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ORIGINAL PAPER

DEVELOPING SMART SERVICES BY INTERNET OF THINGS IN MANUFACTURING BUSINESS

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ABSTRACT. **Background:** The aim of this study is to introduce a framework, which describes a customer-oriented approach for developing data-driven services by the Internet of Things (IoT), also known as "Smart Services" in manufacturing business.

Methods: A literature review presents a background for IoT, data and digitalization of services, as well as the role of simulation technologies for the development process of Smart Services. For the empirical study, an agricultural tractor manufacturer case company was analyzed utilizing Customer Needs Assessment tools to determine the new service requirements.

Results: The agricultural industry is also adopting the IoT related technologies to deliver services which are able to track crop environments in order to optimize crop yields and develop sustainable outcomes.

The results obtained from the Need Interpretation Table and the Trace Matrix show that farmers need Smart Services to be able to connect their tractors and implements to the Internet for a better understanding of agricultural operations. They also demand a personalized everyday working plan based on data analyzed on previous work shifts. From the case company side, it is important to collect and analyze usage data, such as temperature, humidity and pressure of tractor environment, as well as data related to determine root causes and failure rates.

Conclusion: The scientific contribution demonstrates the relationship between Product Lifecycle Management and IoT, and how it can leverage Smart Services. The practical contribution was based on the empirical study results by delivering smart service propositions in a tractor company, such as operation and remote failure tracking, showing customer demands for machine productivity, time saving and sustainable resource optimization.

Key words: industrial product service systems, product lifecycle management, Internet of things, smart services, customer needs assessment.

INTRODUCTION

The complexity of businesses in the current economic environment has transformed the way organizations deliver value to customers by shifting an approach a networked and shared value creation [Möller et al., 2005]. Organizations in several product processes from different value chains are creating an ecosystem where participants' business activities are linked to a platform [Muegge, 2011]. Muegge [2011], defines a platform as a group of entities with interconnected assets, which can utilize such resources to deliver interrelated products or services.

Industrial companies are opting to offer product-related services throughout the product lifecycle due to the increasing input costs and competition [Herterich et al., 2015]. This practice is known under the term "servitization", a service-oriented practice continuously growing among manufacturers, which is changing their offer from selling solely tangible products to complementary services customized to the product [Baines et al., 2009]. Hence, the combination of "servitization" and the traditional practice

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of selling tangible products is referred as Product-Service Systems (Aurich et al., 2006). Industrial Product-Service Systems (IPSS) refer to the industrial field of such product and service bundles [Mikusz, 2014].

The term “Internet of Things” (IoT) refers to a “global network infrastructure where physical and virtual objects are discovered and integrated seamlessly” [Kiritsis, 2011]. These embedded technologies, in the form of sensors, actuators, and radio-frequency identification tags (RFIDs), monitor and gather data related to the behavior, conditions, and environment of a single item or product [Pankakoski, 2015]. The data is later analyzed to transform it into valuable insights and information, used to optimize product processes during lifecycle. The Industrial Internet of Things (IIoT) is the field of IoT related to respond to product information requirements in manufacturing environments [Bras, 2009]. Utilizing IIoT for delivering PSS, also known as “Smart” or digital services, will allow different stakeholders to acquire more flexibility by responding faster to changes in customer needs and product requirements [Gomez et al., 2009].

The objective of this study is to present a new framework for developing product and service bundles with embedded technologies and the IoT. The research question is defined as: How manufacturing companies can leverage the Internet of Things from a customer-oriented perspective for developing smart services?

Based on this question, the expected outcome for this study is to determine the way the IoT facilitate manufacturing companies to develop customer-oriented services. According to Abramovici, Göbel, and Neges [2015], there is an important gap of tools for engineering Smart Services based on data and ICT. Through a literature review and an empirical case study, the expected result is to show the foundations for developing data-based services in the manufacturing business.

