Available online at www.sciencedirect.com

ScienceDirect

IFAC PapersOnLine 52-13 (2019) 2501–2506

Smart Contracts for Smart Supply Chains

Gunnar Prause

Department of Business Administration, Tallinn University of Technology, Tallinn, Estonia (e-mail: gunnar.prause@taltech.ee) & Wismar Business School, Wismar University, Wismar, Germany (e-mail: gunnar.prause@hs-wismar.de)

Abstract: A smart contract is an electronic transaction protocol intended to digitally facilitate, verify, or enforce the negotiation and execution of the terms of an underlying legal contract designed to fulfil common contractual conditions comprising payments, legal obligations, and enforcement without third parties. Thus, by following the traditional perception, smart contracts target to reduce transaction costs including arbitration and enforcement costs by realising trackable and irreversible transactions by using blockchain technology for distributed databases. However, the potential of smart contracts goes far beyond cost reductions by facilitating the entrepreneurial collaboration of cross-organisational business-processes that are characteristic for smart supply chains. A closer look to existing or ongoing smart contract projects reveals that the majority of smart-contract applications in business life are linked to supply chain management, Internet of Things and Industry 4.0 solutions.

The author participated in several EU projects related to transnational entrepreneurial networks and smart supply chains. Thus, the paper discusses the research question of how and to which extent smart contracting and blockchain technology can facilitate the implementation of collaborative business structures for sustainable entrepreneurial activities in smart supply chains. The research is based on expert interviews, surveys and case studies, which took place in the context of the EU projects with a focus on the Baltic Sea Region.

Keywords: Smart Contracts, Blockchain, Smart Supply Chains, Industry 4.0.

1. INTRODUCTION

Supply chain management (SCM) investigates and tries to optimise cross-company business processes that are characterised by downstream flows of goods and services and upstream flows of information and finance (Jacobs & Chase, 2014). The coordination of the underlying supply chain flows represents a challenging task due to different interests of involved stakeholders, complex business processes and distributed structure of a supply chain. Prominent features of SCM challenges are related to the domination of big players, fragmentation, problems in supply chain finance and troubles related to supply chain lead-time and throughput (Nyhuis & Wiendahl 2009, Prause & Hunke 2014, Zhao & Huchzermeier 2018). With the rise of Industry 4.0, these issues are transported into the world of smart manufacturing and logistics but now under the emphasis of fractals, networked cyber-physical systems (CPS), self-organising and self-optimising as well as machine-to-machine (M2M) systems (Prause & Atari, 2017). Hence, in the context of Industry 4.0 the classical SCM challenges become smarter; more networked, more fragmented and distributed (Prause 2015; Olaniyi & Reidolf 2015).

Recent research stresses the potential of blockchain technologies for facilitating entrepreneurial collaboration in networks and smart supply chains to solve problems related to fragmentation and distributed autonomous entities (Norta et al. 2014, Hoffmann et al. 2018). The scholars argue that blockchain technology enables an evolving set of parties to maintain a safe, permanent, and timestamped ledger of transactions without a central authority. In other words, transactions are not recorded centrally, and each party maintains a local copy of the ledger consisting of a linked list of encrypted blocks comprising a set of transactions that are hashed and grouped in blocks and thus broadcasted and recorded by each participant in the blockchain network. When a new block is proposed, the participants in the network agree upon a single valid copy of this block according to a consensus mechanism. Once a block is collectively accepted, it is practically impossible to change it or remove it, i.e., a blockchain can be considered as a replicated append-only transactional data store, which can replace a centralised register of transactions maintained by a trusted authority (Udokwu et al. 2018).

Blockchain platforms usually offer additionally the possibility of executing scripts on top of a blockchain, which is called smart contracts allowing parties to encode business rules like negotiated legal agreements. Thus, a smart contract can be considered as an electronic transaction protocol to enforce digitally the negotiation and execution of the terms of an underlying legal contract designed to fulfil conditions like payments, legal obligations, and enforcement without third

Peer review under responsibility of International Federation of Automatic Control.
10.1016/j.ifacol.2019.11.582

parties. Such a smart contract realises the digital execution of legal agreements and linked transactions between distributed units within a network or supply chain with reduced transaction costs by being trackable and irreversible. Thus, smart contracts together with their transactions are executable due to blockchain technology without the involvement of a third-party and current research points out to tackle essential challenges in smart SCM by using these technologies (Pfohl & Gomm 2009; Bodo et al. 2018; Hofmann et al. 2018). Hence, blockchain technology and smart contracted legal agreements seem to be suitable concepts to redesign and optimise collaborative business processes and supply chains.

