameworks in the general field of Industry 4.0 will result clear and defined, this thesis is going then to deep-dive in the Agrifood sector.

## 3.4. Traceability Definition

According to Olsen and Borit [6], the concept of traceability does not have a unique definition nowadays. This fact depends also on the related sector of application. As far as the scope of this thesis is over the Agrifood field and given that the mentioned paper followed the same focus, the paragraph will be oriented towards a presentation and critical definition of this relevant concept about the food sector.

The main definitions of traceability are reported in Table 1. In the same Table, the origins of the cited definitions are indicated.

Table 1. Main definitions of *traceability* considered, with the reference in the first column.

| | | |
|---|---|---|
| Standards and Codexis | ISO 8402 | "The ability to trace the history, application, or location of an entity by means of recorded identifications" |
| | ISO 22005 | "The ability to trace the history, application, or location of that which is under consideration" |
| | Codex Alimentarius | "The ability to follow the movement of a food through specified stage(s) of production, processing and distribution" |
| Legislation | EU GFL (178/2002) | "The ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution" |
| Scientific Article | [7] | "The ability to track a product batch and its history through the whole, or part, of a production chain from harvest through transport, storage, processing, distribution and sales" |

Even though all these definitions state something correct and valid, they are all incomplete. The common line, however, consists in recognizing that *traceability* is not a type of information. This term is sometimes used as "product properties" which is misleading. Thus, *traceability* is the tool through which information about the product is retrieved, and previously stored and organized as well.

Another interesting point is offered about the definition of the features needed from a system to work properly as a *traceability* system. Therefore, four main characteristics are reported:

- Ingredients and raw materials should be grouped in "traceable resource units" following a criterion based on their similarities between one and the other. This term was reported by Moe [7] and Kim et al. [8].
- Each of the mentioned units should be then marked with a serial number/code which allows to identify it quickly and univocally. At least, this marker should be unique for day of production, product type and brand.
- All the properties and processes related to the unit selected should be recorder and linked to the unit itself.
- Lastly, the system should be provided with an algorithm/path to access easily such information.

For a deeper dive on these components of a *traceability* system, the paper from Olsen and Borit [9] reports a full overview. Summing up, the core information of interest is product location, its original characteristics (for ingredients as well), all the processes such product went through, starting from the very first step (e.g., harvesting) until it reaches the final consumer after all the logistics, sales, and storage steps. Therefore, the main goals are linked to such information, and they are the reasons why *traceability* reached the relevance it has nowadays.

As anticipated in the Introduction, *traceability* has a key role in Industry 4.0. Thanks to many spread technologies already mentioned, progresses were made quickly towards a vast application of this tool towards a more sustainable, safe, and conscious food consumption. Practically, and according to the Triple Bottom Line, economic feedback must have its roots in the concept of *traceability*. Beyond the willing of the customers to be aware of the history of the products, an eye must be dedicated also to the value creation side of this aspect. Moreover, as for the BMs, some archetypes could be identified. Such archetypes concretely allow *traceability* to have a value creation active role for the companies, in terms of income generation. Pang et al. [10] propose some attractive values coming from their research; such values represent possible concrete reasons companies should move towards

application of *traceability* since they represent actual opportunities in a business perception of this framework.

In this specific paper, the focus was on IoT solutions: this peculiarity should sound common, since this thesis is verting on the same innovative aspects for the Agrifood sector. The mentioned values are presented in the bullet point below.

- **Shelf-life prediction**: this parameter is crucial for climacteric fruit. Such fruit must be harvested with a large advance to deliver them to the customers at the right maturation stage. If the ripening exceeds the optimal conditions, the products would be wasted, because of the shortenings of shelf-life which would not allow them to reach the consumers. If this situation is detected on time, solutions to avoid the waste of the stocks may be set on place. A logistics re-planning of the products which are ready to be sold could solve the issue: delivering the items to a closer location would save them from being discarded and would optimize the sales price as well. [11], [12]
- **Sales premium**: this aspect is more costumer preference oriented. If a tracking/monitoring system works properly along all the supply chain of the product, trust from the consumers is enhanced. This may be realized by providing atmosphere information or handling history. This valued added service allows the companies to require a premium price for the product considered, and positive interactions among producers and consumers could born. [13]
- **Precision food production**: the goal of this point is increasing efficiency, productivity and profitability of producers while minimizing impacts on wildlife and environment. The real time information from the fields would provide strategies: for example, in growing processes whereas controlling greenhouse gases emissions. Productive cycle of high-quality wine may be monitored for precise interventions on field and preservation of the storage. The soil moisture can be controlled and forecast to optimize irrigation and maximize productivity. [14]–[18]
- **Insurance cost reduction**: IoT technologies would allow to reduce claim related costs, overall risks, and reputation hazards for the brands. Insurance companies would access information about wastes due to spoilage and consumers would gain visibility and better insurance plans. Hartford Financial Services Group is one of the main brands in this sector. Insurance cost represents around 10% in the total start-up cost of a grocery store during the first 4 years. [19]

Among the technologies which are leading the *traceability* grown nowadays, the radio frequency identification (RFID) is one of the most spread and adopted. This

technology is an example of the potential which lays in the IoT, along with many other opportunities. Thus, as per Tajima [20], some clear added values are offered with RFID. 15 potential benefits were identified, clustered in 4 main sections based on the common actors of the chain.

Table 2 is summing up the results, with the mentioned sections and some keywords about the opportunities offered by the RFID. In the meanwhile, Figure 5 gives and overview of these contents directly on the supply chain for a better idealization. On the other hand, such added values are shared by other technologies: RFID is the one mentioned, but this does not exclude many others which allow similar advantages.

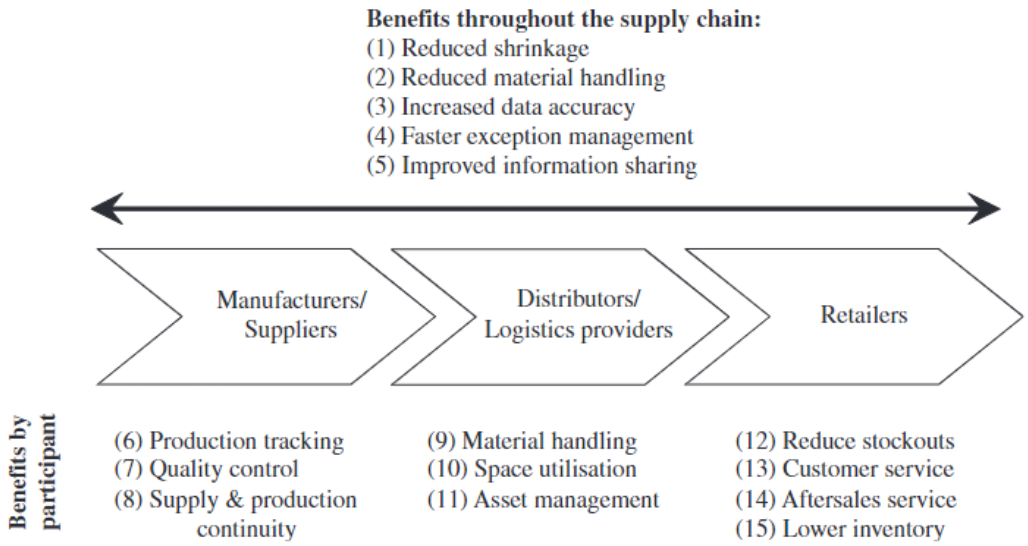


Figure 5. Potential added values thanks to RFID along the whole supply chain. [20]

Moreover, as per Latino et al. [21], the expected innovation brought to a Supply Chain from advantages derived from *traceability* systems depends on the chance of adapting the network of actors and rearrange it, and this topic will be properly discussed in the following paragraph. However, Golan et al. [22] selected three more features to deal with when it comes to a traceability system built over the technologies from Industry 4.0:

- **Amplitude**: amount of data and information that the system can storage;
- **Depth**: number of sectors – and therefore actors – involved in the chain considered which the system would face;
- **Accuracy**: analysis unit referred to the tracking activity;

All the mentioned paths to create value are directly coming from the application of traceability. Despite the social and environments benefits, those examples are concrete opportunities to create, deliver and capture value in Agrifood sector. This should sound convincing for the interested companies in the close future, when an always larger number of brands could adopt this tool.

Table 2. Added values through the employment of RFID, with the related supply chain section of interest and some keywords linked to the opportunities delivered. [20]

| Chain section | Added values | Related keywords |
|---|---|---|
| Whole chain | a) Reduced shrinkage; b) reduced material handling; c) increased data accuracy; d) faster exception management; e) improved information sharing. | a) misplacement, spoilage; b) optimization of operation time, decreasing of human and location errors; c) improving demand forecast and production planning; d) data acquisition, information synchronization; |
| Manufacturers/ suppliers | a) Production tracking; b) quality control; c) supply & production continuity | a) raw materials and end products tracking, status during production; c) equipment downtime and maintenance costs; |
| Distributors/logistic providers | a) Material handling; b) space utilization; c) asset management; | a) automated cross-docking, fewer delays, shorter lead times, labor costs; c) equipment management, lower costs; |
| Retailers | a) Reduced stockouts; b) customer service; c) aftersales service; d) lower inventory; | a) accuracy in inventories; c) warranty details, service history, goods authentication; |

As per Rigattieri at al. [23], moreover, some clear benefits are offered from *traceability*. Such benefits are products safety and an optimization all along the supply chain of interest. Thus, managing, sharing, and storing information efficiently and effectively could lead to operating costs reduction and boosting productivity, which is coherent with Tajima [20] and some elements of Table 2. In the review from Bosona and Gebresenbet [24], some other main benefits are added: customers' satisfaction and contribution to agrifood sustainability.

All the mentioned benefits are summed up in Table 3, and some concrete examples for each benefit are reported, together with related sources. These are the main goals of traceability, in terms of application of the tools and the systems to the sector and the BMs. Since each company performs an internal assessment to evaluate whether adopt such frameworks or not, giving a highlight of the goals and of the consequent advantages is the very first step.