RELATED RESEARCH

Information flows along product lifecycle

Product Lifecycle Management (PLM) is a strategic approach with three essential dimensions [Kiritsis, 2011]. The first one related to managing accessibility and use of product definition information, the second aims to maintain the integrity of such information, the last chases to achieve and maintain business processes used to create, store, share and use information [Kiritsis, 2011].

Information systems allow stakeholders to create and use data within PLM systems, since they can track, manage and control product information at any phase of the lifecycle. Facilitating horizontal and vertical information flows [Kiritsis, 2011, Terzi et al., 2007].

There is a generalized desire from value partners to develop solutions to deal with the problem presented when product information flow is interrupted when it is used, maintained, serviced or recycled [Kiritsis, 2011]. Closed-loop Product Lifecycle Management (CL2M) is an extended PLM approach for improving product design, manufacturing, use, and disposal through data collected and used by technologies (IoT) in a networked environment [Främling et al., 2013]. The IoT goal within CL2M is to solve the problem by eliminating the gaps and interruptions among lifecycle phases.

IoT for product lifecycle value creation

For closing information flows, it is necessary to have the appropriate technology able to monitor and track lifecycle information. Emerging “embedded” technologies, also known as smart devices, are intelligent control units “embedded” to devices in forms of sensors and actuators, able to monitor products and their environment. [Kiritsis, 2011, MacDougall, 2014].

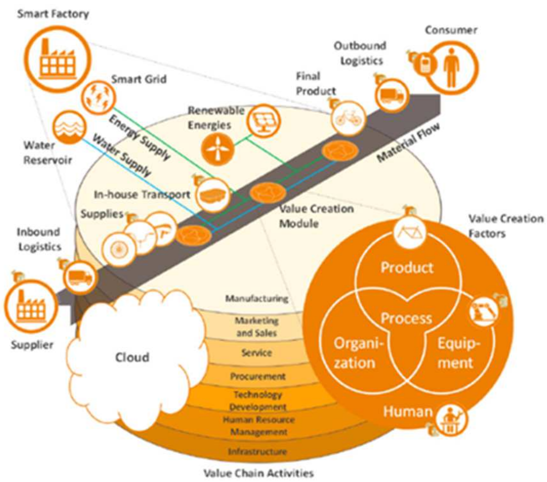
The concept of IoT has been recently obtaining considerable attention within several industries. The IoT can be defined as a global network of interconnected embedded devices able to sense, communicate, identify and collect data from their environment by the employment of technologies such as sensors, actuators and radio frequency identification (RFID), known as "Smart" devices or Cyber-Physical Systems (CPS) [Gomez et al, 2013, CERP-IoT Cluster, 2009]. Such data (big data) is then stored and mined using "smart algorithms based on correlations and probability calculations" [Kagermann, 2015], for obtaining valuable knowledge.

The Industrial IoT came to enhance efficiency and productivity within manufacturing, farming, logistics, among other several straggler sectors. Integrating "smart" devices in the cloud to a machine, will allow such machine to be aware of its status and surrounding environment, e.g. detecting wears on the brakes or if some component needs to be replaced [8]. "The machine also knows how much time it has left before maintenance is required" [Pankakoski, 2015]. In addition, IoT benefits operators in the way it provides them feedback related to the optimal operation of the machine, working as a digital trainer and evaluator.

Industry 4.0 is known as the following step of the third industrial revolution, characterized by the automation of production processes by IT and electronics [Kagermann, 2015]. It focuses on digitalization of manufacturing and industrial services by utilizing Smart devices in the IoT as the main means to connect productive entities among each other, being manufacturing the central point for all the "Smart" product lifecycle. This connection grants the most optimal actions based on data analyzed, synchronizing product processes with the IoT [Kagermann, 2015, MacDougall, 2014].

The Industry 4.0 perspective is classified into two fields, macro and micro [Stock et al., 2016]. The macro combines value chains and CPS, on a lifecycle point of view, where different value creation modules represented as "Smart Factories" exchange information, materials and energy among each other. Value creation modules are entities "cross-linked throughout the complete value chain of a product lifecycle as well as with value creation modules in value chains of adjoining product lifecycles" [Seliger, 2007]. Value creation factors are defined by all the products, equipment, and people integrated into a value creation module.

