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DIGITAL TRANSFORMATION BEHAVIORS IN THE AGRI-FOOD CONTEXT: AN EXPLORATORY ANALYSIS

Abstract. Firms cannot avoid digital transformation and nothing could be more important for them than exploit the digital data created by new technologies. Yet, we still lack a clear understanding of how firms, especially in agri-food industries, are transformed by digital technologies. This article contributes to an understanding of how agri-food firms behave in distinct stages of digital transformation and shows how digitalization enablers influence these behaviors. This research also empirically demonstrates that digital data exploitation behaviors change according to the data sources employed by the firms when trying to develop their products

Keywords. Digital transformation, digital data, firm behavior, multiple case study.

1. INTRODUCTION

Digital transformation is dramatically changing the face of the economy (Matzler *et al.* 2018). Digital transformation is the "application of new technologies […] [which] requires skills that involve the extraction and exchange of data as well as the analysis and conversion of that data into actionable information." (Schallmo, Williams and Boardman 2017: 4). Compared with other economic and social transformations, the digital transformation gives rise to an ever-growing quantity of native digital data which are *"born digital"* that means not subsequently entered in the information system by hand or digitized by computer tools (e.g. scanner) (Piccoli and Watson 2008). Therefore, digital transformation and digital data are having an increasing impact on the development of firms' competitive advantages (Piccoli and Ives 2005).

Previous studies on the digital transformation focused on some features of the phenomenon, such as digital transformation strategies (Ferreira, Fernandes and Ferreira 2019; Hess *et al.* 2016); alteration of the business model (Berman 2012); adoption of new technologies (Pankewitz 2017); data creation, collection, and analysis (Dremel *et al.* 2017). Although these studies have investigated the critical aspects of the digital transformation, they were mostly developed in contexts in

which the use of technologies was already established and in which the observation of the phenomenon was favored. Nowadays, the digital transformation is one of the strongest environmental influence that forces all industries to adapt to the changes it introduces, this is also true for the agri-food sector (Anastasiadis, Tsolakis and Srai 2018; Vlachos 2004). Despite the study of digital transformation in agri-food firms could provide new insights due to the traditional low level of technologies adoption, there is little empirical research that examines how agri-food firms are digitally transformed (Hess *et al.* 2016; Loonam *et al.* 2018).

Conversely, scholars who have intertwined technological innovation and food production (e.g. (Beckeman, Bourlakis and Olsson 2013; Grunert *et al.* 2008), on one hand, have significantly explained how agri-food firms made use of technologies and what new food products have been developed due to the new technologies (e.g. Leek, Szmigin and Carrigan 2001; Marette *et al.* 2009; Steenis and Fischer 2016). On the other hand, they missed the opportunity to investigate the increasing availability of digital data and how the information gathered by the elaboration of such data can foster product development (Schweitzer, Handrich and Heidenreich 2019).

These gaps inspire the research questions, "How are agri-food firms digitally transformed?" and "How do these firms exploit digital data to develop their products?".

By using an exploratory multiple case study design, this study provides two main contributions. First, this article contributes to an understanding of how agri-food firms behave in distinct stages of digital transformation and shows how digitalization enablers influence these behaviors. Second, this research empirically demonstrates that digital data exploitation behaviors change according to the data sources employed by the firms when trying to develop their products.

1.1 How digital transformation has been changing firms

Digital transformation is a complex phenomenon that affects several areas within a company. It has received greater research attention only recently so that it represents the salient topic in the current research agenda. Prior conceptualization of digital transformation are several (Olleros and Zhegu 2016; Schallmo, Williams and Boardman 2017), resulting in fragmented definitions across studies (Loonam *et al.* 2018). Digital transformation is defined as an organizational transformation

that integrates digital technologies and business processes in the digital economy (Liu, Chen and Chou 2011). Digital transformation requires reenergizing the business to benefit from digital technology (Bowersox, Closs and Drayer 2005). Specifically, this means shaping customer relationships, internal processes, and value propositions to exploit firms' main competence through the adoption of digital technology (e.g. analytics, mobility, social media, and smart devices) and gain competitive advantage (Brynjolfsson and Hitt 2000). While Schallmo and colleagues (2017) suggest a definition of digital transformation that recognizes the need to develop skills for collecting and analyzing digital data to convert them into information. So, how has the digital transformation been changing firms? Previous research mainly focused on: 1) digital transformation strategies (Ferreira, Fernandes and Ferreira 2019; Hess *et al.* 2016); 2) changes in the business model (Berman 2012); 3) adoption of new technologies (Pankewitz 2017); 4) data creation, collection, and analysis (data circle) (Dremel *et al.* 2017).

