Master in Economics and Management

THE DIGITAL IMPACT ON THE SUPPLY CHAIN: THE SERVITIZATION OF AGRI-FOOD INDUSTRY

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ABSTRACT

For decades, many firms have been deeply transformed due to the creation and integration of digital technologies in different processes or instances, conceptualized as digitalization. In the specific case of manufacturing industry, this trend has been described as Industry 4.0. Simultaneously, manufacturing firms tend to adapt their business model by including more service offerings to gain competitiveness, described theoretically as servitization. Research on those topics has already provided many case studies for the manufacturing industry. Within this industry, the agri-food sector, though, is sidelined. Nowadays, there is no paper dealing with servitization of agri-food and we face a lack of global overview regarding the digital revolution. However, significant implications are affecting agri-food towards being more agile and fast to increase and diversify offerings in order to answer specific customers' needs. Therefore, the supply chain is deeply changing and faces more complexity. Not only a better economic performance is expected based on capture and advanced analysis of data, but also more sustainability and interconnectivity through corporate social responsibility (CSR) or creating shared value (CSV) to avoid waste and redundant operations. The following thesis aims to provide a theoretical contribution about the impact of digital technologies in the supply chain as imperative enablers of the servitization of agri-food sector. The first section will introduce the subject and the research gap. The second section is dedicated to a state of research of servitization, digitalization and their mutual influences for the manufacturing industry. The third section is a methodology that aims to analyze the main issues to be taken into account. The fourth section is a dynamic description to show that the application of digital tools in the supply chain contribute directly to the servitization of agri-food firms.

Keywords: agri-food, digital technologies, servitization, transparency, traceability

JEL CODE:

1 INTRODUCTION

Nowadays, the digital technologies are core elements of our environment and their constant integration in all instances has been conceptualized as digitalization. Consumers, firms, and institutions have to face deep changes due to new technologies that are commonly described as a part of a bigger phenomenon, called the Fourth Industrial Revolution, that impose new ways of doing business. Regarding manufacturing industry, this context has been specifically defined as Industrie 4.0 issued from the German policy initiative to support the digitalization of manufacturing industry (Neugebauer, Hippmann, Lais, and Landherr, 2016). Commonly translated as Industry 4.0, it was also described as Smart Manufacturing (Porter and Heppelmann, 2015). Even if those several concepts have been provided to explain the increasing use of digital technologies in business procedures and activities, they all commonly revealed a rapid and constant change of the business environment and market rules. Therefore, competitiveness relies on the capabilities of companies to integrate accurately these new tools into their processes and operations. In this context, firms cannot afford to ignore these transformations. It is especially relevant while an important number of manufacturing firms try also to adapt their business model by focusing on service-oriented strategy. This trend is especially key for the manufacturing industry that currently operates a downstream move among the value chain and integrates these new digital technologies to get new opportunities in terms of competitiveness, performance or revenues (Wise and Baumgartner, 1999). Many technologies affect the manufacturing industry such as information and communication technologies (ICT), cyber-physical systems (CPS), Big Data, cloud computing, 3-D printing, operative assistance, Internet of Things (IoT) or advanced robotics. Their progressive integration leads to the implementation of advanced smart systems.

Those changes have an impact at different levels. According to Porter and Heppelmann (2014), digital technologies change the five competitive forces (threat of new entrants, threat of substitutes, bargaining power of suppliers, bargaining power of buyers, and rivalry within the industry) and the boundaries of the competitive environment. The strict boundaries across and within industries are modified due to information sharing and the integration of the smart systems, affecting the product itself and the practices. At the firm level, Porter and Heppelmann (2015) insist also on the internal implications and the direct impact of digital technologies on companies' transformation. At the same time, the

customer is becoming an active participant within the value chain encouraging manufacturing industry to adopt a customer-focus strategy and to develop more complementary services. Defined as servitization, the development of service-offerings is affecting deeply the manufacturing industry in order to remain competitive and to adapt their business model that used to be only product-oriented. The capacities to respond to the customers' need and to be able to analyze them precisely over-time, open to innovation opportunities.

If we consider the different sectors within the manufacturing industry, the agri-food sector remains sidelined from those core changes. Two main aspects can explain the current state of research of agri-food sector facing digital revolution impacts. First, there is a lot of dispersion in research regarding the effective consequences of digital technologies and smart solutions in the case of agri-food. There are papers available but they focus on a specific aspect or application. Moreover, many of them are more oriented to the production part than the whole supply chain. Therefore, there is not an actual global overview available.

Second, the digital revolution itself is generally more visible for marketing purposes more than pure industrial uses. This poor representation is also valuable in terms of services. Thus, there is no relevant paper available dealing directly with servitization in the agri-food sector. Services are not completely absent but they are essentially indirectly mentioned. A first approach can be mentioned. If we look at the evolution of servitization in France between 1997 and 2007 based on the case study gathering empirical data from a sample of 50.000 manufacturing firms of Crozet and Milet (2015), a relative progress can be observed for food, beverage, and tobacco industry. 55% of the firms in this industry sell services to third parties but it remains the less servitized manufacturing sector. In their results, we can underline that for the same industry, services represent 3.5% of total product sales. Servitization is still a constant ongoing process but it is interesting to catch some empirical results and to identify an evolution even if the categorization is larger. The agri-food sector appears to be positively affected by servitization. Facing Industrie 4.0, competitiveness is changing and digital strategies are needed. Firms of agri-food can be more agile and flexible while remaining efficient with digital technologies. What are the applications possible for agri-food sector? What are the needs? Agri-food sector has to take into account changing behaviors and the need for less complexity for the customers while ensuring safety and quality of the products. Those

elements imply a collaborative supply chain based also on respect for the environment, ethics, and regulations. The following thesis aims to provide a theoretical contribution to demonstrate that the servitization of agri-food depends on the advanced digitalization of the supply chain. Therefore, it will be shown that there is a closed and necessary interdependency of digital integration and servitization in the case of agri-food sector to answer the need for developing service offerings enabling quality, sustainability, trust, transparency, safety, supply chain efficiency, and flexibility. First, a state of research of servitization, digitalization and their mutual influences in the manufacturing industry will be provided to get the main implications and issues of the two phenomena. Then, we will introduce the attributes of agri-food current state in order to determinate and select the main issues related to digital impact and the implications in terms of servitization solution and value chain changes. Based on those elements, an analytical overview will be provided accompanied by a conceptual framework.

2 STATE OF RESEARCH

Among research, two major phenomena enable and transform the value chain of manufacturing firms. First, the integration of more service offerings currently called servitization and second, the systematic integration of digital technologies or digitalization. Both phenomena are closely correlated and deeper interdependent in the way to affect the value chain of the manufacturing industry. Their mutual combination is to improve the performance and produce more added value. In order to understand better the transformation of the value chain for the manufacturing industry, an overview of the two trends has to be made.

2.1 SERVITIZATION OF MANUFACTURING INDUSTRY

Service growth is occurring on a global scale. Nowadays in the economy of developed countries, services highly contribute to the value of GDP, underlying the increasing service-orientation of businesses. At the firm level, the integration of service-offerings has already begun during the second half of the 19th century when manufacturing firms

were clearly separated from services firms (Schmenner, 2009). In a greater competitive environment, firms tried to guarantee their profitability to survive by integrating the new means of transportation and communication. According to Schmenner (2009), firms that have managed to combine a vertical integration to control the supply chain with packages of goods and services were successful to install and maintain their domination for decades. Since then, manufacturing industry has been especially concerned by the integration of services as a strategic change to gain more revenues, aiming to reconsider the value chain through customers' needs and defining the necessity to go downstream (Wise and Baumgartner, 1999). Vandermerwe and Rada (1988) conceptualized the process as "servitization" since the separation between goods and services is no more so strict and appeared to be more complex. In the long-term, manufacturing firm would be servitized and would provide both goods and services together as bundles, combinations or solutions.