Table 3. Main benefits deriving from traceability, some practical examples, and the related sources.

| Benefit | Examples | Source |
|---|---|---|
| Products safety | Improving management of hazards incidence, enabling authorities to identify hazardous foodstuffs (and withdraw from market) and detect fraud, tracing the origin of foodstuffs and ingredients, controlling animal and food related diseases. | [22], [25], [26] |
| Supply chain optimization | Increasing transparency and adding value to the quality of the supply chain management by reducing information asymmetries and costs: costs of procurement, inventory, transport, information and data management, warehouse. | [27] |
| Customers' satisfaction | Increasing consumers' confidence in food and reducing customers complaints, promoting food choice (e.g., for consumers with food allergies). | [28], [29] |
| Contribution to sustainability | Implementation of sustainability initiatives in food production, handling, and distribution: traceability data could ensure that food is sourced from appropriate sources or farms | [30], [31] |

On the other hand, some barriers can be detected: these elements contrast the employment of the mentioned traceability systems, and should be overcome. Bosona and Gebresenbet [24] propose some barriers, such as resource limitation, information limitation, standard limitation, capacity limitation and awareness limitation.

A brief description of such barriers is provided below:

- **Resource limitation**: implementing *traceability* tools is expensive and demanding for the first time, some initial resistance is quite natural to happen. As a complex task, it requires a change in the whole business network and to be both cost effective and user friendly to be adopted.
- **Information limitation**: *traceability* in the agrifood sector is associated with uncertainties which make it difficult to acquire certain and timely data at all stages in the supply chain. Both internal (meaning internal at the single company) and external traceability (meaning among the companies of the network) should be precisely connected to allow the information flowing at its best.
- **Standard limitation**: the main issue related to *traceability* technologies such as numerical code, bar code or RFID tags is the lack of standardization. This creates compatibility problems among different solutions introduced by different actors in a supply chain. As of now, data transmission from one actor to another is difficult due to variations in data capturing, inconsistency in types of captured data, variations in sharing data within a facility and among the supply chain partners, and lack of definitions of key terms.
- **Capacity limitation**: such frameworks require skilled staff to be implemented and managed. Different actors may have different goals, and dedicate different sized workforce, when, as anticipated, this process is quite demanding in terms of effort.
- **Awareness limitation**: benefits coming from adopting such models are clear for a portion of the scientific community, whereas such notions are not spread enough yet. *Traceability* is still perceived as an extra effort, and the economic potential is not assessed properly yet. Effective trainings and education programs could solve such issue and increase the awareness of the actors.

Now that BMs were generally defined, and proves about the importance of *traceability* in the market were provided, next paragraph will present the research part in the current BM specifically employed in the Agrifood sector. The goal is linking these frameworks together to obtain as output some BM using *traceability* to create and capture value.

## 3.5. Agrifood current Business Models

As anticipated in the previous paragraphs, the aim of this section of the research was identifying business models specifically for the Agrifood sector. Therefore, maintaining the interest towards Industry 4.0, traceability, innovation and sustainability, the next step towards the results consists in reviewing this specific models currently adopted globally. All the general concepts presented above regarding general models should be considered valid anytime, as well as the added values identified and the opportunities created through the application of the well know technologies. Once these models will be presented, the outcome of the research will be delivered.

As reported, Latino et al. [21] cleared out that the factors determining the models themselves adopted in the Agrifood field are various, and, sometimes, not predictable. By the way, they managed to identify some starting features such models should include. Assuming, once again, the use of Industry 4.0 technologies, the basic characteristics to be considered would be low-cost and pervasive connectivity, advances in storage and data exchange, adaptable and accessible tools, innovative partnerships, application for agricultural information services. This come out with some crucial importance since such models should be employed nowadays by innovating or abandoning older models, that used to work concretely. As it always happens, some extra added value must come with an innovation, to justify this innovation and make it appealing for the companies.

Mainly, this paragraph wants to collect the most spread theoretical archetypes nowadays. Moreover, their building blocks would be reported. To start the analysis about such archetypes the review from Lüdeke-Freund et al. [32] was considered. Such article offers an overview on business models patterns. Some of them will be cited as feasible for models specifically related to agrifood sector. Firstly, the dimensions of the analysis are stated: based on them, the possible options to build models are structured. Each dimension includes two subcategories, resulting in eight main sections of the design options for the archetypes. The mentioned dimensions are:

- Value proposition: related to products and services;
- Value delivery: dealing with target customers and value delivery processes;
- Value creation: referring to partners and stakeholders and value creation processes;
- Value capture: about revenue streams and costs.

Structuring the analysis with these dimensions, the authors offered some design options depending on the models they worked on. The created framework is very versatile: every option can be combined with the others reported to create an archetype. Table 4 reports such options from the article.

As anticipated, the combination of some of the options leads to possible patterns and archetypes. The authors proposed six main patterns: three of them relate to agrifood sector and possible BMs.

- **Recycling BM pattern**: products are based on recycled waste and production employs reusable or recyclable inputs. Services proposed are take-back management and waste handling/processing; the target customer are green ones, in a B2B environment. Value delivery processes should connect suppliers and customers, providing used products, components, materials, or waste, and taking them back. The partners in such archetype are collectors of products, components, materials, or waste. Value creation should be achieved through recycling, upgrading, or upcycling, taking back or recapturing products and winning back base materials. Revenues would be related to additional products, while costs would be related to waste handling and processing, resource inputs and logistics.
- **Cascading and Repurposing BM pattern**: same value proposition and delivery elements cited for Recycling BM pattern, a part from the connection of suppliers and customers. In addition to the collectors of materials, retailers are now a key partner group. Value is now created also through reselling products, over the same processes as before. Revenues and costs are totally shared with the first pattern illustrated.
- **Organic feedstock BM pattern**: same products and services as the others, but value delivery processes consist in taking back used products and materials only. Collectors of products and components would be the partners; the value creation processes would differ from the ones related to Cascading and Repurposing BM pattern since the reselling slot would be replaced by using used products and materials. Once again revenues and costs features would be shared with the previous pattern.

Table 4. Main dimensions and design options for BM archetypes and patterns reported by Lüdeke-Freund et al. [32]

| Main dimensions | | Design options | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Value proposition** | Products | Repaired, refurbished, remanufactured, or recycled products | Reusable or recyclable products | Products based on recycled waste | Long-lasting products | Used products, components, materials, or waste as production input | Reusable or recyclable production inputs | | | | |
| | Services | Facilitating collaboration | Take-back management | Customer education | Waste handling, processing | Product/service-based functions | Maintenance, repair, control | Product/service-based results | Upgrading | Auxiliary services | |
| **Value delivery** | Target customers | Quality-conscious customers | Cost-conscious customers | Green customers | B2B customers | B2C suppliers | B2B suppliers | C2C suppliers | | | |
| | Value delivery processes | Connecting suppliers and customers | Providing access to a product's functionality | Providing (product-based) services and results | Providing used products, components, materials, or waste | Taking back used products, components, materials, or waste | Sharing products, components, materials, or waste | | | | |
| **Value creation** | Partners and stakeholders | Suppliers | Manufacturers | Retailers | Service providers | Public institution | Collectors of products, components, materials, waste | Others (e.g., researchers) | | | |
| | Value creation processes | Maintaining or repairing products, components | Refurbishing or remanufacturing products, components | Recycling of products, components or materials, waste | Upgrading or upcycling of products, components or materials, waste | Reselling products, components or materials, waste | Taking back or recapturing products, components or materials, waste | Winning back base materials | Using used products, components or materials, waste as input | Matching over-and under-capacities | Designing products, components or materials |
| **Value capture** | Revenues | Additional product revenues | Payments per unit of service | Payments for functions or results | Price premiums | | | | | | |
| | Costs | Labor | Repair, maintenance, control | Waste handling, processing | Manufacturing | Resource inputs | Transportation, logistics | Supply risks | | | |

These theoretical design inputs are thought to be sustainable, meaning that they all are environment friendly and social committed. Moreover, some features are shared with the building blocks recognized for general BM in the dedicated paragraph.

Bocken at al. [33] offered one of the most cited articles in the research section about of agrifood BMs. In their review, they proposed eight main archetypes, based on an initial grouping which results different from the one used by Lüdeke-Freund et al. [32]. Now, the clusters are about technological, social, and organizational division. In each cluster, some archetypes are identified, which are then analyzed depending of the four known dimensions also shared from Lüdeke-Freund et al. [32]: value proposition, creation and delivery, and value capture. Once again, some of the presented archetypes were not considered since this paragraph verts on agrifood BMs specifically: the excluded ones are meant to better fit BMs from different sectors. The selected archetypes are now reported.

- **Maximize material productivity and energy efficiency**: this first archetype comes from the technological group and aims to reduce the employed resources, with less emissions, waste, and pollution. Such archetype should run through the entire business and subsequently enhance the value proposition, capturing concepts such as lean, eco-efficiency and waste reduction and contributing to a system-wide reduction of sources consumption. Value is captured abating costs, increasing profits, and delivering competitive pricing advantage.

  Waste is a severe issue related to the agrifood sector, due to perishability of the products obviously, but most of times the cause is the overproduction or bad management of the supply chain overall.

- **Create value from waste**: this model quite resembles some of the alternatives from the previous paper. The core concept is turning waste streams into useful and valuable input to other production, through activities and partnerships ad hoc (e.g., to close material loops). Disposal costs would be reduced or eliminated, and scraps would gain value. For this model, the focus is not about reducing waste but it is about convert it in value. To capture this value at the best, the input speed of new products in the market should be slowed a bit.

- **Encourage sufficiency**: the goal is now about reducing consumption and production; this aspect is quite shared with the first archetype from this review, but the current archetype intends it in a social direction. Indeed, the focus is on customer relationships and influencing consumption attitudes. Higher attention from the customers would traduce itself in premium pricing

for companies, which would allow higher quality production and longer and more stable relationship with customers themselves. Overselling and promotion would be reduced, shifting towards a more sustainable production rate.

A firm which actively engages in demand side management, leading customers towards a conscious consumption would gain reputational benefit and avoid scale-up costs. A less mentioned actor who would play a key role in such archetype would be the governmental institutions, raising awareness in the population and eventually providing incentives to the committed companies.

For all the products which are not strictly food, long durability and longevity are the key concepts adopted: technology and packaging sectors are the most representative.

- **Develop scale-up solutions**: this last archetype belongs to the social cluster as well, and it is quite unique. Its goal is delivering sustainable solutions at a large scale to better deliver benefits to population and environment. This is to allow sustainable BMs to spread and gain appeal for big firms, since this form of commitment (social and environment friendly) is usually shared among start-ups or small companies. Scaling this up would mean deliver much more benefits through brands' structures much more developed and able to effectively accomplish this mission easily. Approaches such franchising and licensing would be correct paths for this, which allow value capture as well. Value creation and delivery would deal with collaborations with authorities and infrastructures.