Regarding the *strategies for facing the digital transformation*, the factors that push firms to develop (or not) new digital processes and their implications in terms of innovation and performance received close attention (Ferreira, Fernandes and Ferreira 2019). Digital transformation is often associated with disruption. Even traditional and big old companies are not immune to the disrupting changes driven by digital transformation (Loonam *et al.* 2018). Thus, traditional firms need to learn from disruptive ventures and reimagine their business models, processes and products trying to strengthen them through the use of digital technology (Matzler *et al.* 2018; Sebastian *et al.* 2017). Other companies are exploiting the agile principles to facilitate the cultural and technical changes required by the digital transformation (Shaughnessy 2018). These strategy adaptations could avoid firms being affected by the disruptive effects of digital transformation (Matzler *et al.* 2018).

Digital transformation often triggers *changes in the business model*. Literature provides a morphology of the business model transformation before and after 2000, documenting the drivers of the changes (Kotarba 2018). However, a systematic approach for developing business models in the context of digital transformation seems missing (Schallmo, Williams and Boardman 2017). A possible plan for modeling the digital transformation consists of identifying existing products and services, deconstructing business models and discovering new configurations (Remane *et al.* 2017). Digital transformation creates an

opportunity to mold new customer-oriented business models grounded in the online customers' engagement at every link of the value chain (Berman 2012).

The *adoption of digital technology* presents differences due to the particular industry, in which it is applied. Examples of digital technology adoption can be the development of a simple e-platform for the digitalization of traditional services (Fisher *et al.* 2000; Liu, Chen and Chou 2011; Sunding and Zilberman 2001), or the use of more complex technologies such as social, mobile, analytics, cloud and Internet of things (IoT). However, the adoption of digital technology can provide unique opportunities as well as existential threats (Sebastian *et al.* 2017). Regarding the opportunities, a series of technologies (e.g. automation, robots, algorithms, and artificial intelligence) has great potential of disrupting not only the industry where they appear but also alike businesses and sectors (Pankewitz 2017).

Once equipped with digital technologies, firms can *generate, collect, and analyze digital data*. Digital transformation dramatically boosted the creation of native digital data which are "born digital" that means, not later entered in the information system manually or digitized after data creation by computer tools (e.g. scanner) (Piccoli and Watson 2008). Recognized antecedents of native digital data are the firm history, its organizational processes and assets (Vitari *et al.* 2012). This kind of data has a positive influence on IT-based competitive advantage, but the benefits are reduced by sudden digital transformation changes (Raguseo, Vitari and Piccoli 2012). In terms of better financial performance, those firms being most capable of exploiting native digital data also have higher financial performance (measured in terms of ROA, ROS and revenue growth) (Raguseo and Vitari 2014). Moreover, firms able to develop skills based on native digital data, obtain higher outputs in terms of data quality and accessibility (Raguseo, Vitari and Pozzi 2016). Firms also benefit from a direct relationship between data, information, and knowledge when supported by a growing number of organizational units that collect data and exploit data analytics (Thornley *et al.* 2016). Such dynamics project the firms in a data-rich environment in which they must develop analytics methods enough flexible to fit structured and unstructured digital data generated within or out of the firms' boundaries (Wedel and Kannan 2016). Data-richness can quickly lead to big data and extracting information from big data is a recognized competitive factor in the digital transformation (Krämer, Tachilzik and Bongaerts 2017). Thanks to a set of recommendations for how to

successfully introduce big data analytics, firms can master the related organizational renovations while facing the digital transformation (Dremel *et al.* 2017). On the other hand, sometimes digital data remain mostly untapped by firms, this implies that data availability not automatically means that firms are going to use them (Balducci and Marinova 2018). Thus, the main resource created by the digital transformation is occasionally ignored or underexploited (Balducci and Marinova 2018).

1.2 Digital technologies in the agri-food industry

The impact of digital transformation in the agri-food industry is greatly influencing raw materials supply chain, production, processing, distribution, and marketing (Wagner Weick 2001). Stimulated by the availability of novel technologies in the food industry, new products like fruit juices fortified with vitamins, yogurt enriched with prebiotics, and omega-3 eggs have radically revolutionized customers' food habits (Bigliardi and Galati 2013). The adoption of micro and nanotechnologies (Marette *et al.* 2009; Steenis and Fischer 2016) allowed, for example, the encapsulation of food active components (Roos *et al.* 2016). As a consequence, firms could introduce in the market a great number of innovative new "functional foods" (Bigliardi and Galati 2013; Tollin, Erz and Vej 2016). Still, the digital transformation in food production fosters the creation of new types of machinery, such as 3D food printers (Charlebois and Juhasz 2018).