The research literature about the integration of service-offerings in product-oriented firms, including manufacturing industry, has evolved from a specific topic of BtoB marketing to a research domain that reached an advanced maturity level that still carry on (Gebauer, Joncourt and Saul, 2015). Besides the original definition provided by Vandermerwe and Rada (1988), the concept of servitization has included various implications depending on the author and the area of research. Kamp and Parry (2017) provide an overview of the multiple ways to define servitization according to the field or the context of the study. It can be defined as a management philosophy, an opportunity for differentiation by the improvement of customer and supplier relationships, an innovative process to create and enhance mutual value with tools, a move to provide goods and services together as a whole package. The goal is to get more opportunities to have stable revenues, higher margins, and a better competitive advantage. Kowalkowski, Gebauer, Kamp, and Parry (2016) compare service-oriented strategies to a "journey" in order to express the strategic exploration of business opportunities thanks to services to gain competitiveness. In that way, they introduce specifications through the comparison with similar concepts such as service infusion, the way a firm increases its service business orientation focusing on emphasis on services. Therefore, Servitization can also be presented as a transformational process in the business model that follows a service-centric approach or a service-dominant logic (Vargo and Lusch, 2008).

The integration of servitization among the firm may differ depending on servitization models, components, and stages. Crozet and Milet (2015) show that servitization permits an increase in the profitability, employment and total sales. The authors also demonstrate the provision of services intensity is positively correlated with the firm performance. The long-term stability is especially relevant while observing the impacts of the crisis of 2008, which has not affected the exports of services whereas simultaneously good exports had decreased (Ariu, 2015). This analysis is an empirical evidence that enhances the capacity of services to provide more stable revenues and to be more resistant to business environment changes or severe economic shocks. Strategies based on the adoption of service business models concern at least two out of three product firms in developed countries (Vendrell-Herrero, Bustinza, Parry and Georgantzis, 2015). This strategic choice is also described as a shift among firms from the simple sale of a manufactured product to innovation and delivery of services (Kowalkowski, Gebauer and Oliva, 2017). However, as soon as it is a strategic change, there is no guarantee of the success of servitization. The potential consequence of a fail may be due to the lack of consideration of potential short-term side effects during the organizational change. Therefore, services may not grant the expected additional revenues creating a service paradox (Gebauer, Fleisch and Friedli, 2005) or launching a reverse process described as deservitization by Kowalkowski et al (2016). Offering services attached to products can become a relevant dynamic strategy.

If servitization is a way to get more opportunities to innovate and standardize but it is also a method to emphasize customer relationships and loyalty (Wim Coreynen, Paul Mathyssens and Wouter Van Bockhaven, 2016). It can increase the value of the customer as soon as products are customized to better fit their needs. This transition can avoid commoditization and allow to face efficiently strategic threats through more flexibility. The development of services is not only about being more profitable but also to build and deploy durable customer satisfaction. Consequently, the added value obtained is not only economic. It also has to deal with reputation and customer relationship enhancement. This approach is directly related to the customer implication as a value co-creator. This active role in value creation process affords the implementation of a “partnership” and mutuality strength (Kohtamäki and Rajala, 2016). The service perspective enlarges the value chain through processes enabling and encouraging more cooperation, and exchange in a long-term approach. In order to manage this move, knowledge is needed. Thus, the new

business model developed in manufacturing industry aims to provide customer knowledge-based services all along the life cycle of products to have a competitive advantage (Bustinza, Gomes, Vendrell-Herrero, and Tarba, 2018). Since the customer is having a greater attention, Weeks and Benade (2015) insist in the all-inclusive logic in the global context of service sector dominance by focusing on client-centric approach accentuation with products and services as an "integrated entity" to be successful. Interestingly they distinguish two types of customer value chain, in one hand the clients' needs and expectations, in the other hand the satisfaction when needs are realized, that is to say, the experience and its qualitative achievement.

2.2 DIGITALIZATION OF MANUFACTURING INDUSTRY

The digitization in manufacturing is a common and current topic. Neugebauer et al (2016) provide a global perspective of digitalization through the concept of "Industrie 4.0" as a new step in industrial production to fill customer's needs. Given this core goal, the concept refers to the widening solutions of the dynamic integration of information "everywhere and at any time" allowed by digitization among the value adding system. New tools based on digital technologies such as cyber-physical systems (CPS) can offer smart solutions enabling more interactions, interoperations, and cooperation. This initiative requires high investment but may provide benefits if associated with lean manufacturing integration and solutions in terms of reduction of operating costs or waste and flows improvement (Sanders, Elangeswaran, and Wulfsberg, 2016).

Nowadays, 3-D printing technology could be considered for instance as a part of this continuous progress to produce faster at a lower cost, with a higher degree of customization of products in a make-to-order basis and less wasted materials through computer-assisted design (CAD) software (Berman, 2012). The current application of this "direct digital manufacturing" involves relative low quantities production of small, high-valued and complex items. However, this example shows the strong potential of supply-chain and conventional logistics transformation (Holmström and Partanen, 2017). It is relevant to remember that innovation is not relying only on the digital impact improvement and diffusion, but also on the innovative combinations of supply chain and digital manufacturing. If firms have to deal with the disruptive technologies, they also

have to think about innovative processes that can also rely on relevant combinations of various technologies.

The digitalization can enhance interactions between technology, human and business systems to develop products and services based on skills and tools such as ICT (Weeks and Benade, 2015). The value chain is deeply affected and its creation tends to be based on more cooperation and networking through cross-linking domains (Miskusz, 2014). It provides more integration and interaction between data and services, which affect the market boundaries based on information sharing and individualization opportunities. For instance, Miskusz (2014) highlights that CPS can gather automatically information in real time being more reactive, flexible, cooperative and interactive to get more productivity gains. Consequently, the level of customization based on coproduction and cooperation can increase the constitution of inter-organizational networking. The aim is to respond effectively to individual customers' requirement by allowing last minute changes in production and more flexibility while facing disruptions. According to Porter and Heppelmann (2014), the integration of smart products or solutions may have a greater impact on manufacturing firms because it is now more and more needed in order to differentiate and gaining expertise in software tools that have not been sufficiently developed.

2.3 THE INTERDEPENDENCIES WITHIN THE TWO PHENOMENA

The competitive environment is changing through the new service issues implied by digital technologies. Therefore, servitization opportunities are clearly widening thanks to digitalization. Coreynen, Matthyssens, and Bockhaven (2016) highlight that thanks to advanced manufacturing technologies servitization is positively influenced as soon as firms can provide standardization and customization at the same time but also reduce transaction costs. In the context of Industry 4.0 and digital age, new technologies are more integrated so they influence servitization practices leading to the implementation of "smart servitization". The main objective is to manage to capture data in order to know customers' needs and specific requirements (Kamp and Parry, 2017). The identification of these needs, through information and communication technologies, improves the interaction between the customer and the provider. Jointly with the first steps of the servitization move, the production process has been improved leading to low-cost

production and continuous speed since the first industrial revolution (Schmenner, 2009). The current development of Big Data and its application in servitization could contribute to decreasing price for product-services thanks to information as the core layer of added value (Opresnik and Taisch, 2015). In this sense, servitization itself is not sufficient because it would depend on the capacity of a firm to acquire data, to analyze and to use them strategically. Therefore, a data perspective is needed to understand servitization and its multiple implications.

The scope of opportunities can also be perceived through the Cyber-Physical systems (CPS) impact on a business and technical perspective. Those tools permit to have more connectivity and more innovative processes that construct Product-service systems. The goal through that combination is to create a hybrid business with smart and connected products (Herterich, Uebernickel and Brenner, 2015). The supply chain management would have a fundamental role to link functions and processes to provide both products and services. The digital technologies will strengthen the up- and downstream activities creating interdependencies that will widen the business opportunities (Vendrell-Herrero, Bustinza, Parry and Georgantzis, 2017). The digital is a tool of the decision-making and will reduce the cost of customization based on CAD capabilities. In this context, Big Data, sensors and in a closer future the artificial intelligence (AI) are essential. This evolution towards a client-centric model has to be specified in the case of agri-food. When we consider this sector, we have to take into account a set of parameters that are especially important: perishability, health, and safety, environment and sustainability. Thus, digital technologies cannot be separated from those parameters and their implications.