However, the role of smart contracts and blockchain technology can go beyond cost reductions and optimisation of flows in supply chains. It opens the opportunity to facilitate the integration of SMEs into cross-organisational business-processes by creating open and harmonised IT-environment in order to realise the possibility of fair participation of SME sector in supply chains since currently linked IT-systems. The underlying business structures are still often closed due to the domination of big players with their dedicated IT-systems together with their business rules that dictate the market conditions within the supply chains and cause high entry barriers to SMEs and entrepreneurs (Prause & Hunke 2014, Prause & Hoffman 2017). Thus, traditionally, the related business processes are executed by relying on central third-party providers with their standards and these centralised architectures create not only dominance and entry barriers, but they also restrain process innovation. Blockchain technology enables these processes to be executed in a distributed way without the need of a central authority or requiring mutual trust among the involved parties.

This paper discusses the research question of how and to which extent smart contracts and blockchain technology can facilitate and improve the implementation of collaborative business structures for sustainable entrepreneurial activities in smart supply chains. The research is based on expert interviews, surveys and case studies, which took place in the context of the EU projects of transnational entrepreneurial activities in the context of smart supply chains with a focus on Baltic Sea Region.

2. BLOCKCHAIN AND SMART CONTRACTS

As already mentioned, the term blockchain indicates two things, a distributed database and a data structure i.e. a linked list of blocks containing transactions, where each block is cryptographically chained to the previous one by including their hash value and a cryptographic signature, in such a way that it is impossible to alter an earlier block without re-creating the entire chain since that block). Linked to the blockchain technology is the concept of smart contracts, i.e., scripts that are executed whenever a particular type of transaction occurs, and that may read and write from the blockchain. Smart contracts allow parties to enforce that whenever a specific transaction takes place, other transactions also take place (Norta 2017).

Let us consider the case of delivery within a supply chain where all data about suppliers, recipient, goods and business conditions are distributed over databases of the supply chain. Selling goods or services can be implemented as a transaction, cryptographically signed by both the vendor and the buyer and by attaching a smart contract for sales transactions. The execution of the transfer of the corresponding funds and rights can be enforced when the sale takes place, and all other agreed conditions like documentation, tax payments or quality checks are realised, i.e., smart contracts can enforce the correct execution of collaborative, entrepreneurial processes. The underlying business processes and related legal agreements are often mathematically modelled by Petri-Nets describing the underlying workflows together with tokens that represent mostly permissions ("authorisation tokens") or information. Thus, one important task represents the translation of a standard Business Process Model and Notation (BPMN) into a Petri-Net and hence to compile this Petri-Net into a smart contract. The technical implementation of a smart contract requires a formal language like eSourcing Markup Language (eSML) to specify the possible interactions and contracts and to enforce the agreements reached (Norta et al. 2014, 2015, Norta 2017).

However, the successful general implementation of smart contracts in the business world requires a general framework for functioning and development of blockchains including legal protections afforded to technological protection measures as well as rights management information that is jointly referred to as Digital Rights Management (DRM) (Bodo et al. 2018). Technical protection measures define technologies that restrict acts that can be performed in respect of a copy of work whereas right management information relates to electronic information attached to a work. The current DLT offers built-in tools to automate transactions enabling users to write sophisticated software with the smart contracting language like eSourcing Markup Language (eSML) that interacts with the distributed ledger and shares the same characteristics comprising self-enforcing or immutable. Thus, smart contracts can be considered as algorithmic account holders on a blockchain, i.e., they represent pieces of code that execute transactions if their encoded conditions are fulfilled. Generally, a smart contract encodes ‘if-then' conditions so that a user pays an amount to the smart contract account if all preconditions of the underlying contract are accomplished. Hence, a smart contract can distribute revenues based on conditions represented by coloured tokens in the sense of Petri-Nets. (Norta et al. 2015, Norta 2017, Bodo et al. 2018).

