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Service Innovation in Agricultural Business

Exploring the Influence of Digital Information Technologies

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List of Abbreviations

A	Association
B2B	Business-to-business
C	Company
CEO	Chief executive officer
Dr.	Doctor
e.g.	Exempli gratia: for example
et al.	Et alii: and others
etc	Et cetera: and so on
EU	European union
FP	Fundamental premises
ha	Hectare
ISO	International organization for standardization
IT	Information technology
ICT	Information and communication technology
IoT	Internet-of-things
kg	Kilogram
LED	Light-emitting diode
Nr.	Number
OS	Operating system
RFID	Radio-frequency identification
Prof.	Professor
PSS	Product-service-system
QR-code	Quick response code
S	Start-up
S-D-L	Service-dominant-logic
z.B.	Zum Beispiel: for example

1 Introduction

This thesis explores the influence of interconnectivity on service innovation in the agricultural sector. The first chapter explains the topic and its high relevance for research and academia. Initially, the motivation to analyse the agricultural sector is provided, followed by the elaboration of the research goal. To give a holistic view, the structure of this thesis is presented at the end of the chapter.

1.1 Motivation

In an interview about technological change and its influence on industries and public perception, Prof. Dr. Nöhle states that "Mercedes does not advertise with a[n out-dated] cable brake" – but with its latest production technology (Liste, 2013: R 3). In contrast to the automotive industry, the agricultural and food sectors advertise with old fashioned production methods, painting the picture of farms where elderly grandmothers milk the cows by hand. The public perception of the production process and the actual manufacturing methods, which highly depend on support by machines, are utterly disparate (Ehrenstein, 2016). Due to regulatory changes (e.g. advanced environmental protection regulations) and population growth, the agricultural sector has to find new solutions to increase its efficiency and reduce its environmental impact (DPA, 2017; Tilman, Cassman, Matson, Naylor, & Polasky, 2002). Therefore, innovative concepts, in particular, interconnectivity solutions such as smart farming or precision farming are becoming progressively important. In Germany, this implementation of interconnectivity solutions is usually known as Industry 4.0[1] (Lee, Kao, & Yang, 2014), which is said to become the next revolution in production processes (Porter & Heppelmann, 2014).
However, the current problem of Industry 4.0 is that its solutions are still in development and their impact is not yet generally evident (Andersson & Mattsson, 2015), whereas in the agricultural sector, the Industry 4.0 solutions are already in use (Birlenberg & Schreier, 2017; Farm & Food 4.0, 2017a). Thus, impacts on the agricultural business are visible and will increase in the future (Fischer & Heidrun, 2017).

[1] The term Industry 4.0 was introduced by the German government and describes the influence of digitalization and Internet of Things on the manufacturing industry (Huber & Kaiser, 2017)

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1.2 Research goal

Due to the change from seller markets to buyer markets, it becomes more and more important for companies to divert their products. (Raddats & Easingwood, 2010). One way of diversification is the provision of services (Porter & Heppelmann, 2015). Manufacturing firms are increasingly focusing on offering solutions instead of selling products because the customer needs shifted (Akram, 2016). These solutions combine integrated products and services (Baines, Lightfoot, Benedettini, & Kay, 2009). It is not imperative anymore to develop the product with the highest quality; but rather the solution with the highest response to customers' unsatisfied needs wins (Fournier, 2005).

This is what service innovation is defined as: "the process of devising a new or improved service concept that satisfies customers' unmet needs" (Bettencourt, 2010: 19). Digitalization enables services to now being stored and transferred like goods. Due to these new qualities, the service sector is one of the fastest growing in the markets (Pajarinen, Rouvinen, & Ylä-Anttila, 2013). The customer relations and the entire value chain are changing as the value generated by the life cycle becomes more important for manufacturing firms than the value generated by sales (Akram, 2016).

Besides the customer relations and the value chain, the composition of service providers is also changing. The market volume of low skill tasks remains unchanged, whereas the medium skill task sector is decreasing, while the high skill task sector is expanding. The market for high skill tasks is connected to the trend of digital interconnectivity or Internet of Things (IoT) (Pajarinen et al., 2013).

This tendency to change is also detectable in the agricultural sector.

The result of Farm & Food 2017, one of the most important conferences for digitalization in the food and agricultural business, was that "digitalization of production- and life processes will open new ways of innovation in the next few years, [and] […] new horizons of human development will be reached"[2] (Deter, 2017: 1). One of these horizons could be *a world without hunger*. To achieve this goal, the limited space on earth has to be used more efficiently with a higher output of food which could be supported by digital solution inventions with smart connected products (Porter & Heppelmann, 2014; Roth, 2016; Tilman et al., 2002).

[2] Orginal:„*Mit der Digitalisierung von Produktions- und Lebensprozessen werden in den nächsten Jahren neue Tore der Innovation aufgestoßen, ja, neue Horizonte der menschlichen Entwicklung erreicht.*“

As illustrated, the interconnectivity in agricultural sector could solve one of the biggest human problems, but the practical influence of interconnectivity on business are not well studied yet. Therefore, a holistic view of the main changes are provided in this paper. As the services increase in their importance (Porter & Heppelmann, 2014) and as the research field has to be limited, the provided details lead to the question of this research:
"In which ways does digital interconnectivity influence service innovation in the agricultural sector?"

1.3 Structure of thesis

After presenting motivation (Section 1.1) and research goal (Section 1.2), the research question is explored based on an interview study approach. *Chapter 2* depicts service innovation that forms the theoretical background of the thesis. First, service innovation is described, before approaches of analysation of service innovation in the context of innovation theories are outlined, followed by showing the impact of digitalization and interconnectivity on service innovation. The last section explains product-service-systems and value networks for a better analysis of interactions in the network.
Chapter 3 illustrates the service-dominant-logic as a theoretical lens to ensure a holistic view on the topic. *Chapter 4* first outlines the data collection during the interviews, by justifying the adaptation of an interview study approach and then describes the way the data was collected. The second part of Chapter 4 explains the data analysis. After presenting the research object, the four findings are illustrated in *Chapter 5,* which are then analysed in *Chapter 6* by using qualitative methods and collected data including literature research.
Chapter 7 describes the implication on theory and management followed by the limitations of this study (*Chapter 8*). The thesis is completed by a conclusion in *Chapter 9.*

2 Theoretical background

This chapter provides the theoretical background of this thesis. After the description of service innovation itself, the approaches of service innovation will be analysed. This is followed by an explanation of the digital service innovation and its modification due to interconnectivity and the influence on the business model. The chapter is rounded up by the exploration of product-service-systems and value network.

2.1 Service innovation

In the 18th century, services were defined as unproductive labor, because it was not possible to store them (Smith, 1905). Melvin observed that there is no universally accepted definition of services (Melvin, 1990: 729) or, to say it with the words of Inman, "like beauty, the definition of a service activity is often in the eye of the beholder" (Inman, 1988: 4). In this thesis for the reasons set out below, the definition of Vargo and Lusch is used as the basic definition of services. They defined services as *"the application of specialized competencies (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself" (Vargo & Lusch, 2004: 2)*. The simultaneous production and consumption is one of the main characteristics of a service. Contrary to a product, which can be stored and consumed afterwards; a service such as an examination by a doctor, cannot (Crespi, Criscuolo, Haskel, & Hawkes, 2006; Hill, 1977).
The change of service definitions shows that the importance of the service has increased over the years. In 2004, Vargo and Lusch (2004) developed the Service-Dominant-Logic (S-D-L) (Chapter 3) which is a meta-theoretical framework to explain value creation through service exchange (value co-creation). This view was contrary to the existing assumption of that time that value is created by the production of goods (Vargo & Lusch, 2004). The S-D-L, with its influence on business models, was impetus for service innovation becoming independent of its big brother- product innovation (Andersson & Mattsson, 2015; Araujo & Spring, 2006; Maglio & Spohrer, 2008).
In literature, service innovation has many definitions. For this thesis, the definition of Bettencourt was chosen. He defined service innovation as "the process of devising a new or improved service concept that satisfies customer's unmet needs" (Bettencourt, 2010: 19). Den Hertog divided service innovation into six dimensions (Table 1), which can occur in combination or separately (den Hertog, Stauss, van der Aa, & Jong, 2010: 494).

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Table 1: Six dimensions to characterize service innovation adapted from den Hertog et al, 2010

Dimension	Content
Service concept/offering	• Way of solving a customer problem • Satisfying a customer need • Configuration of existing service elements
Customer interaction	• Interaction of service provider and customer • Role of customer in value creation • Involvement of customer in service innovation
Value system	• Involvement of business partners in co-production of service • Creation of new value system
Revenue model	• Harmonization of costs and revenues • Implementation of revenue model (especially by multiple actors)
Delivery system: personnel, organization, culture elements	• Design of organizational structures • Design of (inter)personal capabilities or team skills • Alignment of management and organization
Delivery system: Technological elements	• Implementation of technology to improve the service (production or use) • Realization of new interfaces or ways of delivering

If all dimensions are combined, its process is similar to business model innovation (Miles, 2012). Den Hertog et al. also identified that six dynamic service capabilities are able to support the process (den Hertog et al., 2010: 498):

- signaling user needs and technological options,
- conceptualising,
- bundling and unbundling capabilities,
- co-producing and orchestrating,
- scaling and stretching and
- learning and adapting.

2.2 Analysis approaches for service innovation

To understand service innovation as defined in the previous section, it is necessary to analyze its origin and its classification in innovation theory. Droege et al. (2009) identified different approaches of service innovation analysis (Droege, Baron, Hildebrand, & Heras Forcada, 2009): the demarcation approach, the assimilation approach, the technologist approach and synthesis approach.

2.2.1 Demarcation approach

The demarcation approach supposes that service and product innovation are too different to enable knowledge transfer (Droege et al., 2009). It focuses on the idiosyncrasies of services like intangibility and customer co-production (Fitzsimmons & Fitzsimmons, 2000), which affect the innovation process and differentiate services from product innovation (Nijssen, Hillebrand, Vermeulen, & Kemp, 2006). Knowledge transfer between product and service innovation research is desired by this approach (Faridah Djellal & Faïz Gallouj, 2005).
Limitations of the demarcation approach are:

- Unique characteristics of service innovation also apply to product innovation (e.g. costumer co-production) (DeBresson, Hu, Drejer, & Lundvall, 1997; Drejer, 2004; Ordanini & Parasuraman, 2010).
- “Modulization [of services] suggests a convergence between manufacturing and service organizations” (Love & Mansury, 2007: 4).
- Intangible attributes in products are not well studied (Drejer, 2004).
- Distinctive attributes of services are overrated (Drejer, 2004; Ordanini & Parasuraman, 2010).

2.2.2 Assimilation approach

For the assimilation approach on the other hand, Coombs and Miles (2000) compared service attributes to manufacturing attributes and found sufficient agreement to be able to adopt manufacturing theories, concepts and statistical measures to the innovation of services (Coombs & Miles, 2000). Differences between services and manufacturing can be explained through insufficient research in service innovation (Miles, 2012).

Limitations of the assimilation approach are:

- For non-technical service innovations the approach validity is limited (Drazin & Schoonhoven, 1996; Ordanini & Parasuraman, 2010).
- Idiosyncrasy of services is not considered (Akamavi, 2005; Grönroos, 2000; Ordanini & Parasuraman, 2010).

2.2.3 Technologist approach

In contrast to the first two approaches, the technologist approach connects innovation in services with improvements in the information technology and technological progress (Barras, 1986, 1990). Based on the “Lifecycle Theory” (Abernathy & Utterback, 1978), Barra developed the reverse product cycle model.
The cycle begins by process innovation and goes through different patterns until it ends with a completely new service (Barras, 1986; Gadrey, Gallouj, & Weinstein, 1995). This approach can be seen as the starting point of the service innovation research stream (Miles, 2006).

Limitations of the technologist approach are:

- Services are generalized (no differentiation of services in technical and non-technical) (Drejer, 2004; Salter A. & Tether B. S., 2006).
- It is assumed that the dominant influence of technology on service innovation is overrated (Gallouj, 2002).
- Distinction of process and product parts is difficult due to their similarity (Hipp & Grupp, 2005).
- For non-technical service innovations, the approach validity is limited (Salter A. & Tether B. S., 2006).

2.2.4 Synthesis approach

Gallouj and Weinstein (1997) tried to offer an integrative approach for both (services and products) with no excluded manufacturing elements for service innovation (Drejer, 2004; Faïz Gallouj & Olivier Weinstein, 1997). All kinds of innovation are treated with the same importance because all of them enable organizations to innovate. Moreover, this approach is practicable for technical and non-technical innovations. It allows to create empirical and theoretical approaches by mirroring all economic activities equally (Love & Mansury, 2007). The synthesis approach reflects the actual trend of blurring the borders between service and manufacturing (Miles, 2012).

Limitations of the synthesis approach:

- Service and manufacturing innovations are too complex to be substitutes (Evangelista & Sirilli, 1998).
- Differences between service and manufacturing industries are still higher than in theory (Preissl, 2000; Rubalcaba, 2006).

2.2.5 Choice of approach

Regarding the digital service innovation, the synthesis approach is most suitable for this study because it allows using product and/or service innovation knowledge to observe the influence of digital interconnectivity on service innovation.
This is necessary because, especially in the digital sector, the boundaries between products and services blur, ending in a hybrid nature (Drejer, 2004; Yoo, Henfridsson, & Lyytinen, 2010a). Furthermore, it is perfectly harmonizing with S-D-L as theory lens as both approaches are strongly linked (Jonas, 2018).

2.3 Digital service innovation

The influence of digital technology on service innovation by empowering new services through digitalization of non-digital artefacts is described in the following.
The integration of digital technology into physical products enables the provision of digital services, this intertwinement is typical. Several authors observed that new digital services are based on new combinations of digital and physical components. Their realisation is defined as digital innovation. In the case of a service, it is called digital service innovation (Lusch & Nambisan, 2015; Yoo et al., 2010a).
The digitalization of originally non-digital artefacts is an important stimulus as, for example, tractors for farming became smart products with embedded systems. The digitalization can be classified into three evolutionary waves of digitalization (Yoo et al., 2010a; Yoo, Lyytinen, Boland, & Berente, 2010c).
In the first wave, the digitalization of analogue services and content took place without any fundamental changes in business. Digital services provide the same content as their non-digital twin but with reduced cost and only some small changes.
During the second wave, the disjunction of digital devices, networks, services, and contents that were originally firmly linked, eliminate traditional boundaries of industries. Digital service providers were now in competition with more opponents, but could easier provide their products to other markets.

The third wave is defined by the ability to mesh-up different product attributes across different architectural boundaries to create an infinite amount of innovation possibilities for products, services or technologies.

Digital products have increasingly diverse capabilities, which open the way for new business opportunities or models.

Digital products and services have a combination of modular and layered-modular architecture of digital technology (Adomavicius, Bockstedt, Gupta, & Kauffman, 2008; Yoo et al., 2010a). This architecture has four layers: device layer, network layer, service layer or application layer and content layer (Benkler, 2010; Yoo et al., 2010a; Yoo, Lyytinen, Thummadi, & Weiss, 2010b).

