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Procedia CIRP 83 (2019) 534–540

www.elsevier.com/locate/procedia

11th CIRP Conference on Industrial Product-Service Systems

Business Models for Industrial Smart Services – The Example of a Digital Twin for a Product-Service-System for Potato Harvesting

A. Kampker[a], V. Stich[a], P. Jussen[a], B. Moser[a]*, J.Kuntz[a]

[a]*Insitute for Industrial Management at RWTH Aachen University, Campus-Boulevard 55, 52074 Aachen, Germany*
* Corresponding author. Tel.: +49-(0)241-47705-205; fax: +49-(0)241-47705-199. *E-mail address:* benedikt.moser@fir.rwth-aachen.de

Abstract

Modern agricultural machinery manufacturers develop an increasing number of smart services to combine their already excellent physical products with an ever-growing number of physical and digital services to product-service-systems. However, this causes problems for the manufacturers, as these combinations of physical goods, services and digital services are still relatively new, and suitable business models are lacking. This paper presents a morphological framework based on a literature review and expert interviews to develop business models for product service systems. Based on the morphological framework, six different types of general business models for smart services were identified and will be described. The types were validated within the German-based research project Smart-Farming-World along with experts from agriculture and farmers. This paper discusses the first results of the validation with farmers and shows the potential of a business model for a digital twin in the context of potato harvesting.

Peer-review under responsibility of the scientific committee of the 11th CIRP Conference on Industrial Product-Service Systems

Keywords: Business Models; Industrial Smart Services; Product-Service-Systems; Digital Twin; Smart Farming

1. Introduction

Like all industries, agriculture has undergone an enormous digital transformation in recent years. Manufacturers of agricultural machinery not only sell their physical products to farmers and offer matching after-sales services. Whereas products used to be mechanical or electrical objects only, today they are complex systems of components as well as data-driven software applications [1]. Due to increasing customer demands they are also forced to develop additional digital services and sell them in combination with their already existing goods and services in their portfolio as product service systems [2].

The potential of this development in agriculture has not yet been described in detail [3, 4]. Agricultural machinery manufacturers are faced with the challenge that their machines are still the centre of their business activities and that they have to offer appropriate services around them. For many companies, however, the development of suitable business models for this combination poses a challenge. However, modern agricultural machinery is already characterized by a high degree of connectivity and therefore offers an ideal starting point for tackling further developments towards successful product-service-systems and corresponding business models [5, 6].

The aim of this paper is to provide companies with a framework for the successful development of business models for smart services. It describes smart services' typical elements of business models and derives six characteristic types of business models. In this paper, a particular focus is placed on business models for a digital twin of a product-service-system for potato harvesting. Therefore the key research question is: "*What do successful business models for smart services based on a digital twin of a product service system look like?*"

The developed business models are currently being tested and validated in real applications with farmers and experts from agricultural machine manufacturers. First results of this validation and possible business outcomes are presented in this paper.

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10.1016/j.procir.2019.04.114

2. Research Background

2.1. Smart Services

The term *smart services* was first used in 2005, but has been controversial in the literature ever since [3, 7, 8]. What all definitions have in common is that smart services are based on intelligent and connected products that collect data about themselves and their environment. Collected data is combined with information from other sources and processed into smart data. On the basis of this valuable information, smart services and associated business models can be developed [4]. Smart services are also defined as individualized combinations of physical and digital services. They create a benefit for the customer by offering a very individual and context-related added value [6, 7, 9]. In summary, smart services are a new type of product service system, as they combine physical products, physical services and digital services in unprecedented ways and act as an overall system [10].

2.2. Business Models

In the literature, there is no common definition for the term business model, since the term has been considered from different scientific disciplines with different emphases in the past [11, 12]. However, all considerations have in commonthat business models describe the different business processes of a company to achieve the defined goal. Business models consider the processes of an enterprise holistically, reduce their complexity however so far that a holistic illustration of the way arises, how an enterprise creates, sells and maintains value in the market on a long-term basis [11, 13, 14]. The three basic elements of any business model are the service delivery model, the service offering model and the revenue model. These elements describe how a company produces a service, how this service is offered to the market or customers, and finally how a return is generated with this service [15].