The ability of smart contracts to facilitate cross-company and network activities also reflects in already existing or ongoing smart contract projects revealing that more than 70% of the top domains of smart-contract applications in business life are linked to supply chain management (SCM), Internet of Things (IoT) solutions and related topics. The main reason for relying on smart contracts applications are transparency and trust which also represent essential ingredients of Industry 4.0 aiming to develop cyber-physical systems and dynamic production networks in order to achieve flexible and open value chains in the manufacturing of complex mass customisation products in a small series up to lot size 1. A closer look to the Industry 4.0 concept reveals even deeper targets for smart manufacturing and logistics like energy and resource efficiency, shortening of innovation and time-to-market cycles, as well as a rise in productivity by using 3D printing, big data, IoT and Internet of Services. Thus, Industry 4.0 leads to new supply chain paradigms based on complex and intertwined manufacturing networks with changed roles of designers, physical product suppliers, clients, and logistics service providers. The process makes it possible to identify and to trace single products during their entire life cycle and even more because in Industry 4.0 it becomes possible for products to organise and choose their way through the production and related logistics processes (Kagermann et al., 2013; Bauer et al., 2014).

Hence, the concepts of Industry 4.0, blockchains and smart contracts do not only fit structurally together and complement each other, the world of blockchains and smart contracts add the concept of self-enforcing to the already well-known Industry 4.0 properties self-organizing and self-optimizing perfecting the needed characteristics for coordinating smart manufacturing and logistics systems based on fractals, networked CPS and M2M systems. Smart contracts that are modelled by coloured Petri-Nets can be then efficiently coded by corresponding program languages like eSML to execute a reliable automatic self-enforcing transaction in distributed systems with low transaction costs in a standardised way.

3. CASE: DELIVERY ROBOTS

Prause and Atari (2017) studied the case of a modular manufacturing company in the context of networked cross-company value and supply chains. The case study shows all characteristics of networked business structures based on fractals, self-organisation, self-optimisation and distributed systems cooperating in the form of a networked modular enterprise, i.e., the networked modular enterprise concept comes close to existing models for implementations of pre-Industry 4.0 structures. Thus, the application of blockchain technology and smart contracts seems to be well placed within the area of modular companies.

Generally, the concept of Industry 4.0 embraces transactions between CPS that cooperate via internet across company borders within smart manufacturing and logistics networks. The underlying cross-company value creation processes involve automatized objects in different fractals together with M2M communication and the related workflows, and business processes require agreements in a distributed IT-environment. Here, blockchain technology and smart contracts deliver a suitable solution, which offers a traceable, and transparent approach and which can accompany an Industry 4.0 product the entire lifetime. This feature is of particular importance at the interface of a smart supply chain with the client since on one hand side, here the supply chains meet the client expectation and on the other hand, side the client interface is characterised by the last-mile problem coming along with high costs.

Punakivi et al. (2001) still discussed the last mile-issue in the traditional context of B2C and e-commerce; they proposed an unattended reception of goods, which could reduce home delivery costs by up to 60%. The unattended delivery approach is based on two main concepts, being the reception box concept and the delivery box concept: The reception box is installed at the customer’s garage or home yard, whereas the delivery box is an insulated secured box that is equipped with a locking mechanism. Meanwhile, new technological innovations implemented into new business models opened up new solutions to bridge the last-mile to the client by using drones and delivery robots, and food and grocery services gaining first experiences in the use of autonomous devices (Hoffmann & Prause, 2018). Thus, the traditional delivery box concept of Punakivi et al. (2001) can be transferred into an Industry 4.0 context of internet–linked manufacturing and logistics so that autonomous delivery robots can be understood as cyber-physical systems of Industry 4.0 related last-mile delivery including usually three stakeholders, namely the seller, an intermediary and the client.

