Available online at www.sciencedirect.com

ScienceDirect

Procedia CIRP 93 (2020) 730–735

www.elsevier.com/locate/procedia

53rd CIRP Conference on Manufacturing Systems

Using Smart Services as a Key Enabler for Collaboration in Global Production Networks

Florian Stamer[a,]*, Martin Steinke[a], Rainer Silbernagel[a], Benjamin Häfner[a], Gisela Lanza[a]

[a]*wbk Institute of Production Science, Karlsruhe Institute of Technology (KIT), Kaiserstr. 12, 76131 Karlsruhe, Germany*

* Corresponding author. Tel.: +49-1523-950-2618 ; fax: +49-721-608-44153. *E-mail address:* florian.stamer@kit.edu

Abstract

Collaboration in global production networks becomes more important in times of increased interconnectivity and complexity. However, due to various resistors the collaboration potential has not been realized, yet. At the same time digitalization has become a key enabler in today's world of high complexity leading to new, disruptive solutions. Part of digitalization are smart services, triggering incentives by including business models. This and further characteristics of smart services have the potential of overcoming the resistors of collaboration. In this paper an approach is proposed for developing collaborative relationships - from strategy and collaboration scenario modelling to a service-oriented implementation.

Peer-review under responsibility of the scientific committee of the 53rd CIRP Conference on Manufacturing Systems

Keywords: Production Network; Collaboration; Smart Service

1. Introduction

Collaboration is an enabler to improve production processes in global production networks (GPNs), where not only single companies are competing against each other, but also complete supply chains [1]. GPNs are geographically distributed networks of production entities that are connected through material, information and financial flows [2]. Chan & Prakatash [3] define collaboration as negotiated cooperation between independent parties by exchanging capabilities and in sharing burdens to improve collective responsiveness and profitability. Although the advantage of collaboration is known in the literature [4, 5] as well as among practitioners [6], the numbers of successful collaboration projects is lower than 50% [7]. This issue leads to the hypothesis that collaboration fails in the initiation or operation phase due to different resistors. In order to overcome these resistors a new approach is needed.

Smart services may be able to provide such a novel approach to facilitate collaboration. They have received increased interest in recent years in the wake of digitalization as they are able to build a connection between the physical and digital world, upgrade the efficiency of value creation, add a digital layer to products and services, and can transform products into parts of services [8]. Additionally, they change the perspective of business models from product- to customer-centered [9].

Smart services are already loosely associated with collaboration [10, 11], but to the best of our knowledge they have not been examined as a concept to facilitate collaboration in GPNs. Therefore, the purpose of this paper is the general examination of the concept smart service as an enabler of collaboration in GPNs. The applicability of the approach is covered by listing and discussing resistors for collaboration. The examination is then followed up by a state of the art and the presentation of a holistic model for the implementation of collaboration on the foundation of smart services. To enhance the model a tool for modeling smart service enabled collaboration will be presented. The paper will be concluded by a thorough review of the presented approach.

Peer-review under responsibility of the scientific committee of the 53rd CIRP Conference on Manufacturing Systems
10.1016/j.procir.2020.04.065

2. Smart Services as an Enabler of Collaboration

2.1. Complex Smart Services and Collaboration

The goal of GPNs is the delivery of products and associated services, so called product-service systems (PSS), to their customers [2]. A specific type of PSS are smart services [12]. Smart services are based on data-driven business models [11]. A business model can ensure transparency for all parties involved as it reveals the cost, goals and utility of the smart service. As a conclusion smart services can be described as part of product-service systems (PSS) and autonomously utilize knowledge from aggregated data about products or (production) processes to enhance individual value creation through data-driven business models.

The business models of smart services generally require a high level of collaboration [11]. To provide, for example, a smart service such as predictive maintenance, a machine manufacturer may have to team up with its suppliers to ensure that all relevant build-in parts of their machines will be properly monitored. Thus, to provide additional services, companies increasingly collaborate within service value networks to create complex services, which are seen as services that consist of other composite services [13]. Collaboration, therefore, is commonly seen as an enabler for complex smart services. The notion of smart services in this work, however, is fundamentally different.