The phenomenon of the digital transformation in the agri-food industry has divided customers into opened versus skeptics towards the adoption of new technologies. Looking at the relationship between consumers' age and product selection, elderly people are usually willing to pay a premium price for products treated with technologies that provide added health benefits (Leek, Szmigin and Carrigan 2001). Conversely, millennials who care about sustainability issues are skeptical regarding the positive contribution of technologies to produce more sustainable food products and consider technologies adopted to prolong food shelf life dangerous (Cavaliere and Ventura 2018; Steenis and Fischer 2016). However, a study on consumer preferences for "familiar" versus "novel" food products claims that age is not a determinant factor in consumption decisions with familiar products, while it plays a more decisive role in the structure of preference regarding novel food products, particularly in young consumers (Barrenar, García and Camarena 2015). Moreover, the growing use of technologies in the agri-food

industry requires an active role of a large variety of actors (Hoppe *et al.* 2014). Therefore, the literature focused also on retailers, which are described as a powerful actor in the food value chain (Beckeman and Olsson 2011). What is more, those retailers strong enough to develop internal tech-departments are also able to influence the agri-food chain, thanks to their technological capabilities (Ejye Omar 1995). Due to their key position, retailers can promote voluntary market regulation, as the case of adopting a front-of-the-package nutrition scheme, to which all manufacturers had to comply by modifying their labels (Van Camp, Hooker and Souza-Monteiro 2010).

Developing new food products is a hard task. In the attempt to managing food development, actors of the agri-food tie-up inter-organization collaborations. For example, technological centers collaborate with food manufacturers to gain new knowledge, while manufactures usually need experts to get support for product development (Hoppe *et al.* 2014). Regarding food manufacturers, little attention has been paid by researchers. Manufacturers have to mature endogenous capabilities (e.g. build relationships) if they want to develop and introduce new products in the marketplace (Capitanio, Coppola and Pascucci 2010). Some food manufacturers build peer collaborations with other producers, but there is a widespread lack of trust in the food industry which, in turn, leads to a limited sharing of data and information (Beckeman, Bourlakis and Olsson 2013).

So far, agri-food research has greatly explained how technologies have been employed by the food industry and what food products have been created by the intensive use of technologies (e.g. (Leek, Szmigin and Carrigan 2001; Steenis and Fischer 2016). These studies also deeply investigate the role of the customer in the food industry, providing interesting insights regarding the technological centers, suppliers, retailers, and manufacturers too (e.g. (Beckeman, Bourlakis and Olsson 2013; Beckeman and Olsson 2011). Notwithstanding, just a few scholars studied the adoption of new digital technologies and focused on a pivotal phenomenon such as digital transformation in the agri-food firms (Vlachos 2004; Anastasiadis, Tsolakis and Srai 2018). Thus, previous research missed the opportunity to study the digital transformation and the increasing availability of digital data generated by the application of new technologies in food production, and how the information provided by the processing of digital data can support product development (Schweitzer, Handrich and Heidenreich 2019).

2. METHODOLOGY

This paper aims to explore how agri-food firms are digitally transformed and to provide a theoretical framework concerning how digital data are employed for product development. An exploratory multiple case-study design was adopted (Eisenhardt and Graebner 2007) since agri-food firms' digital transformation is an empirically underexplored field of research.

2.1 Research sample and case selection

Case-study research involves collecting and comparing data from 14 cases at agri-food firms (see Table 1).

TABLE 1• OVERVIEW OF THE CASE STUDIES

Case Study	Business Area	Case Description	Size*	Respondent
1	Fruits and vegetable processing	The firm processes bio and local fruits to produce pulps, smoothies, juices, as well as vegetable products like tofu, tempeh, and seitan.	Medium	CEO
2	Fruits processing	The organic farm has a citrus and olive orientation. It produces and commercializes kiwis and citrus fruits, as well as jams, marmalade, juices and extra virgin olive oil.	Small	CEO
3	Olive oil production	The firm is a cooperative of 250 companies that produce different kinds of extra virgin olive oil.	Large	IT specialist
4	Dairy products	The primary activity of the firm is dairy production. Linked to this, there is the whole agricultural and cow breeding sector. The production of raw materials and the transformation of sewage into electricity is done by the firm.	Medium	CEO
5	Dairy products	The firm is a cooperative of shepherds that deals with the transformation of cow milk from the farms of members and the production and distribution of dairy products.	Medium	CEO; IT specialist
6	Dairy products	The firm takes the highest quality sheep milk and whey and processes it to obtain powdered products, combining the natural properties with the benefit of longer shelf life and high solubility.	Small	CEO
7	Dairy products	The firm processes milk and produces mainly mature sheep and goat cheeses.	Medium	Marketing Director