Mainly technical scholar studied M2M systems and the realisation of autonomous logistics agents in the context of Industry 4.0. Wu et al. (2011) investigated M2M systems in the context of embedded internet and identified low cost/high-performance devices, scalable connectivity, and cloud-based device management and services as a vision for the Internet of Things. By considering M2M cases for mobility support, they investigated frame conditions for standards of M2M networks, and Zhang et al. (2011) highlighted self-organisation and self-management as essential factors for success M2M systems. This is due to low human intervention as a major requirement. Meanwhile, based on wireless internet technologies, artificial intelligence concepts and M2M technologies, some entrepreneurs founded start-ups to develop autonomous transport devices on the base of Industry 4.0 related concepts in order to serve the last-mile delivery more or less autonomously. After an initial hype about delivery with flying drones, in recent times land-based delivery robots are in focus for the last-mile (Hoffmann & Prause 2018).

A closer view reveals that autonomous delivery robots enjoy a competitive advantage compared to other delivery modes since the underlying business model emphasises the cost advantage for the last-mile delivery, which is estimated to be less than 1€ per unit/delivery, which is up to 15 times less than current costs. For the customer, the aspect that robot delivery provides a 15-to-20 min delivery window is standard, a much more precise specification than the traditional delivery that can only provide the general date (calendar day) beforehand, gains additional convenience. A notable case for delivery robots represents Starship Technologies Ltd. that was founded in 2014 by Skype co-founders Janus Friis and Ahti Heinla in Tallinn with the aim to tackle the last-mile problem by developing autonomous delivery robots. Today, Starship Technologies is a European technology start-up with subsidiaries in Estonia, the United Kingdom (UK), and the USA, which has built the first commercially available autonomous delivery robots in order to "revolutionise the local delivery industry" (Hoffmann & Prause 2018).

Besides that, Starship claims to be environment-friendly as well, as Starship robots do not emit CO_2. It also claims that their robots contribute to reducing on-road traffic and thus congestions and that Starship provides a solution for retailers and logistics firms to increase supply chain efficiencies and reduce costs. Starship's small self-driving vehicles with a weight of less than 20 kg are electric-powered and are designed for driving on sidewalks with a speed of maximal 6 km/h, being capable of delivering their goods locally within 15–30 min and within a radius of up to 5 km. Since the robots can deliver freight of up to 10 kg for a shipment price up to 15 times lower than the regular price for last-mile deliveries, delivery robots represent an interesting option for e-commerce applications as well as for food deliveries or postal services.

In order to create a smart solution for bridging longer distances of delivery, the company started a collaboration with Daimler in order to develop the "RoboVan," which forms a mobile robot hub on the base of an MB Sprinter mini truck and would considerably extend the range of the robots. This approach for delivery realises a "hub and spoke" concept, which is a well-known standard model in logistics. A RoboVan-Mercedes-Benz Sprinter is to that aim equipped with a storage system for 54 delivery boxes and 8 Starship robots. The Sprinter performs the long-distance elements of transport as a mobile hub, and it brings the robots together with the delivery boxes right into an area were a multitude of individual deliveries has to be performed. From this spot, the robots disembark from the RoboVan autonomously and cover the last-mile to the client in order to individually deliver the goods to the clients and return to the Sprinter afterwards. The approach realises a "hub and spoke" concept with robot delivery for the last short distance. Starship Technologies considers its delivery robots as a supplemental form of shipment, not as a replacement, i.e., the logistical models that can be used with robots are different from those models of traditional delivery methods. Ahti Heinla, the co-founder of Starship Technologies, illustrated in an interview the different areas of complementing delivery with bicycle couriers operating in very dense urban environments since they can overcome gridlocks and traffic jams, whereas autonomous vehicle is predestined for the delivery in the suburbs with low traffic. Access to the cargo in the robots is arranged by a smartphone app, which enables the client to unlock the robot coverlid and retrieve the goods. Moreover, if someone tries to steal the robot, the cameras will take a photograph of the thief, and the alarm will sound. Additionally, multiple tracking devices can track the robot's location via GPS, and the remote operator can speak through two-way speakers with the thief; and the robot will stop working and will not open the cargo unit unless re-programmed by Starship.