The micro perspective describes the internal environment of a particular value creation module. Represented by a production line, cell, module or any other productive entity within the "Smart Factory". In the micro perspective, the "Smart Factory" is always exchanging information in real-time with its factors and value chain activities. The micro perspective is graphically presented In Figure 1, as well as its interaction between external value chain activities.



Source: Stock et al., 2016

Fig. 1. Micro perspective of the Industry 4.0

Manufacturing industry participants are more concerned in offering customized services such as maintenance, repair, training, overhauling, and technical supporting, commonly known as "Servitization in manufacturing" [Lightfoot et al. 2013]

It takes the "Servitization" approach from manufacturing companies to switch from a physical product-based business to a service-oriented strategy. The term Product-Service Systems (PSS) has been an object of study of several authors, interested in the opportunities this new trend represents for the development of new sustainable business models. PSS are defined by a merchantable combination of products and services able to meet or surpass customers' needs in a sustainable way [Goedkoop et al, 1999, Tukker, 2004]. For

Reim, Parida and Örtqvist [2015], the way a company operates and deliver value for stakeholders (Business model), depends on each company or value chain goals. They classify the service-oriented business model strategies as following:

a) Product-Oriented: Selling product-related services in addition to the tangible product (Product maintenance, support, recycling)
b) Use-Oriented: Selling accessibility and availability by renting the usage of tangible products and their intangible services. Commonly known by the periodic payments by contract.
c) Result-Oriented: Selling results, outcomes or performance. No physical product or services are sold. Offering outcomes based on measurable results. (Reim et al., 2015).

The PSS product and service design has the characteristic of considering the whole product lifecycle as the primary reference for new developments [5]. According to Reim, Parida and Örtqvist [2015], for designing and developing customized services, it is firstly necessary to understand and assess product and service requirements.

The Industry 4.0 has leveraged service-oriented business models for manufacturers. CPSs embedded with industrial equipment allow service providers to improve their value-added offers by improving efficiency in support, maintenance, and usage. Services processes such as condition monitoring, operations tracking, and predictive maintenance are only a few examples of how services could be provided to different customers in the value chain. Nowadays, the IoT allows users to identify and predict breakdowns and shutdowns in machinery, or to remotely fix and manipulate machines. Industrial Product-Service Systems (IPSS) are referred as PSS applied to "industrial context to such product-service bundles" [Mikusz, 2014]. The following list represents diverse ISPS2s which can be applied on every stage of the product lifecycle. Such services can be delivered according to the activities, goals and strategies of each company. In addition, the presented list shows a summary of potential applications of Smart Services from the previous research taken and adapted from [Herterich, et al., 2015, Parida et al., 2014, Gelbmann et al., p. 53].

- Beginning of life services: Manufacturability analysis, prototype design and development, simulation-aided prototyping, R&D support, problem analysis, feasibility studies, engineering with operational performance data.
- Middle of life services: Operating sold products, product upgrade services, optimization of equipment operations, remote control and management of equipment, prediction and trigger services, remote diagnosis, and replace field service activities.
- End of life services: Maintenance services by repairing, servicing and upgrading, recycling or reusing, component information services, close the product material cycle by taking products back, secondary utilization of usable parts in new products, and environmental effects report services.

Simulation-aided services

Digitalization of product and service development, as well as other important lifecycle processes have been gaining more importance in manufacturing businesses in recent years. Several stakeholders of diverse value chains are becoming less skeptical and more familiar with the technologies that replicate real behavior of machines and equipment, such as automobiles, tractors, cranes, assemblers, and other machinery within a diverse number of industries. Such replication can be obtained using simulation-based solutions, where different physical conditions, variables and scenarios can be virtually experienced before the real processes are conducted.