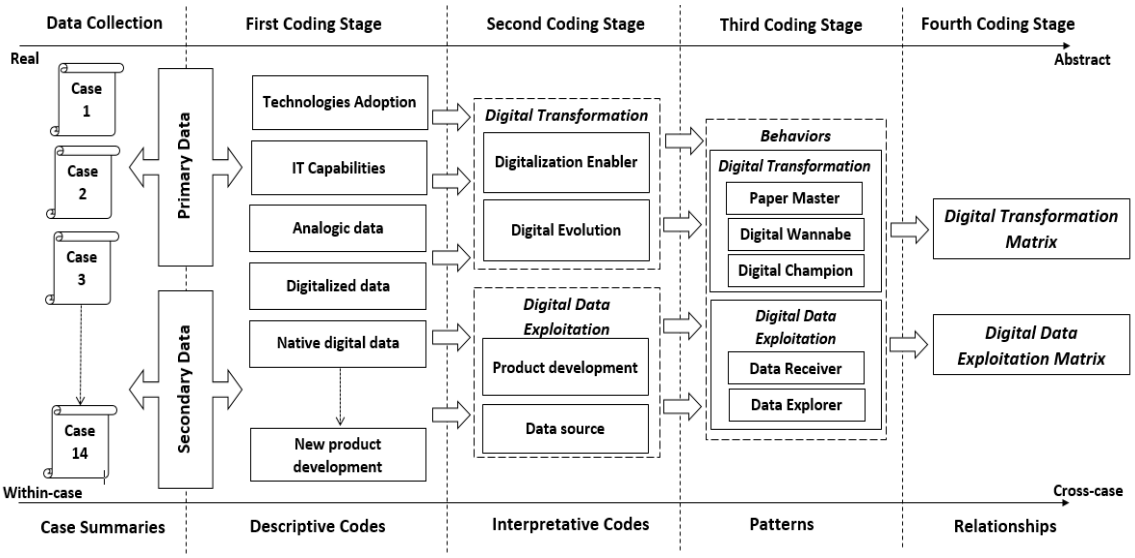
8	Poultry products	The firm is a specialist in the poultry market. It manages the entire integrated production cycle: the selection of raw materials, rearing units, hatcheries, feed facilities, food processing, packaging, and distribution.	Large	Head of IT & Digital Transformation; Head of R&D
9	Pasta and sweet products	The firm is operating for over 30 years in the production of regional fresh and dry pasta and local sweets.	Small	CEO
10	Fresh pasta	The firm produces fresh pasta such as tortellini, ravioli, and gnocchi, etc., for its shops.	Small	CEO
11	Fresh pasta	The firm produces fresh pasta such as tortellini, ravioli, and gnocchi, etc., for the organized large-scale distribution.	Small	CEO
12	Dry pasta and rusks	The firm produces several types and shapes of dry pasta as well as different kinds of rusks.	Large	Quality manager; Head of R&D
13	Food supplements	The firm develops, produces and markets food supplements mainly for athletes such as amino acids, creatine, protein, energy bars, etc.	Medium	Technical director
14	Cured meat	The firm processes and sells top-quality pork products and it is an important market player in several states of the European Union.	Large	Managing director

Firms were selected following a two-steps strategy. First, the main Italian organization and research centers dealing with digital transformation and the agri-food industry were contacted. A list of their food processing firm partners was required. Two organizations and a research center replay to the request suggesting a total of 25 firms to contact. These firms were emailed and five of them participated in this research. Second, the Italian chamber of commerce was phoned to ask if they could provide an equivalent list. They offered to call 228 food processing firms. 27 companies accepted to take part in this study. Collecting interviews was stopped at 14 cases when this study reached theoretical saturation that is "no additional data are being found […]. As he [the researcher] sees similar instances over and over again, the researcher becomes empirically confident that a category is saturated" (Glaser and Straus 2017: 61).

2.2 Data collection

Data analysis was conducted in 4 cumulative stages of coding, starting with the within-case analysis of each case, moving from the specific case context to the overall phenomenon (Saldaña 2015) (see Figure 1).

FIGURE 1 • DATA ANALYSIS PROCESS



The process started with a preliminary within-case analysis of the 14 cases and their characteristics by reconstructing the summaries of individual case studies. Summaries were created by reviewing interview transcripts, archive data, the firms' websites, and social network profiles.

During the first coding process, data were segmented and grouped following a data-driven coding scheme. A set of 11 descriptive codes was identified (Miles and Huberman 1994). Accordingly, the outcome of this stage of coding was a list of codes as observed in the single-considered cases (e.g. technologies adoption, IT capabilities, analogic data, internal data, incremental innovation, new product development).

TABLE 2

Descriptive code	Interpretative code	Definition	Description	Illustrative quote
Technologies adoption	Digitalization enabler	A digitalization enabler helps firms in accomplishing their digital transformation.	The adoption of digital technologies, acquisition of digital capabilities, the effort to increase firms' efficacy and agility in decision-making push firms towards the digital transformation.	The creation of data and information was much more difficult before the adoption of new technologies. Once we had a system that was not as precise as this about milk conductivity. The previous system had a much higher degree of error. Instead [technology name] is very precise. Before we had to rely on the monthly samples we took from the herd. *IT specialist, Case-5.*
Digital data capabilities				
Efficiency pursuing				
Agility seeking				
Analogic data	Digital evolution	Digital evolution is the firms' transition from the creation of analogic data to native digital ones.	Firms in distinct stages of digital evolution create different kinds of data.	"There is a processing sheet in which the operators write all the necessary data, for example, if there have been machinery downtimes, machinery consumptions, etc. Then, the coordinators input the data into the information system. While the most recent technologies are capable of producing digital data in the outgoing phase of the warehouse." *Technical director, Case-13.*
Digitalized data				
Native digital data				