We suggest a different perspective on complex smart services as an approach to facilitate collaboration within a GPN. Complex smart services are defined as an approach to facilitate collaboration within a GPN. These complex smart services consist of multiple composite services (following the definition of complex services in [13]), that can be smart services themselves. Within a GPN, each composite smart service establishes a connection between two partner companies – namely the focal company and one of its suppliers. Picturing the GPN as a graph with each company as a node, this means that every composite smart service establishes an edge between two nodes. The smart services are essentially becoming mediators between the companies. Since each of these composite services is a smart service based on a business model, one can say that a simple form of collaboration between each of these partners already exists independently. However, to establish network-wide collaboration, these composite services must be orchestrated to create a complex smart service. Starting with the customer, a smart service between them and one of the partners within the GPN (usually the focal company) must be established first. The incorporated business model ensures that both, the customer as well as the focal company, have a joint value enhancement. The other composite smart services can now successively be added to aggregate all services into a complex smart service that ensures the improvement of a joint responsiveness and profitability by sharing capacities and burdens – in other words collaboration [2] for all members.

Complex smart services are highly scalable because they are made up of individual smart services each generating a benefit on their own. Scalability in this context can be defined as the ability to change a system size, capability, or characteristics in order to meet changing system performance requirements [14]. Furthermore, as complex smart services are compositions of other smart services, they are highly modular. Additionally, as each individual smart service is adaptable, complex smart services can easily be customized.

2.2. Collaboration Resistors and Smart Services

Multiple resistors for collaboration among partners within a GPN have been identified in the literature [7, 15]. These can be divided into structural, technological and behavioral. Many of them can be mitigated using complex smart services to facilitate collaboration.

One of the most commonly mentioned factors hindering the implementation of collaboration is a lack of trust [7, 15]. While trust can emerge on different levels, interpersonal trust between the employees of each partner company is the primary concern making interpersonal distrust between boundary-spanning employees a major behavioral resistor for collaboration. However, when establishing collaboration through complex smart services, interpersonal trust is sidelined as the smart services become the mediators.

Like every other decision maker, supply chain managers are inherently susceptible to irrational biases. For example, unconscious defense mechanisms against change may cause managers to become reluctant to change [15]. Because complex smart services are easily customized, they can be tailored to each user, thus exploiting individual biases to overcome such irrational behavior.

Another structural reason for collaboration failure are differences in the cost and revenue structure between partners, for they may lead to different incentives to join the collaboration [16]. If these incentives are misaligned, decision makers will focus only on local goals instead of maximizing overall supply chain profitability [17]. The transparency created by smart services, however, helps to mitigate these negative factors. Furthermore, it supports goal alignment as it affects revenue and profit of the participating business units. Even managers who focus on company-intern functional performances and fast financial benefits will, thus, try to establish these smart services. Usually these are managers who fall victim to short term thinking [7] in the effort to protect local and immediate goals [15] and, thus, impede collaboration efforts due to improper performance measures [17]. However, as the business model of the smart service aligns their personal goals with the company's collaboration efforts, this resistor is mitigated.

Free information flow and system integration are commonly mentioned antecedents for collaboration [1]. Thus, when connectivity between the partners is not properly established, the collaboration efforts are likely to fail [7], making incompatible infrastructure another major technological resistor for collaboration. At its core incompatible infrastructure stems from an unwillingness to invest. Even though almost all connectivity issues can be resolved through infrastructure updates, managers are reluctant to do so as they shy away from the risks this can imply. However, complex smart services can help to mitigate these risks. As risk can be defined as the multiplication of the occurrence probability and the severity of harm [18], the impact of complex smart services on the investment risk are twofold. The business model at the core of each smart service mitigates the probability of the occurrence of harm through ensuring that both partners will profit from it. Furthermore, the scalability and incremental implementation of complex smart services enable minimum viable products, which dampens the magnitude of the severity of that harm. Complex smart services consist of multiple adaptable smart services. This means that the entire complex smart service will fail only rarely, because its' components (the smart services) are easily adaptable and exchanged.