Comparing these descriptions with Table 4 enhances its validity. Indeed, that table correctly sums up also the options needed to design these four more archetypes. This way, that framework turns out to be effective to generally describe eventual archetypes not belonging directly to the cluster of models it was built for. Therefore, the mentioned design options, when combined, allow many different archetypes to be recognized. This was a partial goal of the research: potentially, this can work as inspiration for new theoretical models or as implementation for existing ones.

Since finding existing models is the second goal of the research from this thesis, as anticipated, a dedicated paragraph is offered in the following pages. Some of the theoretical archetypes are practically adopted by existing companies, which stresses the focus on the relevance of the papers analyzed. Some extra models are shortly reported below, since they come from a complete review from Lüdeke-Freund et al. [34] and existing examples of brands which employ them are cited. This is another

confirmation of the global interest towards this typology of BMs which will spread more and more in the future.

In the review from Lüdeke-Freund et al. [34], the models were grouped through a Delphi survey. Five of them are now mentioned, since they relate to Agrifood sector or could exist and be employed in such field.

**Group 1 - Closing-the-loop patterns**: patterns that help integrate the idea of circular material and energy flows into partnerships, key activities, and customer channels, i.e., how materials and energy flow into, out of, and return to a company.

- **Industrial Symbiosis**: in the current industrial economy opportunities to leverage wasted and underutilized resources are often overlooked, partly because their potential cannot be exploited by single organizations. The main goal is to optimize and reduce the material and energy streams and associated costs. Employing a shared or cascaded use of resources, by-products, and waste materials among different actors on a commercial basis could solve the issue. Establishing inter-firm exchanges and linkages driven by the need to reduce virgin inputs, waste, and costs allows reducing waste and optimizing material flows among multiple organizations.
- **Online waste exchange platform**: with the same context of the first cited model, a new point is considered. A lot of what is labeled "waste" can still be useful for some producers. It is necessary that useful waste is offered by one partner while it must be identified by another. The proposed solution is creating an electronic marketplace for waste that matches supply and demand. This way, the platform enables the exchange of waste between actors and retaining the value contained in materials. Companies providing such services gain earnings from commissions on transactions.

**Group 2 - Supply chain patterns**: patterns that modify the upstream (partners, resources, capabilities) and/or downstream (customers, relationships, channels) components of a business model, i.e., how inputs are sourced and target groups are reached.

- **Green supply chain management**: the attention upon such model was born given the growing pressure on companies to be more transparent and efficient, in terms of using natural resources and avoiding risks and harms to their supply chain partners and customers. The efficiency and transparency of supply chains needs to be improved, also to mitigate ecological and social risks. Companies must reduce the use of non-sustainable materials and find

ways to substitute risky inputs, source and reuse waste and surplus materials. The solution proposed is sourcing raw inputs and components in the most eco-friendly way possible and reducing or even eliminating toxic inputs. Suppliers are urged to commit to green supply chain management. Partners and networks are crucial actors for green supply chains.

- **Produce on demand**: Aligning supply and demand is particularly challenging for new types of offerings, which can result in excess material in the production cycle and inefficient use of scarce financial resources. In this specific sector, this aspect is honestly complicated to be managed, but the amount of waste due to overproduction is importantly high. Moreover, overproduction results in inefficient resource use and/or a lack of financial resources to produce stocks of products. From this, the point is producing a product only when consumer demand is verified, e.g., via online platforms that allow customers to place pre-orders, to vote on preferred products or even to design their own products. This allows reducing overproduction and inefficient use of resources.
- **Shorter supply chains**: coming from the same context and starting problem of "Green supply chain management" model, the alternative solution proposed is different. Reducing the length and complexity of supply chains, even spatially, through less and closer partner and customer relationships. Then, transparency improves by reducing the number of connections or knowledge sharing with suppliers.

As mentioned, all the previous BMs and archetypes are currently adopted from existing companies. Now that the design options and most spread models were reported and discussed, the theoretical aspect of the research can leave the stage to the second chapter. The following section will converge on showing existing BMs adopted by actual companies, with the related business details. This feedback with the real industrial world is a strong confirmation about the potential of such models and the concrete need for a deeper dive in this research sector. As per many authors cited, indeed, an evident gap comes out in this area, which deserves attention and is gaining interest both from pure researching and industrial side.

# 4 Chapter two

## 4.1. Research Question

As mentioned by various of the cited articles, an actual gap in the literature related to the topic of this thesis exist. Indeed, investigations about agrifood business models, which are sustainable, innovative and adopt traceability as core feature are not spread still. Moreover, *traceability* is still assessed as something conceptually positive more than something concretely useful and which can add value. Overviews regarding practical tools or paths to successfully employ traceability as core aspect of a sustainable business model are far from being definitive.

Therefore, literature about archetypes dealing with the agrifood sector and focusing on the mentioned theme is very scarce. This thesis aims to analyze the theoretical frameworks to build such archetypes which can then inspire eventual concrete business models. Soon after, existing companies which share this business vision and adopt similar business models are considered. Precisely, the research for existing company verts on companies which selected *traceability* as core element of their business.

The research question to perform this review was:

- Which are the main design options regarding agrifood sustainable business models considering traceability as core aspect nowadays and their most relevant features?

## 4.2. Methodology

### 4.2.1. Data collection

The overall research of existing companies focused on brands with a core business directly related to *traceability*. To achieve this result, a database was provided. Such database contained a sample of companies working in the agrifood sector or similar fields. The goal was detecting the interesting brands among the full list, to gain current examples of business models to analyze.

To do so, each company was investigated through the description provided (when available) and the website reported. Gathering information via Internet was the main tool to categorize the brands according to the NACE code from Mirnoorilangeroodi et al. [35]. The adopted process is reported in Figure 6, along with numerical data and results from the database scanning.

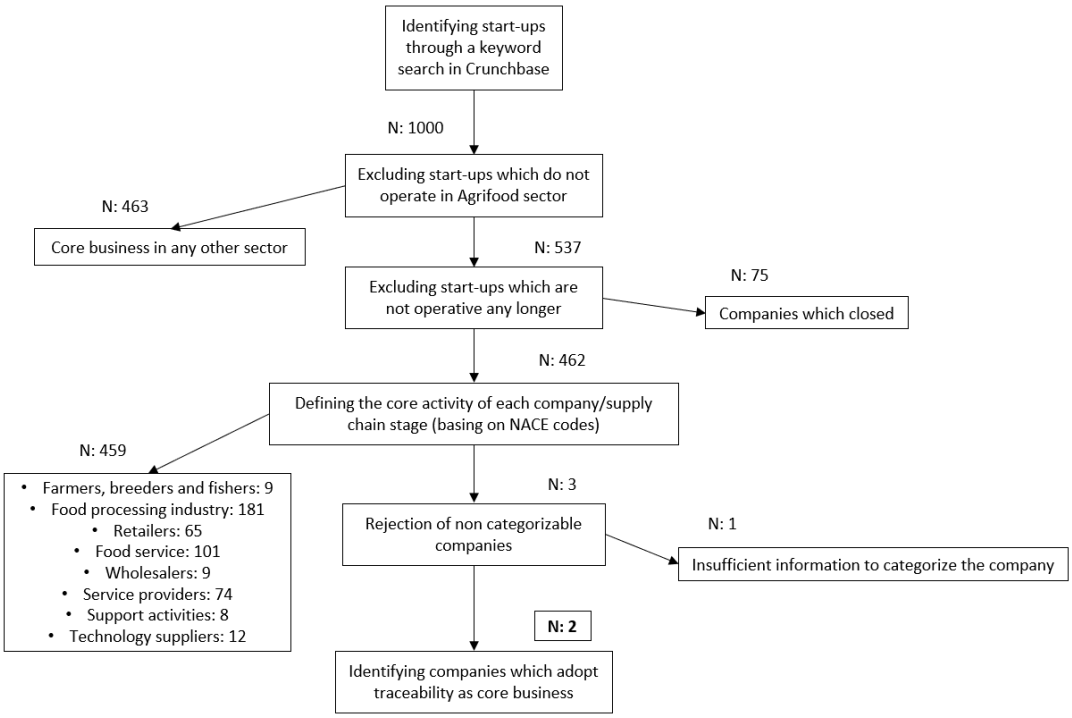


Figure 6. Methodology for data collection from the provided database.

Therefore, starting from a pool of 1000 potential companies and filtering them as reported in Fig. 6, the categorization was performed over a sample of 462

companies, cutting off the ones which were not active any longer and the ones with a core business in a different sector from the agrifood field.

After labelling all of them, the companies operating in the sector of interest and specialized in *traceability* turned out to be two.

At the same time, another research was conducted. The literature review over the theoretical frameworks related to BMs and *traceability* description led to some existing cases of companies operating adopting those theoretical frameworks themselves. Indeed, such information was collected for the paragraphs already presented, and will not be repeated: the same approach is applied for the case studies recognized while presenting the theoretical sections. The results about existing companies will vert on cases found in the database only.

### 4.2.2. Data processing

Soon after the detection of the companies in the assigned section of the database, as described above, the remaining part of the same source was investigated to include other brands in the final pool. Indeed, since only two companies were spotted, the size of the sample to be analyzed for the results sections had to be enlarged.

To do so, research with the keyword "*traceability*" was conducted considering all the companies in the database. This had the scope to spot the companies which somehow were related to such concept, as well known at this point. 67 companies were matched with this keyword. Since the ideal dimension of the pool of companies to be effectively analyzed and discussed in the following paragraphs was set to be around 10, some extra constraints were to be applied.

The 67 companies were checked: the point was to detect their specific sector. The criterion was considering only the companies which focus on non-specific food types: therefore, all the brands dealing with some strict area/products were excluded. On the other hand, the picked companies work horizontally in more than one field, being versatile. Such companies were 45, reducing the pool to 22 samples.

The second criterion applied was geographical: the focus was pointed on the companies working in the European area. Consequently, 14 brands were excluded.

The final group of 8 companies is therefore composed of brands working in Europe, dealing with more than one type of food, and adopting *traceability* as core aspect of their business models. All the mentioned steps to identify this final pool are resumed in Figure 7.