2.3. Potato Harvest and its Digital Twin

The success or failure of potato cultivation is determined by various criteria that must be taken into account when planning the field, sowing, care and harvesting of potatoes. One of the most important process stages is the harvest. Harvesting takes place mechanically using trailed or self-propelled harvesting machines. The highest priority when harvesting potatoes is to harvest the fruit without damage, as damage to the potato tuber significantly affects the subsequent storage life and ultimately the quality of the harvested fruit. This required high quality can only be guaranteed if the machine operators adjust the machines correctly and receive the best possible training from the manufacturer beforehand [16].

This means that shocks have the greatest economic impact or damage potential and are also the easiest to avoid through better machine settings during harvesting. To support operators during harvest a "Digital Potato" can be used as a digital twin or product memory of real potatoes [17]. It is a plastic object the weight and size of a real potato, which is equipped with sensors to detect impacts and rotations [18]. The data is analysed in real time on the agricultural machine and the knowledge gained is displayed to the farmer or driver. The data is evaluated using machine learning methods. This includes classifying harvests and continuously calculating crop damage distributions for the field based on the type of potato planted and its characteristics [16]. The digital potato thus represents the digital twin of the real potatoes during the harvest and offers enormous added value as smart services for an existing product service system [4, 17].

3. Methodology

The development of the business models for an industrial smart service based on a digital twin in potato harvest followed a five-step approach as shown in Fig. 1. The development process can be further separated into a pre-evaluation phase using a morphological framework, a detailing phase and last but not least a validation phase with real customers. The focus of this paper will be on the detailing and validation phase, since the first phase is already described in detail in previous publications [21].

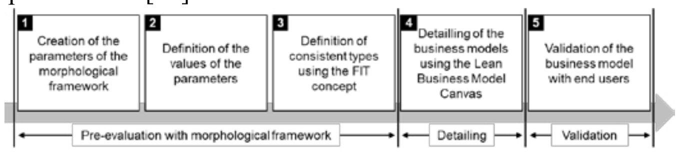

Fig. 1. Procedure to develop and validate business models for smart services

In the first step a morphological framework to describe business models for industrial smart services was derived by the superposition of two different analyses. The first was to describe segments of business models based on already existing frameworks characterizing business models such as Osterwald *et al.* 2010 [14] or Schuh *et al*. 2016 [15]. The identified segments were combined with the increasing influence of the digitalization on the economy and its business models. Influencing factors are for instance the increasing importance of data as a competitive factor and key resource or the strong focus on customer benefits and customer value [4, 19, 20]. An detailed description of all segments and the influencing factors of digitalization is described in Kampker et al. 2018 [21].

Based on the superposition of the segments of business models and the influencing factors a morphological framework with its parameters and values was derived in step two. The complete morphological framework is shown in Fig. 2.

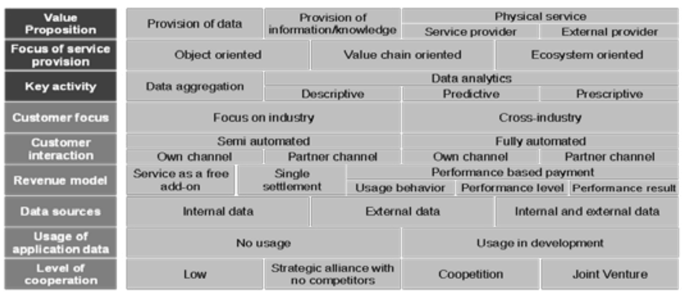

Fig. 2. Morphological framework of business models of industrial smart services [21]

The morphological framework is divided in two groups: constituent and detailing parameters. The constituent parameters are value proposition, focus of service provision and key activity. These first parameters are used in step three to derive different types of business models of industrial smart services.

Value Proposition:

To position successfully an industrial service provider in the market, it requires an outside-in consideration to derive the appropriate range of services [15]. This means that a company identifies and analyses the customer's wishes and expectations in order to derive a suitable service offering. The benefit offered by smart services can be either virtual or physical [27]. Virtual services include the provision of data, information or knowledge. If the service is of physical nature, the product and its digital service are combined into a hybrid bundle. The customer gets an integrated overall solution. The offering can be either provided by the company itself or a third party [28].