Here the well-developed e-governmental infrastructure of Estonia and the gained experience of the last 20 years supported the fast development of Starship Technologies significantly (Prause 2016). The Estonian e-government system (e-Estonia) not only facilitates the handover of the delivery right, but it also opens up the access to the banking system and the full spectrum of public services through its integration concepts of the underlying X-TEE structure. In this sense, the e-Estonia infrastructure facilitates an e-business system that supports the use of autonomous delivery robots at the client interface so that a company like Starship Technologies emerges in Estonia. With the implementation of Estonian digital citizenship, called e-Residency, the Estonian government opens access of foreigners to the Estonian e-government system so that e-Estonia can be used as e-business platform from all over the world (Prause 2016).

4. FINDINGS AND DISCUSSION

Modular enterprises and autonomous delivery robots in the discussed form do not fully deploy the potentials of Industry 4.0 especially not the use of robots for the delivery of food or flowers. The picture dramatically changes by assuming that the delivered good will be high-tech Industry 4.0 products that are accompanied by internet link their whole lifespan because in this case the product itself also becomes an object to tentative transactions through a smart contract even after the time of delivery. If we place the client as another fractal into the context of a networked modular enterprise and assume that the autonomous robots deliver between the linked parts of the modular company, then we will get a more realistic picture of a future Industry 4.0 situation. In such a scenario, the related workflows and cross-company value processes can be understood as an internet-linked smart manufacturing network or supply chain where goods and services are produced and delivered downstream, and information and finance flow upstream and where smart contracts execute electronic transaction protocols in both directions. Thus, the implementation of blockchain technology together with smart contract solutions complement the already existing basis technology towards intended Industry 4.0 solutions. In the case of autonomous delivery robots the added value of smart contracts to supply chain performance, legal issues and product customisation are discussed in the sequel.

4.1 Supply Chain Performance

Nyhuis and Wiendahl (2009) developed logistic operation curve theory and throughput oriented lot sizing to control and optimise operations management and supply chain processes. However, empiric research shows that the theoretic concepts are too rough for practical purposes so that the underlying models have to be adapted on the base of real-time data to align the processes with their optimal models (Schmidt et al. 2015). Here, smart contracts are used to initiate transactions among the units of a supply chain to coordinate and optimise the full supply chain. This process concerns time issues like throughput, cycle and lead-time as well as financial flows through the supply chain. Hofmann et al. (2018) highlight the importance of blockchain technology for supply chain finance, but scholars still discuss the appropriate currency for financial transactions along supply chains. Visible features like conditional money transfer transactions in the moment of product delivery by the robot can be quickly realised by smart contracts with additional modifications like a disabling of specific product functions as long as the client does not fulfil certain conditions, e.g. specific payment agreements.

Norta et al. (2015) favour cryptocurrency for financial transactions since the handling of digital money can be realised by smart contracts without media discontinuity. However, this argument loses impact in case of an integrated e-governmental infrastructure comparable to e-Estonia since here digital access to banking services can be safeguarded in digital mode.

4.2 Legal aspects

Bodó et al. (2018) investigated copyright and licensing issues in context with blockchains and smart contracts that might also appear in the context of robot deliveries. They identified some domains where the implementation of blockchain technology together with smart contracts seems to be promising namely private ordering, copyright issues, and fair remuneration. Nevertheless, all these issues are related to open questions. First, it has to be mentioned that there is no such thing as an international copyright right. There exists the Berne Convention, which consists of 176 different national bundles of copyright rights, which can vary in scope and duration.

Another important aspect is related to the fact that the transfer of copyright often requires a written instrument so that it seems doubtable that courts interpret smart contracts as an appropriate written instrument which highlights a problem field is touching many other types of transaction that require written form. Using blockchain technology for copyright licensing also poses the question between on- and off-chain transactions. While coordination of strictly on-chain uses and users seems to be able to be automated via smart contracts, conflict resolution may require off-chain institutions. Furthermore, the development of blockchain-based smart contracts will be linked to the question of how to retain copyrights and licenses when agreements are later breached, especially by taking under account the frame conditions of the Berne Convention.

In case of retention, conflicts between smart contracts and traditional licenses may appear, e.g., a desynchronization of a blockchain might happen if off-chain transactions are not properly recorded on a digital ledger. Hence, rather than reducing information uncertainty and increasing trust, the introduction of a blockchain-based system may have the opposite effect. Thus, the need for coordination emerges, and it is not yet clear how and indeed, whether platforms developed, using blockchain technology can address these issues.