3 METHODOLOGY

After having shown the importance of servitization and digitalization in the manufacturing industry, we will progressively see the case of agri-food industry regarding those phenomena.

First, as it has been already shown, servitization of the manufacturing industry is a mature research domain with many case studies available. However, the agri-food sector is not mentioned in the case of servitization. If we put agri-food and servitization into Scopus, we get no result. It appears that service offerings studies in agri-food are barely

represented. The work of Cozet and Milet (2015) is one of this work that provides an overview, but it is restricted to France and the category used is wide “food, beverage and tobacco”.

Second, when we want to analyze digitalization, we can notice a dispersion regarding new technologies or smart systems for agri-food. The research in Scopus has shown several difficulties. If we put “agri-food digital technologies” as keywords in Scopus, we get only eight papers and only one paper with “agri-food digitalization”. The alternative term “agribusiness” gives access to thirteen papers but there were not relevant for our purpose. Therefore, another approach had to be adopted. If we focus our research on a specific issue regarding agri-food or a particular technology we get much more paper.

Third, the research domain appears to be more oriented to the engineering and technical field in terms of performance. For instance, Aramyan, Oude Lansink, van der Vorst and van Kooten (2007) provide a case study that mentions important issues of agri-food in a supply chain perspective but focus on the measure of performance. Moreover, it is limited regarding the impact of new technologies since it gains importance in the last decade. However, it is interesting as a conceptual framework basis and has to be updated considering the digital revolution and the integration of service offerings. Consequently, it is difficult to get a global and enriching overview of the value chain changes for the agri-food sector.

The methodology adopted will be as follow. First, we consider the state of agriculture and the traditional value chain. A focus will be made especially on Europe and China using institutional database such as World Bank. The difficulty is that the categorization of the data presents strict boundaries between industries or sectors without really considering the interconnections that have been increasing for decades. Second, the agri-food sector itself and its challenges. Third, the main opportunities regarding the digital tools and services.

3.1 AGRI-FOOD SECTOR CURRENT STATE

In order to understand the impact of digital technologies and servitization, it is essential to get an overview of the current situation of agri-food and to determine the most important issues to take into account. We cross different sources: World Bank, research

papers, and analysis of research trend in some topics in Scopus about core topics of agri-food and press articles.

3.1.1 The traditional value chain

We will define agri-food sector as production and commercialization of food issued by farming activities. Considering this basic description of agri-food, the most common and simplest way to define the value chain within agri-food is from the production of raw material to consumption. In this scheme, we have to take into account third-party logistics (3PL) and so, the intervention of other companies through outsourcing. However, this classical approach can be discussed as soon as there is more complexity in the value chain and logistics flows. External changes (environment, society…) have to be taken into account to widen the perspective.

THE TRADITIONAL VALUE CHAIN OF AGRI-FOOD

First, the environment is highly competitive and in the case of agri-food, price and risk of substitution remain central. Many firms cannot afford to put efforts on maintaining a strong and durable competitive advantage based on price-leadership.

Second, if firms tend to improve their service offerings and to provide more customized solutions to gain or to remain competitive, the implementation of greater individualized production processes at an industrial scale is not always possible due to the need for standardized procedures. However, it has been shown that mass customization can be extended through 3-D printing and allow the introduction of creativity from the supplier but also the customer (Sun, Zhou, Huang, Fuh, and Hong, 2015). Due to investments required to acquire such technology, optimization and efficiency of supply-chain remain the core priorities so customization and the move to an agile supply chain may be limited.

Third, the sector has to face the development of sharing economy and its attractiveness. Cusumano (2014) considers the need for traditional firms to compete with sharing economy counterparts whose business model uses web platform and adopts a “peer-to-

peer services for hire". In the case of agri-food, benefits of sharing economy rely on the increasing willingness of consumers to be closer to the producer or at least to have a better information access of product origins. Consequently, the distributor may lose its central place as an intermediary within the chain. This move finds its roots in the mistrust towards brands and products that seem to be "too industrial" and the media dealing with sanitary scandals. At the same time, there are more and more consumers to feed and more complexity in the chains and linkages.

Fourth, the place granted to sustainability issues gain importance and motivates a step back to the respect of biological processes and animal wellness. The promotion of a fair production and the implementation of environmental friendly processes based on circular economy tend to integrate more ethics in the agri-food sector. This idea to provide better quality by respecting the environment, closely bound with the circular economy spirit and the necessity to reduce waste and destructive environmental impacts through a better management of the resources available.

Fifth, the strong power of buyers in terms of price negotiation (customers) and reputation delivers (consumers). Moreover, they have to face new threats such as Amazon or Alibaba.

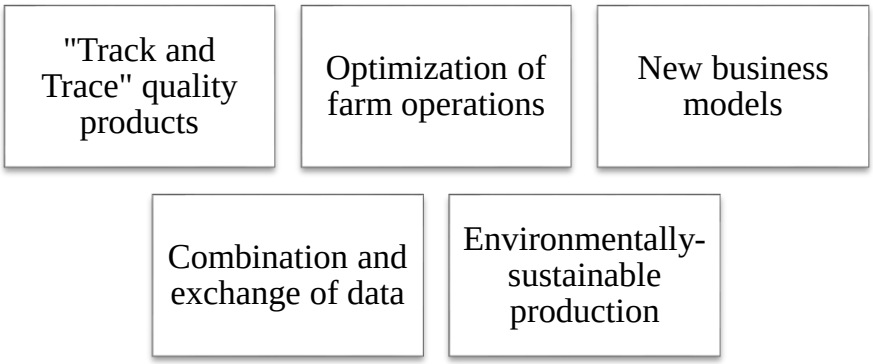
Finally, traceability issues to locate and follow products all along the chain. The information has to be available and recorded even if there are many 3PL.

3.1.2 Agriculture and food industry in Europe

Agriculture has a more limited contribution to GDP in the Western countries even if there are some differences such as in Europe. According to the World Bank database, agriculture represents around 2% for France and Germany but more than 7% for Spain or UK. The value added of the sector has been decreasing continuously until the crisis of 2008 that provoked a stagnation during the last decades. Moreover, the sector is less attractive, facing job destructions, low profitability, and unstable situations. In this context, do digital technologies destroy even more jobs in this sector based on the idea that robotics are replacing humans everywhere? The integration of technological solution and improved smart systems may have a positive impact such as better productivity, reduced over-producing risk or less human efforts. However, farmers who want to

modernize their production and improve their process, have to face considerable investments to survive. Facing those elements, agriculture is currently at the center of political initiatives from the European Union in order to modernize the sector and to offer new opportunities with digital technologies. The sector has been changed with machinery since the first Industrial Revolution. Nowadays, the nature of the job is evolving to a knowledge basis sector based on new technologies. It is no more about producing but how to produce smart and what are the solutions and resources that enable it? The modernization of the agriculture is an important issue in Europe. A workshop organized by the European Commission in 2016 deals with the digitalization of agri-food (Figure 1). The final report distinguished five main clusters within a specific end-user-need approach.

FIGURE 1 THE CORE CLUSTERS FOR DIGITALIZATION OF AGRICULTURE



Those elements may be positive but have to be integrated considering rentability purposes. Those changes needs investments but have to be rentable in the long terms. Price is also another issue. In a globalized world, products from China or other countries may contribute to the fall of prices.

3.1.3 Agriculture and food industry in China

It is difficult to get complete and reliable statistics about China. However, some main points can be analyzed even if there are missing data. The internal food market of China is huge according to an increasing demand while the agricultural land still represents

around 56% of the total land area in 2016 against 52% in 1988 according to the World Bank. Moreover, if we look at the food production index (2004-2006 = 100) also provided by the World Bank, we can observe a significant increase of food production that almost triples in 30 years: 42.31 in 1988 and 130,8 in 2014. China is a great producer and consumer that has to deal with the corresponding agri-food flows within and outside the country. However, China is facing regular sanitary outbreaks with damaging consequences in the population. Based on Tse, Zhang, Yang, Cheng, and Mu (2017) and Tian (2016) we can mention some of them: “toxic rice”, “hair sauce”, the low-quality milk powder, "clenbuterol", "trench oil" and the “Sudan red”. Even if Tse et al. (2017) sustains that the Chinese government worried about food safety issues and may have implemented solutions, Tian (2016) suggests that further efforts have to be done to upgrade agri-food supply systems with the supervision of authorities. This would permit the country to manage sanitary controls, to regulate the procedures and to avoid frauds.