The device layer is the bottom layer and consists of hardware and the operating system. The network layer manages connectivity (wireless and wired), while the service layer, also called application layer, is the user's interface. The user can store, manipulate and create content through the service layer. The top layer, called content layer, includes contents like texts, sounds, images.

The digitalization of non-digital artefacts loosened the tight coupled layered architecture and made it applicable to earlier non-digitalised artefacts like tractors (Yoo et al., 2010a). Additionally, the particular architecture of digitalized artefacts obtains different materiality properties (Yoffie, 1997). They are set out in Table 2.

Table 2: Seven material properties of digitalized artefacts adapted from Yoo et al., 2010c; Yoo et al., 2010b

Name	Description
Programmability	The ability of the digitalized artefact to modify its behavior gets the digitalized artefact through the integration of the programmable digital architecture, thus the object becomes malleable (ITU, 2005).
Addressability	The ability of the digitalized artefact to be unambiguously identified within an ordinary context.
Sensibility	The ability of the digitalized artefact to perceive changes in its environment and to makes it context aware (Dourish, 2001).
Communicability	The ability of the digitalized artefact to use any digital communication.
Memorizeability	The ability of the digitalized artefact to record and store information.
Traceability	The ability of the digitalized artefact to chronologically identify, memorize and interrelate gained information.
Associability	The ability of the digitalized artefact to be related and identified to other entities and allow conclusions about future states and conditions.

These properties permit digital interconnectivity between the artefacts. Digital service innovation can be seen as a result of the digitalization of the products (Akram & Åkesson, 2011). This allows analsing digital service innovations using six dimensions of the digital innovation (Table 3) (Yoo et al., 2010b:p 25).

Table 3: The six dimensions of characteristics of digital innovation adapted of Yoo et al. 2010b

Dimension	Description
Convergence	The homogenization of digital data enables the combination and re-combination of heterogeneous artefacts as devices, networks, services and contents. Thus, it allows building previously unforeseen combinations. Through convergence, products became digital platforms for new digital services as for example the digitalization of cars with its ability to collect the data of the driver's behaviour (Henfridsson, Yoo, & Svahn, 2009). By connecting previously unconnected communities and their technology through digital convergence, the flow of know-how in this network will open new space for digital service innovations (Berente, Srinivasan, Yoo, Boland, & Lyytinen, 2007).
Digital materiality	The integration of digital materiality into the product creates new architectural control points. These interfaces allow to control the flow of information for new innovations. The integration combined with the loose relationship of digital components makes the control of information complicated, which on the other hand enables new innovations (Benkler, 2010; Yoo et al., 2010b).
Generativity	Through the ability to innovate digital innovations, the level of generativity increases by creating new products, services, and content without considering the original purpose or the original creator of the technology (Yoo et al., 2010c; Yoo et al., 2010b; Zittrain, 2006). Generativity has three dimensions (sources) – technological, organizational and business dimension. The technological dimension is based on the agility of the modular architecture and the loose coupling between the layered architecture. The organizational dimension is based on a person's or organization's ability to innovate (Brusoni, Prencipe, & Pavitt, 2001) and the business dimension is based on the ability of business models or value models (Chesbrough, 2007).

Dimension	Description
Heterogeneity	The combination of data and resources in unpredictable ways leads to heterogeneity. The level of heterogeneity can be controlled through architectural control points. If a critical element of the architecture is controlled by one firm, the heterogeneity of the innovation network decreases (Yoo et al., 2010b). The combination of heterogeneity and generativity supports the unrestricted expansion of innovations (Arthur, 2009).
Locus of innovation	The reduced communication costs enable the participation of distributed and previously non-connected actors. The layered architecture enables independent innovation trajectory at the different layers. The innovation activities increase toward the periphery of the innovation network and encourage innovation forms as crowdsourcing and open innovation (Yoo et al., 2010b).
Pace	Due to programmability and convergence innovation cycles increase their frequency. The digital architecture also increases innovation through recombination and the common digital infrastructure enables quicker distribution of the innovation activities (Yoo et al., 2010b).

These dimensions are characteristics of digital innovation during the third wave of digitalization by assuming the established four layers and the increasingly loose coupling between them. These dimensions interact and reinforce each other to increase, in an ongoing cycle of digitalization, the complexity and dynamism of the innovation outcomes and process.

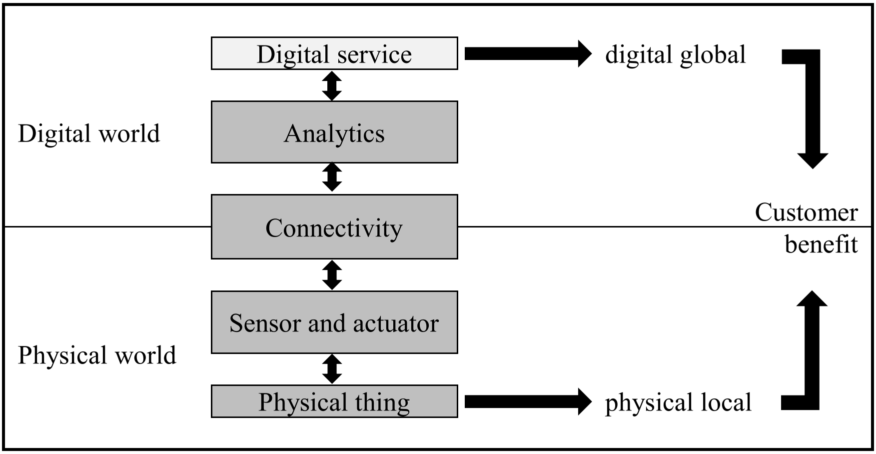
Generativity is seen as the main driver of digital service innovation and influences the value creation in the respective sector. For example, embedding digital sensors into artefacts is associated with generativity. The collected data can be used to design new services, which were not intended when implementing the sensor. An example, therefore, is the provision of predictive maintenance by implementing sensors in machines, which measure the health status. As mentioned above, digital services are often the result of the digitalization of products. Digital services adopt the following characteristics through digitalization: remoteness, heterogeneity, continuous exchange of tangibles, computing capabilities and materiality properties (Yoffie, 1997; Yoo et al., 2010a; Yoo et al., 2010b).

The involvement of information, communication technologies and digital products enables digital services to take on product characteristics such as storability and separation of production and consumption (Jonsson, 2010), which enables the automatization of production of the services. This automatization supports the decrease or elimination of service provider's direct involvement (Akram & Åkesson, 2011).
As an example serves the car business, where sensors measure the health status of the vehicle and transfer this data to a server. An algorithm analyses the automatically collected data and provides the owner with the result via a mobile application. There is no direct involvement of the service provider. If required, the service provider can access the program directly at the digitalized artefact and provide a personalized service by using real-time data of the device (Jonsson, 2010; Yoo et al., 2010c). The use of information and communication technology (ICT) in services is one of the key activities of the service innovation (Edvardsson, Gustafsson, Sandén, & Johnson, 2000). Furthermore, it allows the development of new service concepts (Zeithaml & Bitner, 2000) and the redesigning of existing services (Berry & Lampo, 2016).

2.4 Digital interconnectivity: its influence on service innovation

The next step of digital innovation in technology is the Internet of Things (IoT). This kind of digital innovation opens up new dimensions of the service innovation. The implementation of information technology is also changing the value creation stages as shown in Figure 1. The value creation process is bidirectional and can be seen as an integration of the digital world into the physical world. Due to the integration of IT from the second to the fourth level, the customer benefit increases on the fifth level. This increase is evoked by the addition of extra services, functions or better service quality (Fleisch, Weinberger, & Wortmann, 2015).
Presence sensors in LED-Lights can serve as an example for the value creation process. These LED-lights are used to save energy, but can also be used as security devices as they are able to detect burglars due to unwanted use. Consequently the user benefit increases (Fleisch et al., 2015). Thus, the attention on performance and utilization of the product gains importance instead of product properties. This is the connecting point to the digital innovation logic of Yoo et al. (Baines et al., 2007; Yoo et al., 2010a).

Figure 1: Value creation stages on an IoT solution adapted from Fleisch et al., 2015



2.5 Digital interconnectivity: its influence on business models

In the past, digitalization has influenced business models, an example for the first wave of digitalization (Section 2.3) is the e-commerce business or, for the second wave, crowdfunding and crowdsourcing (Fleisch et al., 2015; O'Reilly, 2005). In the third wave, the influence of digitalization became visible in the mesh-up of different attributes across different product architectural boundaries. Fischer at al. (2015) identified six digital add-ons for existing business models (Fleisch et al., 2015: pp 455–457). These add-ons, presented in Table 4, are independent of sectors and will be used in this research paper to identify the influence of digital interconnectivity on the interviewees' business models.

The add-ons in Table 3 describe the combination of physical products and digital services to a hybrid solution, enabled by IoT or interconnectivity. The add-ons are applicable to business models regardless of the complexity, origin (service offered by the product provider or third party) or the value creation of the services (linked to product or off-context). The combination of elements enables two specific business models for IoT: digital charged products and sensor as a service.

Digital charged products originate as physical products. Due to the implementation of sensors the product has new value propositions.

Sensor as a service has the same origin as "digital charged products" but the focus is on the generated data itself. The data flows into multi-sided markets that serve as a basis for various applications (Fleisch et al., 2015).
In summary, the implementation of digital interconnectivity has influenced business models in all industries. The combination of products and services are called product-service-systems (PSS).

Table 4: Digital add-ons of existing business models adapted of Fleisch et al., 2015

Add-ons of existing Business Model	**Description**
Physical Freemium	Sale of a physical good with a complimentary digital service which is connected to the good, like digital montage, manual or maintenance. In addition, a premium service is offered, like remote monitoring, to generate more revenues(Fleisch et al., 2015). Example: Dropbox, which offers a free data storage, for extra storage the customer has to pay (Peterson, 2018).
Digital add-on	Sale of a physical good with a low margin with option to buy additional digital services (high margin). This additional service could be also offered by third parties (Fleisch et al., 2015). Example: Audi, which will offer a temporary PS-boost for a car for several hours (cst, 2016).
Digital lock-in	A digital or physical platform is only compatible with certain elements. The digital compatibility is guaranteed by a digital handshake of physical goods. Competitors are locked out for example by the use of patents or warranty cuts (Fleisch et al., 2015). Example: Printer manufacturers shorten the warranty, if the customer uses ink cartridges which were not certified as original equipment (Yue, Mukhopadhyay, & Zhu, 2006).

Add-ons of existing Business Model	Description
Product as point of sale	Use of a product as carrier for sales or marketing services, which can be consumed in the product or by using digital devices (Fleisch et al., 2015). Example: Amazon's Echo, which enables the customer to order goods from Amazon via voice-recognition (Kamiwada, Imai, Kanaoka, & Take, 2017).
Object self service	Ability of enabling a good to order products autonomously. The direct selling allows to exclude intermediary and supports solution provider's business models (Fleisch et al., 2015). Example: Washing machine manufacturer Whirlpool enables his machines to automatically order detergents from Amazon (DPA, 2016).
Pay per use	Sale of the actual usage of a product. Due to IoT remote usage and condition monitoring need fewer resources and become profitable for inferior solutions. Essential for this business model is the data transmission to the supplier via internet (Fleisch et al., 2015). Example: The carsharing service Drive-Now, where the user only has to pay if he uses the service (Winkelhake, 2017).

2.6 Product-service-systems

Product-service-systems and their influence on competition are laid out in the following.
Customers are becoming more interested in solutions than in buying products or services (Chesbrough & Rosenbloom, 2002). This and the implementation of information technology supports manufacturing firms to expand their business by providing services next to their core business.
This is called servitization[3] (Akram, 2012).

[3] Servitization is defined as the shift from selling products to providing values in use by an strategic innovation on organizations capabilities and processes (Leseure, Martinez, Bastl, Kingston & Evans, 2010). In contrast to service innovation, servitization describes a strategic transformation of a company towards the

One phenomenon of servitization is to offer PSS, which are assembly combination of product and service, to better satisfy customer needs (Goedkoop, van Halen, Te Riele, & Rommens, 1999). From a S-D-L perspective, PSS enable the optimal configuration of material and non-material resources to co-create value within the value network (Smith, Maull, & Irene, 2014). This triggers changes in competition and value creation within industries. PSS are expanding the industry boundaries by focusing on a bundle of products and services rather than on a certain product (Eaton, Elaluf-Calderwood, Sorensen, & Yoo, 2015; Porter & Heppelmann, 2014).

For example, in the past, tractors were just in competition with other tractors. By implementing sensors and connectivity devices into the physical product tractor, the layer architecture changes and so does its generativity. Due to telemetry on the tractor, it can interact with other farming devices such as harvesters or drillers (CLAAS KGaA mbH, 2017). By connecting devices, their cooperation can be optimised and additional value is created. The tractor becomes a part of a farm equipment system. This shifts the basis of competition from a particular artefact to a competition for a broader product system in which, for example, the tractor forms only one part of the competition itself – the focus of competition spreads. Companies are not only competing by manufacturing single devices anymore. They are now competing regarding the performance of entire farm equipment systems.

Thus, the boundaries of the tractor industry expand to those of a farm equipment industry. By integrating weather stations, irrigation systems, soil and nutrient sources with data on stock prices, other weather data, vermin information and self-learning algorithms, the boundary of competition expands to entire farm management systems (Porter & Heppelmann, 2015). Through the change of competition, the way of value creation changes. Also, these PSS are often enabling co-creation of value with their customer (Möslein & Kölling, 2007).

Additionally, digital innovation increases the opportunities for value creation and enables value co-creation with other actors of the same network (Eaton et al., 2015; Porter & Millar, 1985).

2.7 Value network

As shown, PSS will change the competition, so that the way of value creation will also change. This chapter will define value networks to explore these changes and, in literature, value networks are an important source of innovation. In contrast to innovation networks, value networks commercialize and realize the inherent value of an innovation (Vanhaverbeke & Cloodt, 2006).

In S-D-L, all economic interactions are realized within an actor-to-actor network. A value network is "any set of roles and interactions in which people engage in both tangible and intangible exchanges to achieve economic or social goods" (Allee, 2008: 6). These networks consist of three main elements: roles/actors, exchanges and relations. To understand these networks, it is important to comprehend the intensity of relationships between the network and their combination with roles (Basole & Rouse, 2008; Peppard & Rylander, 2006). The generated value can be measured in value currencies which are goods, services, revenues and intangible benefits (Allee, 2000a, 2000b) including knowledge (Akram, 2016; Allee, 2008).

Roles and actors as one of the main elements are identified as sources of innovation and dynamicity.

Furthermore, Allee ascertains that intangible benefits, such as knowledge, have the same importance as tangible currencies (Allee, 2008).

The mechanism of exchanges or the medium transfer the value of the network to the actors (Allee, 2000a, 2000b). Relationships are influenced by actors' business models. They describe the information about the customer segment and the structures of value creation and capturing value (Chesbrough & Rosenbloom, 2002). Value networks are multi-layered and consist of linked networks of systems (Akram, 2016; Christensen & Rosenbloom, 1995).

In this paper, no classification into straight producers and consumers of value will be made, according to the S-D-L lens (Lusch, Vargo, & Tanniru, 2010). Digital innovation or digitalization influences the structure of the value network, such as the roles in the network and the relationships of an innovation process. The integration of physical artefacts into the digital world by sensors and actuators via real-time expands possibilities for value creation (Fleisch et al., 2015) and the interconnection between the value networks. As shown in Section 2.4, smart connected devices set new boundaries for industries or competition.