Simulations can leverage the knowledge and information generated by CPSs and other embedded technologies to create more accurate predictions from process variables. This integration could allow value partners to observe relevant information from diverse lifecycle processes to further contributing on the value co-creation of innovative PSSs. According to Mevea [2016], real-time simulation consists in a computer model which runs at the same rate at the real physical system. Which means the model needs to obtain actual real-time data from the physical phenomena, which can be obtained through the use of IoT. Contrary to conventional simulation, real-time simulation possesses the ability to analyze user and system behavior in milliseconds "online", instead of the long hours taken by the traditional technologies "offline" [Mevea, 2016].

Real-time simulation allows product and service development teams to "virtually" produce prototypes. Allowing them to obtain predictions concerning user experience feedbacks, user behavior, potential risks, among other valuable data that would be considerable expensive producing physical prototypes. However, it is important to mention that the more real data is collected through CPSs and integrated into simulators, the more accurate and reliable real-time simulation will be. For Hu [2015], without the assimilation and integration of real-life data into simulators, the difference between real life operation and simulation is likely to grow continuously.

RESEARCH APPROACH

This study is based on a literature study and empirical analysis concerning the Smart Service development process from a user-oriented point of view. Several topics including product lifecycle management, novel services on manufacturing industry, service engineering, smart products, customer needs analysis, business models, IoT, value chains and networks were reviewed.

The empirical part employed a qualitative case study in a tractor manufacturing company, by performing semi-structured interviews [Hirsjarvi, 2004], which consider both the interviewee's experience in a particular issue and the general knowledge of the situation from the interviewer.

Interviews were arranged both personally and online-based with five representatives in the case company, covering the Engineering, Administration and Information Technology departments, all of them being key areas in charge of Smart Service development. Further on, the empirical part employed specific Customer Needs Assessment tools, chosen according to the applicability of the tool, resources and time assigned for the analysis.

To begin the Customer Needs Assessment process, it is necessary to understand what the current situation of the company is. This means that analyzers should focus their efforts on identifying what are the real concerns and problems happening in the business and what are the primary goals concerning usability of information obtained [Kärkkäinen et al., 2004] Different tools can be applied to assess customers' needs depending on organization's goals, scopes of the analysis, availability of information, time and resources, among other factors to consider before starting to implement the tool. For purposes and scope of this study, as well as the goals defined by the interviewed collaborators of the case company, the selected tools were the Trace Matrix and the Need Interpretation Table. These tools are respectively used for detecting information demands of a company and for analyzing the "Voice of Customer", to detect background needs and compile a structured analysis of customer information needs [Kärkkäinen et al., 2004]. This paper forms part of the thesis study by Verdugo Cedeno [2016]. More detailed literature and results can be reviewed in [Verdugo Cedeno, 2016].

FRAMEWORK FOR SMART SERVICE DEVELOPMENT

Nowadays, there exists no appropriate methodologies for the engineering and development of smart products and services [Abramovici et al., 2015]. There is a lack of a combined tool for engineering product-services bundles together with ICT technologies (systems). As well as engineering methods in the middle phases of product lifecycle. Thus, this study encounters the identifiable need of a methodology framework able to cover the product use, maintenance and support stages in the lifecycle.

Despite the noticeable gap in availability of appropriate tools, Abramovici, Göbel, and

Neges [2015], consider four characteristics or requirements that a novel engineering approach for developing smart products, services and systems (Smart Engineering) should consider:

- Generic Process Models: They have to contain generic processes with a strong focus on the early development phases, especially on the requirements engineering and functional design.
- Multi-disciplinary networks: The methodology should consider the networked value chain, involving several value partners in the lifecycle.
- User-oriented approach: Users have to be able to easily analyze, employ and share their outcomes with functional and intuitive systems.
- Product use data and information:. The generated knowledge and insights from the data in the IoT can be used for the development of smart products and services.

The following framework in Figure 2 presents a procedure pursued for the development of digital PSS based on customers' information needs.