3.2 AGRI-FOOD MAIN CHALLENGES

Within manufacturing industry, we have to highlight that the agri-food sector is first of all driven by the safety and sanitary issues. A fail in the agri-food chain may directly affect people health with dramatic consequences (diseases, death…) and the firm (reputation, trust…). Therefore, the sector has to guarantee the quality and safety of the products at any time and at each stage of the food chain. Three main issues can be determined: traceability, life cycle management, and trust together with transparency.

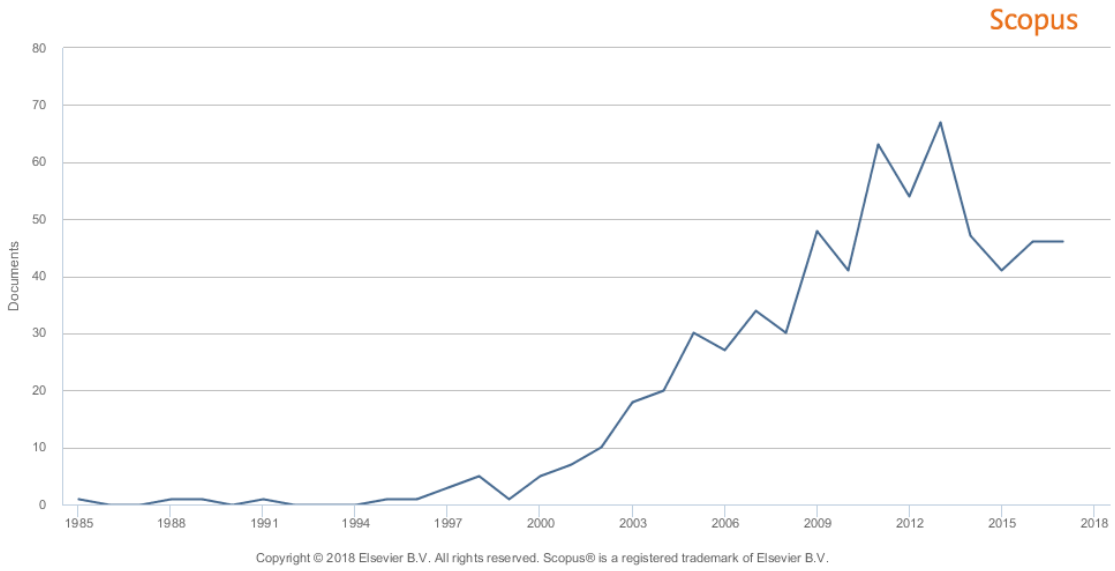
3.2.1 Traceability

Traceability is a central point of agri-food supply chain. It is compulsory by law in Europe to protect consumers but also worldwide such as in Canada, Australia or Argentina (Badia-Melos, Mishra and Ruiz-García, 2015). Moreover, according to the logistics performance index of the World Bank regarding the ability to track and trace consignments (1=low to 5=high), the European Union (EEU) and China (CHN) are at the same level with 3,66 and 3.68. Some countries in Europe are good performer such as Germany or France with respectively 4.27 and 4.02 in 2016. However, the global results

may highlight a lack of alignment inside the European Union that may affect traceability efficiency and quality of food chain. Even if there are several definitions on traceability that can be either broad or strict, traceability can be commonly defined as the ability to track and trace the products and their movement along the supply chain (Dabbene, Gay, and Tortia, 2014). It adopts both a downstream and upstream perspective in order respectively follow the product and to identify it at any time. As a research domain, traceability is strongly settled which confirm that it has become an essential issue for modern agri-food companies (Dabbene et al., 2014). Many recent advances of food traceability systems have been made that not only allow a better efficiency and effectiveness but also the authenticity of a product. Badia-Melos et al. (2015). Traceability is fundamental while improving supply chain visibility and security making recall measures faster.

When we want to analyze the importance of the topic among research, we can underline that traceability in agri-food has been largely discussed especially from the 2000's. Based on the analysis of the number of publications (articles and conference papers) published each year based on Scopus search “Traceability agri-food”, we can observe a surge from 1999 to 2017.

FIGURE 2 TRACEABILITY AGRI-FOOD (AR&CP)

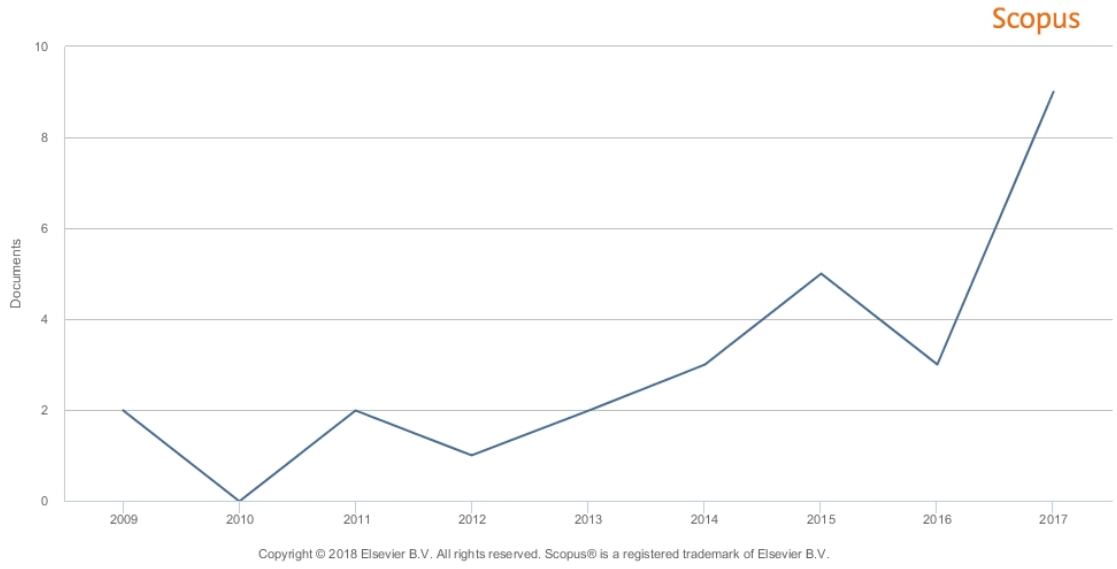


3.2.2 Life cycle management

Product life cycle management is generally understood as the common marketing concept to describe the four phases/stages of the product (introduction, growth, maturity, and decline). In our case, we will consider life cycle in a supply chain perspective and its importance for manufacturing execution systems (MES), which consist in tracking the transformation of raw materials to finished goods allowing process and flow controls within the product life cycle.

If we search for life cycle management and its direct study applied to agri-food as a research topic, we can observe that it is surprisingly quite a new issue (Figure 3). In Scopus, we can find twenty-seven papers (articles and conference papers: AR & CP) from 2009.

FIGURE 3 LIFE CYCLE MANAGEMENT AGRI-FOOD (AR &CP)



Citing Kiritsis (2011), Cedeño et.al. (2018) define the product life cycle management (PLM) as a strategic approach with three dimensions: to access and use product definition information, to maintain its integrity and then, to achieve and maintain business processes. Product life cycle influence as well the demand forecast in the scope of product-driven supply chain design (Collin, Eloranta, and Holmström, 2009) which, in the case of agri-food, can be related to perishability and shelf-life restrictions on operations.