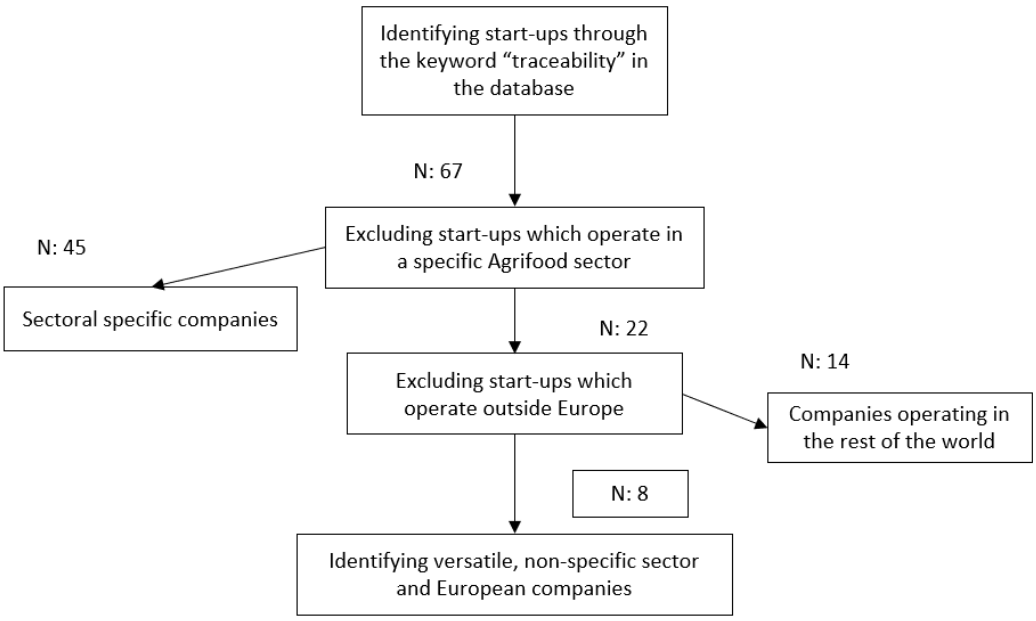


Figure 7. Methodology for the selection of companies from the database, composing the final sample to be analyzed.

Since data were collected and processed, and a final group of companies meeting the requirements stated is composed, the core activity of this second main part of the thesis can begin. The following paragraph focuses on the analysis of this companies' business models.

## 4.3. Results

This paragraph aims to gather and present the results from the data collection and data processing, as discussed in the Methodology section. Therefore, the stage now belongs to an analysis of existing companies which effectively and efficiently adopt BMs and have *traceability* as core element of their business, working in the agrifood sector. Specifically, the picked companies do not focus neither on a specific sector nor on a specific product: they are versatile and capable of operate horizontally among more than one field. In addition, the mentioned group of brands operate in Europe, as per criteria selected.

The structure of the analysis will follow the design options discussed in Table 4, focused on 4 main branches: value proposition, value delivery, value creation and value capture. This analogy gives consistency to the previous effort, linking the

theoretical part of the research with the existing BMs. Therefore, a validation of the framework will be offered through such analysis and comparison. This way, Table 4 - or eventually any derivate tool – confirms itself as an effective instrument in such research, both in contextualizing an existing BM and in creating new possible models as well.

The chapter will be split in sections: the main division is based on the companies, so that each one is reported and discussed singularly. In each company paragraph, the analysis will be carried on according to Table 4 and its four main blocks. Some extra information is provided for the companies, before the real analysis begins.

Lastly, some room will be dedicated to *traceability*: a final resume will be delivered. Indeed, building blocks for BMs dealing with this aspect as the core one will be presented, in the same path of Table 4. The goal is identifying possible options to be considered and adopted to achieve success and sustainability for BMs to be involved with this concept. Therefore, a triple level analysis will come to an end: first step was the theoretical dimension and literature review which led to Table 4 and design options for BMs; step two was research for existing companies which matched the specified requirements; last step is an investigation on *traceability* applied to the spotted BMs, to underline which key aspects are needed to give birth to models in agrifood sector effectively and directly built on *traceability* itself.

### 4.3.1. Company 1 – Bio Sociale

Bio Sociale is an innovative startup founded in 2018, in Italy. Its core business is offering blockchain tracking tools. It was created with the aim of tracing with simplicity the main steps of the supply chain. Iterno is the technological proposal of Bio Sociale, in the design of simplified tracking systems that also allow smaller businesses and organizations to place themselves on the market.

#### 4.3.1.1. Bio Social - Value proposition

Bio Sociale delivers *traceability* services, through its technology Iterno. As a blockchain, the value proposition floats around the certification of data inserted in the chain and shared with the customers, which must be guaranteed, and protected. Such blockchain wants to be a step in the direction of increasing awareness and confidence among consumers. In this logic, the objective is also strengthening the supply chain of small local organic productions that are often excluded from the use of advanced technologies due to the high development costs and the management difficulty.

#### 4.3.1.2. Bio Social - Value delivery

Target customers of such technology, as anticipated, are agrifood companies who want to invest in transparency. Thus, this company adopts a B2B model. On the other hand, sharing information in this way benefits the final customers and all the tiers of the supply chain of the products. This aspect, which indeed belongs to the pros of the blockchain technology, brings value delivery to various actors, and not only to the direct customers of this company.

This flow of safe information composes the value delivery process properly: this is the added value which such services offer. Access to the full products story, from harvesting, to processes and until logistics operation, and information about the packaging as well, allow the final customers to be aware of what they consume. Moreover, a connection is built among the actors of the supply chain, and sensibilization towards sustainability is boosted putting attention on the products history.

#### 4.3.1.3. Bio Sociale - Value creation

As discussed, *traceability* creates and extra appeal for the products traced. More and more nowadays customers are sensible towards eco-friendly processes, sustainability, and fair trade. Providing details regarding the steps the products were through satisfies this demand, pushing the sales even with premium prices eventually. Customers usually perceive a different value for this kind of details and transparency.

On the other hand, the application of Iterno to longer supply chains will also facilitate the logistics operations within the organizations through the continuous monitoring of the times of permanence and displacement of the goods between suppliers and customers.

The first big project from Bio Sociale is currently carried out with Cooperativa Areté, one of the leaders in the bio products distribution in the north of Italy. Products delivered by this cooperative are provided with a QR code, which allow the customer to access all the information related.

### 4.3.2. Company 2 – Tilkal

Tilkal is a French company. As Bio Social, Tilkal operates in the IoT sector, offering blockchain technology. Its mission is bringing *traceability*, transparency and auditability capabilities to the market and the customers, to win the challenge about making supply chains more resilient, sustainable and ethical.

#### 4.3.2.1. Tilkal - Value proposition

Tilkal's solution brings together all the *traceability* elements necessary to create the visibility into the value chain that need to be ensured. In fact, products must meet the right quality requirements, transparency, and regulatory compliance.

Tilkal offers a Suite, which allows to share a Digital Product Passport for B2B and B2C use cases, link non-financial KPIs to the related operations, ensure the compliance with origin, transparency, and due diligence regulations, all in a compact tool.

#### 4.3.2.2. Tilkal - Value delivery

As Bio Sociale, target customers are companies, in a B2B model, but all the actors of the chain are concretely involved in the benefits of this technology. Tilkal Suite platform has 4 main blocks. As anticipated, it is a compact tool, but it articulates in the following branches.

The first one is Connect: the goal is data collection from the suppliers to acquire knowledge and control of the end-to-end supply chain. Connect comes with pre-configured forms and campaign automation tools, as well as seamless integration capabilities via IoT devices and B2B mobile apps.

The second section is Insights: here the user can monitor key *traceability*, performance, impact, or risk indicators of the supply chain in real-time to ensure regulatory compliance and readiness for non-financial reporting. Insights allows the access to alerts and consistency scores, verification for each supplier, product, or category to ensure compliance while detecting anomalies, fraud, and more.

Control Tower provides a fine-grained view of the supply chain stages workings. The main functions of such section are tracking products, categories, batches, collections, or product units, while managing transactions and certifications statuses.

Spotlight allows to Configure product passports according to the specific challenges of each product, whether it is to meet a transparency challenge vis-a-vis the end customers (B2B or B2C), or to be compliant with current and future regulations.

#### 4.3.2.3. Tilkal - Value creation

Tilkal was pushed to offer its services by a precise reason: with the growing need for resilience, the demand for transparency and the increase in regulatory obligations, companies must prove origin and impact from raw materials to end products. End-to-end traceability is becoming a new form of "license to operate". This builds the reputational value added. In addition, Tilkal's *traceability* technology is committed towards an ethical sourcing of raw materials.

Moreover, Tilkal creates value at an operational level. This service enables product recalls at batch level, analyzes product quality data up- and downstream, and increases food safety. Lastly, data about money transfers are traced as well. Therefore, accountability and trust between partners are ensured.

### 4.3.3. Company 3 – Integrity Key

This company is the second Italian case study presented. Integrity Key was born in 2022, after winning some start-up national competitions. The mission is about gaining attention in the *traceability* sector using advanced technologies and offering safety and quality to customers.

#### 4.3.3.1. Integrity Key - Value proposition

The goals of this company are creating a reality without more useless wastes, transparency for the consumer with an extra attention towards the planet and with a look to the future. At Integrity Key, the team studies and implement innovative systems to digitize the food supply chain, to improve food quality and combat food fraud and waste. Once again, the sector is IoT and one of the main tools is a blockchain, to trace and guarantee data safety from fark to fork.

#### 4.3.3.2. Integrity Key - Value delivery

Integrity Key uses sensors, applied directly to the goods batch. All the sensors are then connected wireless to a remote platform. Here, all the actors of the supply chain can access the information which are guaranteed through a blockchain, so this cloud is the core element of the service offered by this company. Critical data are inserted by Smart Contract into the blockchain itself. Collecting data straight from the batches allows a direct monitoring in real time. This requires, obviously, a physical device which must be calibrated and correctly installed. By the way, such technologies are spreading more and more lately, and the need for a hardware system placed on the batches could not represent a slighter disadvantage than before. On the other hand, collecting data from the field always provides reliability.

#### 4.3.3.3. Integrity Key - Value creation

Through the used technologies, Integrity Key aims to offer a different service from case to case, to be fully adaptive and improve food quality and safety. The mentioned platform, where data are collected and actors can access them, is the point to fully digitalize the entire processes information along the whole supply chain. This is to support mostly the small producers and local companies, which

would meet obstacles (both economic and technological) to keep up with such digitalization.

Concretely, the most relevant advantages of such services are cutting food waste, enhancing the productivity and efficiency of the company of interest. Consequently, attention is put on the reliability of the brand: customers' satisfaction and trust are highly considered. The mentioned advantages and goals of Integrity Key are thought to make the companies look appealing and trustable.