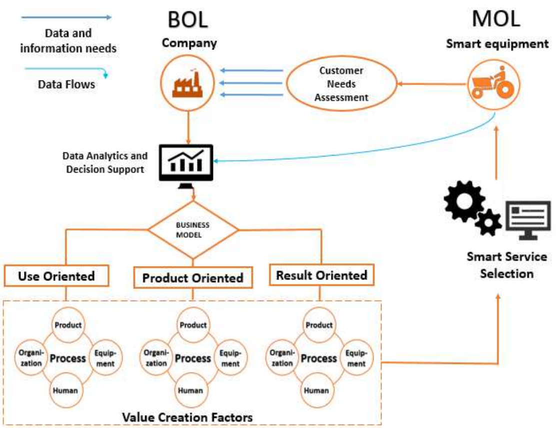


Fig. 2. Framework for Smart Service development

The framework considers the four characteristics, described by Abramovici, Göbel, and Neges [2015] for the Smart Engineering methodology, especially for the development of smart services for use, service, maintenance and support phases of the product lifecycle. However, it should not be considered as a methodology itself, yet a foundation to begin a Smart Engineering process. The aim is to follow a series of steps: starting from the description of the customer needs and particular information requirements through the use of Customer Needs Assessment tools, proceeding by the selection of a suitable business model and factors based on the macro and micro perspectives of value creation module, and finalizing by the selection of the respective "Smart" PSS.

The framework presents a starting phase for a process re-engineering and smart engineering method based on the analysis of the "voice" of customer, as well as the operation insights obtained through data-analytics software, allowing them to make decisions based on both user behavior information and customer needs identification. As shown on Figure 2, the smart equipment will provide significant operational information at the same time the analyzer assesses customer needs. The continuous process feedback will create virtuous cycles for improving customers' operations through the IoT and Customer Needs Assessment tools.

RESULTS AND DISCUSSION

This study aims to analyze the actual information needs presented in the industry for leveraging the IoT. In this case, the analyzed manufacturing company was named as Tractor Co, which is involved in the agricultural industry and food value chains. It provides value to customers through tailor-made services and solutions. Being one of the leading companies worldwide to offer highly customized tractors and tractor-related services to farmers and other stakeholders involved in the farming industry. The case company is interested in finding out what are the main opportunities that the IoT can provide in order to increase the value they deliver to their customers.

The farming industry is not an exemption of the "smartization" era nowadays. Being called as "Precision" or "Smart" Farming, the agriculture industry is experimenting a new phase towards the IoT. "Smart Devices" are tracking the current crop environment and all the productive units interacting with it. This new trend for agri-food businesses represents multiple opportunities for optimizing crop yield and producing sustainable products and services within various value chains involved.

The Trace Matrix applied in this study identified several aspects, to be considered in the recommendations for service development phases. From the farmers' point of view, it is important to connect their tractors and implements to their environment (crops) through the Internet. Starting from the fact that they are interested in performing optimal operations and save the most amount of resources (seeds, fertilizers, chemicals) possible. They demand valuable data regarding the processes made by different implements, as well as their conditions. Farmers also put emphasis on obtaining the everyday working plan based on data analyzed from previous work shifts, progresses, amount of chemicals used, amount of fertilizers and so on. Currently, paperwork is made by operators, causing time expenses and inaccuracy of information. In addition, the documentation is also a requirement from the EU. Finally, farmers desire to keep their equipment working the most number of hours, avoiding repairing times when breakdowns occur, thus receiving failure predictions for components will add value to their operations.

Concerning the Tractor Co, the valuable information that it can collect is related to measurements of product usage and support phases. The information that can contribute to product and service improvements is linked to minimize failure rates by monitoring component conditions. If a component fails, the most valuable information to obtain is the root cause. In this way, the company can focus its efforts on individual issues. The company could also be interested in collecting usage time and conditions, such as average temperature, humidity, and pressure of operation. The Trace Matrix for the case company is presented in Figure 3.