Incremental innovation	Product development	The creation of products with new or different characteristics that offer new or additional benefits to the customer.	Process in which data are involved to create new products or improve the currentlyproduced ones.	"We have another benefit from data analysis. For example, we have shops where we directly sell our products, one of them is next to the dairy building. So, if we want to create some new product or test variations of the original product, we usually do these tests in our stores and collect data from customers." *Marketing Director, Case-7.*
New product development				
Internally created data	Data source	A data source is a location where data that are being used come from.	Firms use various data sources for separate tasks of processes.	"When a product is particularly performing, it could push us to improve its characteristics or those of products that could interest the same consumer. In this case, we very often base our analysis on the trend of internal data. While to find an indirect customer need, the best way is to try to interpret the sectoral market data. Market data are provided by the trade association and are national data." *Technical director, Case-13.*
Externally created data				

TABLE 3 • CROSS-CASE SUMMARY OF THE INTERPRETATIVE CODES

Case Study / ***Interpretative code***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Digitalization enabler	X		X	X	X	X	X	X			X	X		X
Digital evolution	X	X	X	X	X	X		X	X	X		X	X	X
Product development	X	X	X	X			X	X	X			X	X	X
Data source			X	X	X	X	X	X		X	X	X	X	X

Then, the third stage of coding led the analysis to a further level of abstraction. Starting from the previously identified interpretative codes, patterns were pinpointed (Miles and Huberman 1994). In doing so, 5 behaviors were identified which, according to the analysis, reveal the digital transformation of agri-food firms and explain how digital data are employed for product development (see Table 4). Also at this stage, another cross-case analysis was performed to verify whether any construct was repeated in the 14 cases (Table 5).

TABLE 4• SUMMARY OF THE BEHAVIORS RELATED TO DIGITAL TRANSFORMATION AND DIGITAL DATA EMPLOYMENT

Phenomenon	Behavior	Definition	Description	Illustrative quote
Digital transformation	Paper master	A "Paper master" uses paper supports to take notes of data related to food processing.	Behavior performed by firms that mostly collect data on paper.	"At the end of the day, every person who works in a certain phase of the processing, must fill in the worksheets and take them to a production manager who files them. There is a whole paper system, we are not yet digitizing anything." *CEO, Case-11.*
	Digital wannabe	A "Digital wannabe" digitalizes food production data thanks to computer tools (e.g. scanner) or manually inputs data into the information system.	Behavior performed by firms that digitalize analogic data with the aim of benefit from having available digital data.	"Data are collected manually on product sheets that are stored in physical archives. Lately, we are scanning the product sheets. We do this not only because product sheets can be lost, but also because it is much simpler to code and group them by product families. As a result, product sheets are available on a computer to retrieve the data we need." *CEO, Case-2.*
	Digital champion	A "Digital champion" employs machinery able to create and send production data in digital format straight to the information system.	Behavior performed by firms which prefer food processing technologies able to create native digital data and communicate with the information system.	"Data are acquired thanks to sensors located in different points of the production process and transmitted to the information system. Data, directly in digital format, are stored on servers owned by the company." *Head of R&D, Case-12.*

Digital data exploitation	Data receiver	A "Data receiver" waits for prearranged production information to make decisions.	Behavior performed by firms that passively create and collect data while the analysis is done to produce prearranged information.	"Then there are a bunch of analyzes of product quality and productivity. We don't need to do additional analysis. From the data collected by the machinery, the information system generates information for us. Then, the man has to interpret the information, but we have already available all the analyses we need." *Managing director, Case-14*
	Data explorer	A "Data explorer" critically examines data to find new pieces of information.	Behavior performed by firms that actively explore production data by deepening data analysis.	"Machinery suppliers partially limit the autonomy of the company to carry out independent analyses. We are a bit forced to use and follow their models. We can carry out independent analyzes thanks to the additional sensors that we insert in the machinery to produce an autonomous and parallel data collection." *Head of IT & Digital Transformation, Case-8.*

TABLE 5 • CROSS-CASE SUMMARY OF THE BEHAVERS

Case Study / ***Behavior***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Paper master		X							X	X	X		X	
Digital wannabe		X	X		X		X	X		X			X	
Digital champion	X		X	X	X	X		X				X		X
Data receiver		X	X		X	X	X	X	X	X	X	X	X	X
Data explorer	X			X				X				X		X

The final stage of data analysis involved assessing the relationships among them. This final coding aimed at connecting the constructs and transformed them from static and standalone behaviors into dynamic and integrated theoretical frameworks (see Figure 2 and Figure 3). The coding process was supported by Nvivo 10 software.