This predicts new participants and roles in the value network; furthermore, the company's value networks diversify and can become part of the value network for manufacturing, parts manufacturers, and maintenance service providers at the same time. The company has diverse roles, business models and relations within the different networks. Nevertheless, this diversity of business approaches can cooperate and build on one another. Compared to a product-oriented industry, the dynamic of the value network increases, by changing exchanges and relationships in the value network. (Akram, 2016).

The recommendation of Maglio et al (2009) and Alter (2011) for a an abstraction of service systems was not taken, due to the desired holistic view on the research topic and regard on the interactions of the sector via value networks (Alter, 2011; Maglio, Vargo, Caswell, & Spohrer, 2009).
Consequently, due to interconnectivity the importance of service innovation increases in industry. Also, interconnectivity is empowering new business models and the offering of PSS.

3 Service-dominant-logic

After the introduction of the theoretical background, this chapter describes the theoretical lens used to look at the provided theory.
As interconnectivity may influence all players in the agricultural sector, there is a need for a network centric view on players' exchanges. To achieve this view S-D-L for the following reasons. Firstly, the position of this view is ensured in the use of S-D-L. Secondly, S-D-L completes the synthesis approach and allows a generalized perspective. Thirdly, the focus of service innovation lies on performance and utilization, this is similar to the S-D-L of Vargo and Lusch. Furthermore, S-D-L can be used to describe value creation in the digital service innovation, which is necessary to explore the influence on the agricultural sector (Lusch & Nambisan, 2015). The value of the S-D-L is generated by the exchange of services and skills in co-creation with the customer. When introducing the S-D-L, Vargo and Lusch presented nine fundamental premises. In 2008, they modified these premises (Table 5) and added an additional one (Vargo & Lusch, 2008: 7).

Table 5: Fundamental premises of S-D-L adapted from Vargo & Lusch, 2008: 7

FP	Description
FP1	Service is the fundamental basis of exchange.
FP2	Indirect exchange masks the fundamental basis of exchange.
FP3	Goods are distribution mechanisms for service provision.
FP4	Operant resources are the fundamental source of competitive advantage.
FP5	All economies are service economies.
FP6:	Customer is always a co-creator of value.
FP7	A service-centred view is inherently customer oriented and relational.
FP8	A service centred view is customer oriented and relational.
FP9	All social and economic actors are resource integrators.
FP10	Value is always uniquely and phenomenologically determined by the beneficiary.

The, customer co-creation described in FP6, can be separated into two dimensions: co-creation and co-production.
Co-creation describes the overlap of offer and demand; thus, the offer meets the customer's needs and generates value through consumption.
Therefore, the customer has an active role due to the determination of the value-in-use.

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The second dimension, co-production, labels the customer's participation in the core offering itself (Allee, 2008; Bruhn & Stauss, 2009). This could be the "shared inventiveness, co-design, or shared production of related goods and can occur with customers and any other partners in the value network" (Lusch & Vargo, 2006: 284).

The generated value is individually rated through the customer by the actual value of use, contrary to the goods centered logic. Therefore, the S-D-L focuses on process and activities. S-D-L describes a constant relation between provider and customer (Vargo & Lusch, 2004; Vargo & Lusch, 2008). An isolated change of resources, like discrete transactions, is nearly impossible, but the used resources can be separated in operand and operant resources. Operand resources are the platforms for activities or operations to produce an effect and are used without any further modification, for example, raw materials. Intangible operant resources, such as work, are acting on operand resources and other operant resources (Vargo & Lusch, 2004). For example, the customer's ground is an operand resource which is changing through the collaboration of other resources (work, seeds, machinery) into a sunflower field. This collaboration generates know-how, experience and consequently value. Adding complementary information and resources, provided by information technology, the potential for the added value of a service increases (Bruhn & Stauss, 2009).

To conclude, the S-D-L lens permits a holistic view on the agricultural sector by not differentiating between product and service innovation (Lusch & Nambisan, 2015). After the demonstration of the research design the research question (Section 1.3): *"In which ways does digital interconnectivity influence service innovation in the agricultural sector?"*, is answered by having in mind the four meta theoretical foundations of the S-D-L in service innovation: actor-to-actor-networks, resources liquefaction, resources density and integration of resources (Lusch & Nambisan, 2015).

4 Research design

To define, the research goal of this paper, the influence of digital connectivity on service innovation in the agricultural sector an interview study approach was used. This chapter explains the organization of the analysis. The discussion about the choice of qualitative research is followed by a presentation of the approach of data collection which will be analyzed in the end.
The choice of the right research methodology is a delicate choice. Variables like know-how, research duration, resources and high level of scientific evidence have to be balanced. (Flick, Kardorff, & Steinke, 2008a). The reasons for choosing qualitative methods is discussed and justified at the end of the chapter.

4.1 Data collection

The way of data collection is shown in the following. First, the choice of a qualitive method is discussed, followed by the explanation of interview studies as research approach. After presenting the interview structure, the choice of interview partners is explained, and concluded by the illustration of the interviewing process.

4.1.1 Qualitative research methods

In order to discover and measure of the influence of interconnectivity on service innovation, the use of a quantitative method is not suitable for this research. As numbers, statistics or random samples cannot be used to analyse this occurrence (Auer-Srnka, 2009; Silverman, 2006), the use of a quantitative method was not favoured. Qualitative methods have the advantage that they offer the opportunity of getting a deeper insight into the research topic with the intent to focus on the individual and to concentrate on the words, opinions, and experience presented in the interviews (Mayring, 2003).

Additionally, qualitative methods allow to analyse people's experiences in their context to the provided information to offer a applicable answer to the research question (Flick, Kardorff, & Steinke, 2008b). The weaknesses of qualitative methods, e.g. reliability and validity, do not carry a lot of weight, as the aim is to understand and explore the presented research goal and its context (Bryman, 2008).

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The missing reliability and validity of qualitative methods are caused by the limited generalization of the case, which is provided by the random choice of samples and the personal involvement of the researcher. Reliability in science is an important good and in order to improve it, Silverman proposes certain measures. The following advices are used in this thesis (Silverman, 2006):

- Describing the process of research and choice of theory transparently;
- Transcribing and voice recording the interviews to get access to concrete observations during, for example, an interview;
- Using an interview guide to raise reliability.

The validity of this thesis is grounded on accurately measuring only the important information (Silverman, 2006). The quality of the process of designing and conducting the research, defines its validity and it can be improved by giving examples (Lampard & Pole, 2002). As deductive approaches are restrictive and do not allow for the examination of certain topics, the thesis is mostly analysed by an inductive approach. Saunders, Lewis, and Thornhill (2016) recommend setting a light framework for inductive approaches to get an overview and detect the main components and variables of the research project (Saunders, Lewis, & Thornhill, 2016: 570 et seq.). This advice was realized in this thesis. Furthermore, the authors mentioned that, in practice, components of both approaches are combined (Saunders et al., 2016). Consequently, the theoretical framework of this thesis is service innovation and the S-D-L.

4.1.2 Interview study approach

Due to the provided flexibility in the research frame work and the possibility to gain in-deep knowledge in a rather comfortable atmosphere for the participant, an explorative interview study approach with a semi structured-interview guide was selected. Accordingly, for the selection of interviewees the snowballing-method was used (Miles, Huberman, & Saldaña, 2014).

For acquiring interview partners, it can be beneficial, that interviews are a familiar research method as they are the most known part of qualitative data collection (King, 2004). Besides, the open-end style of interviews enables the researcher to identify unknown types of influences on service innovation and not to just justify general beliefs (King & Horrocks, 2010).

The focus on understanding the perspective and experience of the interviewee in relation to the research question facilitates identification of the general influence of digital interconnectivity (King, 2004).

Qualitative interviews vary from semi-structured to unstructured (Reinders, 2011: 88). Semi-structured interviews seem to be the most fitting qualitative method for this research project because of the small sample and the goal of getting rich and in-depth data of the agricultural sector (Lampard & Pole, 2002; Yin, 2009). Furthermore, they guarantee a certain orientation and coverage of important topics by using an interview guide. Additionally, the incomplete structuring allows to treat and deepen individual experiences and opinions (Lampard & Pole, 2002; Silverman, 2006). One limitation of an interview is the influence of the particular interview situation and the social relation between the interview partners (Lampard & Pole, 2002).
As the positive aspects outweigh the negative ones an explorative interview study approach was chosen. The case study approach or an interview study approach with expert interviews was considered but not selected due to its limiting attitudes on potential interview partners. The recognition of experts in this sector is very extensive and was avoided by applying the snowballing method. Nevertheless, it is recommended that the chosen interviewees have the same deep knowledge and overview of the topic as experts.

4.1.3 Interview structure

The interview is structured by an interview guide. This guide is used to support orientation during the interview and to guarantee that all areas of research are covered. Therefore, the prepared questions are separated into main topics. However, for this paper, the order was only taken as advice during the interview process as it is more promising to not interrupt the fluency by following a certain structure of interview (Patton, 2002). The interview language was, if possible, German to avoid misunderstandings and to profit from sharing the same mother tongue in addition to better non-verbal communication (Sauerbier, 2011). The interview guide was modified eight times during the data collection, due to the following reasons: adaption on the type of interview partner (company or association); need for deeper information about a topic and translation of the interview guide.

4.1.4 Choice of interview partners

The main goal of the interviews was to get inside information about how digital interconnectivity influences the service innovation in the agricultural sector, which depends highly on the choice of interview partners.
The sampling in qualitative studies does not aim to be statistically representative but intends to be able to generalize and to be transferable. For this purpose, it is not indicated to use an entirely provisional opportunistic sampling strategy. The sample has to be related to the systematic manner of the observed environment (King & Horrocks, 2010). The most common, recommended criterion for sampling strategies is diversity. It enables a multiple-view on the problem at stake by collecting different experiences in the observed environment for a better understanding and generalization of the targeted problem. Matthew et al. (2014) and Merkens (2008) advise to increase the diversity and the perspectives on the regarded problem by also sampling the peripheries of the observed environment (Matthew, Huberman, & Saldana, 2014: 36; Merkens, 2008: 291).

Due to the small sample size in qualitative studies, it is important to get information which is efficient and also rich on content as in purposeful sampling (Palinkas, Horwitz, Green, Wisdom, Duan, & Hoagwood, 2015). Therefore, it is important to identify and select interview partners, which are very knowledgeable about or experienced with the observed phenomenon (Creswell & Clark, 2011). The availability, ability and the willingness of sharing information are desired point for choosing interview partners (Bernard, 2006; Spradley, 1979). Besides, the pool of possible interview partners is limited due to the wish of the interviewer to conduct the interviews in person with German as the preferred interviewing language. Consequently, the choice is limited and focuses on a particular homogenous group of people. As a result, snowballing is the most suitable sampling method which is explained in the following. Snowballing focuses on similarities between the interviewees such as being part of the agricultural sector, having deep knowledge of service innovation and digital innovation. In order to choose the right starting points and to ensure an optimal choice of interview partners, criterion-I-sampling will also be implemented in the sampling processes. Criterion-I will be deep knowledge of the digital connectivity of the agricultural business (Palinkas et al., 2015).
In order to follow the advice of Merkens and Matthew et al. (Matthew et al., 2014: 36; Merkens, 2008: 291) and to increase the author's inside knowledge, the starting points for snowballing are set in the peripheries of the agricultural sector.

The two starting points are two lobbying associations in the agricultural sector, these were chosen due to their high accessibility, the good overview and their networking in the agricultural sector. However, criterion-I of having deep knowledge of digital connectivity is partly satisfied as their associations only affect the peripheries of the agricultural sector. Regarding the fact of using the starting points also as a test for the interview guide and introduction to the sector, lobbying associations are suitable partners for the first interviews.
Table 6 sets out the complete overview of interviewees by showing their position and type of organization. Their names and the names of the organizations have been anonymised according to an arrangement with the participants. The column type describes the type of organization: associations (A), companies (C), and start-up (S).

Conduct describes the medium of communication: in person (P) and via telephone (T). Citations of the interviewees are translated from German to English and quoted with the number of the interview and type of association.

Table 6: Overview of interviewees and data collection

Nr.	Code	Organization and position	Type	Duration
1	1A	Lobbying associations, manager of digital affairs	A	27:21
2	2A	Lobbying associations, two managers of digital affairs	A	71:58
3	3C	Trade association for agricultural goods, CEO	C	22:10
4	4S	Start-up agricultural sector (digital connectivity machines), sales manager	S	27:37
5	5C	Trade association for agricultural goods, digital manager	C	61:57
6	6S	Start-up agricultural sector (indoor farming), sales manager	S	22:23
7	7C	Machinery manufacturer, manager for service development	C	21:40
8	8C	Machinery manufacturer, sales manager	C	39:16
9	9S	Start-up from IT supplier company, CEO	S	18:22
10	10S	Start-up agricultural sector (digital connectivity machines), CEO	S	23:38
11	11C	Company for digital connectivity machines); sales manager	C	28:42
12	12C	Machinery manufacturer, product manager electronics	C	41:55
13	13S	Start-up agricultural sector (digital connectivity machines), CEO	S	24:11
14	14A	Agricultural university (scientific assistant)	A	30:47

The variance of interviewed associations was high. It ranged from young companies, such as start-ups (youngest 6 months), to established companies with over 180 years of history and from digital firms to machinery manufacturers to associations, which had an overview over the agricultural business.

Further information on the interviewees cannot be provides for confidentiality reasons. The high variance enabled a precise overview of the sector without missing a general perspective.

4.1.5 Interviews conduction

All interviews were recorded via audio recorder. Nine of fourteen interviews were held in person, mostly in the offices or meeting rooms provided by the interviewee. The missing five interviews were carried out via telephone. The calls were recorded as a back-up via a phone application. All recordings were started after getting the permission of the interviewees.

4.2 Data analysis

Due to the requirement of qualitative methods to ensure accountability and avoiding incomprehensibility, the following chapter presents the transcription, then the analysation follows (King & Horrocks, 2010).

4.2.1 Interview transcription

The interviews were registered by using an audio recorder. To transform the audio files into usable research input, they were transcribed by using the commonly used software f4. For a better accountability, the interviews were fully transcribed verbatimly by considering the advices of King and Horrocks (King & Horrocks, 2010: 143–149). The transcripts were entered in the process of data cleaning, the word files reviewed for mistakes by the author and then sent to the interviewees. The interviewees checked the transcripts for mistakes or misunderstandings as it was part of the agreement between the interviewer and the interviewees. Some interviewees would not have accepted an interview without the chance of proofreading their interviews.
The whole process of data collection and analyzing was carried out by the same person which provides serval advantages such as understanding the non-verbal communication, knowing the context of a term and becoming acquainted with the collected data (Langdridge, 2004; Saunders et al., 2016).

4.2.2 *Qualitative data coding*

To extract qualitative data from the collected data, the collected data was simplified and summarized through coding. The use of MAXQDA (commonly used software for data analysis) increases the transparency by supporting a systematic approach. The coding procedure was a thematic analysis (King & Horrocks, 2012), which has three stages: descriptive coding, interpretive coding and overreaching themes.