Focus of service provision:

In order to offer smart services, industrial companies need to answer strategic positioning questions [29]. If the smart service focuses on individual systems or machines, it is an object-oriented focus of service provision. If the real-time visualization of the machine parameters is not limited to the machine of the supplier, but also includes machine data from other manufacturers within the customer's company and other external data from the value chain, the focus of service provision is expanded and therefore value chain oriented. In the last step, the focus of service supply is ecosystem oriented. Data from the entire ecosystem is linked in order to offer the greatest possible benefit to the user. The data is available not only to the user, but also to other participating companies within the ecosystem [30].

Focus of service provision:

The key activity of the industrial smart service is focused on the entire topic of data collection and aggregation. Of course there are also other activities necessary to provide a suitable smart service such as maintenance and repair activities for example, but due to the focus on data based services it is not described in more detail. The characteristic includes both the own acquisition of data by sensors (data generation) and the purchase of external data (data acquisition). Since the analysis of data is an important activity [31], it is being further elaborated. The data analysis can be divided into the sub-variants descriptive, predictive and prescriptive [27, 32]. Descriptive analysis of data is dedicated to description. It shows what happened in the past or what is currently happening. Predictive data analysis deals with the future and includes predictions. The result of the analysis is therefore a prognostic statement [33]. The prescriptive data analysis is a step further and adds an evaluative perspective. Recommendations for action are given based on knowledge of future conditions. These should serve to optimize processes and decision-making [30].

All other parameters are used for further detailing of the business models. Nevertheless, the three constituent parameters are most important for industrial smart services. Especially the focus of the service provision is important in industrial environments due to the complex arrangements in supply chains and value networks. Based on the morphological framework six different types of industrial smart services were developed in step three based on the FIT-concept of Ansorge [22].

In step four of the process, experts from the Smart-Farming project evaluated in several workshops the feasibility of each type of business model for the described use case of a digital twin for potato harvest. Out of these six types three business models were identified and further detailed using the Lean Business Model Canvas by Maurya 2012 [23]. The canvas is based on the business model design toolkit by Osterwalder and Pigneur [14] and is especially feasible to develop and document innovative business models. With this tool, all important aspects of a business model can be summarized and iteratively further developed in the shortest time possible. The framework is shown in Fig. 3 and will be further explained in chapter 4.

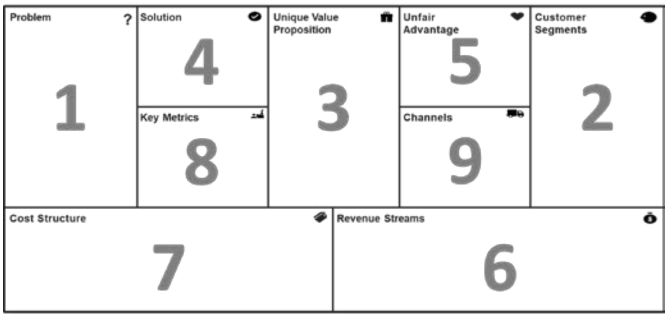

Fig. 3. Lean-Business-Model-Canvas by Maurya 2012 [23]

In the business model design process last step the developed cases were validated during field tests of the digital twin with real farmers in autumn 2018 and spring 2019. First results of the application will be presented in chapter five.

4. Types of Business Models for Industrial Smart Services

While using the morphological framework described before six different types of business models for smart services were identified. These will be explained in the following.

Type 1: Data producer:

The first type "data producer" collects data of a physical good using sensors. It aggregates this data and is able to sell these data sets to other external customers. It has no abilities to analyze data and therefore only receives small revenues from selling the data to others who can use the data (cf. Fig. 4) [21].

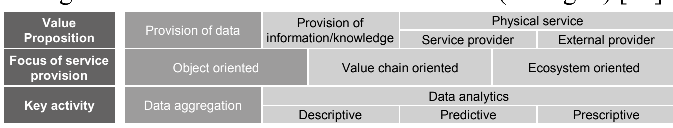

Fig. 4. Parameter values of the type data producer

Type 2: Data broker:

This type collects data from external machines along the whole value chain or ecosystem. It is not analyzing the data, but sells sets of more valuable data to others who can use the data (cf. Fig. 5) [21].