### 4.3.4. Company 4 – Tracifier

Tracifier is a blockchain-based traceability application used for supply chain and certificate verification. This company was born in Germany, with the vision of empowering brands and consumers alike by promoting transparency through connected products and sharing economy.

#### 4.3.4.1. Tracifier - Value proposition

For this company, the goal is helping companies unlock the monetization potential of product data with an innovative approach, enabling the creation of clear and compelling story telling and communication concepts for their partners and end-customers. Utilizing blockchain technology, Tracifier enables effortless product tracking and tracing, ensuring authenticity and combating counterfeits. By showcasing social responsibility, brands captivate customers and cultivate shared values.

#### 4.3.4.2. Tracifier - Value delivery

Tracifier created the Product Transparency Wallet which holds a digital fingerprint of the physical product itself. By creating a digital twin of products, customers unlock related product information. Thus, customers' engagement is maximized with a digital product passport linked to products and packaging. Lastly, Traficier elevates customer relationships with NFTs, personalized experiences and enhanced communication and loyalty programs.

To do so, comprehensive end-to-end item *traceability* is performed, capturing the entire lifecycle from manufacturing through sales, customer utilization, resale, and recycling. Seamlessly access real-time, valuable data to make informed and timely decisions. Therefore, the task is sharing the authenticity of products through engaging stories and captivating visual representations. The customers get connected with the unique journey behind each item, fostering trust and appreciation. Moreover, the positive impact of product's sustainability and

circularity approach in the market is shown, as well as the commitment to environmental responsibility.

On the other hand, Tracifier owns an e-commerce meant for brands to expand their reach to a broader audience and implement a cutting-edge customer membership and loyalty program using NFTs. Secondly, they engage new customers with exclusive benefits while fostering loyalty among existing ones, creating a thriving and sustainable customer community.

#### 4.3.4.3. Tracifier - Value creation

Some use cases are highlighted as strength point of working along with this company. The first one regards certifications: through the blockchain offered, it is possible to securely e-sign and share the product certification with partners and colleagues; customers can verify the authenticity of the documents in real time. This pushes the reliability of the brands and products from customers' eyes.

The second point is related to quality control: this aspect is boosted thanks to the collection of all required documents and the creation of product protocols, shared with colleagues and partners easily. Therefore, quality is one of the top considered aspects to care about.

The third point regards sales: making the steps faster and procedures streamlined – when it comes to data collection and data sharing - time and efforts are saved to push the sales of the products themselves. Such optimization can make the companies more efficient. Similarly, growth of the companies in terms of human resource management and recruiting can be enhanced.

To sum up, Tracifier proposes itself as a *traceability* operating company, providing IoT related services and technologies. On the other hand, it strongly commits as a quite fully management opportunities provider, taking care of the whole company situation considering various aspect to optimize efficiency and performances.

### 4.3.5. Company 5 – Cied BV

CIED BV is a Dutch company, founded in 2011, and committed in building a customized blockchain-based farm-to-fork traceability system that can help customers predicting how much food can be trusted.

#### 4.3.5.1. Cied BV - Value proposition

At Cied BV, by partnering with Standards and Certification Bodies, the goal is building a gold standard for risk assessment that will possibly be used by every actor in agri-food supply chains. Moreover, the mission is to guarantee the

transparency of food, driving disruptive innovations through rapid technological developments at practical costs to protect all aspects of food safety and health.

This company proposes to help customers in many challenges related to their business, such as verifying the compliance levels of all the suppliers, building supply chain credibility, introducing *traceability* to less technical supply chain members, ensuring fair prices, showcasing *traceability* data to customers and consumers, and organizing datasets properly.

#### 4.3.5.2. Cied BV - Value delivery

Cied BV designed the Supply Chain traceability Software to connect every member working along the supply chain and offering consultancy services to help their customers with on-ground implementation and strategy, from initial strategic discussions to final implementations. Such software is customizable to meet unique client needs, delivering an interface which totally adapts on the customers' expectations: the user interface and user experience are strong advantages of this brand.

Moreover, the technology Cied BV relies on for supply chain management ensures sustainability and food safety and is compatible with IoT devices to provide accurate data collection. Such versatility makes the proposed products appealing to a large market share.

The second platform offered by this company is CBSoft, built for certification bodies to manage and maintain inspections and inspection-related activities. Therefore, the focus is tracking everything related to inspections, such as status, staff involved, payment information, related files manager section, etc. The main features of such platform are supporting 24h/7, user dashboards, report, file and inspections management, personal assistance, communications and finance trackers, and human resource planner. This way, CBSoft proposes itself to be a concrete source in the overall management of a large area of the customer's business.

Last product offered from CIED BV is Auditor Desk, a cloud-based application where users can document their accreditations, audits, and reports. The main advantages regard support to all types of audits, filling up checklist, attaches files, photos and generating results, assigning audits, managing reports and related communications, and reminders and notifications prior to the audits.

#### 4.3.5.3. Cied BV - Value creation

CIED consultancy and services advise the customers on tech decisions, IoT budget allocations, setting KPIs to monitor the overall performance and ROI basing on the business goals of the single company. These aspects push a growth towards the

technology and management areas. In addition, requirement analysis, proposal evaluations, roadmaps, delivery strategizing and best-fit tools are performed by CIED, to support the customers in establishing a strong IT ecosystem.

As already stated, audits receive attentions in CIED: this is meant to reduce software bloat, enhance resilience, and mitigate risks for clients' businesses. Moreover, the offered services will support the users to plan, maintain, and optimize project lifecycles, milestones, and deployments.

### 4.3.6. Company 6 – Farmsio

Farmsio is an English company founded in 2020. It was created to combine founders' passion for the planet with their expertise in technology. Their express purpose is accelerating sustainable development across the agriculture value chain.

#### 4.3.6.1. Farmsio - Value proposition

The goal at Farmsio is providing customers with the research-driven climate information and tools they need to enable smart decision-making. In addition, the purpose is the regeneration of natural capital for economic and social benefits, enabling the best inputs and outputs in food production. Farmsio is committed to ensure best governance, social and sustainable practices with all the stakeholders.

Therefore, Farmsio offers solutions suitable for farmers, government, and policymakers, which makes their proposition wide, embracing many different possible actors.

#### 4.3.6.2. Farmsio - Value delivery

Farmsio offers a platfrom which compacts all the main data, providing an environment which easily contains the relevant features and information together: both agriculture and climate solutions. The climate risks mitigation is possible thanks to smart tools and tailored analytics, foster sustainability, and *traceability*. On the other hand, financial risks can be assessed with scorecards which are climate focused. Farmsio's climate tech ecosystem connects all the actors of the supply chain, from farmers to financiers, with easy-to-use digital tools and flexible, climate-smart solutions.

Specifically, six main topics of interest are selected in such platform. Farm management is digitized for enhanced efficiency, productivity, and profitability. Timely crop insights from weather and satellite data are offered, adapting to changing soil and climate conditions. A carbon analysis tool is employed to boost soil health, understanding, and elevate overall crop performance. Scoring tools

provide deep insights, guiding optimal land and resource decisions, elevating farming practices. Tailored data using digital tools enrich reports via remote monitoring for comprehensive analysis. *Traceability* ensures supply chain transparency from farm to retail, promoting quality control and reducing waste.

#### 4.3.6.3. Farmsio - Value creation

The solutions offered from Farmsio are directed towards a climate change. Firstly, the Farm Management Solution improves the efficiency, productivity, and profitability of the farmlands by digitizing all the aspects of farm management from pre- to post-cultivation, integrating data with specialists' advices.

Farm Traceability Solution helps to build trust with the end consumer by providing supply chain *traceability* from farm to retail. The unique tracking codes ensure quality control, fair farming practices and reduces waste.

Farm Monitoring and Evaluation Solution allows to track crop health and farming practices remotely, using GPS mapping and data storage tools. Customized surveys are available to analyze and advise on crop and soil health, harvest cycles and climate smart solutions.

Crop Monitoring Solution registers and transmits timely insights on crop growth and soil health through weather forecasting and satellite image data, enabling the user to take actions to adapt to changing conditions and climate risk. The goal is reducing losses with tailored information and advices.

Scoring Solutions are thought to access and assess financial support with pre-loan, climate vulnerability and sustainability scoring. The aim is understanding credit worthiness and ensuring the best financial terms.

Carbon Analysis do improve and understand soil health and crop performance to enable access to new voluntary carbon markets and revenue streams.

Agri Advisory is built to propose customized alerts and reports for information from satellite and weather sources or regional pest and disease predictions. Agriculture and climate specialists are asked for tailored advice on farm management and climate mitigation.

Land Use and Land Cover are indicators which have the role of easily sharing digitalized information on farm geography and geotagged maps on land use, while access to further services is possible to enrich scorecard data.

Post-Harvest (Supply Chain) Farm is a tool which allows the users to get complete visibility of the supply chain from farm to retail with real-time GPS product monitoring. It ensures that ethical and sustainable agriculture practices are observed for reassurance.

Crop Acreage and Yield Estimation improve crop yield and acreage using predictive data for timely interventions and management. Advanced notice of expected harvest dates, crop loss and yield are collected and reported in this section.

Survey and Inspection area gathers customized information and data using flexible, digital survey tools. Reports are enriched with remote monitoring and evaluation tools for consistent and detailed analysis.

Lastly, Marketplace connects sellers and buyers on a single platform. Here, input including seeds, fertilizers, pesticides, and equipment or buy output are available to improve procurement and market linkage.

### 4.3.7. Company 7 – Enismaro

Enismaro is an Italian company, founded in 2021 to help improve *traceability* and accountability in the food supply chain using blockchain technology and IoT sensors. The advanced technology platform helps retailers, distributors, manufacturers, and farmers all around the world to enhance their food and beverage supply chains.

#### 4.3.7.1. Enismaro - Value proposition

Enismaro focuses on five different types of actors: retailers, distributors, brands, farmers, and manufacturers.

Negative food events can have an unexpected knock-on effect throughout the supply chain. Retailers should be interested in protecting their brand from disruptions and reputational risks: Enismaro offers solutions for such situations, which will be discussed in the following sub-paragraph.

Intelligent tracking is proposed for distributors, to transform food shipment tracking. This IoT and Blockchain technology helps to create and maintain optimal transportation conditions for any class of food products.

Enismaro boosts brands visibility as well, helping such brands to enhance the complete story of the food products from origin to sale. This way, brands' identity is defined, improving trust and loyalty from the customers.