In agri-food sector, life cycle management is also strongly bound to environmental impact analysis. The optimization of processes, the reduction of impacts on the environment and the availability of environmental performance of products may settle solutions for a sustainable supply chain (Del Borghi, Gallo, Strazza, and Del Borghi, 2014). The idea is not to consider only the products but every element used from its production to delivery that may have an influence in terms of quality, safety or ethics. In their study, Garofalo, D'Andrea, Tomaiuolo, Venezia, and Castrignanò (2017) take into account the cropping phase, processing phase, packaging, and transportation, in order to get data in terms of resources, uses such as electricity and diesel, or in terms of energy release.

Therefore, a deep analysis of those internal and external parameters may lead a firm to adapt its processes to be more environmental friendly at each stage of the life cycle. Avoiding the use of pesticides or water waste are also current issues to produce "smarter".

3.2.3 Transparency and trust: Sanitary outbreaks

An overview of the scandals that occurred in Europe and their consequences may present how much the transparency and trust can be strongly related to safety issues (Table 2). Since a few research papers are available on this topic, the traditional newspapers (see References) have been used to get information about the most important food scandals based on their impact on society and on media. However, it is hard to find clear explanations and figures may differ from an article to another. Those differences have been included in the table if they were not important.

Based on those data, we can say that even if digital technologies have been developed to improve the agri-food chain, it seems that there is a stagnation in terms of security guarantee and there are still sanitary problems due to failures among the chain. Wognum et al (2011) suggest that the several food crises reposition public health as a core issue. Moreover, the consumers expect more quality and safety. Therefore, they want to be well informed not only about the product itself but also about the diverse procedures in terms of production methods, hygiene or environmental issues such as carbon footprint.

TABLE 1 OVERVIEW OF THE MAIN AGRI-FOOD SCANDALS IN EUROPE SINCE THE 1980'S

Year	What	Origin	Impacts	Problems raised
2018	Lactalis Contamination of salmonella for infantile products	France	Disease and contamination of hundreds of babies in France	No transparency and high suspicion of fraudulent behavior Information available not transmitted completely since the beginning Failures in the chain: a recall procedure has been launched but not all products have been retrieved from shelves of supermarkets on time.
2017	Eggs fipronil	Holland	16 countries in Europe affected	Even if the quantity was not dangerous for human health, a form of laxity and lack of ethics can be underlined
2013	The Horsemeat Scandal: beef products supplemented or substituted by the horsemeat	Romania	750 tons of meat under consideration 4.5millions dishes impacted	The horsemeat was labeled so but then has been falsified by the different traders Traceability problem that demonstrates the complexity and the opacity of supply and transformation flows.
2012	Ikea excrements	Sweden	23 countries concerned Destructions of the quantities 6000 cakes consumed in France	Problem detected due to a control by the Chinese authorities after exportation. Lack of quality control?
2011	Escherichia coli (E. coli)	Bienenenbüttel (Germany) in a biological farm Contaminated fenugreek from Egypt in 2009	47 deaths (48?), 4000 people sick in 12 countries A decrease of sells (70% of loses)	Weeks of inquiry to discover the origin. The contamination process in the production chain is unknown
1999	Chicken gate Dioxin	Belgium	France, Germany, and Holland Cost of 650M for Belgium and 2 ministers resigned	Dioxins came from a contamination by PCB oil of the tank used for animal feeds manufacturing. Implementation of a PCB monitoring program since contamination traceability was impossible. (Bernard et al., 2002) Other dioxin outbreaks occurred after
1996	Crazy cow / BSE	UK	Psychosis 200 000 cows infected Embargo UK. 224 death (Between October 1996 and March 2011 National identification system implemented	Real impact by human not well-known Social crisis and panic: precautionary principle adopted by consumers that lead high economic impact Diplomatic tensions with other countries in Europe. Durable embargo Inadequate control measures of first raw materials. The concept of traceability underlined as the core issue
1981	Colza oil watered-down: oil destined to an industrial use sold as an oil for consumption	Spain	From 700 to 1200 deaths and 25 000 people sick (5000 disabled) According to El Pais, 4537 death people and more than 20 000 contaminated Some recent data speak about of 3800 death people	Major case of fraud According to El Pais, the oil was bought in France and then sold in Spain.

The press has treated those scandals but if we go deeper, we may notice other many current problems. In 2015, according to the European Food Safety Authority (EFSA), salmonellosis, listeriosis, and campylobacteriosis infection cases have risen since 2008. For instance, the results provided show an increase of 16% of listeriosis infections between 2013 and 2014. The case of salmonellosis is under control thanks to the salmonella control program among EU members because reported salmonella outbreak

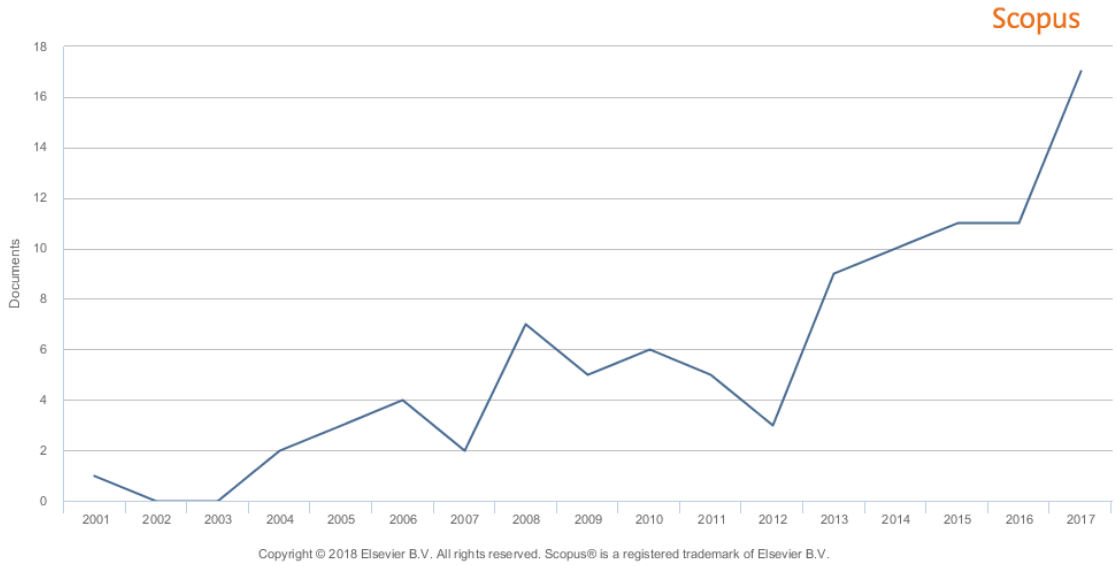
decreased by 44% between 2008 and 2014. We can also mention the several cases of contamination with dioxin that have occurred since the last decades such as pork contamination in Belgium in 2006 and in Ireland in 2008 affecting 23 countries, mozzarella in Italy the same year or eggs in France and Germany in 2011.

Considering all those elements, we are facing some stagnation while technologies available are more efficient. The reason is that the reduction of technological obstacles is accompanied at the same time by a greater complexity of the chain. Moreover, solutions may exist but there is not always the willingness to integrate them because of investments. Therefore, fraudulent practices are still possible using this weakness. In order to avoid reluctant behavior to implement the appropriate technologies to face these issues, Canavari et.al (2010) highlight the importance of trust while encouraging the shit towards digital-based relationships.

As soon as the collaboration and share of information become a key issue, the shift toward electronic devices will be driven by the support of trust in order to communicate food quality and safety. The cost of technologies may be relatively low compared to the cost of losing trust since it has an economic impact and may deter the reputation. Consumers enter into action through the use of social networks and Internet in general. For instance, there is an initiative in Germany that through an online platform “lebensmittelklarheit.de” encourages consumers to express their suspicion of false information such as ingredients or origins.

This need for more trust and transparency is also a current issue in research (Figure 4). Looking at the publications during the last twenty years, we can observe that 2013 is a turning point. Since that year, the number of articles and conferences papers related to transparency in agri-food has increased significantly. The Horsemeat Scandal the same year may have enhanced the trend.