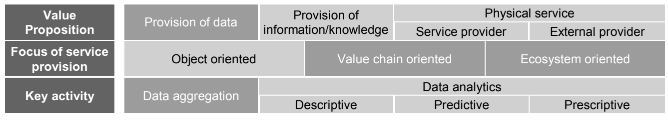

Fig. 5. Parameter values of the type data broker

Type 3: Decision supporter:

This type focuses not only on the aggregation of data, but empathizes the knowledge creation to provide the user with valuable process knowledge. It increases the productivity of its own machines to increase the value the customer gets from this product-service-system (cf. Fig. 6) [21].

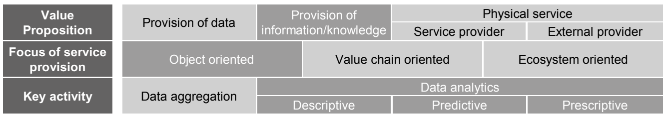

Fig. 6. Parameter values of the type decision supporter

Type 4: Added value provider:

The added value provider is quite similar to type 3. The only difference to the type before is that it puts more emphasis on the machines along the whole value chain or even the entire ecosystem. This leads to a significantly higher added value for the customer, as knowledge is based on processes across manufacturers and companies. (cf. Fig. 7) [21].

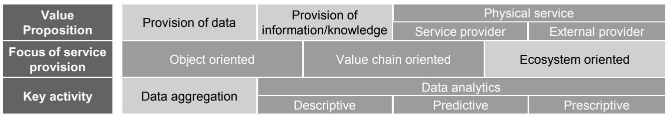

Fig. 7. Parameter values of the type added value provider

Type 5: Solution provider:

The solution provider offers a complete product-service-system to the customer. To realize this offering its main activity is the analysis internal as well as external data in order to gain information that can be used to provide valuable solutions, such as machine optimization. Ideally, the solution provider can take over entire processes of the customer and promise him a specific result of the process. (cf. Fig. 8) [21].

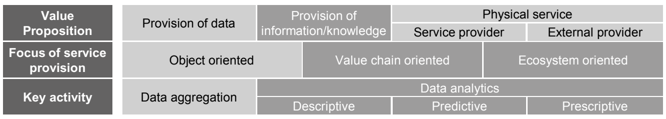

Fig. 8. Parameter values of the type solution provider

Type 6: Orchestrator:

This type offers a product-service-system as a complete solution to the customer. However, the orchestrator only decides which services are provided by itself and which by third parties. The goal is always to offer the best possible service, regardless of whether it is an own solution or one of another players within the ecosystem, (cf. Fig. 9) [21].

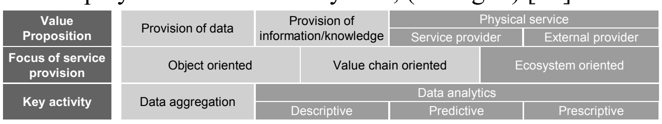

Fig. 9. Parameter values of the type orchestrator

5. Business Model Application and Validation

The explained types of business models were used as a starting point to further detail an actual business model for the use case of a digital twin for potato harvesting. In this chapter the technical setup of the use case will be described, followed by a detailed description of the possible business models and a validation with farmers as possible end users.

5.1. Description of the technical Setup of the Digital Twin for Potato Harvesting

As mentioned before, operators of harvesting machines currently setup the machines during potato harvesting based on data from the previous year and the “gut feeling” of each operator. In this case the productivity of each machine is currently highly dependable on the experience of the operator and not at all standardized. To reduce the number of damaged potatoes during the harvest, the digital twin is planted in the field next to the real potatoes and is picked up by the harvesting machine. The twin runs through the same process stages during the harvest as the real potatoes and uses various built-in sensors to display the condition of the neighboring potatoes in real time. This includes in particular the detection of shocks and blows as well as the rotation speed to derive the abrasion. The generated data can be used to adjust the settings of the machines to the current conditions during the harvest, thus minimizing damage to the potatoes [18]. One of the most common sources of damage is excessive stress due to falling damage at the transition between different conveyor belts. The operator receives real-time information about incorrectly adjusted conveyor belts and can react accordingly to increase the productivity of the harvester and ensure a high quality of the product [16].. The technical architecture of the digital twin is further detailed in Fig. 10.