Farmers are supported with enhanced decision-making for higher productivity, through a better farm administration, production optimization and farm analytics. The goal is pursued by maintaining an accurate record of all the farm activities, using data from IoT sensors, real-time weather monitoring, and supervising farm performance and avoid inefficiencies with detailed reports regarding crops, livestock, production costs and sales.

Manufacturers usually focus on food quality assurance. Therefore, the platform helps to meet and maintain high quality standards from ingredients to the final product, to trace supplier information to stay compliant with regulatory requirements and to ensure consumers safety, avoiding the damaging business impact of potential product recalls.

#### 4.3.7.2. Enismaro - Value delivery

The blockchain powered platform is cloud based, scalable to any number of users and it integrates with existing sensor infrastructure. Indeed, such platform seamlessly integrates with sensors, biosensors, and food tracers allowing to monitor crops and products conditions in real time. Moreover, it permits to monitor temperature-sensitive food items using IoT devices during transportation. It works with smart contracts, and enforces transparency across the production chain and reduce food safety incidents. The last feature regards the prevention of pest infestation in the stored grain to avoid waste in the supply chain and public health consequences. Three alternative key concepts of this value delivery are live tracking, QR data encoding, real-time visibility.

#### 4.3.7.3. Enismaro - Value creation

Enismaro enables manufacturers, suppliers, distributors, and retailers to achieve real-time visibility into shipment location and conditions to reduce delays, eliminate inefficiencies, and maintain product quality standards.

For instance, product contamination prevention during harvesting, production, and shipping is a key aspect, and value created. In addition, smart contracts use quality, safety, or logistical information to trigger contract execution and automate incident resolution. Brand transparency help customers gain trust in your products as soon as they pick them off the shelf.

Blockchain technology reduce quality checks on arrival thanks to transparent, immutable data collected during transportation and minimize the risk of product rejection with transparent access to transport conditions. Moreover, thanks to Enismaro, users can access a comprehensive and secure database of information, reducing the time and effort required for audits.

### 4.3.8. Company 8 – In4Agri

In4Agri is the last company of the pool considered. This Italian startup was founded in 2021, to develop innovative solutions for the digital transformation of companies and Industry 4.0.

#### 4.3.8.1. In4Agri - Value proposition

In4Agri can manage the entire supply chain "from farm to fork", according to the guidelines of the "F2F" strategy approved by the European Commission. The goal is to establish an effective connection between the digital innovation system and the agri-food sector, to achieve sustainable models for the environment, consumer health and the competitiveness of companies. The targets are optimizing resources, cutting costs, increasing product quality and quantity, making the production process more efficient, cutting errors, monitoring consumptions, and providing quick access to complex technologies.

#### 4.3.8.2. In4Agri - Value delivery

In4Agri is a 4.0 digital agriculture system with innovative technology such as integrated computer systems, IoT and AI, based on the Food & Farm Management System software. It consists in a fully customizable platform, to support the decision-making and strategic activities of the user.

Such cloud base platform is accessible via web from any associated device, data driven - using data collected via sensors and controls to provide indicators. It is provided with a Dashboard for viewing statistical data and the entire system and offers predictive analytics through a review of current and historical data to forecast the future events. All the data are resumed and compacted through KPIs, table and graphics to allow the users to monitor in a real-time session all the sensible information considered. The key features of this software are interconnection of plants, sensors and vehicles, supply chain *traceability*, field mapping and process tracking, energy control, collection of environmental and atmospheric data, monitoring of CO2 emissions, geolocation and data collection of vehicles and process and transformation management.

#### 4.3.8.3. In4Agri - Value capture

In4Agri offers customized solutions to automate, connect and monitor plants and vehicles of agricultural, agri-food and livestock farms, to make the production system more efficient in terms of sustainability and *traceability*. Moreover, the economic and environmental sustainability of the company is monitored.

## 4.4. Companies' final comparison

Firstly, as easily notable when looking at the main dimensions of Table 4, information about Value Capture sector was not reported online in companies' websites. Therefore, some assumptions will be resumed now. All the analyzed companies are involved in a 4.0 environment: this logically suggests that the main costs of their businesses are not related to production aspects. A company which does not deal with the industrial production sector does not cause physical scraps. Brands which offer services and work in the informatic sector usually face costs mainly related to platforms maintenance, personnel wages, R&D and technological investments, human resource recruiting, and energetic needs.

On the other hand, revenue streams were not indicated neither. For the mentioned companies' classification, for their BMs, and for their applications, such streams may be assumed as mainly made of subscriptions fees paid by the customers. Some software could also be bought and paid once, but the economic conversion of the customers affiliation is usually based on monthly or yearly fees. Such fees may be layered to offer different packages of services at different prices, to allow users to pick the options which better fits their needs, so that no potential deal gets lost. In addition, such companies could offer deals based on the improvements they create. This way, considering a boost on sales, savings, efficiency and so on, companies may require a fee on such additional incomes: this would allow the customers to pay only in the case they concretely benefit of the services offered.

Customizable offers are also spread, as anticipated: the customers can compose their services pack to get what they really are interested in, and paying only for that. Lastly, some premium functions or services can be offered and sold in the platform (or application) itself. Such expansions allow the services providers to optimize and meet the customers' needs even more efficiently. Summing up, on one hand the costs voices in the bill are usually similar for one company to the other – when it comes to the company models investigated as of now. On the contrary, despite some features that may be shared regarding structuring the revenue streams, there is a higher variety about the path such brands may adopt to earn and capture value through their BMs.

The 8-samples pool investigated in this paragraph offered some interesting points to build a comparison discussion. On top, each company has its own identity and BM, no one of them resulted the same to the others. Surely, each company had a specific value delivery, offering their software or platforms, which are exclusive. Such products and services have features and functions. Despite each one of them was designed and developed from a different company, some shared concepts can

be identified. This brings to a comparison on value proposition, where similarities can be highlighted. This is mainly due to the guidelines that this type of startup adopt: sustainability, green innovation, social and environmental commitment, digitalization, waste cut, efficiency optimization, real-time monitoring, energy savings, transparency, ethical business, customers sensibilization and education, and emissions cuts are the main shared goals. As anticipated, such goals became relevant also for a pull process from the final customers of the agrifood industry: nowadays people are interested in knowing what they consume, how it was processed and the food story.

As next step of this Results section, a collection of all the requirements met in the cited companies is proposed. Such requirements are essential features to be adopted to make the BM successful in this sector. The scope of this resume is to compact all the information and features shared by the different companies, as discussed until this moment.

1. **Data certification**: obvious feature for all the companies involved in the blockchain segment of market. On the other hand, data shared and acquired from the various platforms must be certified in any case, even if they are not directly inserted in a blockchain. Therefore, such feature is shared from all the companies met until now. Guaranteeing the reliability of the information flowing in the network of actors is a key aspect, and it is much considered in this sector.
2. **Awareness of customers**: this feature is a crucial goal. Thus, aiming at the awareness and confidence of the customers was cited as one of the top goals of these companies. All the brands investigated wanted to gain this point towards the final customers, who, on the other hand, demand for transparency and want to learn more and more about the products they buy.
3. **Transparency**: as all the companies grouped are involved in the IoT sector, transparency must be a shared feature and a relevant quality offered. This is a key detail of traceability itself, which was already declared as the main actor of this Thesis. Customers themselves strongly demand this element from the companies they deal with. Logically, transparency shares the stage with all the other nice to have features for these BMs.
4. **Reaching smaller customers**: IoT technologies are often far from being employed by small companies and local customers. This obstacle is due to limited budget of smaller brands, and the limited advantages that such expense would bring. The investigated companies have the goal of reaching even such minor realities, to allow them in the sector and permitting a growth beneath the mentioned limitations.

5. **Networking**: to make such technologies and BMs spread, adopted and efficient a strong networking is needed. The actors involved all along the supply chain get in contact one another in a capillary way: nowadays the linear model left the floor to a more articulated model. Therefore, the relationships among the various actors are now differently interrelated.
6. **Attention on sustainability**: after customers' willing to buy eco-friendly products, sustainability became a relevant point for the investigated companies. Thus, sustainability of all the sources and event along the supply chain are considered, reported, and guaranteed. Traceability of the products include such information as well.
7. **Management improving**: this feature belongs to the value creation sections. Generally, all the platforms or software provided and filled with the related data about processes and food history allow the user to better manage his own activities. This deals with wastes, energetic optimization, efficiency, logistics, product recalls and all the other aspect cited above.
8. **Smart decision making**: this skill is one of the most relevant points about the mission of the companies. The users are meant to get this skill boosted through the data collection and processes and all the functions of the platforms provided. This point is strongly linked with point 7.
9. **User friendly tools**: lastly, the tools, platforms, software offered must be user friendly, meaning that they must be easy to use and must deliver the added value in a short time with small effort from users' side. Delivering such accessible tools allow the tools themselves to spread and be adopted more and more.

All the mentioned features were the ones shared by all the companies, which means that a brand which wants to operate in the defined sector should adopt them as guidelines.

Over these requirements, some "nice to have" additional features can be detected. Therefore, such characteristics are the step after the requirements. Now, the point is about extra features, which set the company's target to a higher level. The goals can be reaching more customers, offering premium experiences, providing more services or higher performing services which already can be identified in the market.

1. **Personalized interfaces**: adapting the interface to the user's needs makes the experience better and unique. This kind of engagement always pays back in terms of results and customers satisfaction.

2. **Economic KPIs**: such indicators give a concrete overview of the economic performance of the company which is employing an IoT solution as the ones mentioned. This feedback is the most appealing to the customers who are paying for a service and expect to experience for benefits in return.
3. **No physical devices**: avoiding to force customers to install devices or any hardware on goods, trucks or machines would allow the services to look smoother and easier to be used. For instance, lots of companies offering traceability services involve sensors applied to the lots themselves: this is not a deterrent, but having no need of anything physical basing on a totally virtual and digitalized tracking processes would be even more appealing.
4. **Mobile App**: a web version of any platform or website considered is the very first step and version delivered to the user. On the other hand, providing a mobile version of the same platform is not common and underrated. A mobile version to be launched and used on a smartphone would allow an easier access, monitoring, and a potential wider range of users. Digitalizing any process deals with different generations of workers who have different grade of technology usability.
5. **Customized offer**: as anticipated, this formula would allow customers to build their own package of service. This means that the final offer could be modular: customers could pick among different features to be included or excluded, composing a customized product. Since "one size does not fit all", this feature is close to nice-to-have feature #1, and would allow to meet customers' needs even better.

All the presented features will now be presented in the following Table. The goal is showing which company investigated offers such elements in their BMs.

