Agri-food firm's digital transformation behaviors: a multiple case study

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Abstract:

This study aims to explore how agri-food firms are digitally transformed. Our analysis shows that internal manufacturing data creation can dramatically defer from firm to firm, pinpointing three main types of data: analogic, digitalized, and native digital data. Furthermore, the analysis also unveils digital transformation enablers that indiscriminately push firms to adopt digital solutions. By combining the types of data with the digitalization enablers, we find four main behaviours related to digital transformation (Paper master, Digital wannabe, Digital champion, and Digital migrant). This work contributes to an understanding of how agri-food firms behave in distinct stages of digital transformation, and it illustrates how digitalization enablers influence these behaviours. This paper also provides managerial guidelines that help agri-food firms recognize the features of how food processing might take advantage of digital transformation.

1   Introduction

Digital transformation, 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, & Boardman, 2017, p. 4), enables and triggers adaptive innovation of organizational structure (Schwarzmüller, Brosi, Duman, & Welpe, 2018; Singh & Hess, 2017), digital transformation strategies (Ferreira, Fernandes, & Ferreira, 2019; Hess, Matt, Benlian, & Wiesböck, 2016), and business model (Berman, 2012). While digital transformation is identified as an influential environmental contingency that shapes industry and firm-level innovations alike (Anastasiadis, Tsolakis, & Srai, 2018; Li, Su, Zhang, & Mao, 2018; Vlachos, 2004), surprisingly, little attention has been devoted on how agri-food business adopt to these changes (for exception, see Anastasiadis et al., 2018; Vlachos, 2004), which may limit our comprehensive understanding of the phenomenon, as firms in incumbent industries may show different paths towards digital transformation.

Against this backdrops, this study - using an exploratory multiple case study design – offers a typology of firms in different stages of digital transformation in the agri-food industry, and contributes to a more nuanced understanding of how firms behave in *distinct stages* of digital transformation and how digitalization *enablers* influence these behaviors.

2   Theoretical background

Although this study aims to explore how firms in the agri-food industry -considered as a low digital technology intensity- are being digitally transformed, extant research typically focuses on firms and industries in a more advanced stage of digitalization. Prior research mainly focuses on three main domains, digital *transformation strategies*, changes in the *organizational structure* (Schwarzmüller et al., 2018; Singh & Hess, 2017), and in the *business model* (Berman, 2012).

Regarding the *digital transformation strategies*, close attention has been devoted to factors that push firms to develop (or not) new digital processes and their implications in terms of innovation and performance (Ferreira et al., 2019). As digital transformation shapes various businesses, firms do not have the option anymore to miss out; instead they only have options to opt for the right strategy that shows high congruence with the digital transformation changes (Hess et al., 2016). Digital transformation is often associated with disruption. Even traditional companies are subject to disruption driven by digital transformation (Loonam et al., 2018). Companies are exploiting the agile principles to facilitate the cultural and technical

changes required by the digital transformation (Shaughnessy, 2018), hindering disruptive consequences of digital transformation (Matzler, Friedrich von den Eichen, Anschober, & Kohler, 2018). Digital transformation is also recognized as a tool to revamp firms in trouble, as these companies may need to implement pioneering digital strategies to overcome their problems (Westerman & Bonnet, 2015).

Digital transformation strongly requires changes in the firm *organizational structure* of various employees and leaders involved in the digital transformation to the workplace. The lack of digital talent in current firms' workforce is identified as one of the major causes of problematic digital transformation (Nair, 2019). This necessitates push the flexing, deepening, and revitalizing of digital competence among firms' current employees (Eden, Jones, Casey, & Draheim, 2019). To attract new employees, specifically those born in the digital era, firms need to emphasize the adoption of digital technology into every phase of their businesses (Heinze, Griffiths, Fenton, & Fletcher, 2018). Even the leaders have been affected by digital transformation. Some firms are shifting digital strategy responsibility from the chief information officer (CIO) to the newly created position of the chief digital officer (CDO). CDO position has unique responsibilities to differentiate this role from the IT leaders, e.g., supporting top management in formulating and executing the dedicated digital transformation strategy, coordinating the digital transformation of a firm, fostering cross-functional collaboration (horizontal influence) and encourage the digital culture across hierarchy levels (vertical influence) (Singh & Hess, 2017). *Workplaces* are changing too. The adoption and integration of digital technologies (e.g., mobile; big data; cloud computing) are shaping the features of the digital workplace (White, 2012) and the profiles of the new smart organization (Iapichino, De Rosa, & Liberace, 2018).

Digital transformation often triggers changes in the *business model*. Although a recent review by Kotarba (2018) provides a morphology of the business model transformation by identifying two waves (before and after 2000) and showing the key drivers of changes, a systematic approach for developing business models in the context of digital transformation is as of yet missing from the extant literature (Schallmo et al., 2017). As 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), a viable option to model the digital transformation focuses on identifying existing products and services, deconstructing business models and discovering new configurations (Remane, Hanelt, Nickerson, & Kolbe, 2017).