In the first step, relevant material was identified and categorized with descriptive codes. The following step clustered these codes and linked them with the research question. The codes were modified into interpretive codes. Lastly, by considering practical and theoretical viewpoints, key themes were extracted. For better understanding and overview, they were put in a hierarchical order. After every stage, the results were checked for quality and clarity (King & Horrocks, 2012) and for a better overview, the number of codes was limited to a maximum of 30 (Saunders et al., 2016).

4.2.3 *Conclusions draw and test*

As mentioned before, for a qualitative data analysis, it is important to ensure reliability and validity. This applies especially in this step of analysis, which is supposed to be very influenceable by the author's opinion. To reduce this influence, the propositions were tested against alternative explanations and negative cases. The verification or declination of a conclusion was supported by literature research (King & Horrocks, 2012). Due to the propositions of Miles et al (2014) to increase reliability, objectivity, internal and external validity and utilization were applied (Miles et al., 2014: 311–315).

4.3 Agricultural sector

After defining the framework of the thesis, the prospected research field is chosen, described and specified due to its wide range and the limited resources.
Digital interconnectivity has a lot of presence in the media due to the buzzword Industry 4.0, but this term constitutes rather a vision (Bube, 2015). This is different for the agricultural sector, because digital interconnectivity applications actually are in use and have higher implementation rates as in other industries (bitkom,

2016; Friedli et al., 2015; Rohleder & Krüsken, 2016). This was the reason for choosing the agricultural sector for this research project. Additionally, with its revenue of 50 billion € in 2016, the agricultural sector is of high economic importance. The sector consists of the following subsectors (Bundesministerium für Ernährung, 2016): arable farming, animal husbandry, viticulture, orcharding and horticulture.

In their article *How smart connected products are transforming competition* Porter and Heppelmann (2014) explained the influence of digital interconnectivity on businesses by using the agricultural tractor business as an example.

They showed that the competition a tractor company has to face increases through digital connectivity from other tractor companies as competitors to all players in the farm automatization industry. Based on their finding, the approach to answer the research field was developed. Thus, the farm automatization industry was identified as the main provider of digital interconnectivity in the sector.

To determine the influence on the sector, it is helpful to evaluate the provider's influence on the agricultural sector. The following players with influence on the sector were recognised: machinery builders and farm management system providers (Porter & Heppelmann, 2014). To gain a differentiated view of the topic, retailers were equally considered. Farmers and agricultural contracting business were not taken into account, due to their relation to the above-mentioned players. The farmers and the contracting businesses are consumers of the goods of the farming automatization systems.

The retailers are providers of the goods of farm automatization goods or services, and, as they also offer solutions, they are also competitors. Another reason for excluding the farmers from the interviews is their strongly divergent appearance regarding size and ownership models. The size varies mainly from 5 ha up to more than 1000 ha, also the size of the average farm depends on the federal state. For example, the average farm in Baden-Wurttemberg has 31 ha and is a sole proprietorship. In Mecklenburg-West Pomerania however the average size is 286 ha and owned by corporation (Gurrath, 2011).

To target the agricultural technology, the focus of this research project was put on the arable farming sector because machinery is used the most in this sector.

Thus, the biggest number of innovations involving digital connectivity are made (The economist, 2016). The other sectors were not excluded, but no interview partners were explicitly searched for in these sectors due to the limited resources.

In agricultural media, the joining of digital interconnectivity and agriculture is called digital farming.

This is influenced by Industry 4.0 that includes the use of sensors, machinery connectivity, precision or smart farming and robotics to increase efficiency, to connect and to automate the production process of agricultural goods (Clasen, 2016; Hemmerling & Pascher, 2015). The three main topics of agricultural technology in the present are (Schmitz, 2017):

- Precision farming with its roots in the 90s. The term describes the subarea cultivation of plants on the field while optimising the growth via sensors and technology;
- Smart farming meaning the support of decisions via fusion and analysation of information[4] and
- Farming 4.0 implementing Iot, cloud computing and big data into the farming business.

The application of digital farming in practice has developed the following solutions like digital field impact files, documentary software, farm management software, yield mapping or automatic steering systems with GPS connection. Every second farm in Germany uses digital farming solutions (Gandorfer, Schleicher, Heuser, Pfeiffer, & Demmel, 2017).
In this thesis the following terms are limited to the following meanings. The term *machine manufacturers* is used to describe arable farming machines manufacturers. They produce machines and relating equipment like tractors, harvester or sprayers. The term *farm automatization providers* however is limited to the providers of platforms for farm management. Providers, which are only enabling the digitalization of goods like steering systems, tire pressure control were not taken in account. It seemed more important to focus only on actual platforms as Farmdoc, 365Farmnet, Farmedge etc. These platforms provide farm management tools like the automated drawing of field records or are facilitating the legally-required documentation reports for plant protection and fertilisation.

[4] In an IT-context, the terms data and information can be seen as similar (on a high abstraction level) (Stenmark, 2002).

5 Findings

This study aim is to analyse the influence of digital interconnectivity on the agricultural sector. Given the theoretical framework of service innovation and S-D-L, fourteen interviews with members of the agricultural sector were conducted. The qualitative data analysis of the collected data lead to the following findings:

- Due to increased importance information share, a data exchange platform is needed.
- PSS gain importance to bind costumers and to diversify.
- Interconnectivity influences the players' business models.
- Digitalized production factors satisfy the end-customer's need of transparency.

The findings were put in context in Figure 2. Interconnectivity in between the prospected value network empowers certain changes in terms of offering and business models and also enables to satisfy the demand for transparency by the customer. Due to laying the foundation for a better understanding of the other findings, Section 5.1 is more detailed as the other findings.

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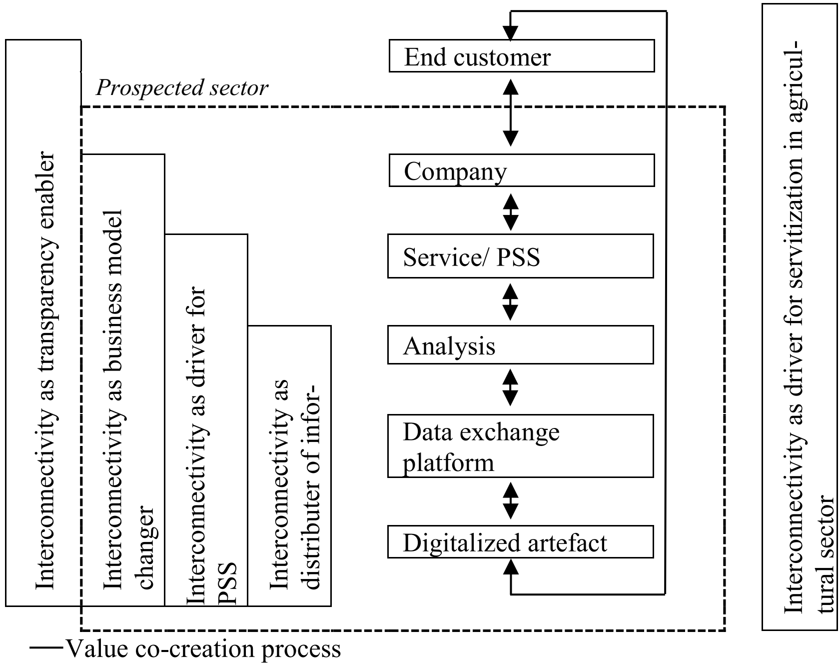
Figure 2: Subsumption of the findings in context based on Fleisch et al.



5.1 Digital interconnectivity – the connector of the agricultural value network

Interconnectivity as the distributor of information in the value network lays the foundation of the other findings. It is presented first as followed. The actual way of value creation from the digital artefact to the end customer provides a complete overview in Section 5.4. Due to the complexity of the observed network, the present network is described followed by the presentation of changing relations between the actors. Afterwards, these are summarized in the characteristics of the future value network.

Digital influence on the value network, namely digital interconnectivity and digital service innovations, has a big importance for the network structure as it increases the importance of the data flow within the network.

As a result, the one who controls the flow can also control the network. Digital influence also increases the importance of the solution providers.
As Akram predicted, the structure of the network is changing with its interactions, roles and the exchange of goods due to interconnectivity (Akram, 2016). The first influence on the value network of the agricultural business already became evident through the implementation of the traceability service. This service is changing the interactions between the providers and the importance of the players by increasing the importance of the information flow. The focal point of value network is be able to control and be able to analyze these flows of information. As solution providers bundle these flows of information, the first impact is that the importance of the solution providers increases. The second impact is difficult to predict because it is not sure who will gain control over the streams of information: the machinery industry and agrichemical industry, such as Monsanto or Bayer, the retailers or associations of companies. No exact prediction can be made based on the currently available data. The arguments for these three predictions will be in the following paragraph. The most probable is the prediction that the retailers, such as BayWa, will achieve control of the most important streams of information. Changes of business models of the solution providers or question of data handling will be dealt in the following chapters.

5.1.1 Present value network

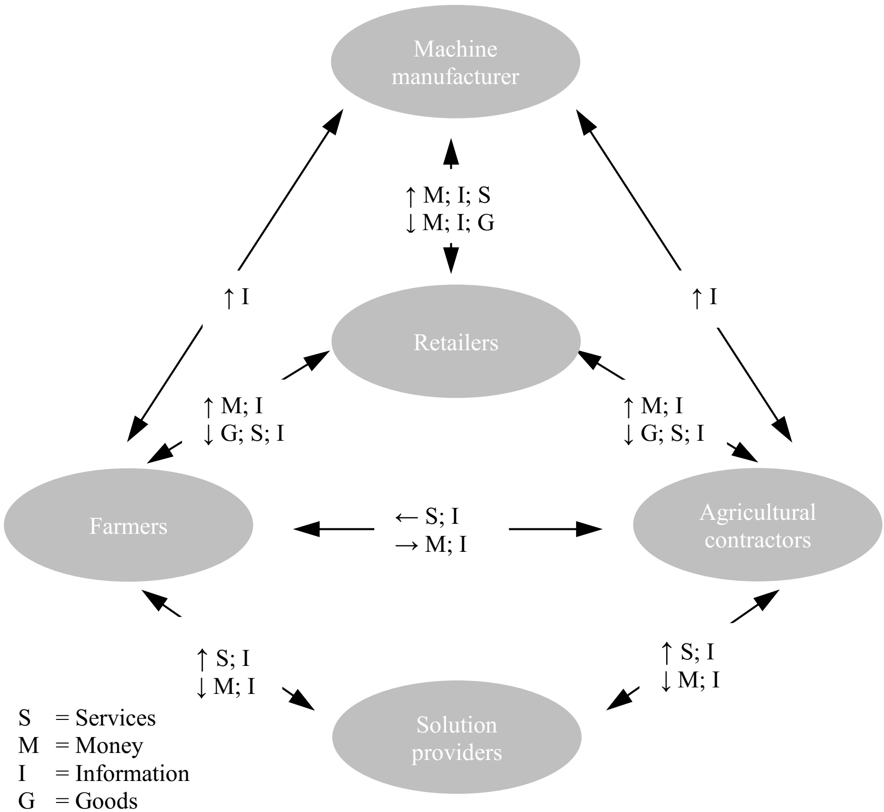
For an efficient evaluation of the influence of digital interconnectivity, the observed value network will be displayed by presenting the involved players.

5.1.1.1 Describing the present value network

This section lays out the current value network. The observed value network is limited to the presentation of the farm automatization industry together with retailers and farmers. Farmers and agricultural contracting businesses are integrated into the value network as customers and form an essential part of their business. The retailers are part of the value network because they are usually the intermediaries of transactions between the farming industry and the farmers (7C; 8C). The present network is product-orientated.
Based on the interview data, a simplified model of the present value network was drawn. The network model (Figure 3) shows the interaction and the exchanges of the observed players in Section 4.3. The different sectors, such as machine manufacturers, are oversimplified as one player. The author is aware that this reduction is not representing the heterogeneity in the different industries.

Nevertheless, the model can be drawn without the need to display this heterogeneity overview of the prospected sector.
In the following, the players are introduced based on the knowledge of analyzing mainly the interviews, background talks and literature. The specified interactions of the players are shown in the Appendix A. The change of this value network can be prospected without listing all specific relations. In the following, the players of Figure 3 will be presented by a short description and their adaptions on digital interconnectivity.

Figure 3: Simplified model of the value network of the prosected sector



5.1.1.2 Machine manufacturers

The term *Machine manufacturers* is used as a term which summarizes all suppliers of technical artefacts. These suppliers vary in their range of products from full range suppliers to specialists. All companies offer mainly arable farming machines. Therefore, in this study, the term *machine manufacturer* is used as arable machine manufacturer. The four big players in this sector of agricultural engineering are John Deere, Case New Holland (CNH), Agco and Claas. In 2014, the agricultural market volume worldwide was 100 billion € (boerse.ARD.de, 2015). The market revenue was 5,2 billion € in 2016 in Germany (Hemmerling, Pascher, & Naß, 2017). Two of these big four companies were interviewed as well as two machine suppliers. The interviewed manufacturers explained that the products are sold in a two-stage sales approach. Furthermore, digital interconnectivity is a huge trend the manufacturers do not want to miss. The importance or the meaning of digital interconnectivity for their value network is not yet known. A product manager answers the question on importance of digital interconnectivity for his company's value network as followed:

> *Hmm, we don't know it ourselves. (product manager,12C)*

Nevertheless, the manufacturers implement digital interconnectivity in their daily work, such as tracking solutions implemented in their production or smart farming solutions. At the time of the data collection several manufacturers offered first smart farming solution platforms using two different approaches. One of the approaches is the in-house implementation of a maintenance platform or establishment of a subsidiary company with a smart farming platform, for example, 365 Farmnet and Claas. Currently the platforms are not compatible. As subsidiaries are independent, they are listed as own players in *farm automatization providers* (Sentker, 2015).

5.1.1.3 Retailers

Retailers is used as a term for agricultural trading companies. In the German market, direct sales of machine and tech-suppliers are very rare. Based on the historical development and geological distribution, pre-products, operation materials and technical supplies were offered by middlemen like Baywa or cooperative Raiffeisen-cooperatives. These players have a big influence on the farmers' implementation of innovations or ignoring them.

If retailers don't trust a new product, they refrain from offering it so that the product cannot be introduced to the customer. Besides, these middlemen are often the farmers' customers.

They buy the farmers' products to resell them in bigger sizes to the food industry (Bronsema, H., & Theuvsen, L., 2010). Retailers often provide services in the name of the manufacturing firms like maintenance and commissioning services. Digital interconnectivity also gains importance for the retailers. The examined players established a subsidiary company with smart farming platforms as Farmfacts or Netfarming. As subsidiaries are independent, they are listed as own players in *farm automatization providers*. In the present value network, they can be seen as most important players.

5.1.1.4 Agricultural contractors

The term *Agricultural contractors* is in this thesis defined as machinery rings and machinery contractors. Machinery rings are increasingly spread out in the west of Germany. The machinery contractors are largely found in the east as a digital manager of a lobbying association explained.