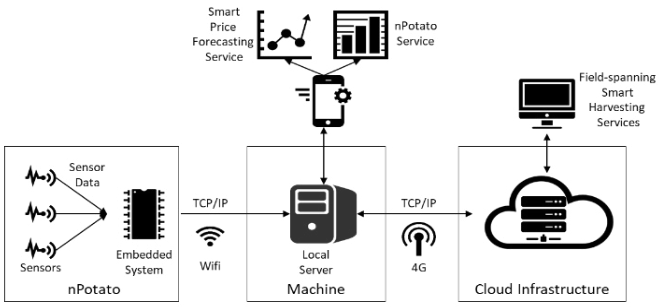

Fig. 10. Technical architecture of the digital twin [16]

5.2. Detailed Business Models for the Digital Twin

The previously derived types were used to work out possible business models for the digital twin in several workshops together with experts from agricultural machinery manufacturers and end users. A total of three possible business models were identified, which are described in more detail below. The Lean-Business-Model-Canvas was used for an uniform development and documentation [23]. The combined presentation of all business models is summarized in Fig. 11 on the next page. The individual business models are explained in further detail in the following chapters.

Decision supporter for machine operators

The data of the digital twin is analyzed and recommendations for action are given. A correction of the machine parameters is recommended to the operator via a digital interface.

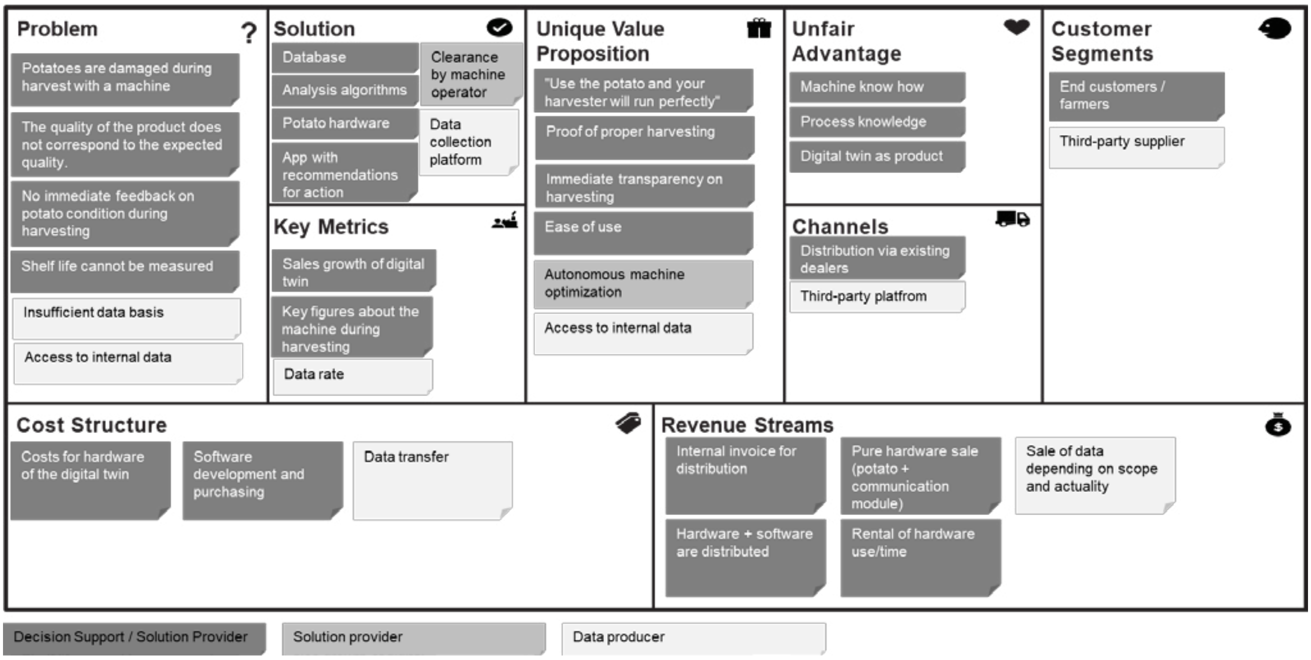

Fig. 11. Lean-Business-Model-Canvas for the Digital Twin

1. Problem and customer segments

The damage to the potato caused by the harvesting process reduces, its shelf life. At the moment, the operator of a harvesting machine does not receive immediate feedback on the condition of the potato during the harvesting process. The decision supporter addresses this problem and identifies the operator and the farming company as a direct customer.