Table 5. Resume of the nice-to-have features offered by the investigated companies.

| | **Nice to have features** | | | | |
|---|---|---|---|---|---|
| **Company** | 1 | 2 | 3 | 4 | 5 |
| BioSocial | | | X | | |
| Tilkal | | | | X | |
| Integrity Key | | | | | |
| Tracifier | | | | | |
| Cied BV | X | X | | X | |
| Farmsio | | | | | |
| Enismaro | | | X | | |
| In4Agri | X | X | | | |

Given that such features were both extracted by the analysis of the companies and by some critical assumptions, they were not expected to be shared by all the brands. Indeed, that would make them minimum requirements. Coherently, companies could also miss all of them currently, as per Integrity Key, Tracifier and Farmsio. The fact that such features are barely shared by a part of the investigated pool highlights that improving margins do exist. Such brands could adapt some details of their BMs to be even stronger on the market. On the other hand, further research and benchmarks on different companies could identify extra features which could make a BM successful.

The recent concept which links all the mentioned features, providing customers with the sensible data, is traceability. To offer this tool, companies' efforts are directed towards the same point. Each one of them adopts traceability differently, they can stress different aspects of the mentioned goals or push on specific features, but the aim of their BMs remains the same.

### 4.4.1. Traceability: BM design options

To enhance even more the key role of *traceability*, Table 6 was filled with information following the structure of Table 4. This analogy was offered on purpose to answer the Research Question and highlight the relevance of this concept in this Thesis. After the research and companies' analysis, the mechanisms about capturing value and realizing profitable businesses out of traceability should now be clear. Therefore, Table 6 sums up the options validated as of now, suggesting possible paths to be followed for possible BMs relying on this concept and profitable.

Table 6 relies firstly on the literature review conducted, but the 8-companies pool investigated almost all the design options reported. As underlined in the previous sections, the validation of this sort of information, found in theoretical research, through exiting realities and models is one of the main pillars of the Thesis. Thus, obtaining such confirmation from the real business environment strongly supports the frameworks provided and collected in the mentioned papers.

More detailed comments on the correlation of the mentioned Tables, the results reported and the theoretical frameworks discussed will be offered in the Discussion sections.

Table 6. Main design options for BMs adopting traceability as core aspect in agrifood sector.

| Main dimensions | | Design options | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Value proposition** | Services | Facilitating information sharing | Customer education | Customer awareness | More effective respect of regulations | Producers' commitment towards responsible production | | |
| **Value delivery** | Target customers | Quality-conscious customers | Cost-conscious customers | Green customers | B2B customers | B2C suppliers | B2B suppliers | C2C suppliers |
| | Value delivery processes | Connecting suppliers and customers | Providing access to products' history | Providing product-based services | Preventing hazards incidence | Taking back used products, components, materials, or waste | Sharing products, components, materials, or waste | |
| **Value creation** | Partners and stakeholders | Suppliers | Manufacturers | Retailers | Service providers | Public institution | IoT services developers | Others (e.g., researchers) |
| | Value creation processes | Increasing transparency | Supply chain management optimization | Production optimization, waste reduction | Customers' satisfaction | Quality of production increase | Quality of raw materials increase | Food safety | Food and food processes sustainability improvement | Designing processes, flows of information and products |
| **Value capture** | Revenues | Additional product revenues | Payments per unit of service | Payments for functions or results | Price premiums | | | |
| | Costs | Labor | Technology implementations | Services management | Technology distribution | Production innovation | Supply chain redesign | Supply risks |

## 4.5. Discussion

This section is meant to be the main one, which contains the critical examination of the results, both from the theoretical research and from the analysis of the well-known companies. Comments and explanations will be provided, regarding the archetypes found and validated from existing BMs. The results of the research highlights that, basically, the main sustainable goals are widely shared, despite of the country the company operates in or its dimension. The peculiarities of the specific companies lie in the way they deliver value, mainly, which was considered as the services they offer. Consequently, and partially, differences lie in the way such value is created, even if, as just considered, the paths tend to meet at this step.

The analysis of the BMs from existing and operating companies was basically structured on top of four main dimensions: Value Proposition, Value Delivery, Value Creation and Value Capture [32]. The logical flow behind this sequence should sound like proposing a mission, being able to deliver these added values to target customers and through the most suitable processes, create concrete advantages for the customers and lastly capturing value from these services. The considered sequence could be rearranged and discussed, but it was adopted basing on the review of the state of art and the literature. To accomplish each goal for each step, some details should be considered. After both theoretical research and a benchmark of existing brands, some guidelines can now be designed. The goal of such observations is proposing key steps to be followed to build a successful BM. The success of this BM is based on various points and goals to be accomplished.

The very first step is making potential customers aware of the importance of *traceability*. Such mission should be based on creating the interest towards this concept. Nowadays this goal became easier to be reached for all the reasons explained in the dedicated chapter. Therefore, as already specified, this level of awareness and willing to be informed about the history of the products deals both with a push from the companies and a pull from the customers. Anyway, the attention is now focused on making *traceability* relevant for companies which process and produce food products. To do so, proposing added value is crucial, and such values must be appealing for the potential customers. In this sense, some key features are now considered significative for the companies operating in the agrifood sector: food safety, supply chain optimization, and premium pricing were already mentioned as benefits. These three elements can generate the needed interest from the customers: consequently, each company which wants to enter this

market should be able to effectively communicate that these benefits will be delivered with their services. Concretely, *traceability* must be given a sense of qualitive differentiation strategic move. It is not only something seen as ethic but it effectively produces advantages and benefits in economic terms.

*Traceability* faces some barriers, as stated, which must be overcome to operate successfully in this business. A good communication basing on crucial and appealing added values plays the main role in the initial development of a brand. Thus, companies which may employ *traceability* services need also final customers who are open to buy traced products, and often at a premium price, or at least preferring them to non-traced ones. This is the result of a strategy based on qualitative differentiation: traced products on the shelves can now gain attention from the customers, and they can be evaluated as safer, higher-quality, ethic, sustainable. Target food producers and processors companies should be detected, to address the marketing and communication efforts correctly and effectively. On one hand, target companies should be the ones with potential market in terms of final customers as discussed. On the other hand, such companies should have a sustainability-oriented vision, which brings them closer to the IoT sector. Indeed, they would have to invest in such technologies and services: therefore, they should be young companies, or old companies which are living a digitalization process. This is because not all the companies operating in agrifood sector are ready or open to meet these new opportunities. However, big companies usually do invest in technological development and innovation. Excluding smaller companies from getting in touch with such technologies would be a mistake, anyway. On one hand they may lack funds to keep up with the considered innovation, but on the other one they may be more flexible to adapt their own BM to such processes. Then, they would be faster to properly deal with these services. This is why many of the investigated existing companies try to reach small customers, in their B2B strategy, both for an equity reason and for a strategic goal.

Once that target companies are detected and reached, the next step deals with how they can get in touch with the offered services, how easily, how fast, and how quickly the expected results will be obtained. Therefore, despite of what kind of platform or software would be delivered to the customer, it should be user friendly. Users are not expected to be perfectly sharp with technology, and are not requested to become fully skilled with that. They are fairly interested in the results, so the interface of the platform should be intuitive enough to allow them to interact comfortably. Moreover, a mobile version is recommended to spread the service even more and to release it to be used only via laptop. All in all, the latest technologies meet this kind of innovation, and mobiles (tablets and smartphones) are more than fine to deal with such applications. In addition, data and information

are supposed to be collected and shared among the various actors of the supply chain, in a cooperative networking. This enhances the relevance of a good accessibility from the users, since they belong to different tiers and step of the whole chain. Smart choices would be – and currently are one of the most spread solutions – using QR Codes, which are the easiest and quickest way to access to digital contents, user friendly and basically applicable everywhere.

- *Traceability* services must be delivered through user friendly platforms together with mobile versions to allow more and more personnel to use them also on a smartphone: this would allow an easier access to data, monitoring of processes, and a potential wider range of users.

Now that the service is delivered to the customers, significative results must be delivered as well. The value creation side should be based on crucial aspects such as a whole chain optimization, an improving of the management of the company itself through the best KPIs analysis, transparency experienced from the final customers for a reputational boost and a growth in the sales. The optimization touches different points, such as wastes cutting, products recall and a logistical efficiency. This aspect is more about an internal benefit for the company which chooses to employ the *traceability* solutions. Properly collecting and processing historical data of goods and processes allow the company to monitor each lot. Scraps provoked by a scarce supervision on such elements would surely be cut down. Having this kind of control of what happens in the facility permits the brand to become more efficient in production, energetic consumptions and to become leaner. Proper KPIs would keep track of the mentioned aspects and would lastly end in an overall economic performance category of indicators which concretely represent the trend of the company.

- *Traceability* needs to strategically meet the requirements of the customers to consequently create a need to be satisfied, as this concept is still emerging in the market.

Moreover, logistics plays a huge role as well: tracking the products once they leave the facility is crucial. The flow of information, which is the soul of traceability, goes with the same pace of the flow of goods. One of the most critical causes of money loss for a company has its roots in the logistic sector. Reference now is about an efficient planning, optimized load volume, reverse logistic and timing management. Once again, as tracking of the loads is at its best performance, costs can be lowered. This is even most relevant when it comes to perishable food products, that may have precise and short life cycles and could easily perish during the transportations. Taking track of the history of the products through the processes and logistics steps has the goal of delivering them to the final customers. Here, the economic aspect must pay back the efforts and investments which were oriented to meet specific

needs of the customers, and hopefully to gain new ones aiming at attention and relevance on transparency and traceability. Thus, such added values are supposed to promote products to a wider public, willing to buy sustainable goods and aware of the importance of the efforts of the producers and processors in this direction. Both optimizing the efficiency of the whole supply chain with costs reductions and improving volumes of sales with income boosting should be the goal of the *traceability* services.

- *Traceability* related services should give the chance to optimize the general performance of the company and the whole supply chain management by monitoring them with the proper KPIs.
  - Logistics area strongly benefits from proper tracking records by a network optimization, avoiding useless shifts of goods.
  - Reputational benefits would come by boosting customers' perception of the products.