3   Methods

Since agri-food firms' digital transformation is an empirically underexplored field of research (Von Tunzelmann & Acha, 2005), we adopt an exploratory multiple case-study design (Eisenhardt & Graebner, 2007).

3.1   Data collection

We collected data from both primary and secondary sources: semi-structured interviews were conducted with actors involved in the digital transformation strategy and digital data analysis (e.g., chief executive officers, information technology leaders, research and development managers, and digital transformation specialists); gathered archival data (e.g. technological improvement), and data from company social media pages and websites. We adopted an interview protocol consisting of twelve questions divided into two sections: a) preliminary questions about the company, the interviewee and the context of the phenomenon, and b) questions related to the firm's technologies that create data regarding the manufacturing process. The questions asked of the interviewees included, e.g., "What sort of data does food processing machinery create?" and "How does the firm save/store data related to food processing?". The eleven interviews, one of each firm involved in this study, lasted from 35 to 58 minutes. We complemented the interviews with the collection of data from firms' social media, websites, and internal plans and reports (when available) in order to triangulate data sources.

3.2   Data analysis

Data analysis was conducted in three cumulative stages of coding, starting with the within-case analysis of each case, moving from the specific case context to the overall phenomenon (Eisenhardt & Graebner, 2007). We started with a preliminary within-case analysis of the eleven firms and their characteristics by reconstructing the summaries of individual case studies. Summaries were created by reviewing interview transcripts, archival data, the firms' websites, and social network profiles. During the first coding process, we segmented and grouped data following a data-driven coding scheme. We identified a set of descriptive codes (Miles & Huberman, 1994). Accordingly, the outcome of this stage of coding was a list of codes, as observed in the single-considered cases. At the second stage of coding, we began with the abstraction process, either categorized new data under existing codes, grouping similar codes or created a new code if it was analytically distinct. Consequently, we reanalyzed the descriptive codes, looking for interpretative codes that reflect the researcher's understanding of the data (Miles & Huberman, 1994). Finally, we carried out the third stage

of coding which led the analysis to a further level of abstraction. Starting from the previously identified interpretative codes, we identified patterns (Miles & Huberman, 1994).

4   Results

As a result of our analysis, four distinctive digital transformation behaviors emerged (Table 1). In each of the eleven cases, data regarding the manufacturing process are created and managed. However, data creation dramatically differs from case to case, depending on how advanced is the specific firm in terms of digital transformation. Despite the variety of data created by the firms, the analysis of the cases unveils digital transformation enablers that indiscriminately push firms to adopt digital solutions. Reviewing the various degrees of digital evolution and the digitalization enablers, we pinpointed four main behaviors related to digital transformation: Paper master, Digital wannabe, Digital champion, Digital migrant).

Table 1: Typology of the digital transformation behaviors

Typology and illustrative quote	Key characteristics
Paper master: "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 study 11.*	Paper-based data management, under or no use of digital tools even if available, lack of employees' digital capabilities, and/or employees fail to transform their digital capabilities manifested by extensive use of social media to a work context.
Digital migrants: "Many of our records are kept according to the requirements for obtaining quality certifications. Then, we have slimmer online records for our internal data that we use to make decisions. We have a sort of dual data acquisition system" *CEO, case study 4*	Typically, paper-based data management, however, due to external pressure from powerful clients and quality certification bodies, the coexistence of different technologies.
Digital wannabe: "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 study 2.*	Manually entering analogic data to the digital systems resulting in high data collection costs, time-consuming data collection activities, poor data quality, which is affected by human errors, and missing information.
Digital champion: "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 study 1.*	Digitally born data through the whole supply chain, supporting agile, real-time decision making, which improves production efficiency (this link is positively moderated by digital capabilities).

Paper masters extensively use analog methods (e.g., paper) to keep track of some aspects of food processing (e.g., quantities of raw material, temperatures, electricity consumption). Paper masters prefer to employ paper even when machinery can generate digital data. As the CEO of case study 9 put it: "*Data collection is manual, there are a number of data that are detected by the machine, which can be downloaded 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. The CEO of case study 9 carried on: "*even if you have very good workers if you ask them to turn on a PC… they know how to go to Facebook and post any kind of content… then you ask them to open an Excel sheet and upload some data, the panic starts!*". This means that technological equipment is not enough to trigger the digital transformation. Our dataset analyst unveils that digital capabilities are needed too.