While this list of resistors of collaboration and the solutions presented by smart services is far from being exhaustive, it provides a good overview of the most prevalent ones and the multiple layers (namely structural, technological and behavioral) that each individually acts upon. Furthermore, none of these resistors act independently but instead are all interconnected. Hence, a holistic approach is needed to tackle the aforementioned issues to facilitate collaboration through the use of smart services.

3. State of the Art

Various approaches have been described in literature to implement smart services, however, none of them presented a detailed framework for the implementation of smart services to facilitate collaboration in GPNs. Hence, the following section deals with a discussion on the required characteristics of a framework to foster collaboration enabled by smart services and the most influential frameworks in research so far, and how they match these criteria.

3.1. Criteria for the Framework

A suitable framework for smart services enhancing collaboration must address the development of smart services as well as incorporate the specific requirements that collaboration calls for. Furthermore, as the framework should provide a basis to guide through the development and implementation of smart services it needs to incorporate a holistic approach only bounded by the GPN focus.

The requirements for smart services in GPNs differ fundamentally from those in other systems. As GPNs are systems of production entities that are interlinked by material, information and financial flows [2], smart services facilitating collaboration among them have to target all of these dimensions. Thus, a successful framework needs to cater for these specific requirements and must focus on GPNs. Furthermore, the incentive design, namely the business model that is inherently incorporated in smart services [11], helps to overcome numerous collaboration resistors (see section 2.2) and, thus, needs to be taken into account as well.

As mentioned in section 2, the full potential of smart services for collaboration is realized if they are designed in a flexible and modular way so that they can be easily orchestrated in a different manner. Therefore, a framework to enable to facilitate the advantages of smart services in collaboration must ensure that re-orchestration can quickly be realized, which is done best by providing a quantitative approach in order to be able to utilize computer-aided decision-making systems.

3.2. Existing Frameworks in Literature

As mentioned previously, various frameworks for the development and implementation of smart services exist. In the following, a selection of the most influential ones is presented, and their subsequent relation to the specified requirements mentioned in section 3.1 will be discussed. A brief summary of this discussion can be found in Table 1.

Table 1. Evaluation of existing frameworks based on the criteria specified in section 3.1

	Blau et al. 2009 [13] & Blau 2011 [19]	Bullinger, Meiren & Nägele 2015 [20]	Cedeno et al. 2018 [21]	Höckmayr & Roth 2017 [22]	Marquardt 2017 [8]	Poeppelbuss & Durst 2019 [23]
Focus on (global) Production Networks	-	X	X	-	X	X
Development of Smart Services	-	X	X	X	X	X
Incentive Design	X	X	X	X	X	X
Holistic Approach	-	X	-	X	X	-
Collaboration	X	-	-	-	-	-
Quantitative Approach	X	-	-	-	-	-

Note: Entries with an "X" mark the category that the respective framework meets

Blau et al. [13, 19] deal with facilitating improved coordination through the design of services in the context of Service Value Networks. One key concept is the orchestration and choreography of different composite services to one complex service. To ensure that such a service provides value to all parties involved and incentivizes participation, an Algorithmic Design Mechanism is presented [19]. Even though Blau et al. present in his work a detailed quantitative framework which is usable for collaboration, it does not cater to the specific needs of collaboration in GPNs as there is no focus on production processes and the material flow itself.

The framework presented by Cedeno et al. [21] starts with a description of the customer needs, then defines a suitable business model and finally derives the appropriate smart product-service system. However, the framework is not a holistic methodology guiding the entire development process, but rather laying the foundations for the engineering process. Furthermore, the framework is neither addressing the specific needs of collaboration nor does it present a quantitative approach.

The Smart Service Canvas in Poeppelbuss & Durst [23] is an approach based on the renowned Business Model Canvas. Smart services in GPNs are developed as a fit between the customer and value perspective while additionally taking the ecosystem into account, thus providing the incentive design. While the canvas establishes a good methodology to outline and analyze the vision of future smart services, it fails to give detailed guidelines as to how the implementation should be realized. In this respect the model is not holistic. Furthermore, the specific requirements of smart services to facilitate collaboration are not included and the approach provides no quantitative view.