4.3 Product customising

Jacobs and Chase (2014) define mass customisation is the method of effectively postponing the task of differentiating a product for a specific customer until the latest possible point in the supply network. For Industry 4.0 manufacturing of complex mass customisation products in a small series up to lot size 1 represents one of the main motivations, which require close interaction and a good relationship with current and potential customers. The postponement task of mass customisation is solved too significant extent by the concept of modularisation, i.e., a deconstruction into more or less independent units, called modules, in order to reduce the complexity of a system, e.g., a business process, an organisational structure or an IT application. The modules exist independently from each other, but the system as a whole can only function as an integrated structure. Product modularity provides flexibility and responsiveness that enables firms to serve a variety of customer needs.

Howard and Squire (2007) investigated modularisation and its impact on supply relationships and found out that an advantage of modularity concerning supply chain design is that pursuing product variations has only a limited impact on production and assembly processes. Modular design allows a firm to differentiate its product to a high degree by combining a limited number of standard parts and modularity has been extensively applied successfully in the in electronics and automotive sectors. Pine (1992) differentiated four types of mass customisation, namely collaborative, adaptive, transparent and cosmetic customisation. In the case of product delivery by a robot, the adaptive customisation scenario seems to be the most exciting case since here to a company produces and delivers a standardised, modular designed product and the product customisation takes place at the client. By assuming an Industry 4.0 product that enjoys internet linkage during its full life cycle, smart contracts can activate or block product or module functions according to agreements between supply chain units and the client. Based on this concept sustainable business models suitable for Industry 4.0 can be implemented (Prause 2015).

Hence, already the case of autonomous delivery robots highlight that the use of blockchain technology and smart contracts complement the existing solutions for smart supply chains and to spur the development towards Industry 4.0 by filling essential gaps in the context of technical Industry 4.0 applications.

5. CONCLUSIONS

Smart contracts are electronic transaction protocols created for executing and enforcing underlying legal contracts by using blockchain technologies for distributed databases. They are designed to fulfil self-enforcing contractual conditions like payments and legal obligations without the need for an existing trusted third party. Thus, smart contracts target to reduce transaction and enforcement costs by realising trackable and irreversible transactions. The research reveals that the potential of smart contracts goes far beyond cost reductions by facilitating the entrepreneurial collaboration of cross-organisational business-processes that are characteristic for smart supply chains. Smart-contract applications linked to smart supply chain management, Internet of Things and

Industry 4.0 can contribute solutions to critical challenges in the area of smart manufacturing and logistics.

By considering the case of autonomous delivery robots, the paper highlights that the concepts of Industry 4.0, blockchains and smart contracts fit structurally well together and complement each other by adding self-enforcing to the already well-known Industry 4.0 features of self-organising and self-optimising. Thus, the implementation of blockchain technology together with smart contract solutions complement the already existing basis technology towards intended Industry 4.0 solutions including the implementation of collaborative business structures for sustainable entrepreneurial activities in smart supply chains. In the case of autonomous delivery robots, the added value of smart contracts lies in supply chain performance, legal issues, and product customisation.

REFERENCES

Bauer, W., Schlund, S., Marrenbach, D., Ganschar, O. (2014). Industry 4.0 – Volkswirtschaftliches Potenzial für Deutschland, *BITKOM*, Berlin, 46p.

Bodó, B., Gervais, D., Quintais, J. (2018). Blockchain and smart contracts: the missing link in copyright licensing?, *International Journal of Law and Information Technology*, Volume 26, Issue 4, 1 December 2018, Pages 311–336, https://doi.org/10.1093/ijlit/eay014.

Hoffmann, T., Prause, G. (2018). On the Regulatory Framework for Last-Mile Delivery Robots. *Machines*, 6(3) (33).10.3390/machines6030033.

Hofmann, E., Strewe, U., Bosia, N. (2018). Supply Chain Finance and Blockchain Technology, *Springer*, ISBN 978-3-319-62371-9.