2. Value proposition

The value proposition communicated to the customer is, on the one hand, an optimally adjusted potato harvester when using the digital twin and, on the other hand, proof of proper harvesting. Damage to the crop is minimized and the storage life of the potatoes is significantly increased. Farmers can thus react more flexibly to market demands. The responsibility for the best machine settings during the harvesting process shifts from the farmer to the service provider. The digital twin creates immediate transparency about the harvesting process.

3. Solution and unfair advantage

The data collected on the potato's sensor node are collected in a potato database, sorted using algorithms, analysed and sequentially derived recommendations for action. These recommendations are then presented to the operator via an app. The unfair advantage of this business model for an agricultural machinery manufacturer lies in its know-how about the product and the process knowledge about the potato harvest.

4. Cost and revenues

The business model provides four different options of revenue model. First, the service can be handled via internal invoices via sales. This does not change the previous relationship between the dealer and the agricultural machinery manufacturer. The second revenue model is a pure hardware sale of the digital potato. The product nPotato is detached from the product and can be purchased as a supplement. However, this model does not include any supporting software. The third alternative is to distribute the software in combination with the hardware. The two products are offered in a bundle and can be marketed with different revenue models. A pay-per-use or pay-per-performance model is easy to establish here. Another possibility is that the product does not become the property of the operator. Instead, the hardware, including the software, is leased to the user. In this case, the risk for functionality and performance remains with the provider and thus relieves the user.

5. Key matrics and channels

The success of the business model can be directly derived from the comparison of customers with and without the use of digital twin. This information is particularly relevant for the manufacturer of agricultural machinery. For the customer, the influence of the nPotato can be directly derived from the increased yield of the harvest of the corresponding machine.

Solution provider for autonomous harvesting machines

Through the analysis of the collected data, not only recommendations for action are given, but direct changes in the settings of the machine are made automatically. Since many components of the business model are similar to the previous one, only the individual differences will be presented in detail.

1. Solution and unfair advantage

In this case the machine operator only has to give his approval to the recommendation and the service provider is able to change the settings remotely.

Data producer for a harvest recommendation system

With the type data producer, the company that harvests the potatoes records the data and sends it to a potato database. Therefore, no data analysis is carried out by the company itself. It merely positions itself as a pure supplier of data.

1. Problem and customer segments

For a successful harvest optimization a comprehensive data base is necessary. Thus it is necessary to have a high level of contributing parties of valuable data sets. The buyers of this data are third party providers of harvest optimisation software.

2. *Value proposition*

Within the use case, it is ensured that valid data is made available in a predefined scope and actuality to increase the value of a potato database.

3. *Solution and unfair advantage*

By merging and providing several data sources, this use case enables existing data to be used profitably and further processed by a third-party provider.

4. *Cost and revenues*

The collected data is continuously merged into a growing database at a fixed price. This results in a direct added value for the owner of the data and the user can create a further benefit from it.

5. *Key metrics and channels*

To analyse the business models impact the data rate of sold packages can be monitored.

5.3. Validation of the Business Models with Farmers

On the basis of user surveys with a total number of five farmers and machine operators the following preliminary results for the business model evaluation could be achieved and will be more detailed in the following months: Using the average data for potato harvesting of the year 2018 the test results allow a possible yield increase of 5 % per cultivated hectare [24]. On this basis, an average increase in turnover of € 560 per hectare can be assumed [25, 26], which shows a high potential of the first developed business model. In addition, farmers stated that they see a high potential to collect and sell data of the potato harvesting and contribute to a potato database. Farmers preceived a potential to earn money via this digital business model. In addition farmers see a great potential in the training of unskilled machine operators using the digital twin. In order to achieve an average harvest result, a great deal of experience is still necessary. This dependence can be easily reduced by the direct feedback of the digital twin during the harvesting process and before hand. At the same time, the discussions show that an autonomous adjustment of the machine parameters is taken up with a high level of skepticism. However, machine support in machine operation, for example by visual specifications, is also highly desirable for experienced machine operators.