Marquardt [8] provides a holistic but very generic and only qualitative framework to develop smart services for manufacturing companies. Starting with the identification of the target customers and analysis of the current business model, new services are then designed to suite a corresponding business model. The organization, technology and resources need to be prepared before the implementation of these new services. In the final step of the model, the smart services are executed together with their subsequent business model and continuously improved based on the usage data. Even though the model gives a rather holistic view of the implementation of smart services in the context of GPNs and incorporates the incentive design in form of a business model, it falls short of addressing the specific issues of collaboration and provides a rather generic approach that is not quantitative.

The T-REX framework in Bullinger, Meiren & Nägele [20] is a holistic approach to develop smart services in manufacturing companies using the business model as an initial starting point. However, the framework does not cater to the specific needs of collaboration in GPNs, but rather sees collaboration as a factor that needs to be addressed. Furthermore, the framework remains on a high-level view and does not provide a quantitative approach.

The TRIGGER model in Höckmayr & Roth [22] provides a holistic approach for the development of smart services based on the concept of information density in service system. Starting with the analysis of the value created for the stakeholder on a system wide level, it then narrows down the potential for new smart services resulting in a service blueprint. In a final step, the service system is reconfigured to maximize the information density within the service system. Even though the framework is based on information theory it falls short of providing a quantitative approach and does not address the specific requirements for smart services to facilitate collaboration.

To summarize, it becomes apparent that none of the frameworks currently discussed in the literature cater to the specific need of the development and implementation of smart services to facilitate collaboration in GPNs. This is further illustrated in Table 1. All presented frameworks have major shortcomings, resulting in the call for a novel holistic framework that provides guidelines for the implementation of smart services to facilitate collaboration in GPNs. Such a framework will be introduced in section 4.

4. Framework for the Implementation of Smart Services for Collaboration

It is assumed that every successful, globally networked production company has a production strategy for the design and operation of GPNs [2]. In order to provide a holistic collaboration approach for companies of the industrial sector, it is suggested to start the development of collaboration on the production strategy level. From there on a top down approach is chosen. The framework that will be introduced in the following section is depicted in Figure 1.

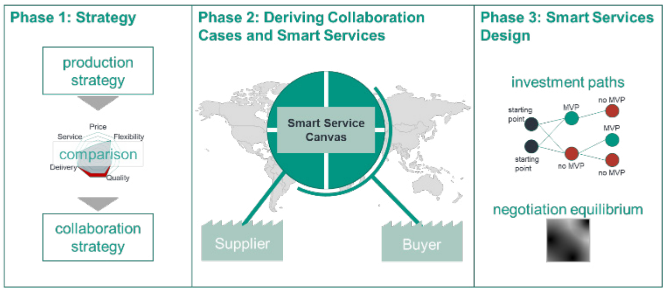

Fig. 1. Framework for the Implementation of Smart Services for Collaboration.

First, the term collaboration strategy is introduced in the context of this article. Based on the strategy definition by Mintzberg [24], collaboration strategy is defined as follows:

A collaboration strategy is a pattern in a stream of decisions in a production environment which enables a business unit to reach competitive advantages by collaboratively improving specific KPIs of strategic dimensions and thus realize the production strategy.

Following this definition, the collaboration strategy is aligned to implement the production strategy in phase 1 of the framework. Commonly the differentiating factors of the production strategy are price, flexibility (with the categories comprehensive product range, customizable product design, and flexibility of order size), quality (with the categories product quality and adherence to specifications), delivery (with the categories supply reliability and supply speed) as well as service [25]. In a similar way, a collaboration strategy can be formalized. Through the production strategy, the target state of the system is defined. The collaboration strategy is then derived from the difference of the target and the current state, helping to facilitate the blueprint to implement the production strategy (see Figure 2).

After setting the individual collaboration strategy of a

Fig. 2. Deriving the collaboration strategy from production strategy.

company, collaboration cases can be developed in phase 2 of the framework to overcome the gap between current and target state. Each case shall be defined by the dimensions that it shall improve. Furthermore, the case is defined by the involved stakeholders (e.g. suppliers), a general vision of the collaboration including a business model and the basic conditions. For the development of a general vision the concerned partners should already be included as it is crucial for success that every partner accepts it.