Howard, M., Squire, B. (2007). Modularization and the impact on supply relationships, *International Journal of Operations & Production Management*, 27(11), 1192-1212.

Jacobs, R., Chase, R. (2014). Operations and Supply Chain Management, *McGraw-Hill*, 14th edition, ISBN: 978-1259666100.

Kagermann, H., Wahlster, W., Helbig, J. (2013). Recommendations for implementing the strategic initiative INDUSTRY 4.0, *National Academy of Science and Engineering*, Berlin/Frankfurt, 82p.

Norta, A. (2017). Designing a smart-contract application layer for transacting decentralized autonomous organizations. In: Singh, M.; et al. (Ed.). *Advances in Computing and Data Sciences*, pp. 595−604, Springer Communications in Computer and Information Science; 721, DOI: 10.1007/978-981-10-5427-3_61.

Norta, A., Ma, L., Duan, Y., Rull, A., Kolvart, M., Taveter, K. (2015). eContractual choreography-language properties towards cross-organizational business collaboration. *Journal of Internet Services and Applications*, 6(1):1-23.

Norta, A., Grefen, P., Narendra, N.C. (2014). A reference architecture for managing dynamic inter-organisational business processes, *Data & Knowledge Engineering*, Vol. 91, pp. 52-89, DOI: 10.1016/j.datak.2014.04.001.

Nyhuis, P., Wiendahl, H.-P. (2009). Fundamentals of Production Logistics, *Springer*, ISBN 9783540342113.

Olaniyi, E.O., Reidolf, M. (2015). Organizational Innovation Strategies in the Context of Smart Specialisation, *Security and Sustainability Issues*, 5, 213–227.

Pfohl, H.C., Gomm, M. (2009). Supply chain finance: optimizing financial flows in supply chains, *Logistics Research*, 1(3-4), 149–161, DOI: 10.1007/s12159-009-0020-y.

Pine, J. (1993). Mass Customization – The New Frontier in Business Competition. *Harvard Business School Press*, ISBN 0-87584-372-7

Prause, G.; Atari, S. (2017). On sustainable production networks for Industry 4.0. *Journal of Entrepreneurship and Sustainability Issues*, 4, 421–431.

Prause, G. (2016). e-Residency: A business platform for Industry 4.0, *Journal of Entrepreneurship and Sustainability Issues*, 33, 216-227.

Prause, G. (2015). Sustainable business models and structures for industry 4.0, *Journal of Security and Sustainability Issues*, Vol. 5(2), DOI: 10.9770/jssi.2015.5.2(3).

Prause, G.; Hoffmann, T. (2017). Cooperative Business Structures for Green Transport Corridors. *Baltic Journal of European Studies*, 7, 3–27.

Prause, G., Hunke, K. (2014). Secure and Sustainable Supply Chain Management: Integrated ICT-Systems for Green Transport Corridors. *Journal of Security and Sustainability Issues*, 3 (4), pp. 5−16, DOI: 10.9770/jssi.2014.3.4(1).

Punakivi, M., Yrjölä, H., Holmström, J. (2001). Solving the last-mile issue: Reception box or delivery box? International Journal of Physical Distribution and Logistics Management, 31(6), 427–439.

Schmidt, M., Münzberg, B., Nyhuis, P. (2015). Determining lot sizes in production areas – exact calculations versus research-based estimation, Procedia CIRP 28, 143 – 148.

Udokwu, C., Kormiltsyny, A., Thangalimodziz, K., Norta, A. (2018). The State of the Art for Blockchain-Enabled Smart-Contract Applications in the Organization, *Ivannikov ISPRAS Open Conference* sections, Moscow, Russian Academy of Science.

Wu, G., Talwar, S., Johnsson, K., Himayat, N., Johnson, K. (2011). M2M: From Mobile to Embedded Internet, *IEEE Communication Magazine*, 49, 36–43.

Zhang, Y., Yu, R., Xie, S., Yao, W., Xiao, Y., Guizani, M. (2011). Home M2M Networks: Architectures, Standards and QoS Improvement, *IEEE Communication Magazine*, 49, 44–52.

Zhao, L., Huchzermeier, A. (2018). Supply Chain Finance, *Springer*, ISBN 978-3-319-76663-8.