The validation with farmers and end users show that the developed business models have a high potential in the market. First quantitative calculations of the yield increase show also a high marcoeconomic benefit based on the usage of the digital twin. However, especially autonomous systems still meet with great reservations among farmers, as they often still rely on their own experiences and not necessarily on data-based decisions. The real added value and any fact-based reservations against autonomous systems must be better communicated via functioning business models.

6. Contribution and Discussion

This paper has introduced different types of business models of industrial smart services and detailed three of them for a digital twin of a product-service-system to support potato harvesting. The initial research question of what makes business models for smart services based on a digital twin of a product service system successful has been answered in detail. Two out of the three developed business models show the high potential of digital twins during harvesting processes and even their macroeconomic impact. Furthermore, especially the validation with farmers and machine operators showed even other opportunities to use the digital twin. Nevertheless, the survey also shows that many business models based on autonomous machines and settings are still met with great skepticism and that these models are therefore currently still unable to find an application.

Further research activities are required to better understand the particularities of business models for product-service-systems and digital twins with. Especially the communication of different value propositions, the potential of pay-per-x revenue models and the whole sales organization are interesting research topics that have not yet been studied in detail. The change in the business model from a purely product-centric model to a solution model poses a major challenge for industrial companies in particular. What the change to subscription business models can look like has not yet been clarified, both in practice and in research, and it remains to be worked on further.ö

Acknowledgements

The research work underlying this paper was conducted as part of the project “Smart-Farming-World”, which is funded by the German Federal Ministry of Economic Affairs and Energy (BMWi) with the project funding reference number 01MD16007E.

References

[1] Schallmo D, Rusnjak A, Anzengruber J, Werani T, Jünger M. Digitale Transformation von Geschäftsmodellen: Grundlagen, Instrumente und Best Practices. Wiesbaden: Springer Gabler, 2017.

[2] Gassmann O, Sutter P. Digitale Transformation im Unternehmen gestalten: Geschäftsmodelle Erfolgsfaktoren Fallstudien. Regensburg: Carl Hanser Fachbuchverlag, 2016.

[3] Chae BK. Big data and IT-enabled services: Ecosystem and coevolution. IT Professional 2015;17(2): 20-25.

[4] Kagermann H, Riemensperger F, Hoke D, Schuh G, Scheer AW. Smart Service World: Recommendations for the strategic initiative ‚web-based services for business. *acatech – Deutsche Akademie der Technikwissenschaften*, Berlin, 2015.

[5] Barrett M, Davidson E, Prabhu J, Vargo S. Service innovation in the digital age. Key contributions and future directions. MIS Quarterly 39, 2015.

[6] Porter ME, Heppelmann JE. How smart, connected products are transforming competition. Harvard business review 2014;92(11):64-88

[7] Allmendinger G, Lombreglia R. Four strategies for the age of smart services. Harvard business review 2005;83(10):1-11.

[8] Klein M. Design rules of smart services. Overcoming barriers with rational heuristics. Ph.D. dissertation, University of St. Gallen, St. Gallen, Switzerland, 2017.

[9] Wünderlich NV, Wangenheim FV, Bitner MJ. High tech and high touch: A framework for understanding user attitudes and behaviors related to smart interactive services. Journal of Service Research 2012;16(1):3-20.

[10] Bullinger HJ, Meiren T, Nägele R. Smart Services in Manufacturing Companies. 23rd International Conference on Production Research, ICPR 2015. Manila, pp. 7-14, 2015.

[11] Bieger T, zu Knyphausen-Aufseß D, Krys C (eds.. Innovative Geschäftsmodelle. Academic Network. Springer, Berlin 2011.