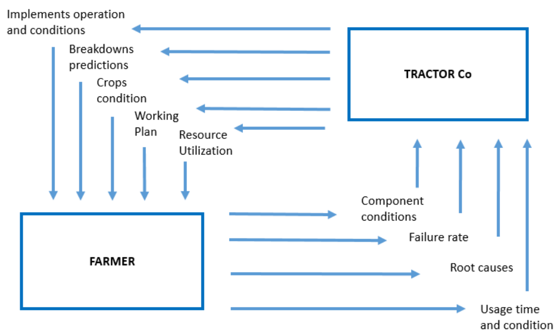


Fig. 3. Trace Matrix for the company's and farmers' information

Table 1. Need interpretation table implements

Voice of customer	Customer need	Information needs	Potential Solution
Farmers need to know: what is happening in tractor implements	Implement integration. Improve customer experience from tractors. Obtain information from different farming processes.	Track implement operation and interaction with environment	Remote monitoring of implement operations. Synchronization with farming environment.

Table 2. Need Interpretation Table Working Plan

Voice of customer	Customer need	Information needs	Potential Solution
Paperwork for making work plans and resource consumption reports takes too much time.	Efficient work plan elaboration. Resource consumption reports Meeting EU-governmental requirements Resource optimization, reducing inputs and operative costs.	Register work shift progress Collect resource consumpion records Identify areas which require resource application Track real-time resource consumption	Automatic work plan generator Resource consumption reports Resource consumption optimizer

More information needs were identified when creating the Need Interpretation Table, complementing the needs described in the Trace Matrix. In other words, company needs the information generated from farmers' operations for product and service developments, while farmers need information generated from company's technologies to increase productivity and reduce costs.

In Table 1 and 2, there is presented one of the results obtained in the Need Interpretation Table, and it clearly shows the process from identifying a general need for describing a particular information need from the farmer's point of view. Once identified the information requirement, the following steps of the presented framework for smart service development consist in the selection of the business model, value creation factors and Smart service in question.

As explained on Table 1, one of the main concerns from the farmers' point of view is to perform optimal work with every implement they use in their tractors. Using embedded technologies to the implements and connecting them to the tractor and the whole environment could improve farmers' operations and crop yields. Meanwhile, on Table 2 the "voice" of farmer is represented by the complain of spending too much time on non-value-added and bureaucratic activities for creating working plans, registering all the supplies used and filling governmental requirements. Such "voice" can be translated into information needs e.g. resource consumption real-time tracking and work shift progress registration.

Table 3. Smart services for optimizing tractor-implement operations

Customer need: Farmers need implement integration with tractors	
Information needs	• Track implement operation data
	• Track remote failure events
	• Track component condition
Potential "Smart Services"	• Product System: Highly integrated tractor with implements for optimal operations
	• Optimization of equipment operations: Implement operation optimized based on historic operation data
	• Remote diagnosis: Diagnosis accomplished remotely through remote service centers
	• Remote repairing: Non-complex repairs made by remote service centres
	• Predictive services: Trigger service activities based on current component condition Anticipated spare part orders by forecasting real-time demands
	• Real-time simulations: Simulate different tractor-implement operations for prototyping and testing purposes
Business Model	• Product-oriented
Value creation	• Product and process
Impacts	• Highly integrated systems
	• Interoperability and synchronization between tractor and implements
	• Higher functionality and added value
	• Flexibility and response
	• Prevention of breakdown
Implications	• Technology investments
	• Development costs
	• Lack of system integration (APIs)
	• Customer adoption

Table 4. Smart services for automating work plans

Customer need: Making the work plan elaboration more efficient	
Information needs	• Track and record work progress and resource consumption
	• Database from activities "to do" and resources
Potential "Smart Services"	• Automatic work plan generator: Generate work plans according to current progress and available resources.
	• Real-time project manager: Track the current progress, forecast potential delivery times and resource consumption based on historic data.
Business Model	• Use-oriented
Value creation	• Process
Impacts	• Save paperwork time to operators
	• Increase time for productive activities
	• Increase reliability of work plans
	• More accurate understanding on tasks "to be done"
	• Reports from work progresses and resources
Implications	• Investments on technology and development
	• Learning curves and training
	• Interoperability with current systems

Following the presented framework for developing smart services, several Smart Services can be implemented as shown in Table 3 and 4. The potential services for meeting the need related to the interconnectivity of implement-tractor are the following: remote monitoring of components for triggering maintenances, optimization of operations based on historic product usage data, remote diagnosis in case of breakdowns, even remote operation through a highly automated solution, among other services that can leverage operation outcomes. Regarding the potential services for meeting the need of generating a customized automated work-plan are: automatic work-plan generator for creating work plans according to current progress and resource available and a real-time project manager for tracking the current progress and resource consumption, and forecasting potential delivery times.