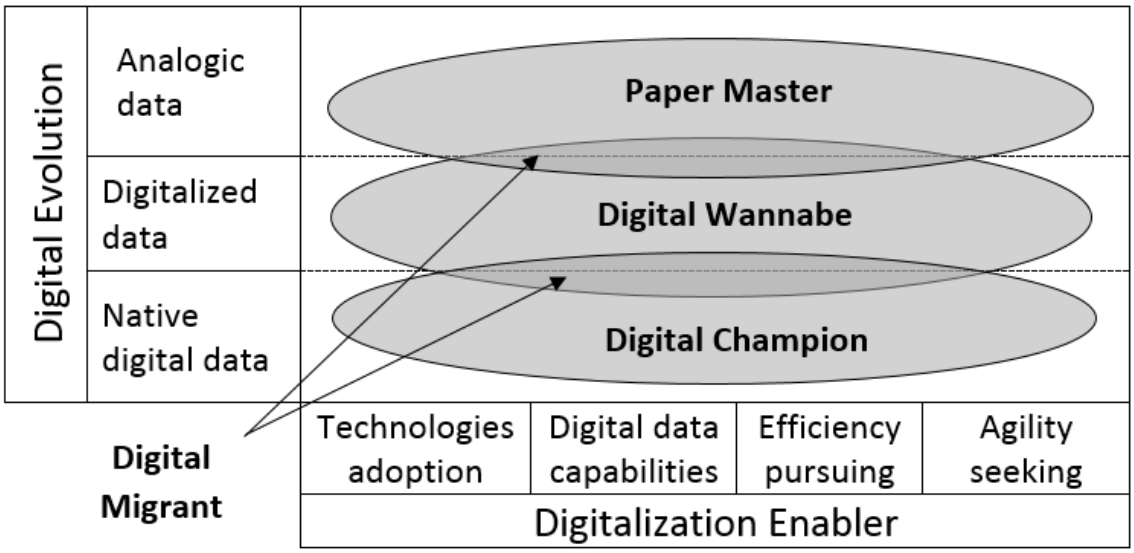
3. Digital transformation and digital data exploitation behaviors in agri-food firms

The findings of this study show that agri-food firms adopt five main behaviors when dealing with digital technologies that were labeled as Paper master, Digital wannabe, Digital champion, Data receiver, and Data explorer. Two groups of behaviors emerge from the analysis. The first one is related to the phenomenon of digital transformation and illustrates what firms do at several stages of digital evolution. The second has behaviors of digital data exploitation. Here, firms generate information from different digital data sources to develop their products

3.1 Digital transformation behaviors

In each of the 14 cases, data are created and managed. However, data creation can dramatically defer from case to case depicting how evolved is a firm in terms of digital transformation. Despite the kind of data used by the firms, the analysis of the cases unveils digital transformation enablers that indiscriminately push firms to adopt digital solutions. By combining the degrees of digital evolution and the digitalization enablers, three main behaviors related to digital transformation were pinpointed (see Figure 2).

FIGURE 2 • DIGITAL TRANSFORMATION MATRIX



Paper Master. Firms enacting this behavior are far from a complete digital transformation. The main characteristic that discerns Paper masters' behavior is the extensive and pervasive use of paper. The case-study analysis elicits that Paper masters employ paper in data collection because their technological equipment produces analogic data. Thus, Paper masters have no alternative that uses physical support to keep track of some aspects of food processing (e.g. quantities of raw material, temperatures, electricity consumption). However, the case-study analysis displays Paper masters pursuing efficient and fast decision making. The search for higher levels of efficiency and decision agility push firms in planning to acquire digital technologies: "At the moment, we have no technologies that allow us to weigh and mix the ingredients automatically. From this point of view, we are anchored to the older part of the factory technology. We planned to acquire better technologies because every year we invest to increase our efficiency and production capacity." (CEO, Case-11). Yet, Paper masters prefer to employ paper even when machinery can generate digital data, as the CEO Case-9 put it: "Data collection is manual, there are several data that are detected by the machine, which can be downloaded onto a USB stick and then transferred to a computer, but… these measurements are written on paper." Among the reasons for the pervasive use of paper, there is, for example, the employees' lack of digital capabilities: "even if you have very good workers, if you ask them to turn on a PC and open an Excel sheet for uploading some data, the panic starts!". This means that the technological equipment, purposes of improving efficiency and decision agility are not enough to make firms behave as more evolved ones in the digital transformation. The dataset analyst unveils that digital capabilities are needed too.