[12] Johnson MW, Christensen CM, Kagermann H. Reinventing your business model. Harcard business review 2008;87(12):52-60.
[13] Schuh G, Boos W, Kampker A, Gartzen U. Strategie. In: Handbuch Produktion und Management 1. Strategie und Management produzierender Unternehmen. Eds.: G. Schuh; A. Kampker. 2. Auflage. Springer, Berlin 2011, p. 63-131.
[14] Osterwalder A, Pigneur Y. Business model generation. A handbook for vision-aries, game changers, and challengers. Flash Reproductions, Toronto 2010.
[15] Schuh G, Gudergan G, Grefrath C. Geschäftsmodelle für industrielle Dienstleistungen. In: Management industrieller Dienstleistungen. Eds.: G. Schuh; G. Gudergan; A. Kampker. Handbuch Produktion und Management. Springer, Berlin 2016, p. 65-104.
[16] Maaß W, Pier M, Moser B. Smart Services in der Landwirtschaft. In Service Engineering, K. Meyer, S. Klingner, C. Zinke. Wiesbaden: Springer Vieweg, 2018, p. 167-181.
[17] Schuh G, Anderl R, Gausemeier J, ten Hompel M, Wahlster W (eds.). Industrie 4.0 Maturity Index: Managing the Digital Transformation of Companies. München: Herbert Utz Verlag; 2017.
[18] Maaß W, Shcherbatyi I, Marquardt S. Real-time Decision Making with Smart Farming Services. Proc. of 75th International Conference on Agricultural Engineering (AgEng), 2017.
[19] Dijkman RM, Sprenkels B, Peeters T, Janssen A. Business models for the Internet of Things. International Journal of Information Management 2015;35(6): 672-678.
[20] Kreutzer R. Treiber und Hintergründe der digitalen Transformation. In: Digitale Transformation von Geschäftsmodellen. Grundlagen, Instrumente und Best Practices. Eds.: D. Schallmo, A. Rusnjak, J. Anzengruber, T. Werani, J. Jünger. Springer Gabler, Wiesbaden 2017, pp. 33-58.
[21] Kampker A, Jussen P, Moser B. Industrial Smart Services: Types of Smart Service Business Models in the Digitalized Agriculture. In: Proceedings of the 2018 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), Bangkok 2018, pp. 1081-1085.
[22] Ansorge B. Ordnungsrahmen für die Positionierung industrieller Dienstleister. Schriftenreihe Rationalisierung, vol. 129, Ph.D. dissertation, RWTH Aachen University, Aachen, Germany, 2014.
[23] Maurya A. Running Lean: Iterate from Plan A to a Plan That Works. O'Reilly, Sebastopol 2012.
[24] Leiting, T, Moser, B. Smart-Farming-World. Interplay of Smart Services and Systems to support Potato Harvest. Presentation during the EPoSS General Assembly & Annual Forum 2018 and MNBS 2018, Thessaloniki 2018.
[25] Statista: Average potato production per hectare in the Netherlands from 2012 to 2018 (in kilos). Online via: https://www.statista.com/statistics/753103/average-potato-production-per-hectare-in-the-netherlands/. Last checked: 29.03.2019.
[26] Raiffeisen: Kartoffelpreis in EUR/dt (EEX). Online via: https://www.raiffeisen.com/markt/telegramm/produkt/eex/kartoffeln/index.html. Last checked 29.03.2019.
[27] Hartmann, P M, Zaki, M, Feldmann, N, Neely, A. Capturing value from big data – a taxonomy of data-driven business models used by start-up firms. International Journal of Operations & Production Management 2016;36(10): 1382 – 1406.
[28] Fleisch, E, Weinberger, M, Wortmann, F. Geschäftsmodelle im Internet der Dinge. HMD Praxis der Wirtschaftsinformatik 2014;6(8): 812 – 826.
[29] Kampker, A, Frank, J, Jussen, P. Digitale Vernetzung im Service. Wandel im Servicegeschäft zwingt Unternehmen zum Handeln. WiSt – Wirtschaftswissenschaftliches Studium 2017;46(5): 4-11.
[30] Herterich, M M, Uebernickel, F, Brenner, W. The Impact of Cyber-physical Systems on Industrial Services in Manufacturing. Procedia CIRP 2015;30(30): 323-328.
[31] Brownlow, J, Zaki, M, Neely, A, Urmetzer, F. Data-Driven Business Models: A Blueprint for Innovation. The Competitive Advantage of the New Big Data World. Cambridge: Cambridge Service Alliance; 2015.
[32] Delen, D, Demirkan, H. Data, information and analytics as services. Decision Support Systems 2013;55(1): 359-363.
[33] Samulat, P. Die Digitalisierung der Welt. Wie das Industrielle Internet der Dinge aus Produkten Services macht. Wiesbaden: Springer, 2017.