FIGURE 4 FOOD SUPPLY CHAIN AND TRANSPARENCY (AR&CP)



4 FINDINGS

Digital technologies are enablers of a new business model based on transparency, connectivity, traceability and other features that may strengthen business opportunities, supply chain integration and actors' engagement for cooperation. The digital impact is a necessity for agri-food sector and offers greater opportunities to introduce a servitization strategy while remaining product-oriented in terms of supply chain conditions. Based on the literature review of servitization and digitalization of manufacturing industry and the exploration of the challenges, we will present the potential digital tools that may contribute to servitized agri-food firms through their supply chain.

4.1 DIGITAL ATTRIBUTES OF SERVICE OFFERINGS FOR AGRI-FOOD

Several reasons may explain the delay in agri-food. First, not all firms have MES as the fundamental basis for factories. Second, there is more complexity in the processes currently evolving. The basic and linear approach that describes the traditional chain through formulation, quantification, and packaging, has to be transformed. Third, there is a global lack of investments in the sector to implement efficient traceability systems

enabling transparency and safety. Verdugo, Papinniemi, Hannola, and Donoghue (2018) publish a very actual application of IoT in agriculture to demonstrate the way that smart services can improve the productivity, the time saving and a sustainable optimization of the resources.

4.1.1 Trust and transparency guarantee

Agri-food companies have to be transparent for customers, consumers, and governments in order to fulfill respectively demands and regulations. Transparency is one of the principal customer's expectations of quality responsiveness, safety, and health. It supposed communication and openness in order to serve and manage operations. Companies have to be able to provide and share information with the actors of the chain. The set of information about the product itself, the processes and the surrounding environment, has to be accurate, complete and clear avoiding ambiguity. Transparency in food chains has to comply with safety and quality standards assumed and proved with the integration of ICT solutions. The exchange of transparent information implies to have detailed information available at any time. The aim is not only to offer some guarantees but also to include aspects that are more ethical in order to be closer to the customer and to put more sustainability (Trienekens, Wognum, Beulens, and van der Vorst, 2012). As we have already seen, the sector is facing scandals whose impacts on society are wider due to the media power, social networks, and fierce political communication. The lack of trust and the need to have a controlled and qualitative consumption, contribute to the ongoing global value chain shift, changing deeply the way to design, produce and commercialize.

In this context, service offerings should focus on the necessity to reconnect positively with the customer. Some papers deal with sanitary scandal as a research topic. If we only take into account Europe, it is noticeable that the Horsemeat scandal in 2013 is a turning point regarding agri-food issues. Barnet et al. (2015) provide an analysis of the impact of the Horsemeat Scandal on consumer's confidence. Through a survey by e-mail, they determine how the consumption practices have been affected and what the expectations of consumers regarding food industry and authorities are. Even if the sample is quite small and geographically restricted (sixty-one people from UK and Republic of Ireland), the

results provided may give a consistent indication of behavior changes. An interesting point is that the consumers notify their surprise about the complexity of flows and the number of intermediaries step before a product is on the supermarket shelves. Consumers tend also to ask for more transparency and to get a better access to information about the procedures. Some consumers have not been affected not because they do not care but because they are already suspicious and their confidence low. If we consider those results, we can notice that consumer are more careful in their purchase so price may not be always the core choice parameter. The motivation may have changed and we can suppose the attractiveness of sharing economy.

Enabling transparency can be supported by a web-based system. For instance, tracing movement and informative integration are a way of avoiding falsification or fraudulent actions such as imitations of Protected Designation of Origin (PDO) (Costa et al., 2012). The adoption of an e-business and ICT solutions, through the use of the internet to support business processes and to improve collaboration, implies the creation of a trustworthy environment. However, there are several potential barriers that may put skepticism. According to Canavari et al. (2010), e-business is much more uncertain in terms of relationships since an online environment is more impersonal. Second, it can create information asymmetry. Therefore, if trust is about sharing information, it will only work with the establishment of e-trust. This e-trust could be supported by Blockchain as a great opportunity to fight against fraud. A centralized organization implies an asymmetry in terms of information shared. In that case, trust can be threatened due to potential bribery. Second, systems can be hacked if there is a single point of failure (Tian, 2017).

If the Horsemeat scandal has been largely mediatized in Europe, the author underlines that this kind of food scandal outbreak are recurrent and even more dangerous in China. Therefore, the Chinese population is no more trusting its own domestic market. The high frequency of sanitary scandal in China is based on lack of modern equipment, poor regulations or at least efficient regulatory structure, traceability and supply chain systems are still at an early stage of development. In terms of logistics, the agri-food loss ratio in China is closed to 30% while it reaches up to 3% in Europe or America (Tian, 2016). In that case, digitalization is a way to improve the systems and to put more intelligence for guaranteeing safety.

4.1.2 Track and trace improvements

The traceability is quite recent in the European legislation but the progressive integration of smart technologies open nice opportunities for improvements. However, Dabbene, Gay and Tortia (2014) notice that if traceability has to comply with regulations, standards, and certifications, this has been essentially developed after the BSE outbreak. Since this scandal, there is probably a first noticeable turning point. Since the 1st January 2005, traceability is a legal obligation in the sense that all food has to be traceable from production (Aiello et al., 2015). However, an increasing frequency of food crisis is also occurring (Dabbene et al., 2014). The regulations implemented and the increasing numbers of European members in 2004 have not prevented sanitary scandals. As answered, the development of smart technologies and information systems made traceability essential in order to be reactive in a more complex value chain. In the case of the Horsemeat Scandal of 2013, we can see the complexity of the traceability in an open market such as the European Union. According to *Le Monde*, the horsemeat has been brought in Rumania by a Cypriot intermediary with a Belgian postal box and finally, stored in the Netherlands. More than ten years after the European legislation, the traceability issue has not been solved but has gained more attention.

Security has to be strengthened in order to (re)establish a trust contract, to reduce sanitary risks and to limit the economic costs. For that a traceability system is a strategic investment in terms of getting consumer confidence in the long-term (Aiello, Enea, and Muriana, 2015). The legal conformity has to be accompanied by the willingness and ethical posture to assure food safety and quality. The cost of an advanced traceability will be less than product recall in terms of economic and reputation. In the case of agri-food, the other issue is to deal with perishability by controlling the deterioration process and to analyze what the responsible factors. According to Aiello et al. (2015), the traceability has to be properly designed to get benefits in terms of efficiency and returns. The new technologies will be able to maximize the value of quality level.

The management of information is about security. RFID is a major tool to identify a product at any time from origin to distribution stage. According to Costa et al. (2012), a web-based tracing system is a way to improve the transparency of information. RFID allows info-tracking and can be applied for traceability purpose but also quality management goals. The “technology track” made the product itself to be a source of data.

RFID makes the product smart (Porter and Heppelmann, 2015) Therefore, design, manufacturing, operations, and services of the product can be improved significantly. It will be a way to overcome the heterogeneity that can be caused by 3PL participation at different stages.

4.1.3 Product life cycle and perishability

The stock management supposes reactivity and flexibility based on responsiveness (alert system) and information transmission. In the case of agri-food, perishability is an important parameter. The deterioration of quality affects more or less the level of pressure on the chain. All variation that may alter the characteristics of a product over time makes the food supply chain even more dynamic (Trienekens et al, 2012).

The perishability is a core element while dealing with agri-food issues since products have to be consumed in a specific timeline depending on the life cycle and shelf life. This parameter is key to deal with stock issues, production and sells forecast. In that sense, perishability shows the importance of the demand chain to forecast the closest to the reality the quantities to be consumed. Forecasting needs to integrate the knowledge related to life-cycle production due to consumer behavior uncertainty. If too many products were produced, they would have to be sold in a second choice market or if no other alternatives, they would be destroyed. On the contrary, if not enough quantities are produced, firms would not be able to satisfy plainly the customers' needs so the customer satisfaction would decrease with the potential risk to lose the market and position if the firm is not able to react and to have good responsiveness. In all cases, the most accurate the forecasts are, the more the high costs of waste or destruction would be limited. It can be considered as a necessity to have a good visibility to stock in real time to regulate supply and demand but also the stock at the right place. Thus, digital tools may provide more accuracy and improve reality fitness.