Once that added values are proposed, delivered to the customers and concrete benefits are created, the brand which deliver and offer such traceability service must look for its own incomes. The most recommended way to propose such IoT products and services on the market is offering different packages and deals for the customers, and, if possible, modular ones. The formula should be related to periodic fees to be paid from the customers. Having standardized prices would work as well, but may end in a reduction of market and eventual loss of potential sales. Offering modular deals has the goal to meet the highest number of customers and meeting the needs of each one of them in the closest point. Since IoT and *traceability* services are versatile and can adapt to different food sectors, their price and economic offers should adapt as well to the different requirements of the customers. A basic package of service and functionalities should be formulated, and higher quality level packages from that on with the relative higher prices. Each customer could then select the service level based on its own needs and pay the most suitable fee for its business. Moreover, the fees paid should be proportional to the income generated through the services they are paid for. Such proportion would push the customers to be satisfied with this price structure since they would pay a small part of the earning directly coming from such services. On the other hand, paying a standard fee may be fine as well but could put extra pressure on the obtaining of the economic results: such fee would become a cost as all the others for the customers, who must earn form the service they are paying for to justify such expense. On the contrary, talking again about a proportional fee, this cost for the customers would be an effective cost only if the service they subscribed for begins to produce incomes.

- *Traceability* services providers should offer customizable subscription packages and fees to the customers, and fees should be proportional to the income generated by using their own services. This is for meeting different economic capabilities and services demands which are usually different from customer to customer, and be as inclusive as possible to have a wide range of customers.

The mentioned guidelines are proposed to offer a recommended practical path to be followed by a company to operate in the agrifood sector, which wants to design a specific BM for this. The theoretical frameworks related to this topic which were found in the literature review were more generally oriented to non-specific indications and built on top of concepts consolidated over years of global trends examination. The key step to collect, process and critically present the information about design guidelines for BMs was the investigation of existing companies operating in the sector of interest, meeting specific criteria used as constraints to make the analysis more effective and precise. Further research on BMs adopted by existing companies may be performed through interview with such companies, and hopefully obtaining real data to be processed. This way, quantitative information and conclusions could be reached. Moreover, the Value Capture section of the companies' analysis was mainly based on assumptions since the websites were not provided with that sensible data. With a direct contact with the companies, a deeper investigation and more layered research can be performed. In addition, extra design options could be identified and validated. Surely, such BMs and relative paths to make profits from *traceability* are yet to be improved and spread. This topic is quite new, and it is developing in the present as the global trends for sustainability and transparency are gaining attention from the public opinion.

## 4.6. Conclusions

### 4.6.1. Summary

The present paragraph is the last one for the current Thesis. Here, all the final resume about the data collection, processes, results, and discussion will be delivered.

The first block, coherently with the structure of this work, is dedicated to *traceability*. The Research Question was stressing the role of this concept in the chance of making a BM profitable, and the features needed to accomplish this goal. Pang et al. [10] proposed some benefits offered by adopting a *traceability*-oriented approach. To use the same dictionary, such benefits fit the Value Creation hypothetic section.

Therefore, they are related to concrete advantages and impacts on the business performance. Production efficiency, wastes cut, better management and boosted sales were the original benefits recognized. On the same path, Table 2 [20] presented some additional concrete benefits. Thus, practical advantages are needed when it comes to innovations. *Traceability* properly stands in a digital and technological innovation therefore all the potential customers must be aware of the advantages offered. On the other hand, some barriers for the spreading of this concept in the market were identified. They mainly deal with scarcity of information and poor awareness about the related benefits, the high costs of technology implementations which could be required for such innovation, limitations in prepared staff and human resource and, lastly, a common standard for data sharing is missing. Facing barriers is a normal condition for each new element entering the market.

Therefore, some design options for successful BMs adopting *traceability* as core aspect were detected. Features which allow companies to make business in this sector were found in the state of art review and validated through a second investigation over a pool of 8 existing companies. Lüdeke-Freund and two teams ([32] – [34]) offered some archetypes of BMs, defining the related main features and goals. Table 4 were built offering design options for hypothetical BMs basing on four main dimensions: Vale Proposition, Value Delivery, Value Creation and Value Capture. These options can be matched together to assemble archetypes for BMs. From the mentioned papers, some structured patterns were presented, such as recycling pattern, cascading and repurposing pattern and organic feedstock pattern. These were the options for theoretical patterns to be followed for a BM dealing with agrifood sector. Moreover, some other pillars were offered: such concepts should be adopted as theoretical guidelines. Thus, maximizing material productivity and energy efficiency, creating value from waste, encourage sufficiency and developing scale-up solutions are general starting points to set a wide standard for the BM features to be found. In addition, some extra patterns were cited. The first group deals with closed loop patterns, according to circularity guidelines which are well known nowadays. The second one is related to supply chain features: green-oriented, on demand production and shortening of the chains were the main mentioned concepts.

The first part, dedicated to the review of the state of art, ends with the proposal of the mentioned archetypes and patterns which can be employed to develop a concrete BM. A second main investigation were then conducted over a database filled with existing companies. To do so, all the brands contained in the assign section of the database were checked out aiming at spotting the ones adopting *traceability* as core aspect. Figure 6 shows the data collection process which led to two companies matching the stated feature from the whole database. The remaining

part of the database was inspected by using "*traceability*" as key word and some criteria: companies elected operate in Europe and do not deal with a specific food sector. Figure 7 represents this selection process. A final group of eight companies was found. Such companies were deeper investigated basing of the dimensions from Table 4. This analysis had the goal of validating the theoretical frameworks from the literature review, or proposing different BMs options. The results were resumed in minimum requirements and nice-to-have features. Requirements were characteristics shared by all the companies selected, while the nice-to-have features were both critically proposed and presented by some of the brands. However, none of them offers all the nice-to-have features, and some of them offer no one. Table 5 reports the situation. The identified requirements were data certification, awareness of customers, transparency, reaching smaller customers, networking, attention on sustainability, management improving, smart decision making, and user-friendly tools. The extra nice-to-have features were instead personalized interfaces, economic KPIs, no physical devices, mobile apps, customized offers. Moreover, Table 6 offers specific design options related to *traceability*. The mentioned characteristics enhanced by the benchmark of existing companies are linked to the table structure adopted in the theoretical part: such correlation wants to validate the theoretical results and frameworks through the second investigation conducted. The chance of using those theoretical frameworks also in an analysis of a concrete company, adapting the options time to time, stresses that these tools are effectively useful.

The critical discussion over the results from the companies' investigation led to some guidelines for a possible design of a BM. Such BM should anyway include the features mentioned before. Therefore, a BM should:

- Include the delivery of *traceability* services through user friendly platforms together with mobile versions to allow more and more personnel to use them.
- Be strategically address to meet the requirements of the customers to consequently create a need to be satisfied, as the concept of *traceability* is still emerging in the market.
- Exploit the strong benefits for the logistics section from proper tracking records by a network optimization, avoiding useless shifts of goods.
- Exploit the customers' perception boost of the products from the sense of transparency.
- Offer customizable subscription packages and fees to the customers, and fees should be proportional to the income generated by using their own services.

## 4.6.2. Implications

### 4.6.2.1. Practical implications

The focus will now be dedicated to the implications that this work can offer to a company operating in the defined sector and with a BM which is compatible with the ones discussed.

The investigation of the pool of companies clearly proved that some requirements are spread and consolidated, whereas nice-to-have features are still missing partially or totally in some of the examples. In this sense, many steps could be taken as of now from existing companies. Indeed, this market is still young and consequently improvement margins are still large. Firstly, adopting the nice-to-have features offered in this thesis could be a starting point for a company to grow and get closer to its customers' needs. In this view, by eventually comparing companies from other sectors and not related to *traceability* to the ones investigated, differences can be spotted. This comparison confirms that in older and more structured sectors the nice-to-have features offered in this thesis were already adopted (or at least similar features). Therefore, what composes the nice-to-have features in a growing and younger market can be translated in requirements for an older one. The key view, now, is the importance of this evolution, from nice-to-have to required. This confirms the relevance of the features spotted, and the importance of adopting them as fast as possible too. This way, the companies which can step up in this growing process effectively jump to the higher quality class with respect to the competitors.

### 4.6.2.2. Theoretical implications

In this subparagraph the interest is about the implications that this thesis can bring to the knowledge related to traceability literature in agrifood sector.

Given that the state of art of any recent concept is yet to be expanded, this thesis aimed, firstly, at collecting as sources as possible related to BMs adopting *traceability* as core aspect. Therefore, a first contribution to the knowledge consisted in grouping archetypes and patterns from different authors. This way, paths to be validated through the second research were detected. The goal was building a bunch of possible BMs structures starting from as many options as possible. By providing as many options as possible, and combining them, lots of potential models can be identified. This initial group of general options was delivered spotting the mentioned archetypes from the current literature reviewed. Secondly, Table 6 was filled adopting the same structure of Table 4 to maintain the same BM dimensions. This tool offers options to generate models dealing with *traceability*. The meaning was using elements from the companies' investigation to be inserted in the

framework obtained by the literature research: this validates the framework itself which can be used in further research.

### 4.6.3. Limitations

The weak points of this thesis are now presented: they are meant to be intended as opportunities for further research which will be discussed in the following section.

The limited number of sources found for this specific topic stands as first weak point: this is surely because of the recent exploit of the concept and related applications. Thus, papers were about general archetypes or non-specific patterns for the BMs, as they were structured upon the most known aspects of sustainability and circularity which are similar at other fields and non-specific. This basis is anyway valid, since the sector of application was the agrifood one, but it shows a gap in the literature which will surely be filled in the future. Some deductions had to be formulated to fill Table 6 indeed, and a second relevant investigation on existing companies was required as well.

In the companies' analysis, instead, no information was found about the revenue streams and income generation of such brands. This led to assumptions related to this topic, and consequent critical hypothesis on such a crucial point. This do not invalidate the obtained results but still demands for eventual more detailed data to make them more realistic and closer to reality since it stands as one of the most interesting aspects of a BM analysis.

### 4.6.4. Further research

From the Limitations section, some possible further researches are recommended. The literature research could be expanded, since the development of this field is raising currently, and many and many sources and papers gets published. This could lead to fill the mentioned gap and update the state of art. For sure, *traceability* related sources will offer a wider knowledge in the future, and extra tools and frameworks will be delivered. This way, a more precise basis of theoretical guidelines to develop BMs will be available.

In addition, deeper investigations on existing companies could be conducted, maybe expanding the database size. As mentioned, the economic aspects of the mentioned companies were not clearly defined in their websites. Research through more accurate channels would hopefully provide the missing data and therefore complete the Value Capture discussions. However, the goal of the thesis was delivering some guidelines both theoretical and practical to design a BM or compare

existing ones. More precise features and more detailed indications are expected with a deeper investigation of this area as well, to implement the list of the requirements and nice-to-have features of such companies.

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