CONCLUSIONS

The presented study had a purpose to conduct a literature-based research and empirical analysis to prove that smart and digital services by the IoT can improve product processes through the whole lifecycle, more specifically in the use, service and maintenance phases. Such improvements are showed up in the form of resource optimization, maximizing efficiency of operations, reducing material and human risks, improving staff skills and qualification, increasing value-added tasks, among other benefits that increase value. Businesses are always looking for increasing profitability and higher economic outcomes, thus companies need more and more to cooperate with each other to develop new innovative business models based on smart and digital services.

The theoretical contribution of this study lies in presenting the relationship between PLM and the emerging embedded technologies (IoT) for facilitating product traceability, by monitoring, storing and analyzing the information flows presented along business lifecycle processes in real-time. Traceability function can help organizations to create new service-based business models. The effective synergy of PLM systems (people, resources, processes and information) with the IoT will allow value partners to visualize and control product and user behaviour from all the phases of the lifecycle, achieving the so-called Closed-loop PLM. In addition, this paper contributes in presenting the initial phases of a Smart Engineering process.

The practical contribution of this study is to illustrate the creation process and Customer Needs Assessment tools in designing new data-based 'smart' services in a case company. The study also points out the possibility and importance of real-time data, collected by the IoT technologies and utilized e.g. in product development, maintenance and training processes. Finally, a list of smart services was ideated and analyzed for the case company. Starting from the services oriented to the development of new products by digital prototyping and simulation services, going through the use, support and maintenance services for predictive and remote assistance, for finally using the information tracked from the new technologies for the reuse, remanufacturing and recycle of components.

Further research could focus on modelling the entire Smart Engineering methodology and process for the development of smart and digital services. Regarding the main concern of the case company, further research can focus on utilizing Smart Technologies and solutions to improve food traceability through the whole value chain, aiming the production of valuable information to customers in all the links of the chain, from the consumer to the tractor company as closed-loop lifecycles.

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ROZWÓJ USŁUG TYPU SMART W OBRĘBIE INTERNETU RZECZY W BRANŻY PRODUKCYJNEJ

STRESZCZENIE. **Wstęp:** Celem pracy jest wprowadzenie struktury, opisującej, zorientowane na klienta, podejście do rozwoju usług związanych z Internetem rzeczy, określanych jako usługi typu smart w działalności produkcyjnej.
Metody: W przeglądzie literatury zaprezentowano ideę Internetu rzeczy, usługi związane z digitalizacją jak również rolę technologii symulacji dla procesu rozwoju usług typu smart. W części empirycznej, na podstawie przykładu producenta ciągników rolniczych określono zapotrzebowanie na nowe usługi poprzez zastosowanie narzędzia oceny potrzeb klienta.
Wyniki: Technologie oparte na Internecie rzeczy zostały zaadaptowane również w przemyśle rolniczym w celu dostarczania usług umożliwiających śledzenie środowiska uprawianych plonów e celu optymalizacji uzyskiwanych plonów uprawianych zgodnie z zaleceniami gospodarki zrównoważonej.
Wyniki otrzymane z tabeli analizy potrzeb oraz matrycy śledzącej wskazuje na zapotrzebowanie wśród rolników na usługi typu smart w celu lepszego wykorzystania swoich maszyn w różnych pracach związanych z rolnictwem. Oczekiwana była również przez nich dostępność codziennego planu roboczego opartego na analizowanych danych oraz wcześniej wykonywanych pracach. Z punktu widzenia tego typu przedsiębiorstwa, istotne jest zbieranie oraz analiza takich danych jak temperatura, wilgotność i ciśnienie otoczenia, w którym pracuje ciągnik jak również danych dotyczących wypadków i awarii.