Digital Wannabe. Firms that belong to this category are more aware of the benefits of having digital technologies, especially as regards the availability of digital data: "I come from the ICT sector, I am perfectly aware of the importance of the data. Even when data do not seem useful, after a while or when certain things happen […] data turn useful" (CEO, Case-10). This awareness pushes Digital wannabes to collect a wider range of data compared with the Paper masters. Furthermore, the Digital wannabes make great effort for digitalizing data and it is a feature that differentiates their behavior. Form the analysis emerges that Digital wannabes' employees have at least basic digital data capabilities. These workers digitalize data employing computer tools such as keyboards by inputting

manually analogic data into an information system or scanning paper sheets to have a digital copy. As a result, Digital wannabes benefit from some of the digital transformation advantages. For example, they get useful information from the digitalized data analysis in operation management such as better standardization of the production and the improvement of quality control accuracy: "We have several milk suppliers, all the data related to the milk analysis are [manually] uploaded to files and stored. We use these data to evaluate milk quality and estimate what price to pay for it" (Marketing director, Case-7). Nonetheless, the analysis reveals data digitalization's side effects like high data collection costs, time-consuming data collection activities, poor data quality which is affected by human errors, and missing information. Concluding, Digital wannabes yearn to improve their digital conditions and they are halfway in the digital transformation. However, their technologies and capabilities limit a full transformation.

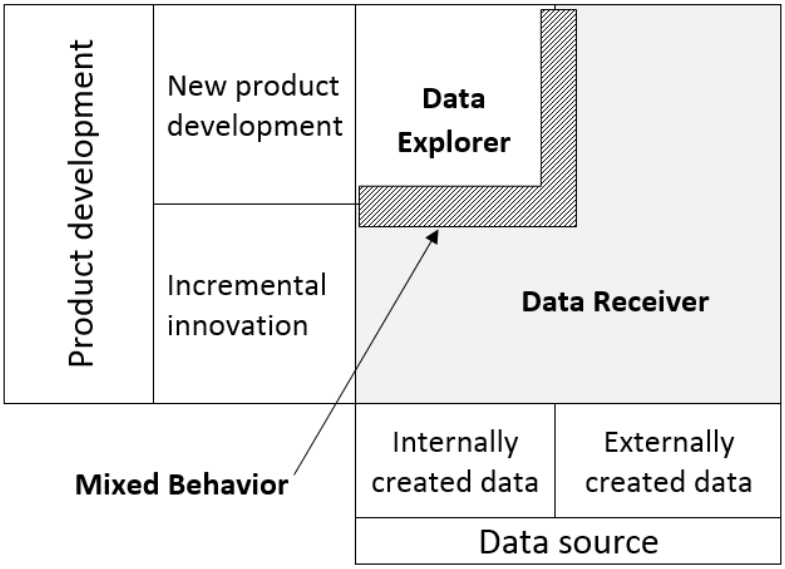
Digital Champion. Here, a pivotal role is played by the firms' technologies adoption: "the rusks factory is the most recent group's facility. No one in our company had ever run a facility with such recent production technologies." (Head of the R&D, Case-12). Digital champions' machinery creates data straight in digital format which are saved on servers connected to an information system. Firms have available a great variety of data regarding the details of the whole food processing chain, from the supply of raw materials to the sales results: "To give you some examples… the number of hectares cultivated; the real-time quantity of product harvested by machine; product humidity; in which warehouse the product must be stored; etc." (CEO, Case-4). Thanks to the digital data analysis, Digital champions use the available information to make real-time decisions, as the CEO Case-4 keep explaining: "Comfortably seated in our office, we receive a variety of information available in real-time. Based on this information, we advise the employee who is using the machine." Digital data employed by the information system quickly generate precise and ease to access information which in turn fuel agile decision making. The analysis suggests that a real-time decision-making process is the distinguishing feature of the Digital champions' behavior. It helps Digital champions reach a high level of efficiency since greater control of the production process improves the quantity and speed the production and decreases costs: "Based on the data collected during the production process, we look for a correlation between the flour mixture and the finished product yield and quality. If we see that there is a negative trend, we can strategically choose to modify the

flours mixture. On the contrary, if a production process has a very constant trend, we can decide to make a longer production getting a bigger quantity of a better outcome." (Quality manager, Case-12). Nevertheless, in some cases, the potential of digital technologies is not fully exploited (e.g. Case-6 and -14). Lack of digital data capabilities has a negative role in the digital transformation: "Unfortunately, we use approximately 30-40% of the potential of the technologies we have available because we do not have the right people to do this." (CEO Case-14). This means that, while technology adoption, efficiency pursuing and decision agility seeking seems to have mainly positive effects in the firms' digital transformation, the digital data capabilities can positively or negatively influence the transformation.

3.2 Digital data exploitation behaviors

Firms analyze data for several reasons. The research focuses on the exploitation of digital data for product development in terms of additional benefits to the customer (incremental innovation) or the creation of new products. By combining the types of product development processes with different data sources two behaviors were found both connected to digital data exploitation: Data receiver and Data explorer (see Figure 3).