> *In the east, the agricultural contractors are much stronger, but in the west are mainly the so-called machinery rings. (digital manager, 2A)*

The difference between both terms is the approach to business. The machinery rings were founded by farmers as solitary communities to help each other by sharing machines, know-how and work power. Machinery contractors, however are service providers in main occupation or side-line job. These associations take on special tasks as pest control or side-line jobs for the farmers as crop harvest for a dairy-farmer.

> *For example, the dairy farmers, they have own fields, whose ownership they have to prove. I have to have a minimum of agricultural area for my number of [farm] animals. On the fields, I will grow forage maize or similar. And I will not harvest it myself, this is taken over by agricultural contractors [or machinery rings]. (digital manager, 2A)*

A digital manager estimates that nearly thirty percent of the farms use the services of the contracting business. None of the interviewees was from agricultural contractors.

> *Everything else is done by agricultural contracting companies. This is the reality for, I estimate, that around 30 percent of the farmers. (digital manager, 2A)*

In 2016 the machinery contractors had a revenue of 2,3 billion € in Germany and the machinery rings 636 million € in Germany (Hemmerling et al., 2017).

The data collected in the interviews does not provide information on the implementation of digital interconnectivity. Due to the similarity to the farmers, an adoption of interconnectivity solutions like farm management solutions is probable.

5.1.1.5 Farmers

Farmers is defined as arable farming and animal husbandry. Both forms often appear mixed as the animal husbandries are forced to have agricultural areas, too (digital manager, 2A). As shown in Section 4.3, the demeanor of the farmers in size or output is also heterogeneous. The production process in both sectors are strictly regulated. The farmers have to fulfil several requirements from environmental protection extending to food laws and requirements to gain EU funding. It is essential for the farmer to gain this funding as it equals 42 % of his revenue (Brandt, 2014). As set out in Section 4.3, none of the interviewees was from this player. The revenues of German farmers amounted to 36,5 billion € in 2017 (Statistisches Bundesamt, 2018). Interconnectivity solutions are used by 53% of the farmers. Applications on smartphone are implemented by 34% of farmers but only 13 % use farm management solutions (Rohleder & Krüsken, 2016).

5.1.1.6 Solution providers

Solution providers is used as a term for *farm automatization providers*. The market of smart farming solutions is very heterogeneous. The variance ranges from subsidiaries of major companies to small startups. Furthermore, the ownership is divergent and shows the (future) importance of this market for established agricultural companies. Machinery manufacturers, retailers and the agrochemical industry want to establish their solutions on the market. The business approach of solution providers is to facilitate the farmers documentation or the monitoring of his machines or increasing his efficiency. Most solution providers offer their solution for a manual fee, which usually includes the technical components, software and support. Depending on the provider a set-up-fee is required. A small number of providers offers their services for free. These offers are mostly temporary or supported by another business case (Section 5.3). Farm management platforms and farmers have a high potential of customer co-creation. As a sales manager observed, the integration of these systems into the production process generates more value due to machine communication.

> *When the machines can communicate without the driver, it will lead to an immense drive of small and less specialized farmers, because the machines work more effectively than the workers who control them. (Sales manager, 11C)*

Currently, the systems are not competitive and do not share information. For this thesis, four start-ups of this sector and two subsidiaries were interviewed.

5.1.2 Claiming the need of data exchange platforms

In the following, the future influence of digital interconnectivity on the value network is described by showing the need of a platform for data exchange for increased value creation.

The analysis of the collected data suggests that the need of a platform of data transmission is the key to understand the transformation of the sector. The market of farm automation solutions is very heterogeneous and most of the solutions or systems are incompatible. Thus, data transmission is often not possible, as necessary data is often gained from the farmer's[5] smartphone or self-developed interfaces (CEO, 10S). For the next years, six interviewees predict a market shakeout of providers (7C, 8C, 9S, 11C, 13S, 14A). A manager of digital affairs expects the compatibility of the different systems:

> *My guess is that the [farm automatization] systems will be able to communicate with each other. On my opinion, the biggest task is that the companies communicate with each other and that they share data. (manager of digital affairs, 1A)*

Compatibility is presently not given because of a lack of unified standards, which regulate interfaces and the sharing of data. A sales manager stated:

> *The market barriers are still high due to the lack of standards in certain areas [data collection, data transmission, the share of data and the data property]. (sales manager, 8C)*

The most common interface for data transmission is ISOBUS. ISOBUS is a communication protocol for agricultural machines; it is based on the norm ISO 11783, which was introduced by the Agricultural Industry Electronics Foundation, a union of 150 companies and associations of the agricultural sector that was founded in 2008 (van der Vlugt, 2016).

[5] In the following thesis, the term *farmer* includes the contracting business which has the similar prospected interactions with the machine manufacturers.

The goal of this association is to facilitate the data transmission primarily from the tractor to the equipment and, in general, within the sector. At present, this objective has only been realized partially. Reasons are the insufficient distribution of ISOBUS-interfaces, in mostly older agricultural machines currently in use, and the know-how protection of the machine manufacturers. The manufacturers encrypt certain ISOBUS data to insure know-how protection and customer loyalty. There are efforts to lower these barriers of data transmission, but these have not yet been successful. A sales manager compared the situation with computer operating systems and expected that there will always be incompatible systems such as Microsoft Windows, Apple macOs and Google Chrome Os. It is possible to exchange data but no deep work data. He pointed out that if the customer sector with ten billion customers does not homogenize the agricultural sector will not either:

> *I don't think that there will be comparable systems, because after 20 years in the customer sector, the companies Microsoft, Google and Apple have still incomparable systems. That's the way it is. Nowadays, I can open power-point on Apple, but deeper work is not possible. And if they were not able with ten billion customers, we won't do it with 50.000 customers. (manager for service development, 7C)*

The data of this case study showed differences to the compared consumer market. First, the agricultural market is smaller (manager for service development, 7C) and it is a different market type as it is a B2B market (10S; 4S). The most important argument for having a data-transfer-standard in the agricultural sector includes players like the retailers, which are building their own systems, integrate the interfaces of the manufacturers systematically and force them to partly open the encryption to set a data-transfer-standard. A sales manager claims:

> *The farmer says: "I have another tractor and for some reasons, I do not want to buy this one [product], but I do like the [farm management] system." The agricultural contractor wants to transfer data from one system to another. This means for us, we have to create interfaces and to get the permission [of the farm management providers and the machine manufacturers]. But we get the permission, due to our importance to the market. Then we will program the automatized data flows. (sales manager, 11C)*

Therefore, and to provide real interconnectivity, it is necessary to develop a standard or a platform for data exchange as Google Playstore for Android.
It is essential that these platforms are open to other service providers, because farmers ask for individualized solutions and want to choose the most fitting solutions (10S,11C,13S). The finding for a need for general platform for data exchange is similar to Lusch &Nambisan, who predicted that service platforms support service innovation and services (Lusch & Nambisan, 2015).

To conclude, a platform or standard for data transmission does not exist but is expected to be founded in the future.

5.1.3 Describing the changing relations

The change of the relation in the value network is shown in this chapter. The relation of the players with the solutions providers gains in value. All interactions of the players are shown in Appendix A. Having in mind the past finding, the future evolution of the relation between two players of the value network is described.

5.1.3.1 Relationship farmers – machine producers

The relationship between farmers *and machine producers* will change due to expanded data flow. The machine producers will evolve the value proposition for farmers by offering solutions and interconnectivity which will become their sales argument.
As a product manager said, the implementation of sensors will increase knowledge about the lifecycle of the product. Today, the reflux of information of the producers is minimal. Most knowledge is acquired by sampling.

> *As I said, today, we sell a machine and we never see it again. But if we connect the machine to the Internet, we will get a higher flow of information. How fast does he [the customer] drive with the machine? What engine power does he have? How is the machined filled and further? As said, we just assume today. We examine them [the machines] but in small quantities. We examine one machine not thousands. (product manager, 12C)*

This flow of information will be used to improve the products and its requirements. Furthermore, the availability of the products during the peak season will increase by using predictive maintenance. At the exhibition Agrictechnica 2017, first machine companies offered carefree packages with full service, training, and, if needed, replacement machines.
This could be the first step of the machine producers towars the sale of solutions instead of products. A manager for service development agreed:

Interviewee: If they say: Here you buy a bundle, in this bundle is in case of emergency a replacement machine, training and full-service etc. It will continue that way, but in the end, you need a machine plus a service. It is not that you just buy 500 operating hours. That does not exist.
Interviewer: In the future?
Interviewee: Certainly, it will be an issue in the future.
(manager for service development, 7C)

The vision of selling operating time instead of machines was mentioned by three other interviewees (3C; 5C;11C).
The next modification to be expected in this relation is the change of farmers' requirements. A prerequisite for the need for interconnectivity for smart farming is the capability of the machines to connect. A product manager assumes that in the future the sales argument will be interconnectivity and not efficiency, power or availability.

That the future the consumer does not say: I buy the harvester XY because he has the best hectare capacity, and the best availability etc. The connectivity will be the sales argument. (product manager, 12C)

To sum up, the relationship between farmers *and machine producers* is getting more intertwined and more intense than before the use of interconnectivity solutions.

5.1.3.2 Relationship farmers – retailers

The relationship between *farmers* and *retailers* seems to be stable, due to the high importance the retailers play in the two-stage approach of the machine companies. The low interest interactions, such as selling operating material, will be automated. In other interactions the retailers will help to find the way through the jungle of hi-tech solutions. Currently, the services provided by the retailers are often more significant than the actual product itself as a sales manager determined:

The main reason to buy a machine is the service. [...] The importance increases. We see that, if a retailer switches to another brand, because of generation changes or take-overs, he will take his customers with him. Most of them will not buy John Deere anymore because they want to stay with the retailer. The same game played, when we integrate retailers of another brand into our system, we will win 80% of his customer. (sales manager, 8C)

The interconnectivity enables the retailers to increase the provided service quality by a two-level approach. The first level of services is the usual service providers as garages, repairmen or sales managers.

They are supported by second level, the competence centres for IT, machines etc., if they are consulted they will receive the relevant data to solve the data.
The two-stage sales approach of the machine producers was not questioned by any interviewee. In the immediate future, the retailers will become more and more important for the farmers to provide an overview in the rising complexity and range of the agricultural technology. For example, a CEO said it will be the task of the retailers to create opportunities to combine the solutions of different providers.

> *That [to create the opportunity to combine different solutions] is our task in the future, where we have to help our customers [e.g. farmers]. If the farmers uses different systems that we are able to offer solutions for. (CEO, 3C)*

Depending on the heterogeneity of the different solutions, the importance of the retailers will grow. In the near future, the merger of different systems and solutions, without setting a standard, cannot get realized by a startup or else as a sales manager determined.

> *The farmers says: "I have another tractor and for some reasons, I do not want to buy this one [product], but I do like the [farm management] system." The agricultural contractor wants to transfer data from one system to another. This is for us, we have to create interfaces and to get the permission [of the farm management providers and the machine manufacturers]. But we get the permission, due to our importance to the market. Then we will program the automatized data flows. (sales manager, 11C)*

Digital interconnectivity is of great significance for the retailers; for example, the BayWa set up a new department for innovation and digitization. As machine manufacturers, the retailers also establish farm management systems on the market. The interviewees of these firms underlined the openness of their farm automatization systems for other companies. As a sales manager said:

> *We [the agricultural sector] want and have to be connective and because the world is heterogenic, and every manufacturer is doing his own thing, it is important that somebody like us exists. Manufacturer-independent providers are essential for realizing these ideas [of smart farming]. (sales manager, 11C)*

The integration of farm management systems into the production process of the farmer will automate and individualize ordering of operating materials, such as fertilizer or seeds. For example, the farm management system detects via field sensors the required composition of fertilizer of a field and sends the composition to the retailers, where the fertilizer is mixed and prepared for delivery.
The whole process will be automated as a digital manager noted in a background discussion (digital manager, 5C).

All these basic interactions will be done automatically. However, high-interest transactions, such as machine purchases will still need consultation services due to the increasing technology as scientific assistant predicted.

> *Wherever standard products, do not need consulting services, they can be sold automatically, and this will be accepted. This is different for agricultural machines: before buying a machine I need consultation. (scientific assistant, 14A)*

To wrap up the relationship between farmers and retailers will stay stable. Only low interest interactions will be sorted out.

5.1.3.3 Relationship farmers – agricultural contractors

The relationship between *farmers* and *agricultural contractors,* including machinery rings, will become more intense in the near future. In short term, agricultural contractors and machinery rings gain of importance for the farmers due to the easier communication and the increasing technology complexity and higher investment requirements. In mid to long term, machine manufacturers could change their business model from selling machines to renting machines which will substitute the contractors. These findings will be shown in the following.
According to an example of a sales manager, the communication between the farmers and the agricultural contractor is going to become easier.
The farmer as the client sends the order with telemetry data directly to the contractor's device. The contractor accepts the order. The shared data enables the contractor to drive to the field and start working due to the automated configuration of the machine.

> *In the future, we can use it [interconnectivity] to do more preparation in the planning stage by predefining of production parameters. The [contractor] driver drives to the field and the machine detects automatically the place, the task and the contractor can solve the task. (sales manager, 8C)*

However, increasing technological complexity and the required investments are too high for the average farmers.

> *When they [the machines] have reached a certain size, the technical innovations become too expensive for them to afford them alone and they will provide agricultural contractors. (digital manager, 2A)*

Due to increasing legal requirements in the agricultural sector and a limited number of annual applications of special tasks, as pest control will be outsourced by small companies as a scientific assistant explained.

> *It can be observed that small companies outsource things like pest control. The entire obligations as verifying the sprayer or visiting educational events cease [by outsourcing]. He does not have to keep the overview; which products can be combined. (scientific assistant, 14 A)*

The transfer of data and the continuous collection of data during the service process provides the contractors with a good base to improve their services. Combined with increasing numbers of operations the contractor will benefit of the economies of scale and scope.

> *The contracting business performs better and from a farmer's perspective they are cheaper. Due to the increasing technology and the small distances between the areas to be machined, the contractor can lower the prices. The offer of complete bundles, beginning by taking care of the soil to the seeding, to the harvesting ending by selling the harvest, reduces the work load of the farmers. (digital manager, 2A)*

All interviewees predicted a continuous and increasing trend of specialisation. Due to the high need of investments of time, money and know-how in technology, the farmers will focus more on their main business and become specialists. The contractors will overtake the outsourced parts and become specialists in their sector. The trend of specialisation is also detectable in other economic sectors as a sales manager mentioned.

> *The more the world specialises, the more specialised companies or people will work in these sectors. That is why there is more and more of separation. But this division of labour is the same in other sectors. (sales manager, 11C)*

Half of the interviewees think that this trend increases in the agricultural sector and will yield in a strong agricultural service sector. Therefore, the different tasks will be realized by different actors.
In summary, the relationship *farmers-contracting business* will become more intense short-term, and mid-to long-term the existing business models of contractors will be substituted by machine manufacturers.

5.1.3.4 Relationship farmers – solution providers

The relationship between *farmers and solution providers* has a high potential of co-creation to realize the solutions to become individualized and trustworthy. This relation has a first mover advantage. These findings are explained in the following.

It is essential to be the first, to build a relationship with the farmers, because most of the farm management tools need a high investment. Otherwise it is of low interest for the farmers. The reason is that, the willingness of the farmers to change farm management systems is minimal as a sales manager explained.