If the targeted partners neglect to participate, the case idea can be terminated. In Figure 3 an example for a general vision of a solution that facilitates collaboration between independent

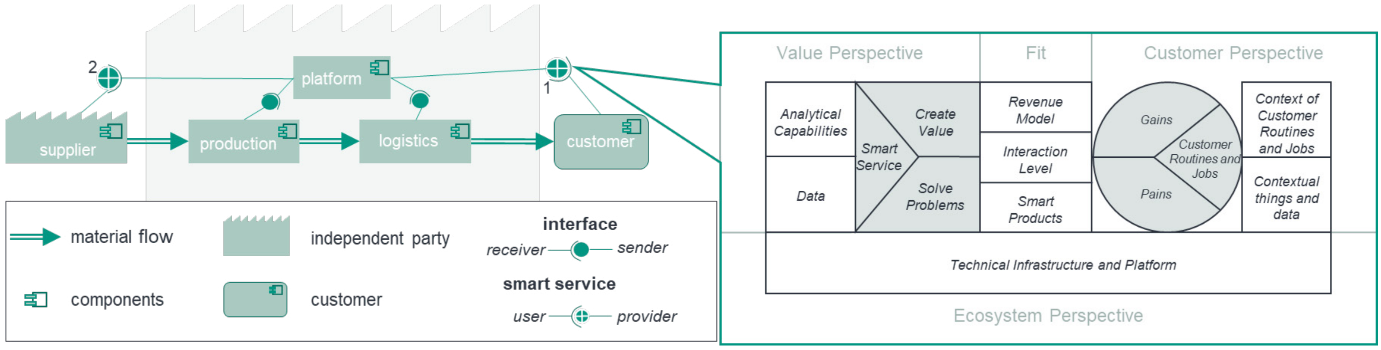

Fig. 3. General vision of the interaction between different partners through a smart service based on the Smart Service Canvas.

actors in a GPN through smart services is illustrated. Both, the material as well as the information flow between the different components of the GPN are depicted. Information can be exchanged through interfaces (usually between components that are part of the same actor) or through smart services. As the smart service approach can overcome the resistors of collaboration (see chapter 2), the concept should always be used, if two independent parties are participating in an interaction with a collaborative setting (compare the definition of collaboration in chapter 1).

Every other interaction (e.g. between two machines or two co-workers of the same team – i.e. two partners within the same independent party) is not focused and is assumed to not be a challenge. Additionally, each smart service is characterized by a business model that can be further described through the Smart Service Canvas [23]. Furthermore, it should be noted that the vision can include multiple smart services.

In phase 3 of the framework, each partner, being a possible smart service provider, needs to develop an investment plan as illustrated in Figure 4 describing different possible paths to provide a suitable service. These investment paths can also be interpreted as different implementation roadmaps with annotated costs and time estimations at each discrete node. The concrete solutions depend on the general vision, which is the common basis for all partners. To take into account the collaboration resistors of distrust and the relating fear of loss of investment, the preferred way is to reduce the risk as much as possible when selecting target investments on the investment paths. In practice this is valid because of the great scalability of smart services. In theory the nodes representing minimum viable products (MVP) are identified. To formalize this, each investment node is considered to have a distribution of cost C, time T and service function S. Following this structure, the MVPs can be identified by tracing the investment path until S > 0. Up to this point, the service content is roughly clear, but not the price.

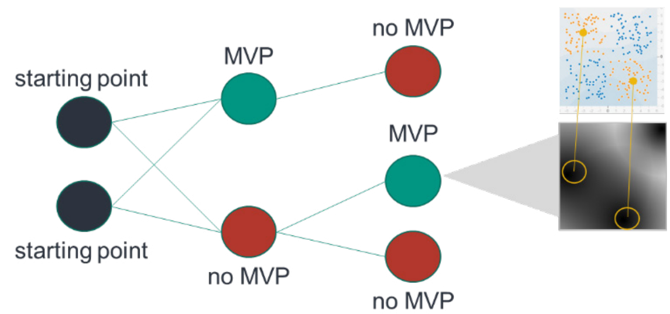

Fig. 4. Illustration of the investment paths from the starting point to a minimum viable product (MVP).