FIGURE 3 • DIGITAL DATA EXPLOITATION MATRIX



Data Receiver. Data receivers have a passive attitude towards data analysis which is mainly done to produce standardize pieces of information to foster product development. The Data receiver is the most common behavior among firms. It appears in three of the four quadrants of the matrix. According to the analysis, Data receivers located in the bottom-left quadrant conduct analysis on data concerning internal aspects of the firm. Here, firms aim at improving products that are already produced exploiting internally created data: "Each production is a test, the data are analyzed to identify strengths and weaknesses of the product. Over time, we improve our products" (Quality manager, Case-12). The firms placed in the bottom-right quadrant are Data receivers too. They also want to improve their current products (or create variations of them), but they do that by analyzing firms' external dynamics (e.g. sales or mark trends): "We track everything we sell and we usually invest in products that sell the most to create variations of them." (IT specialist, Case-3). Lastly, Data receivers populate the top-left quadrant too. There, firms are exploiting externally collected data to create new products. For instance, by analyzing competitors' products: "We are followers as regards the creation of new products. We observe large companies that can make important investments in R&D. Then, we analyze their products and we try to adapt to what the biggest companies do." (CEO, Case-6).

Data Explorer. Such behavior is adopted by firms that explore digital data by examining them with a critical eye, and deepening data analysis, find novel pieces of information. Digital explorer is a minority and it is located in the top-left quadrant of the matrix. These firms query their database to create new products and understand whether they can do so, as the CEO Case-1 up it: "Production data are analyzed to create new products. Therefore, the opening of new markets is done by analyzing the production data to understand if the production plant is capable of producing a product that presents new characteristics that make the products more interesting to the final customer".

4. Discussion

Building on prior research on digital transformation and digital technologies in the agri-food industry, this study contributes by exploring the digital transformation in the agri-food sector and providing first insights about how such

firms exploit digital data for product development. First, this article contributes to an understanding of how agri-food firms behave in different stages of digital transformation and shows how distinct kinds of data and digitalization enablers influence these behaviors. Second, the research empirically demonstrates that digital data exploitation behaviors change according to the data sources employed by the firms when trying to develop their products.

4.1. Digital transformation behaviors mirror firms' data evolution

To date, former studies on the digital transformation focused on, e.g., changes in the firm digital transformation strategies (Ferreira, Fernandes and Ferreira 2019; Hess *et al.* 2016); alteration of the business model (Berman 2012); adoption of new technologies (Pankewitz 2017); data creation, collection, and analysis (Dremel *et al.* 2017). Even though these studies have examined significant digital transformation features, they were mostly developed in high-tech industries. Nevertheless, digital transformation is a priority in agri-food industries too (Anastasiadis, Tsolakis and Srai 2018; Vlachos 2004). Thus, previous studies live us without an explanation about how agri-food firms are digitally transformed (Hess *et al.* 2016; Loonam *et al.* 2018). The study contributes integrating previous literature by pinpointing three behaviors adopted by agri-food firms during the digital transformation. In particular, the results reveal that firms behave depending on the kind of data they use to operate and on digital enablers (e.g., digital data capabilities, technology adoption). For example, firms that make great use of paper (Paper master) are doing that because they deal with analogic data or have not capabilities to collect and use digital data. While aware of the advantage of managing digital data, firms try to digitalize their data (Digital wannabe), even if these firms get some pros of digitalizing data, they also face its cons (e.g., high costs of data collection). The most advanced firms in the digital transformation are those wich use native digital data (Digital champion). Oslo in this case, their digital capabilities can limit the advantages they can obtain from the utilization of digital data.

4.2. Digital data exploitation behaviors and the lack of new product miners

Earlier research identifies digital data as the key outcome of the digital transformation (Dremel *et al.* 2017). Studies on technological innovation in the food production (e.g., Beckeman, Bourlakis and Olsson 2013; Grunert et al. 2008),

on one hand, shed light on how agri-food firms utilize technologies and what new products have been developed due to the new technologies (e.g., Leek, Szmigin and Carrigan 2001; Marette *et al.* 2009; Steenis and Fischer 2016). On the other hand, they do not investigate the increasing availability of digital data in the agri-food sector, and how the information gathered by the analysis of digital data can affect product development (Schweitzer, Handrich and Heidenreich 2019). The study extends previous research by identifying digital data behaviors and theorizing how these behaviors change according to the data source and the kinds of the product development process. More specifically, while previous research demonstrates that new technologies adoption has positive implications in terms of product development, this article suggests that firms mostly adopt a passive behavior, (Data receiver) when exploiting digital data both for incremental innovation and for new product development. However, this study also shows that active behavior (Data explorer) is needed to exploit internally created data (e.g., production data) with the intent of creating new products. Despite the importance of exploiting digital data for new product development, Data explores are a minority. They display an active will in finding correlation between their available data and the possibility to create new producers.

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