The respect of the production and their consumption vary depending on categories such as freshness at the different steps of the supply chain (e.g.: 20 days ultra-fresh, 50 days fresh and so on…). According to Trienekens et al (2012), one of the major problems is a usual mismatch between quality delivered and quality expected because both intrinsic and extrinsic attributes change. Quality measurements may be key to maximize value added.

Considering this element, the goal to be reached would be a knowledge of the variables to make accurate predictions and to have a better control of the product lifecycle and the variation of its attributes. This aspect is key since companies have to deal with higher delivery frequency and often cross-docking issues.

4.2 SERVITIZATION AND IT STRATEGY INTERDEPENDENCIES FOR AGRI-FOOD

A servitization strategy has to be combined with an IT strategy in the case of agri-food in order to create value. This evolution implies organizational changes that have to clearly define and supposes to be aware of both benefits and risks. Based on the digital attributes we presented and their application to deal with agri-food challenges, we can provide an overview of the service offerings and propose a theoretical framework.

4.2.1 Service offerings application of technologies for supply chain

In Table 3, the technologies already mentioned among the paper have been associated with their IT implications and the service offering that can be provided through a summary description. The objective is to provide a comprehensive understanding of digital technologies for developing advanced services. Then, we propose a brief application in terms of supply chain design.

TABLE 2 TECHNOLOGIES AND SERVICE OFFERINGS APPLICATION

Technology	Definition and applications	IT issues	Service offering
3-D printing	Rapid prototyping technology integrating CAD software and other digital files. Small-quantity production of small and complex items or prototypes Advantages of low fixed-cost: custom orders in a niche market, at least 40% less waste material and time-saving (Berman, 2012)	Standardized processes and customization flexibility Precision and prototypes Smart manufacturing systems and automation with flexibility	Processes' improvement upgrading food products more opportunities for customization (Food design according to the customers' needs)
RFID	RFID is a technology used in the agri-food sector to manage information and traceability within the supply chain in order to preserve food safety (Costa et al., 2012). Sensing and communication technologies maturity. The more accurate, the more data to be processed and the higher the cost are (Aiello et al., 2015)	Info tracking Localization Real-time information The automated share of information Data capture: the product itself and surrounding environment Monitoring Other technologies: GPS, WSN, GIS	Food safety through traceability Information management within the supply chain Connected objects and sensors through internet applications Continuous control To make a product smart and connected Reality fitness
IoT	"global network infrastructure", Network of interconnected tools including sensors, cyber-physical systems (CPS) to capture and communicate data through the use of different technologies (sensors or RFID). CPS: to capture real-time information about the system and environmental conditions and interaction with that information (Mikusz, 2014) Physical systems and digital solutions	Ecosystem and networking Smartization: to limit waste, to decrease costs and to produce aware (less environmental impact) CPS development sensors	PLM Control and improvement of the life cycle information. Self-monitoring of product and environmental information Coproduction Last minute change capability Responsiveness
Big Data	Business intelligence and advanced analytics Data-driven decision making Data science and behavioral analytics "5Vs": Value, Volume, Variety, Velocity, and Verification. (Opresnik and Taisch, 2015)	Data capture and cross data analytics Algorithms basis Manufacturing service Ecosystem (MSE) Precision	Understanding needs, variations, and behaviors To find the relevant variables in order to make a systematic analysis Collaborative servitization MES: structuration plus exploitation and valuable data (identification)
Blockchain	An innovative solution to be applied for food safety issues especially tracking and more globally traceability. Modification or manipulation would need a lot of computing power, so information is more protected (Tse, Zhang, Yang, Cheng, and Mu, 2017).	Transparency Security Focus on safety and quality Authenticity guarantee for transactions Decentralized system	Symmetry of information Trust information without modification Preventive solution

Based on the framework of Collin et al. (2009), we comment supply chain design possibilities and comments for the agri-food sector.

Thanks to ICT, information can be visible and available weeks or months in advance, so the production can be organized precisely. This can allow visibility-to-plan" and "make-to-order" design. However, if the data shared are taken as fixed long-time in advance, there are less flexibility and possibility of last minute changes. The information is not indicative and the factory may ask for definitive quantities to organize his own schedule. The flexibility is restricted and depends on multiple factors such as production and delivery timing, product's shelf life or stock of factory and of a transitional warehouse. Consequently, in the case of agri-food, it is difficult to implement real-time modifications for high quantities due to the risk of waste and higher costs. If the demand change is risky, the reliability of the plan has to be the closest as possible. A higher cooperation between the supplier and customer may offer bigger opportunities through closer relationships and then, the introduction of more responsiveness.

The management of stock capacities of factories and warehouses, it is possible to implement a "visibility-to-execution" and "pack-to-order" design to a certain extent. It provides better responsiveness, flexibility, and real-time update but as soon as the production has been planned according to the demand plan, there is a risk of waste if quantities to be packed are under the forecasts. Moreover, agri-food industry has to deal with perishable products and packing moment counts for shelf-life calculation.

Since one of the main points of agri-food is to deal with shelf life and freshness of products, this could be related to "visibility-to-inventory management" design. However, expectations may differ according to the customers making flexibility relatively difficult to manage. Stock issue is key while dealing with products that have a restricted life cycle. IoT solutions through CPS could manage those difficulties and help for decision making rapidly.

For agri-food, those designs may work together as soon as the digital technologies permit to get all the information at the same time and interconnections are stronger. As soon as each participant of the chain integrate software and proceed to an IT alignment, the supply chain may be able to contribute to the constitution of an ecosystem.

4.2.2 The risk of the digital paradox for agri-food

Nowadays, the digitalization is a necessity in order to be more efficient, to better coordinate processes and to accomplish tasks that a human cannot easily do. However, adopting a pure IT approach, based on some idealism of technology, tends to exclude the human factor in many ways. If there are automated tasks and procedures, there are still active human users. That is why it is not a no-risk change with guaranteed returns. This can be presented as a digital paradox. Avoiding this paradox would be necessary to proceed servitization strategy in agri-food by taking into account the potential risks. As soon as technologies are integrated, they are not always intuitive to use and may be complex to understand. In the case of agri-food, implementation of advanced technologies and their comprehension inside a company are not that obvious and a natural change to manage. According to Aiello et al. (2015), many SME carries on using non-digital systems. They are more reluctant to change because of costly investment to be done for a limited scale of operations and due to lack of skills or knowledge. Then, it is essential to preserve a human insight by having the right people with the expertise to gather adequate skills and competencies to settle an efficient organization. The main idea is not to rely only on analysis also but to have also an accurate judgment to recognize qualitative data and to adopt a critical thinking. Moreover, the expertise should not be possessed by a restricted number of employees (Shah, Horne and Capella, 2012). Therefore, a knowledge basis is a priority more than the technologies themselves. This knowledge should not only be supported by data scientists or statisticians but by all employees. If operations need executants to focus on their tasks to work properly without doubting about the information they receive, the intuitive and mechanic use of technologies without understanding them can also create dispersion, poor decision-making or under-exploitation (mechanical approach reducing initiatives and self-improvement). Therefore, there is a risk of minimizing the need for training collaborators about the “for what” and not only the “how” to use accurately these technologies. IT strategies require internal transformations to be useful, efficient, and understandable. Therefore, users may not be aware of the real complexity or may avoid it, which could lead to poor motivation and restricted knowledge acquisition. Opresnik and Taish (2015) characterize a Big Data strategy based on the "5Ws" data dimensions: What, where, when, who and why. Depending on the stage, Big Data generation of Big Data exploitation, the