Digital Migrants almost behave as paper masters; however, they begin to recognize the advantages linked with digital data. Some digital migrants are forced to digitalize data due to legal obligations or requests made by powerful clients and quality certification bodies. According to our analysis, the simultaneous use of two kinds of data (e.g., analogic and digitalized data) is typical of a group of digital migrants, as the CEO of the case 10 put it: "*Many of our records are kept according to the requirements for obtaining quality certifications. Then, we have slimmer online records for our internal data that we use to make decisions. We have a sort of dual data acquisition system*". While our analysis also displays that a sub-group of digital migrants behave like digital wannabes and digital champions as they employ digitalized and native digital data at the same time. The dual data creation process is due to the coexistence of different technologies, as explained by the IT specialist of case study 4: "*In large companies, different levels of digitalization coexist. So, to be able to integrate data created by several generations of technology [some older than others] is a pretty difficult task.*"

Digital wannabe firms are more aware of the benefits of having digital technologies, especially as regards to the availability of digital data: "*I come from the ICT sector, I am perfectly aware of the importance of the data.*" claimed the CEO of case study 10. This awareness pushes digital wannabes to collect a broader range of data compared with the paper masters. Furthermore, digital wannabes make great efforts for digitalizing data, and that is a feature differentiating their behavior from paper masters. Employees digitalize data employing computer tools such as keyboards by manually entering analogic data into an information system or scanning paper sheets to have digital copies. As a result, digital

wannabes benefit from some of the digital transformation advantages (e.g., control accuracy). The marketing director of case study 7 explained: *"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."*

Nonetheless, our analysis reveals that data digitalization has some downturns, such as 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 Champions devote pivotal roles to technologies adoption: *"the rusks factory is the most recent group's facility. No one in our company had ever run a facility with such resent production technologies."* said the head of the R&D of the case study 1. Digital champions' machinery creates data straight in a digital format which are saved on hard drives or in servers connected to an information system. Firms have a great variety of data regarding the details of the whole food processing chain available, from the supply of raw materials to the sales results: *"To give you some examples… real-time quantity of product produced by machine; product humidity; to which warehouse the product must be stored; to whom and what price should we sell the product,"* examined the CEO of case study 4. As a result of digital data analysis, digital champions use the available information to make real-time decisions, as the CEO of the case study 4 keep explaining: *"Comfortably seated in our office, we receive a variety of information available in real-time. Based on this information, we give advice to the employee who is using the machine".* Digital data employed by the information system quickly generate precisely and ease to access information which in turn fuel agile decision making.

Our results suggest that a real-time decision-making process is the distinguishing feature of the digital champions' behavior. It helps digital champions to reach a high level of efficiency since greater control of the production process improves production quantity, speed, and cost-efficiency. Nevertheless, we observed in some of the analyzed cases that the potential of digital technologies is not fully exploited (e.g., case study 6 and 8). Once again, lack of digital data capabilities have a negative role in the digital transformation as acknowledged by the CEO of the case 9: *"with the advance of working methods based on the use of technology, the lack of employees able to fully exploit the potential of new technologies leaves the firm with many problems. 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.".* 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.

5   Discussion

5.1   Summary and theoretical implications

Building on prior research on digital transformation, this study sheds further light on how agri-food firms behave in different stages of digital transformation and show how distinct kinds of data and digitalization enablers influence these behaviors.

To date, former studies on the digital transformation focused on changes in, e.g., the firm organizational structure (Schwarzmüller et al., 2018; Singh & Hess, 2017), digital transformation strategies (Ferreira et al., 2019; Hess et al., 2016), and alteration of the business model (Berman, 2012). 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 incumbent industries as well, such as in the agri-food sector (Anastasiadis et al., 2018; Li et al., 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). Our results identify four behavioral stages of agri-food firms' digital transformation. In particular, our results reveal that these behavioral stages correlate with the kind of data gather and manage, and also related to digital enablers (e.g., digital data capabilities, technology adoption). For example, firms that extensively use paper-based solutions for data management (i.e., paper masters) have analogic data and lack capabilities to collect and use digital data. Another group of firms in parallel use two kinds of data (e.g., analogic and digitalized data or digitalized and digital data) and are usually facing migration from a stage to another one (digital migrant). While aware of the advantage of managing digital data, digital wannabes try to digitalize their data, 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 are the digital champions that use native digital data. Even in their case, digital capabilities can limit the advantages they can obtain from the utilization of digital data.

5.2   Managerial implications

Our results show that in agri-food firms, firm-level digital transformation behavior is driven by the type of data created and by some digitalization enablers such as the technologies adopted, the digital capabilities developed, and their attitude towards pursuing production

efficacy and decision-making agility. Further, as our findings imply, the use of analogic data impedes digital transformation of the firm; however, environmental contingencies, such as pressure from a digitally more advanced competitor, or legal obligations, firms that are used to rely on analogic data, may face external pressure for the transition. Moreover, this study points out that digitalizing analogic data give just the illusion of exploiting the benefits of the digital transformation. While, for the practitioners stuck in a stage of the digital transformation, a manner to move forward is to produce a more evolved kind of data. For instance, a firm that behaves as a digital wannabe and aims to become a digital champion has to start creating native digital data (e.g., by purchasing suitable technologies).

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