> *This relation (farm management provider-farmers) is a close relation. That is why, it is essential to secure this customer relation. Switching [of farm management systems] is not attractive for the customer. This is a low interest topic for him [the farmer], which he has to do, as obligations to provide proof or accounting. So, he avoids switching, this means who sets up this digital channel to the farmer, has a big chance to stay. (sales manager, 11C)*

This relation is a delicate relationship. On the one hand, the farm management software has the goal to improve the production process of the *farmers*, on the other hand the provider gains insight views of the farmer's processes. In background discussions, farmers mentioned reservations against farm management systems because they register small violations such as pesticides in the production process, which can be critical, if regulations or public opinion changes. Two interviewees complained that the public compares agricultural solutions by applications for smart phones (8C,12C). The most critical point is the low-price expectation.

> *These [the customers of the application] are farmers who are generating revenues of ten to 100 million €. And if somebody like this invests in a digital solution, it will cost more than 1,99 € because it will have a higher impact and responsibility as any fun-application. And a lot of people [also farmers] don't realize this point. (sales manager, 8C)*

The offering of farm management solutions often generates other non-monetary revenues. Machine manufacturers, retailers or biochemistry suppliers provide these solutions or software services to gain more data for their main business as a sales manager mentioned:

> *So, it is a little bit different when we are competing against companies like John Deere and companies like Monsanto, and there could be a secondary reason to basically collect the data; either you just sell them more equipment or iron or you sell them more genetics or chemistry. (sales manager, 6S)*

For the co-creation of services between farmers and solution providers, it is important that the solutions are individualized on the farmer's needs and properties. This is in particular essential if the farm management software is used for documentation purposes or to gain EU funding.

Due to the poor adoption of foreign farm management solutions to Austrian market requirements, Austrian start-ups are dominant in this market.

> *Because they offer these specialties as documentation support for funding like for the program for environmentally friendly agriculture. The Austrian solutions can calculate the required area percentages for the different kinds of funding. This is not interesting for german or swiss producers. But these local specialties are essential for the famers. (scientific assistant, 14A)*

To gain these fundings, it is essential not to violate certain limits. As a scientific assistant explained, during the production process, it is easy to violate these regulations, for example, fertilizing with 151kg/ha instead of 150 kg/ha. To not lose funding because of small violations, farmers demand the option to correct the collected data in certain limits before submitting it.

> *This is an important thing, that famers often communicate. They want to be able to correct the collected data before submitting them to the final documentation. For example, the limit of nitrogen is 151 kg/ha and if the systems calculate that he scatted 151 kg/ha, he wants to correct to 150 kg. He does not want to discuss about the 1 kg. (scientific assistant, 14A)*

To conclude the relationship between *farmers* and *solution providers* will be a close trustful long-term relation with a high customer co-creation once it stabilizes. Yet, it is not considered to be stable due to the present findings.

5.1.3.5 Relationship retailers – machine manufacturers

The relationship between *retailers* and *machine* manufacturers has two faces: on the one hand, the two-step approach of selling machines will stay stable, but on the other hand, the two businesses are indirectly in competition with their subsidiary farm solution companies.

Due to the two steps approach, the retailers stay responsible for the manufacturer's services. As previously stated, the need for technological know-how will increase. This implements a higher need for consultation by the farmers. To be able to share this information with the farmers, the manufacturers have to share this information with the retailers.

> *These [the products] are trainings-intensive. This implements two types of services, the service to train the retailer and they have to have the knowledge to train the farmers. This is a close relationship. As I said, the products require consultation. (product manager, 12C)*

On the other hand, as already mentioned the retailers need information about the interfaces of the machines from the retailers to implement it into the farm automatization solutions. They gain this information due to their market power. The future relationship depends on the question of who gains control of standards or of platform for data transmission, because this gives control over the informational flow in the value network. A sales manager summarizes the situation:

> *Everybody [machine manufacturers and retailers] tries to establish a direct channel to the customer. The retailers try, the machine manufacturers and people like Climate [start-up of bio chemistry supplier] and all are fighting for the same channel [the farm management solutions], the same shelf space. It is an additional scene. (sales manager, 8C)*

In summary, the machine manufacturers-retailers relationship will become an ally-enemy relationship.

5.1.3.6 Relationship machine manufacturer – solution providers

For the relationship between *machine manufacturers* and *solution providers*, the gained data shows that this relation depends on whether or not the manufacturers can implement a standard for data transmission or if the retailers will.
In the first case, the manufacturers stay in control of their machine data. In the second case, they cannot control them. The relationship provides high potential for value co-creation for the whole network. This finding will be illustrated in the following. In the future, it will be more important for the solution providers to have full access to the machines. The connectivity of different machines within a farm automatization system will be a selling argument as a product manager explained:

> *So that the future consumer does not say: I buy harvester XY because it has the best hectare capacity, and the best availability, etc. The connectivity will be the sales argument. This could become the problem for the sector. (product manager, 12C)*

The interaction between the manufacturer and the solution provider will heavily increase the potential for customer co-creation. Due to analysis software and better consultation services, the farmer can save money, time and other production factors. Besides, it enables the higher value co-creation with the end-consumer as mentioned in Section 5.4.
The product manager mentioned that connectivity could become a problem for the sector.

Today, independent suppliers use interfaces for the machines like ISOBUS or smartphones, but as mentioned, not all data is accessible to them (sales manager, 11C). Nevertheless, the smaller players fear the digital lock-in of the full range suppliers as the sales argument connectivity gains value:

> *I would say, we belong to the group [of suppliers], who has some fear [of the digital lock-in of the full-range suppliers.]. (product manager,12C)*

Full-range suppliers only provide all generated machine data to their smart farming platforms to stay in control of the generated data and their products. Certain machine data is encrypted for protecting trade secrets or technical advantages. Officially, platforms of the full range suppliers are open to external products or companies. As the president of John Deere's Agriculture and Turf Division, Mark von Pentz, announced, John Deere wants to create a similar platform as iTunes for smartphones for the agricultural sector (Farm & Food 4.0, 2017b).
To interfere with this lock-in in 2016, some manufacturers founded the association agrirouter with the main goal to build a platform for data exchange. This platform has a standardised interface for data in- and output.
Additionally, the farmer/user is able to set rules to determine, who gains how much data and whom he can exchange it with (dke-data.com, 2017).
Farmers can use this platform free of charge; the data consumers pay per consumed data that is measured as with a water meter. Three interviewees (12C, 13S, 14A) were sceptical, as only one full-range-suppliers participate in the platform (Fendt, 2017). Without them it will become difficult to implement a standard for the industry. If the manufacturers do not find a standard, another option would be for the retailers to implement a platform for data exchange and, worst case, the manufacturers would decrease to suppliers of the farm automatization industry (scientific assistant, 14A).
As mentioned, this is necessary to integrate all machines into the solution providers' network, but it is not sure who is including them. A full integration into the network is increasing the potential for value co-creation in the network.

5.1.3.7 Relationship solution providers - retailers

In general, *solution providers* and *retailers* will both be intermediaries for each other: the retailers are responsible for establishing the costumer contact or support and the solutions providers are responsible for low interest goods. In detail, the relationship also depends on who will implement the platform of data exchange (retailers or machine manufacturers). First, the finding of the retailer as intermediary is explained, then the description is divided in subsidiaries of retailers and retailer-independent solution providers.

Due to the fact that solution providers have to offer physical support, it is probable that the retailers will offer them for the solution providers, due to their existing infrastructure. The services and products of the solution providers are sold via internet or via the retailers (CEO, 13S). Solutions which are easy to implement do not need the support of retailers, but it seems to be that customers require more support for technically sophisticated products, especially if the products have to be implemented in an existing system (sales manager, 11C).

For better analysis, it will be differentiated between subsidiaries of retailers and other solution providers.

The subsidiaries will have a high information flow with their parent company, collected information will be used to improve internal processes like storekeeping or to provide better services (Sentker, 2015).

Although the parent companies will provide information about interfaces to the subsidiaries, due to their market power, they will move the manufacturers share certain interfaces or machine data with them (sales manager, 11C).

The retailer-independent will not have these relations except if they join forces. It applies to all solution providers, as mentioned, that low interest goods such as operating material will be ordered automatically by the farmers from the retailers on the solutions providers' platform (manager of digital affairs, 1A). This development could weaken the retailers as it is possible to skip retailers and order directly from the producer. In the present future this development seems to be unrealistic. Retailers will gain profitability through the information collected of the subsidiaries and, thanks to their market power, they will establish them on the market (11C, 14A).

To conclude, the relation between the retailers and solution providers seems to become similar to the present machine manufacturer-retailer relation. They need each other but are sustainable. If the manufacturers do not implement the platform, the relationship should get closer.

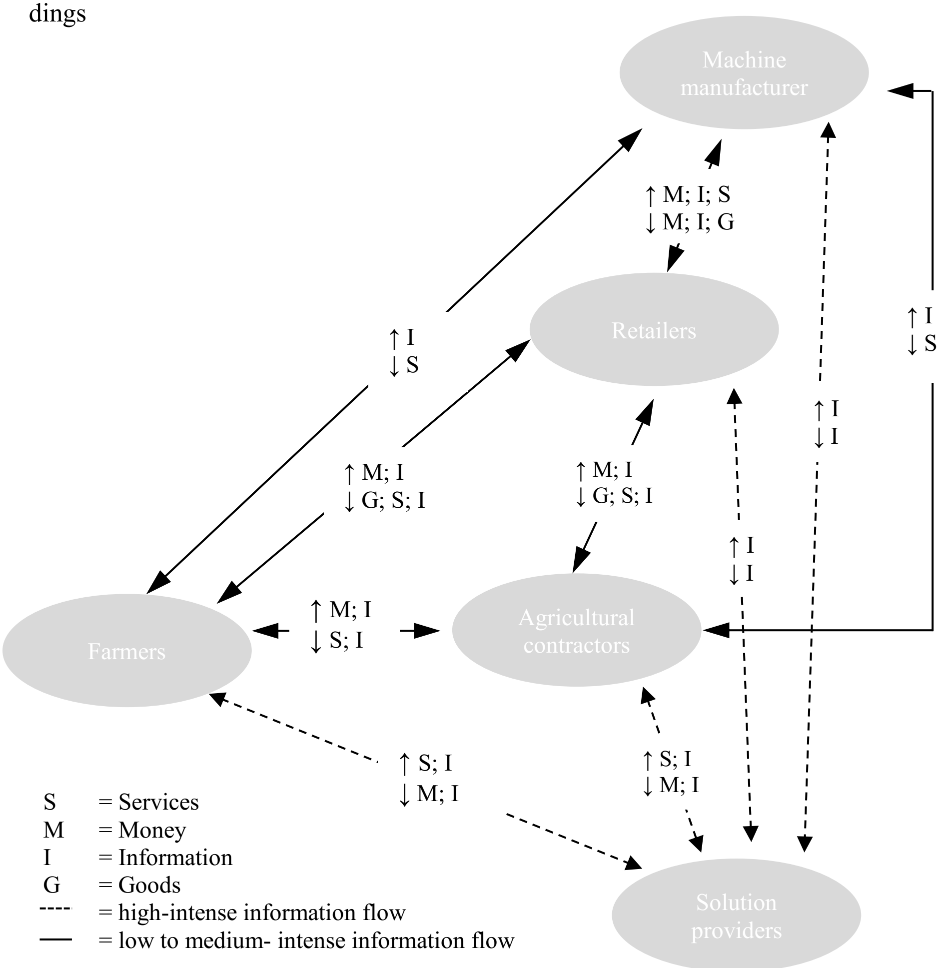
5.1.4 Future model of the value network

Now that the relationships on the agricultural sector are laid out, the future model of the value network (Figure 4) is presented with a service-oriented focus and solution providers as essential node for data transmission are taking the focal position in the value network.

In the future model, new players will enter the value network such as IT-suppliers, e.g., Bosch or Google. Due to their value proposition, they are considered solution providers, but the market entry barriers still remain high (sales manager, 8C). The next change in the value network is the shift from a product-oriented to a service-orientated network with a high importance of digital services as prospected.

It was mentioned that digital services are mostly based on information exchange and analysis. Thus, data mining or the exchange of data will become essential for prospected players to increase their value creation. Consequently, the share of information increases as shown in Figure 4. Collected data predicts that the essential platform for the data flow will be in between the solution providers, due to the digitalization of the non-digitalized artefacts (scientific assistant, 14A). The information flow of ordering operating goods will change completely.

Figure 4: Simplified model of the prospected value network adopted on the findings



In the following example, all information passes by the solution provider's platform. Sensors in the soil measure the composition of it. An algorithm of the solution provider analyses the quality of the soil and sends a fertilizer order via M2M communication to the retailer, which delivers it to the farmer. The farmer or the autonomous tractor distributes the fertilizer according to the calculations automatically on the field; the sprayed volume will be documented for legal reasons (CEO, 3C).

This will raise the importance of the solution providers in general in the sector, especially for specialized task with low repetitions or task with high official requirements like pest control. Therefore, the solutions provider will become an architectural control point.

As shown in Figure 4, the solution providers will maintain high intense data exchanges (depicted in blue) with every player in the value network by assuming that they will be the central platform for data exchanges (scientific assistant, 14A). Certainly, data will be exchanged outside this platform, but this will be of minimal volume. Therefore, the controller of this node will increase its influence on the value network and will become the focal point of the network. The interview data predicts a race of the retailers and the manufacturers to gain control over the platform. If the manufacturers keep their heterogeneous occur, the retailers could gain the control on the data transmission. If not, the manufacturers will stay in control of the data.

To summarize, interconnectivity will empower the sharing of information in the agricultural sector. This will lead to more interaction between the players and a more service-oriented sector. The solutions providers will gain and raise their importance heavily from a side player to an essential part of the network due to the assumption of including the platform for data transmission. Mid-term, all players will stay in the value network. As Akram predicted, the structure of the network was changing regarding its interactions, roles and the exchange of goods due to interconnectivity (Akram, 2016).

5.2 Product-service-system – differentiation and customer retention

As shown in Figure 2, interconnectivity supports a higher information exchange and changs the interactions in between the network. This influences also the offerings of the players. The prospected data demonstrated the increasing importance of PSS due to the trend to offer PSS instead of products in the agricultural sector. This is reviewed and analysed. PSS becomes an appropriate source of customer loyalty and differentiation. First, PSS as a differentiation possibility is discussed.

5.2.1 *Product-service-systems – differentiation*

This section describes now PSS will be used by manufacturers and farmers to differentiate their products from competition. A product manager prospects that services become important to differentiate the homogeneous products. As shown, the digital charged product food has the same differentiation possibilities via traceability services.

> *Today the importance of services rises significantly; especially through the increasingly difficulty to differentiate himself by products. (product manager,12C)*

A sales manager noted in Argitechnica 2017 that the first machine suppliers started to differentiate themselves using PSS. By buying a tractor, the customer gains the choice to buy the tractor in bundle with extensive services, training and a replacement machine or separately.

> *I see the first time at this exhibition, that machine producers communicate this topic. They offer: "Here you can buy a bundle, this includes, if needed a replacement machine, training and full service and so on. (manager for service development, 7C)*

A sales manager predicts the need of these service bundles for the technical products without which they would not be operational. On the one hand, the technology and the connection to the farm management system is not accessible for the users.