Also further conditions need to be set, e.g. purchase quantity, performance unit size etc. All condition features could be covered by a morphological approach similar to the one presented by Kampker et al. [26]. At this point the challenge of setting proper incentives becomes crucial. In order to be incentive the parties need to find an agreement on the MVP and conditions. This is part of negotiations, especially in the business-to-business industrial sector, where the number of customers can be as low as one (for example for engineering to order). In this framework each interaction between two partners is designed individually and it is therefore assumed that the further conditions of the smart service are always negotiated. To further provide recommendation for optimal action the possible, robust equilibria of the negotiation need to be identified. Only in a robust negotiation equilibrium no party has an incentive to deviate from the strategy. The term robustness in this context is meant as a measure describing the maximum deviation impact event without leaving the equilibrium in the long run. The equilibria and their robustness can be examined using methods of game theory. Examples examining equilibria in negotiations of game like settings are [27], [28] and [29]. In this case, the negotiation is identified as a sequential game with information asymmetry.

In this sequential game the partners negotiate until they achieve a result, e.g. agreement or final disagreement. Moreover, the provider and the user both have beliefs about the development cost of the service, the potential for the specific production system of the user, the risk type of the participants and more. Of course, the beliefs of the provider about the assets in his sphere of influence can be considered closer to the true nature of the game. These beliefs should be included when trying to find equilibria and it is assumed that a more detailed modeling of the game will result in more realistic equilibria.

As a result the equilibria with the computed robustness can be used to review possible outcomes and as a basis for real negotiations. Thus, the framework gives a guide line from strategy to implementation level in order to implement GPN centric collaboration.

5. Summary and Outlook

Collaboration in GPNs cannot realize its full theoretical potential due to different counteracting resistors. Examples for resistors are missing goal alignment, irrational behavior or investment risks. In this article it was shown qualitatively that these resistors can be addressed by smart services. Some resistors are overcome by inherent properties which apply when using smart services. Other resistors can be overcome by a specific design, which is possible, because smart services offer many degrees of freedom. To concretize this hypothesis regarding collaboration enabled by smart services, a framework was proposed. This framework starts on a strategy level by defining a collaboration strategy and then moving top down via different modelling and concretizing steps to the implementation. The implementation is quantitatively guided by using investment paths and the analysis of negotiation equilibria. However, there are some limitations or prerequisites for the framework to consider. A collaborative culture within the company is indispensable for a successful collaboration and needs to be introduced. Additionally, the framework draws on the availability of necessary data and knowledge from the partners. Thus, a thorough market analysis and data gathering will still be necessary before collaboration can be realized. To be able to analyze the data and implement smart services, the companies further need the necessary know-how in the field of digitalization. If the competencies are not available in house, they either need to be acquired or sourced through external service providers.

As a next step, the different steps in the framework will be further detailed in order to make the framework applicable. Especially the modelling details in terms of scope and methodology need to be further elaborated. Here the influence of third parties like insurances need to be examined, too. Also, algorithms to solve the described negotiation problem need to be researched. A simulation could be a potential means to make results more tangible and transparent for possible users. Finally, the whole approach needs to be validated on real use cases to identify its benefits and weaknesses.

6. Acknowledgment

This publication is based on the research and development project "ReKoNeT" which is / was funded by the German Federal Ministry of Education and Research (BMBF) within the "Innovations for Tomorrow's Production, Services, and Work" Program and implemented by the Project Management Agency Karlsruhe (PTKA). The author is responsible for the content of this publication.

References

[1] Ho, D., Kumar, A., Shiwakoti, N., 2019. A Literature Review of Supply Chain Collaboration Mechanisms and Their Impact on Performance *31*, p. 47.

[2] Lanza, G., Ferdows, K., Kara, S., Mourtzis, D. *et al.*, 2019. Global production networks: Design and operation *68*, p. 823.

[3] Chan, F.T.S., Prakash, A., 2012. Inventory management in a lateral collaborative manufacturing supply chain: a simulation study *50*, p. 4670.

[4] Goffin, K., Lemke, F., Szwejczewski, M., 2006. An exploratory study of 'close' supplier-manufacturer relationships *24*, p. 189.