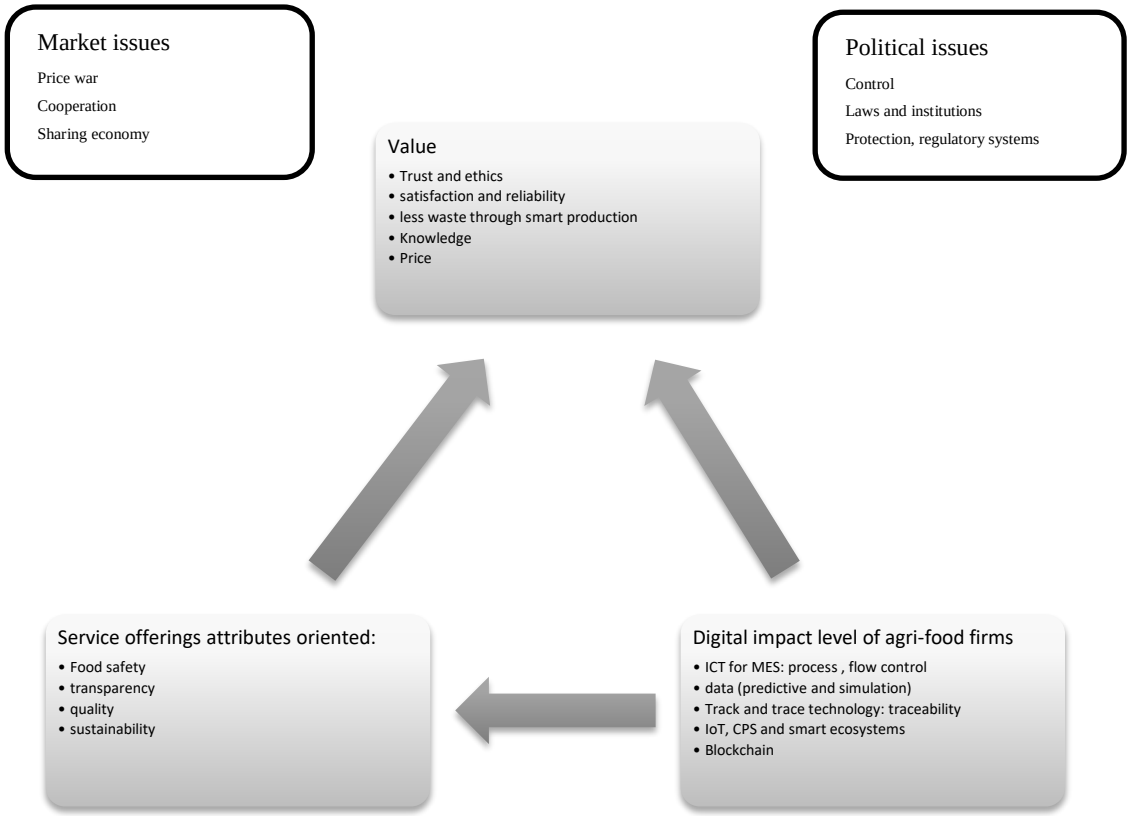
answers differ. However, this approach does not really mention the final purpose and the main question to be answered: For what a Big Data strategy has to be done? What is the core need defined? The digital change can create conflicts among collaborators if there is no harmonization and IT alignment in terms of culture. Agri-food remains a traditional industry and the integration of digital technologies may not be applied at the same level within the chain. A global ecosystem has to be defined to assist the potential benefits of technologies and to demonstrate a win-to-win relationship in terms of shared value. This is central to the perspective of servitization as an enabler of loyalty and stable customer's satisfaction.

If Big Data or IoT solutions strengthen data-driven decision-making, the risk is not having a rational approach due to a high and fast development of digital solutions but without an appropriate integration. Big Data is a step that overpasses Business Intelligence technics and offers more possibilities to collect, to treat and to use data within a massive flow of data. In the case of agri-food, Big Data has to be included to strengthen MES flow control and processes in order to be relevant in the food-chain improvement. The main issue is not to run empirical statistics but to analyze and understand information such as behaviors. Those can be product deterioration, environmental changes or any variables modifications. Data is needed but it is important to consider only relevant data and the purpose of their use. Information we get through analytics is not always consistent and reliable. Some correlations may be statically correct but absurd. If the profusion can reach more specific information to be captured, it can reduce the visibility and the understanding for the user in the specific context of a firm, creating more digital noise. It is not about getting quantitative results but to ask the right question to answer a defined need. Consequently, there is a key issue of putting more intelligence while dealing with new technologies' integration.

4.2.3 Framework Services offerings for agri-food overview

We can propose four main attributes for service orientation in agri-food as mediators of digital impact on value: Food safety, quality, transparency, and sustainability. We can consider two external issues that may have a significant influence: Market (competitive environment) and political issues (legal and institutional environment). Agri-food

ecosystem aims to be based on interconnectivity, transparent and reliable information sharing to guarantee safety and provide value.



5 CONCLUSION

5.1 THEORICAL CONTRIBUTION

This paper aims to show that the digitalization of the supply chain is the necessary enabler of servitization of agri-food. Both servitization and digitalization of manufacturing industry have been treated and a literature review has been made to get the main issues and current ideas. However, it has also been shown that servitization has not been treated for agri-food sector among research. In comparison, digitalization is not such a new issue but the difficulty is the absence of a global approach and synthesis of digital impact on

agri-food. The phenomenon is mostly treated through a specific topic or the application of a technology. Moreover the production step is highly privileged. As an attempt to bring a first theoretical basis regarding servitization and digitalization interdependencies of agri-food industry, it was essential to present the current state of the sector at the business scale but also by mentioning some national (China) and supranational elements (Europe) and then to determine the main challenges the agri-food sector has to deal with. Those challenges are traceability, trust and transparency, life cycle management and health. Then, the IT applications have been provided to present the opportunities and to show that digital technologies are key to manage a servitization strategy that bring more value.

5.2 MANAGERIAL IMPLICATIONS

The digital impact has become a real prospect for the future of agri-food sector. If agri-food firms preserve a product-focus business model, the integration of digital technologies for the food-chain offer a large number of opportunities. The adoption of a digital strategy is the way to offer qualitative shared-value among actors, to enhance quality, transparency, and interconnectivity. The promotion of digital tools that enable better data and information sharing may enforce a strategic collaborative system and advanced synergies. Therefore, the "smart servitization" move may enhance a global business intelligence within each agri-food firm and for all partners. However, as soon as the firm decide to adopt to co-operate with the customer, the organizational changes implied by new technologies have to be driven by the willingness and the assurance to provide more value and more quality in a long-term perspective. The evolution with customer should be based on a supply chain perspective more than a marketing logic. Thus, servitization a supply chain strategic issue.

Those organizational changes will also permit to better take into account customers' requirements and to have a better understanding of their needs. This knowledge basis may grant more precise and relevant offers for the customers. IoT, Big Data or RFID are fundamental tools to be developed in order to integrate, record and analyze any information in real time for MES purposes such as traceability or life cycle management. Those technologies may allow more responsiveness and flexibility in a sector that looks for an efficient supply chain. However, it is also important to be aware of the complexity

generated within the supply chain. If data are meant to participate directly in the decision-making process, an over-confidence in digital technologies accompanied by a lack of rational and reflexive approach would lead to a digital paradox. Managers should have to diffuse the knowledge needed depending on employees' missions to use the data properly. Moreover, they have to define for what they want to develop digital technologies. Even if it is essential to digitalize, it has to be motivated by clear needs. In parallel, cybersecurity must not be forgotten to contribute to the safety of the processes, systems and the e-trust.

5.3 LIMITATIONS AND FUTURE RESEARCH

This is a theoretical approach based on the current knowledge and applications developed among research. Therefore, it has to be completed by empirical analysis. For that, case studies about agri-food servitization should be a way to widen the analysis and to understand more precisely the role of digital tools. Moreover, just few of those tools have been taken into account for this work. Some others aspects have been only briefly described. For instance, the current state of agriculture have been mentioned only by drawing a simplified parallel between China and Europe to get the most common challenges. Consequently, it could be interesting to provide a deeper dynamic comparison introducing more macroeconomics information that may affect the way to face the different challenges previously chosen.

Some aspects such as sustainability or sharing economy model will need more precise attention since there are having a greater influence in the society and in terms of consumption behavior (local food consumption, fewer intermediaries from "farm to fork", win-to-win relationship…). As soon as sustainability and environmental issues are more and more at the center of the attention in our daily life, another interesting future research area may be a focus on green supply chain opportunities and digital capacities to participate to the circular economy.

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