> *The services [commissioning with implementation in the farm management systems] have a high value, I would even pretend that they are more important than the classic services, because the users are able to use it only. No matter what they buy. (sales manager, 11C)*

On the other hand, the users could be forced by third parties to use PSS to receive, for example, funding or, in the food industry, for ensuring transparency (sales manager, 11C). Thus, the interaction of the agricultural products will become a sales argument and the way to differentiate from competitors.

> *So that the future the consumer does not say: I buy the harvester XY because he has the best hectare capacity, and the best availability etc. The connectivity will be the sales argument. (product manager, 12C)*

Due to PSS, the numbers of rivals for the machine manufacturers will increase (Porter & Heppelmann, 2014).
Also, farmers will use PSS to differentiate their products.

For example, farmers enable the customer to monitor the vineyard via smart phone to differentiate their wine (Section 5.4). This approach will be applied on high quality food sector. Another type of product systems was realized by Spanish orange farmers. They sell the customer an orange tree and also provide the fostering and harvesting of the oranges. This type of PSS is also used in animal husbandry (like cattle leasing) (Divé, 2016). The service is possible without digital interconnectivity, but its distribution facilitates by it.
To wrap up, PSS will be used to differentiate from competition. Another positive aspect is the customer loyalty. The farmer impedes the costumer to change the service provider of care services by fixing the product especially the tree. The aspect of customer loyalty will be discussed in the next chapter.

5.2.2 Product-service-systems – customer retention

Additionally, PSS became an appropriate tool to implement new products or solutions on the market to gain customer loyalty.
Farmers rank the services of retailers higher than the actual product. These findings are also used by companies to implement their farm management solutions. Due to companies' expectations of a low customer's willingness to switch farm managements solutions, they link their existing products to farm management solutions. Sometimes this link is optional, but the inclusion of the farm management system may also be compulsory, to open the first channel to the customer.
For example, seed producers obligate farmers to use their farm management solutions, which are free of charge.

> *Depending on the products, you will be mandated to use measurement units [weather stations or soil controllers], which are offered without charge. (digital manager, 2A)*

This solution includes the services of soil analysis and harvest control. Therefore, measurement stations are built on the field and the data of the measurement units is analysed and provides the farmer with information about his fields.
The aggregated data can also be used within the provider's company. Another stimulus is the service of guaranteeing the harvest if a certain system is used and if its suggestions were followed as a CEO added.

> *An approach of Monsanto [to implement its farm management platform] is to offer crop guarantees, if he [the farmer] follows their suggestions, pest control seeds, the time and amount of spraying, etc. and if he follows exactly these advices, then he will get his money even by crop failure. (CEO, 13S)*

Machine manufacturers also use PSS to establish their farm management platforms. They are included in the offered PSS as option. Using the option releases extra services like extra warranty or better service quality. This combination of offering farm management solution, services and products merge the manufacturer to a farm automatization provider. By providing a whole farm automatization ecosystem, with perfectly interacting components, the provider could impel the customer to buy system-loyal to retain this interconnectivity (product manager, 12C). This would insure the customer loyalty and differentiation.
To conclude, PSS became an appropriate tool to increase differentiation and customer loyalty. This is especially used by manufacturers and farmers.

5.3 Interconnectivity – influence on the business models

The interconnectivity of things and the different offerings will push the players to change their business model. This applies especially the machine manufacturers. This change of systems is described in the following beginning with the farmers, followed by retailers and machine manufacturers.
The digitalized products of the machine manufacturers will gain a digital add-on. The machines can be sold with a low margin and the software solutions and the interconnectivity solutions will be sold with a high margin. A digital manager describes this by selling a milk robot with a lower margin, as the software will be more profitable (manager of digital affairs, 2A). This example is also applicable on tractors or other agricultural technology, with margins of four to five percent (Dryancour, 2016).
As shown, machine manufacturers provide the infrastructure and the data for the more profitable farm automatization applications (Leimeister & Glauner, 2008). These applications can be provided by third parties.
The interconnectivity of the machines connected with farm automatization systems provides extra value to the farmers as it increased productivity or efficiency. Therefore, the agricultural machines become digital charged products. The sensor as service approach does not fit due to the remaining product focus of the manufacturers. In the future, the machine manufacturers will implement the pay per use element in their business model as outlined in Section 5.1.3.1.
As interconnectivity will become a sales argument, it is possible that the physical products of the manufacturers will be locked-in. First indications are the additional warranty or services if the customer uses the company-own farm management solution (7C, 8C). A lock-in would be just the reverse for data sharing in the sector, but no proving data was found for this example. The other elements of adaptions to the business models are possible, but also not proven by the collected data.

The food as digital charged product enables the farmers to change their business model. As demonstrated, the farmers offer PSS, which could be point of sale for other services or products. The customer could, for example, use an application to monitor his cow or to book a vacation on the farm as a sales manager added in a background discussion (CEO, 3C). A more radical approach of changing the business model is to define the farmers as growers of plants, as is basis for the business model of Infarm, a start-up of Berlin. The company rents bundles (including automated greenhouses as well as growing and maintenance services) to supermarkets, where it plants spices and vegetables according to the demand of the supermarkets, which will then be sold in the supermarket (sales manager, 6S). If a farmer is seen as a person, who grows plants or animals to eat, this example would be a great change of the business model.

The gained data allows no particular forecast about a change of the business model for the contracting business. Only the threat of the existing business model can be proven as manufacturers are predicted to sell the working-power of the machines instead of the machines.

The retailers will use farm automatization solutions to enable product as point of sale or object self-service. As demonstrated in Section 5.1.3.2, the farm solution platform will allow to purchase low interested goods from the retailer, but it is not predictable if the farmer always has to accept the purchase of the platform or not. The platform will also be used to sell other services, such as operation analysis or indicates if the farmer needs a new tractor.

Due to the focus on their generated data, the major business model for farm solution providers is the sensor as a service approach. As outlined, the agricultural machines become digital charged products.

Some providers of the farm management solutions are planning to enlarge their business models in selling the collected data to third parties (with the acceptance by the customers), for example to insurances or hedge funds. They could analyse the data and predict crop losses or similar events (manager of digital affairs, 2A; sales manager, 4S). Thus, new revenue streams for the solution provider would be established.

This chapter predicts the finding that a part of the agricultural sector will change its business models according to the findings of Fleisch et al.

5.4 Digitalized artefacts – sources of new services

This finding sets all other findings in context. Due to the increasing demand for transparency and the increasing implementation of digital interconnectivity, agricultural products especially non-processed food, will become a PSS in the future and transparency services will increase the value creation. To explain this finding firstly, the source of service innovation, the digitalization of production factors such as fields is set out. In the next step, the additional value creation stage is explained by the model of Fleischmann et al. In a final step the created value is shown for the stakeholders and a short example of implications for the farmers' business model is given.

The implementation of sensors in the production process, for example, the field, connects the production factors (Porter & Heppelmann, 2015). These production factors can share information with each other and react to external factors like the weather so that they become digitalized artefacts.

A sales manager described the digitalization of a fertilizer spreader as follows:

> *Today it is different. A fertilizer spreader, if it is high-tech, will be linked to a digital [field] card, this card shows the fertilizer spreader which spot is in the need of fertilizer. (Sales manager, 5S)*

This finding is complementary to the article of Porter and Heppelmann, who described the digitalization of a tractor. Due to the implementation of, for example, Farmers Edge's CanPlug-system, the soil status and weather condition can be monitored. The tractor is also able to react to this input by ordering the right fertilizer at the wholesale trader or by providing information for field work. Therefore, the seven material properties are applicable on fields as shown in Table 7.

Table 7: Application of the seven material properties on fields

Name	Description
Programmability	In arable farming, field sensors measure, for example, the soil status and order the right fertilizer. (CEO, 3C)
Addressability	Fields can be identified via field sensors. (CEO, 3C)
Sensibility	Fields can show their environmental changes such as weather or soil and can also react to it, for example, by ordering the correct fertilizer. (CEO, 3C)
Communicability	Fields can, for example, communicate their actual weather conditions to prevent the farmer from spread manure because it is too windy. (scientific assistant; 14 A)
Memorizeability	The information about fertilizer, weather, crop protection and growth process, etc. are monitored and stored. (CEO, 3C)
Traceability	The information about the use of other digitalized artefacts are monitored and chronologically stored. (sales manager, 6S)
Associability	The gained information can be used to forecast, for example, certain production steps or even the output. (digital manager, 5C)

As a digitalized artefact, the field obtains a four-layer architecture. The digitalization of the field enables the implementation of new digital services through the value creation stages.

Regarding non-processed food, including wine, beer and dairy products, the value creation will increase by providing the customer with the documentation of the production process by the labeling the food with QR-codes or stock codes.

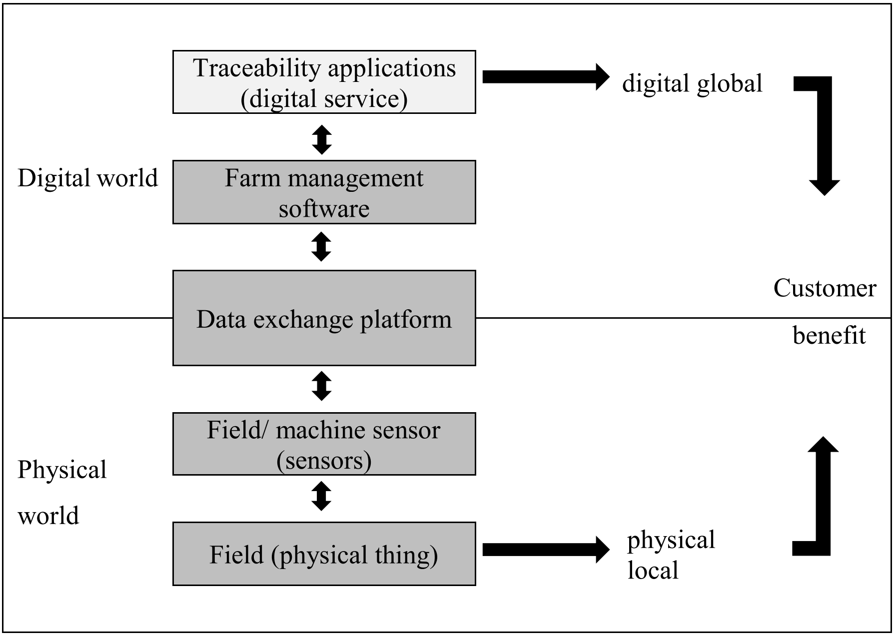
The customer gains access to the service layer of the field and can check the information about the production process as a CEO predicted:

> *The main advantage of digitalization [in the agricultural sector] is, in my opinion, the documentation. I imagine, that the customer finds the product's QR-Code/ stock code and can detect [via smart device] that pest control was used and, additionally, fertilizer. Everything was done properly without breach. Furthermore, the product is from Upper Bavaria. (CEO, 3C)*

The integration of digital interconnectivity into the agricultural artefacts adds an additional dimension of value creation as shown in Figure 5. The model was adapted to the agricultural sector based on the theory of Fleisch et al.

The physical field gains access to the digital world via connected sensors such as the mentioned Farmer Edge's CanPlug.
These sensors collect production data about the weather, soil, fertilizer and pest control applications. The collected data is analyzed and stored by the farm management software. The new traceability service via QR or RFID-chip is enabled by this process and costumer gains access to this data.

Figure 5: Value creation stages on a digitalized field based on theory of Fleisch et al



Offering traceability services will be necessary to satisfy the increasing need of transparency by the customer and the law. The issue of increasing transparency in the agricultural sector was mentioned by seven persons and was for the majority the main advantage of digital interconnectivity.
The rise of transparency was evident because the sensitivity of customer and policy for food quality and traceability increases. Thus, the food retailers will demand higher traceability standards of the farmer. As the value creation stages are bidirectional the farmers' value creation also changes.

On the one hand, the higher traceability of agricultural goods will increase the farmers' input but on the other hand, the extra input will ensure their sales as sales manager 6S states by quoting a presentation for young farmers, he has heard.

> *This [the increasing traceability] is something new [implementation of digital interconnectivity], but would be helpful for us [farmers]. There was the picture of [Lidl's] cereals with a banner which informs that the cereal currently being sold and it has 20 different legally allowed residues of pesticides. These are below the limit, but still. He said: If anybody will reduce these from 20 to 15, he will advertise it. The market will follow this example. And how do you get a cereal with only 15 residues? Who produces the ingredients? That is you, farmer, you have the chance to participate. So, what is our benefit? Ensuring of sales. And there is also a legal change in this sector. If there are any new regulations or environmental legislation, and this includes that everybody can scan [as an example] anywhere with his smartphone apples on residues [of pesticides] anywhere. (Sales Manager, 11C)*

Digital interconnectivity also increases the value for the farmer. The documentation obligations continue to increase over the years. The automated data collection and storing of the farm management system will facilitate the satisfaction of documentary and traceability, as mentioned by a sales manager:

> *He will see that specific planning, for example, actual governmental requests, such as fertilization plans and nutritional balances, will not be practical without [farm management] software usage. (Sales Manager, 11C)*

To share collected information with the members along the supply chain or consumer is the next logical step and does not require with a data exchange platform much effort as illustrated in Section 5.1.1. A digital manager mentioned that sharing production data will increase value creation:

> *Along the supply chain, the one who provides more or fewer data will probably benefit from it. (Digital manager, 11C)*

The following step distinguishes between indirect sales and direct sales. Previsions regarding the monetization of traceability services for the farmer in indirect sales are not possible with the collected data.

It is not discernible to predict a higher monetarization of the supply chain, if the farmer either shares the collected production data voluntarily or whether this will be just a requirement for selling his products. The following quote of a sales manager predicts a tendency to non-direct-monetary remuneration.

If a market, politics or society has its demands and I can't satisfy them, I will have a problem. (Sales Manager, 11C)

For direct sales or branding, the offering of traceability services will increase the monetary remuneration for the farmer. The client will not pay for the service itself but will pay a higher price for the bundle. The higher price could be explained by the satisfaction of the customer's need for transparency or the emotional charging of the food product. Sales manager 6S has given the following example of a wine-grower who sells organic wine labeled with QR-codes. By scanning them, the customer gains access to the webcam of the vineyard.

He gains, according to him, for one hectare over 30.000 €. Usually, it is 12.000€, so this means three times as much. One of his sales arguments and tools is the labeling of every wine bottle with QR-codes. The customer can scan the QR-code and pursue for the whole season the site of this wine via his smartphone. (Sales manager, 11C)

Charging the product emotionally together with accessibility could lead to another business model called crowd farming. The farmer becomes a service provider for the customer. The customer buys a seed or animal and the farmer grows or raises it for a service fee. The customer can monitor the growth process via internet and can then consume the produced food (11C). In Spain, customers can rent or buy an orange tree. The farm grows the tree and, for a service fee they send the harvest to the owner of the tree (Urban, 2016). Please see Section 5.2.1 for other example, such as beef leasing.

To sum up, due to the digitalization of the production factors (e.g. fields), the food supply chain is enabled to offer their products as PSS with an additional value-creation stage. This stage will provide additional value by offering traceability services. The need of traceability and these PSS could lead to an evolving business model of all farmers (Section 5.3).