[5] Kilger, C., Reuter, B., Stadtler, H., 2008. Collaborative Planning, in *Supply Chain Management and Advanced Planning: Concepts, models, software, and case studies*, Springer, Berlin, Heidelberg, p. 263.

[6] Lison, U., Hartel, D., 2016. *Global Trade Management Agenda 2016: Supply Chain Collaboration in der Unternehmenspraxis. Und die wichtigsten Aufgaben beim Management internationaler Lieferketten.*

[7] Kampstra, R.P., Ashayeri, J., Gattorna, J.L., 2006. Realities of supply chain collaboration *17*, p. 312.

[8] Marquardt, K., 2017. Smart services – characteristics, challenges, opportunities and business models *11*, p. 789.

[9] Allmendinger, G., Lombreglia, R., 2005. Four Strategies for the Age of Smart Services *83*.

[10] Beverungen, D., Müller, O., Matzner, M., Mendling, J. *et al.*, 2019. Conceptualizing smart service systems *29*, p. 7.

[11] Smart Service Welt Working Group/acatech, 2015. *Smart Service Welt: Recommendations for the Strategic Initiative Web-based Services for Businesses*, Berlin.

[12] Mittag, T., Rabe, M., Gradert, T., Kühn, A. *et al.*, 2018. Building blocks for planning and implementation of smart services based on existing products *73*, p. 102.

[13] Blau, B., Kramer, J., Conte, T., van Dinther, C., 2009. Service Value Networks, in *2009 IEEE Conference on Commerce and Enterprise Computing*, IEEE, p. 194.

[14] Weik, M.H., 2000. scalability, in *Computer science and communications dictionary*, Kluwer Academic, Boston, p. 1517.

[15] Fawcett, S.E., McCarter, M.W., Fawcett, A.M., Webb, G.S. *et al.*, 2015. Why supply chain collaboration fails: the socio-structural view of resistance to relational strategies *20*, p. 648.

[16] Simatupang, T.M., Sridharan, R., 2005. An integrative framework for supply chain collaboration *16*, p. 257.

[17] Simatupang, T.M., Sridharan, R., 2002. The Collaborative Supply Chain *13*.

[18] International Organization for Standardization / International Electrotechnical Commission. ISO/IEC GUIDE 51:2014(E): Safety aspects - Guidelines for their inclusion in standards, Geneva, Switzerland, 2014. www.iso.org.

[19] Blau, B.S., 2011. *Coordination in Service Value Networks A Mechanism Design Approach*. KIT Scientific Publishing.

[20] Bullinger, H.-J., Meiren, T., Nägele, R., 2015. Smart Services in Manufacturing Companies, in *23rd International Conference on Production research (ICPR 2015): Manila, Philippines, August 2-5,2015*.

[21] Cedeno, J.M.V., Papinniemi, J., Hannola, L., Donoghue, I., 2018. Developing smart services by internet of things in manufacturing business *14*, p. 59.

[22] Höckmayr, B.S., Roth, A., 2017. Design of a Method for Service Systems Engineering in the Digital Age *8*.

[23] Poeppelbuss, J., Durst, C., 2019. Smart Service Canvas – A tool for analyzing and designing smart product-service systems *83*, p. 324.

[24] Mintzberg, H., 1978. Patterns in Strategy Formation *24*, p. 934.

[25] Friedli, T., Mundt, A., Thomas, S., 2014. *Strategic Management of Global Manufacturing Networks*. Springer Berlin Heidelberg, Berlin, Heidelberg.

[26] Kampker, A., Stich, V., Jussen, P., Moser, B. *et al.*, 2019. Business Models for Industrial Smart Services – The Example of a Digital Twin for a Product-Service-System for Potato Harvesting *83*, p. 534.

[27] Wang, X., Geng, S., Cheng, T.C.E., 2018. Negotiation mechanisms for an order subcontracting and scheduling problem *77*, p. 154.

[28] Moon, Y., Yao, T., Park, S., 2011. Price negotiation under uncertainty *134*, p. 413.

[29] Carbonneau, R., Kersten, G.E., Vahidov, R., 2008. Predicting opponent's moves in electronic negotiations using neural networks *34*, p. 1266.