Wnioski: Wykazano zależność pomiędzy zarządzaniem cyklem życia produktu a Internetem rzeczy oraz jego wpływu na usługi typu smart. Praktycznym rozwiązaniem było przygotowanie propozycji wdrożenia tego usług typu smart w analizowanym przedsiębiorstwie, takich jak śledzenie operacji oraz awarii, określanie zapotrzebowania na wydajność maszyn, oszczędność czasu oraz optymalizacja zasobów uwzględniająca rozwój zrównoważony.

Słowa kluczowe: przemysłowe produkcyjne systemy usługowe, zarządzanie cyklem życia produktu, Internet rzeczy, usługi typu smart, ocena potrzeb klienta

DIE ENTWICKLUNG VON SMART-DIENSTLEISTUNGEN IM INTERNET DER DINGE IN DER PRODUKTIVEN BRANCHE

ZUSAMMENFASSUNG. Einleitung: Das Ziel der Arbeit ist es, die kundenorientierte Struktur einzuführen, die eine Herangehensweise an die Entwicklung der mit dem Internet der Dinge verbundenen Smart-Dienstleistungen in der produktiven Branche beschreibt.

Methoden: In der Literaturübersicht projizierte man die Idee des Internets der Dinge, die mit der Digitalisierung verbundenen Dienstleistungen, sowie die Rolle der Simulationstechnologie im Prozess der Entwicklung der Smart-Dienstleistungen. Im empirischen Teil ermittelte man auf der Grundlage des Beispiels eines Produzenten von landwirtschaftlichen Treckern den Bedarf für neue Dienstleistungen mittels der Anwendung eines Werkzeugs für die Bestimmung von Kundenbedürfnissen.

Ergebnisse: Die auf das Internet der Dinge gestützten Technologien wurden auch in der landwirtschaftlichen Industrie zwecks der Bereitstellung von Dienstleistungen, die die Verfolgung von Pflanzenanbau zwecks einer Optimierung der zu erzielenden Erträge anhand von Empfehlungen der nachhaltigen Wirtschaft ermöglichen, adaptiert.

Die aus der Analysentabelle und der Verfolgungsmatrix gewonnenen Ergebnisse bezüglich des Bedarfs seitens der landwirtschaftlichen Produzenten weisen auf die Nachfrage für die Smart-Dienstleistungen zwecks einer besseren Inanspruchnahme von Maschinen innerhalb von landwirtschaftlichen Einsätzen hin. Der Zugriff auf den täglichen, auf die analysierten Daten und die früher ausgeführten Arbeiten gestützten Arbeitsplan wurde auch von ihnen erwartet. Aus dem Gesichtspunkt eines solchen landwirtschaftlichen Unternehmens sind die Ermittlung und Analyse der Daten wie: Temperatur, Luftfeuchte und -druck, Gegebenheiten der Umwelt, in denen der Trecker arbeitet, sowie die Angaben bezügl. der Ausfälle und Havarien äußerst wichtig.

Fazit: Es wurde auf die Abhängigkeit zwischen dem Management des Produkt-Lebenszyklus und dem Internet der Dinge, sowie dessen Einfluss auf die Smart-Dienstleistungen hingewiesen. Eine praktische Lösung stellte die Ausarbeitung eines Vorschlags für die Einführung im betreffenden Unternehmen der folgenden Smart-Dienstleistungen, wie: die Verfolgung von Operationen, Einsätzen und Maschinenausfällen, die Festlegung des Bedarfs für die Maschinenauslastung, Zeitersparung und Ressourcen-Optimierung, die die nachhaltige Entwicklung berücksichtigt, dar.

Codewörter: industriemäßige Produktions- und Dienstleistungssysteme, Management des Produkt-Lebenszyklus, Internet der Dinge, Smart-Dienstleistungen, Bestimmung von Kundenbedürfnissen

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