6 Discussion

This thesis explores the influence of digital interconnectivity on service innovation in the agricultural sector. The S-D-L and fourteen interviews enabled a holistic view on this topic, which led to four main findings that will be evaluated and set in relation with current literature. The findings can be summed up, that the interconnectivity of the prospected players triggers a continuously increasing data exchange of the players. As expected, this interconnectivity initiates a huge change in the agricultural sector due to servitization (Neely, 2013), interaction between the players and increasing transparency.

As Figure 2 shows, innovations for interconnectivity empower an increase in data sharing, which is transforming opportunities to co-producing value (Bournigal, Houllier, Lecouvey, & Pringuet, 2015; Weiß, 2013). Therefore, this lays the foundation of the prospected findings. The interaction and data sharing of the prospected players increases significantly, especially the interconnectivity of the agricultural artefacts allow information sharing, which before was difficult to realize (e.g. customer-farmer) (Hefley, Murphy, Demirkan, Spohrer, & Krishna, 2011). The sharing of information along the fertilization of fields upsurges the value of the information for each player. For example, the farmer can growth his harvest, the manufacturer gains information of the machine utilization, the farm solution provider can improve his data base and, thus, his algorithm and the retailer increases his sales and can optimise his offer (digital manager, 5C).

The information exchange combined with different information sources raises the value of information significantly for every player, but also lays the foundation for most digital architectural solution and services (Cebulsky & Günther, 2015; Turenne, 2017). Therefore, the farm solution provider functions as data exchange platform as he combines a high density of resources (meeting point of the information flows) and facilitates the data collection, thus a liquefaction of resources.

According to the findings of Lusch and Nambisan, the data transmission platform can be seen as service platform because it facilitates the service exchange and service innovation (Lusch & Nambisan, 2015). Thus, it is important that these data transmission platforms are able to bundle and collect all data sources. Otherwise, an optimum use of the co-creation of value or service innovation potential would not be possible (genius, 2017; Lusch & Nambisan, 2015). The platform agrirouter was a step in the right direction, but collected data showed reservations against the full implementation on the market despite the agreement of Fendt/AGCO to participate on the project (Fendt, 2017) .

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The controller of this focal point, the platform for data exchange, will be allowed to set up architectural control points for future innovation in the whole network and not become independent from other players as presented in Section 5.1.3.6. There is no non-proprietary-approach of the full-liners to provide this data platform, which includes all players. Thus, they could lose their current architectural control point on their machines, if retailers or other are implementing this platform (Porter & Heppelmann, 2014). In the automotive sector, this risk motivated the automobile manufacturers BMW and Mercedes to join forces to create a platform for mobility services (DPA, 2018) and together with Audi, they bought the map-provider Here to ensure their control over essential data for autonomous driving. Without this cooperation, IT-companies like Google would have stayed in control of this data (Wagner & Koch, 2017).

The fear of non-agricultural-companies gaining control of the sector by controlling the data flows, inspired the French government to offer AgGate, which is a public-private cooperation to build a neutral platform for data exchange. This platform aims to spread in the EU to guarantee a neutral data exchange. These data exchange platforms can stimulate service innovation in the agricultural sector (Bournigal, 2016).

The increasing importance of PSS in the offering of the players is also strengthened the enabled data flows. Akram detected the same increasing importance in the automotive business. He explained it with the implementation of IT, which is similar to the present finding (Akram, 2012).

He concluded, that this modification of offers is an indicator for Servitization. This is supported by the results of this thesis and will be discussed in the following.

As illustrated in Figure 2 interconnectivity influences the business models in the agricultural sector. According to the S-D-L lens, the importance of services and co-creating value increases due to servitization (Bournigal et al., 2015). The agricultural sector shifts form a product-oriented business via product-service-systems to a service-oriented business. Corresponding theory explains this by the transformation along a product service continuum as, e.g. PSS (Oliva & Kallenberg, 2003). The example of the machine manufacturers also shows this. In present, the importance of PSS (Section 5.2) will rise and, in long term the machine manufacturers will offer their machines as product-as-a-service systems or solution. This was proven by Claas-Mühlhäuser, the chair of board of Claas, in a presentation (Farm & Food 4.0, 2016). Due to the need for high investments, high logistic expenses and the agricultural idiosyncrasies, the offering of product-as-a-service is difficult to be economical (sales manager, 8C). One example of agricultural characteristics is the high variability of needed machinery support with rare high maxima (harvest-periods). Thus, there are small temporary peaks of demand and long periods with small demands (manager for service development, 7C).

Additionally, cannibalization effects on spare parts or maintenance services are detectable (Porter & Heppelmann, 2014). Porter and Heppelmann demonstrate PSS as a hybrid model in these scenarios (Porter & Heppelmann, 2014: 85). Data analysis and impressions presented at the congress Farm and Food 2016-2018, however, indicate that these characteristics will slow down the trend but will not impede it.

Another stimulus of agricultural service innovation is the traceability demand of the end-customers and the legislative (Brink & Chaves, 2017). On the one hand transparency of operations can increase, for example, customer satisfaction and create value like online package tracking (Chesbrough & Spohrer, 2006). On the other hand, most farm solution start-ups were founded to support the farmers by the increasing legal request of transparency (CEO, 10S).

This forced transparency will need a mind change in the prospected sector especially of the farmers (Heemsbergen, 2015). The farmer will become a vitreous farmer. For 30 percent of the farmers, this loss of data property is an obstacle for the implementation of digital solutions (Rohleder & Krüsken, 2016). This reluctance could be solved by an integration of the farmers into the process and being transparent what happens with their collected data (Ayuso, Rodríguez, & Ricart, 2006). Additionally, farmers are afraid of crossing future limits and disclose them due to the increasing transparency. For example, the farmer produces his products law-abidingly, but if in the near future science discovers, e.g., health damaging effects of a production factor, over night the harvest may become worthless (Farm & Food 4.0, 2017a). Another obstacle are legal concerns and was mentioned in Section 5.1.3.4. Farmers have concerns of repercussions if they marginally override certain limits due to calculation round ups, wind influences or other reasons. This obstacle is difficult to eliminate because, as mentioned, the demanded transparency wants to show the compliance of the product gaplessly as the research in the implementation of block chain into the agricultural sector shows (Galvin, 2017; Tian, 2016). Furthermore, the new label to indicate the production properties of meat shows the increasing transparency in the sector (Balser, 2018).

To conclude, the interconnectivity will have a huge impact due to servitization on the agricultural sector and, thus, on service innovation. The manufacturers, especially the full-range-suppliers could lose their focal position in the value network. The increasing demand of transparency and higher technological complexity will mainly encourage the change. Due to changing business models and higher transparency the presentation of the agricultural sector will change and lose its gap of marketing and reality.

7 Managerial implications for theory and management

This section proposes implications of the findings in theory and management. Interconnectivity is enabling a higher interaction in the value network and is so supporting new co-creation of value. This is mostly built on digital information exchange. The need for a platform for data exchange and the influence on the focal position in the value network were demonstrated. Additionally, the demand for transparency was illustrated as another driver for service innovation. In the following, implications for theory and management are drawn.

7.1 Implications for theory

On the one hand, this thesis provides findings about the influence of digital interconnectivity on an industry sector which is not commonly used as research field, the agricultural sector. Thus, it expands the data bases for future meta-studies and shows interesting research objects in the prospected sector as for example the implementation of a data exchange platform. On the other hand, the findings support to explore the supposition that the interplay of transparency and IT influences service innovation, perhaps in other industries as mining or forestry, especially with the focus on the end-customer's transparency demand (Bournigal et al., 2015; Chesbrough & Spohrer, 2006).

7.2 Implications for business

This thesis provides an overview of the changing environment of the prospected players, according to interviews, which was new to many actors. Thus, the offered data could be taken as input for business development. Pursuant to the determined need of a data exchange platform, it seems worth for full range suppliers to build an own non-proprietary platform or join existing platforms like agrirouter or Ag-Gate. Besides, the present findings support the movement of more transparency in the agricultural business, but it seems necessary to adjust also marketing promises to fit onto the new transparency (Liste, 2013).

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8 Limitations und outlook

The provided findings are based on qualitative data, which was collected in an interview study approach. Therefore, this thesis has the general limitations of a qualitative study, although preventions have been taken. As the sample of interviewees is very small, according to the prospected area of research, other interview partners could have validated these findings or extended the presented findings. A specific limitation is that only particular actors of the value network were interviewed. Even though the retailers, manufacturers and farm solution providers seemed the most qualified interview partners and due to a good overall picture because of repeated interviewing of different companies of these players, it cannot be certain that every aspect was covered, or other perspectives could have been given. Despite the literature updates and continuous literature research, the provided theoretical base cannot be on the latest state of art, thus, provided findings can be interpreted differently.

Future research could deepen the provided findings as the present thesis aimed to generate an overview of the topic. Especially the interaction between interconnectivity and transparency could be a fruitful topic to explore the influence on service innovation. Another interesting topic of research could be the continuation of this research and the influence of interconnectivity on the sector for several years with focus groups and case studies. This could validate the present findings and provide broader findings on the research question. As outlined, the findings could also be adapted to the industrial IoT. Most interview partners explained the wish for broader research on this topic, especially regarding changes of the value chain. Therefore, it should be possible to gain them as partners for continuous research.

The impact of higher transparency by offering production information of the actual product on customer purchase decisions would also be an interesting topic of research. Since there are differences of customer perception of the production environments and the real production environments, a mind change will be need (Ehrenstein, 2016).

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9 Conclusion

This interview study explores the influence of interconnectivity on service innovation in the agricultural business. Fourteen interviews were analysed to illustrate the picture of a more collaborating sector, where the digitization of non-digital artefact lay the foundation for an increasingly higher information sharing process. As the information exchange is essential for digital services and also gains importance for the non-digital world, the implementation of a data exchange platform is useful. The successful implementation of present platform approaches is not predictable as most full-range suppliers are not demonstrating the will to join. Due to the presented changes, the focal point of the value network could shift from the machine manufacturers to the controllers of the data exchange platform. In present, solution providers take the place of this platform.

The terms of interconnectivity, service innovation and transparency are mutually reinforcing each other. The innovations in interconnectivity are enabling new transparency services or solutions and the customer or legal demand of higher transparency pull solutions or innovations in interconnectivity. This interaction could be the topic of future research, also in other industries like forestry or mining where society increases its interest in transparency.

To conclude, interconnectivity supports the shift of the agricultural sector from a product-oriented to a service-oriented focus due to servitization. This includes changing business models, interactions between the players and increasing importance of services or solutions. Caveats of participating players could be lifted by more transparency of the data collection. Furthermore, the demand of transparency is one of the main drivers for interconnection solutions in the agricultural sector. The provided transparency might change the fashion of the public perception of the agricultural sector, so that one day the agricultural sector might advertise with its latest production techniques just like Mercedes does not advertise with its old cable breaks.

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Appendix A Relations

The examples were found in literature, interview data and background discussions.

S. Gack, *Service Innovation in Agricultural Business*, BestMasters,
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Examples of exchanges of the machine manufacturer in between the value network

= receiving = sending	*New exchange*	**Retailer**	**Farmers**	**Solution provider**	**Contractor**
Information about		Customer	*Usage behaviour; machine data (mostly through solution provider)*	*Usage behaviour; machine data, Information about technical environment*	*Usage behaviour; machine data (mostly through solution provider)*
Services		Teaching of customer; after-sales-services for customer	-	-	-
Goods		-	-	-	-
Money		Remuneration for goods / PSS	-	-	-
Information about		Products and solutions	-	Machines	-
Services		-	After-sales services	-	After-sales services
Goods		Products for sale	-	-	-
Money		Remuneration for services	-	-	-

Examples of exchanges of retailer in between the value network

= receiving = sending	*New exchange*	Machine manufacturer	Farmers	Solution provider	Contractor
Information about		Products and solutions	Customer needs	*Usage behaviour; machine data, Information about technical environment, Customer needs*	Customer needs
Services		-	-	-	-
Goods		Products for sale	-	-	-
Money		Remuneration for services	Remuneration for products, PSS and services	-	Remuneration for products, PSS and services
Information about		Customer	Products, solutions and services	Machines, product data (e.g. fertilizer) etc.	Products, solutions and services
Services		Teaching of customer; after-sales-services for customer	After-sales services, maintenance, *individualized solutions*, delivery etc.	-	After-sales services, maintenance, *individualized solutions*, delivery etc.
Goods		-	Products and PSS	-	Products and PSS
Money		Remuneration for goods and PSS	-	-	-

Examples of exchanges of farmers in between the value network

📩= **receiving** 📨= **sending**	***New exchange***	**Machine manufacturer**	**Retailer**	**Solution provider**	**Contractor**
Information 📩 about		-	Products, solutions and services	Machines, weather, plant status etc.	*Orders execution*
Services 📩		After-sales services	After-sales services, maintenance, *individualized solutions,* delivery etc.	Yield managment, soil analysation, *interconnectivity solutions*	Harvesting, pest-control, planting etc.
Goods 📩		-	Products and PSS	-	-
Money 📩		-	-	-	-
Information 📨 about		*Usage behaviour; machine data (mostly through solution provider)*	Customer needs	*Usage behaviour; Information about technical environment, Customer needs, production*	*Fields, plants, other production factors*
Services 📨		-	-	-	-
Goods 📨		-	-	-	-
Money 📨		-	Remuneration for products, PSS and services	Remuneration for services or solution	Remuneration for services

Examples of exchanges of solution providers in between the value network

= receiving = sending	*New exchange*	Machine manufacturer	Retailer	Farmers	Contractor
Information about		-	Machines, product data (e.g. fertilizer) etc.	*Usage behaviour; Information about technical environment, Customer needs, production*	*Usage behaviour; Information about technical environment, Customer needs, production*
Services		Machines	-	-	-
Goods		-	-	-	-
Money		-	-	Remuneration for services or solution	Remuneration for services
Information about		*Usage behaviour; machine data (mostly through solution provider)*	*Usage behaviour; machine data, Information about technical environment, Customer needs*	Machines status / maintenance, weather, plant status etc.	*Fields, plants, other production factors, order details*
Services		-		Yield management, soil analysation, *interconnectivity solutions*	Production optimisation, *interconnectivity solutions*
Goods		-	-	-	-
Money		-	-	-	-

Examples of exchanges of contractor in between the value network

(receiving icon)= receiving (sending icon)= sending	*New exchange*	Machine manufacturer	Retailer	Solution provider	Farmers
Information (receiving) about		-	Products, solutions and services	*Fields, plants, other production factors, order details*	*Fields, plants, other production factors*
Services (receiving)		After-sales services	After-sales services, maintenance, *individualized solutions*, delivery etc.	Production optimisa-tion, *interconnectivity solutions*	-
Goods (receiving)		-	Products and PSS	-	-
Money (receiving)		-	-	-	Remuneration for services
Information (sending) about		*Usage behaviour; machine data (mostly through solution provider)*	Customer needs	*Usage behaviour; Infor-mation about technical environment, Customer needs, production*	*Orders execution*
Services (sending)		-	-	-	Harvesting, pest-con-trol, planting etc.
Goods (sending)		-	-	-	-
Money (sending)		-	Remuneration for prod-ucts, PSS and services	Remuneration for services	-