

A digitalizáció hatásának vizsgálata az ellátási láncok nyomon követhetőségére és átláthatóságára

Examining the effect of digitalization regarding traceability and transparency in supply chains

LÁSZLÓ BUICS¹

Absztrakt

Jelen tanulmány célja annak megvizsgálása, hogy a digitalizáció és a modern technológiai fejlesztések milyen befolyással bírnak az ellátási láncokra, miként változtatják meg azokat. A negyedik ipari forradalomként is emlegetett Industry 4.0 kapcsán számos új technológiai megoldás születik és kerül alkalmazásra abból a célból, hogy a vállalatok növelni tudják saját a hatékonyságukat és versenyelőnyhöz jussanak a piacon. Ennek az elméleti tanulmánynak az a célja, hogy megvizsgálja, hogy az új technológiai innovációk lehetséges alkalmazási módjai hogyan tudnak jobb, hatékonyabb, okosabb ellátási láncokat létrehozni, és hogy ezek az új technológiai megoldások miként tudják befolyásolni a logisztikai folyamatokat és megoldásokat a jövőben. A modern technológiák és megoldások megváltoztatják a hagyományos ellátási láncokat, rugalmasabbá, gyorsabbá, okosabbá téve őket, eközben pedig lehetővé teszik, hogy a követhetőség és az átláthatóság egy új szintre lépjen.

Kulcsszavak: digitalizáció, ellátási láncok, IoT, okos technológiák, követhetőség, átláthatóság

Abstract

The purpose of this paper is to examine how digitalization and modern technological advancements can change the way how we think about supply chains. In the age of Industry 4.0 we are the witnesses of the spread of new technological solutions across the companies in order to keep up or even increase efficiency and effectiveness while trying to gain competitive advantage. The aim of this theoretical paper is to examine how new technological innovations can create smart supply chains and how these changes could affect logistics methods and solutions in the future. Smart technologies and solutions are emerging and changing traditional supply chains by making them more flexible, faster, and ultimately smarter while they enable to traceability and transparency methods to reach a higher level.

Keywords: digitalization, supply chains, IoT, smart technologies, traceability, transparency

INTRODUCTION

The phenomenon of digitalization become the part of our life more and more in the last decade, and conquered more and more different fields from administration to manufacturing. Alongside with the phenomenon of Industry 4.0 several new technological advancements and solutions are taking place in many organizations because they want to keep up with the competitors and gain competitive advantage.

Supply chains are also affected by the organizational and technological changes. Whether we are speaking about the phenomenon of Industry 4.0, Logistics 4.0 or Supply Chain Management 4.0 we are speaking about several technologies and concepts like the Internet of Things, cyber-physical systems, advanced data analytics, blockchain, driverless transportation, intelligent containers, smart warehousing, smart ports, smart shelves ect. which

¹ PhD student, Széchenyi István University, Győr, Hungary, buics.laszlo@sze.hu

are altogether more than just simple implementation of the modern technological solutions. (Burkett, Johnson, 2016)

The goal of this theoretical paper is to examine how new technological innovations can affect and change logistics methods and solutions in the future with a special focus on changes regarding supply chain traceability and transparency. Smart technologies and solutions are emerging and changing traditional supply chains by making them more flexible, faster, and ultimately smarter while they enable traceability and transparency methods to reach a higher level.

In this paper I concentrate on the examination of recent technological developments and tools which can replace long time existing methods or can develop them further within the supply chains to enable new ways and levels regarding traceability and transparency. In this paper I would like to examine through a literature review how the new technological advancements, like IoT technology based identification methods and the different kind of blockchain application technologies, can affect and change present and future supply chains while making them smarter along the process. First I will examine recent technological trends and so called “buzzwords” then I will examine how these phenomena are connected to supply chain traceability and transparency.

Emerging technologies, particularly the Internet of Things (IoT), which allows objects to communicate with each other and with various other platforms in real-time, has a growing attention (Chung, Kim, 2016) because these methods are taking connectivity to a new level and create new opportunities for both manufacturers and customers. “The Internet of things is a next generation of Internet connected embedded ICT systems in a digital environment to seamlessly integrate supply chain and logistics processes.” (Tharaka et al., 2018, 1)

The Internet of Things can be defined as “an object of the physical world (physical thing) or the information world (virtual thing), which is capable of being identified and integrated into communication networks.” (Kafle, Fukushima, Harai, 2016, 44) and embraces the idea that “virtually all objects become smart and connected” (Weinberger, Bilgeri, Fleisch, 2016, 700) and the network of objects (e.g. devices, vehicles, machines, containers), embedded with sensors and software has the potential to collect data and communicate with each other through the Internet (Edwards-Hopkins, 2018).

1. SMART SUPPLY CHAINS AND INTERNET OF THINGS

Nowadays the business environment is more competitive than ever, where supply chains are competing with each other rather than individual organizations (Christopher, 2016; Christopher-Towill, 2001) and the ones who are able to perform better achieve a competitive advantage (Seuring-Müller, 2008). In conceptualizing supply chain management (Christopher-Crum-Holweg, 2011; Ellram-Cooper, 1993; Ho-Au-Newton, 2002), the supply chain integration – which can be defined as collaborative inter- and intra-organizational management on the strategic, tactical and operational business processes to achieve effective and efficient flows of products, information and funds to provide the maximum value to the end customer at the lowest cost and the greatest speed (Huo, 2012; Yu, 2015; Zhao et al., 2011). - represents a mechanism for improving supply chain performance (Alfalla-Luque et al., 2013; Ataseven & Nair, 2017).

The success of a business and its supply chain is increasingly determined by the business's ability to react quickly to market forces and make smart decisions based on hard data. There have been a number of studies that have investigated the ICT-enabled supply chain processes integration in improving the performance (Li et al., 2009; Qrunfleh-Tarafdar, 2014; Rai et al., 2006; Vanpoucke et al., 2017). According to Veiga Mendes (2017) who made a literature

review with a focus on IoT technologies with connection of supply chain management more than 72 thousand documents were found on this topic in the Web of Science database. This research indicates that the topic of IoT based supply chain management has a growing interest by researchers year by year.

As traditional supply chains are becoming more complex with more and more embedded objects with sensors and better communication capabilities, the overall intelligence of supply chains are growing and create new opportunities for achieving cost reduction and increasing efficiency. (Wu et al., 2016) In smart supply chains we can monitor conditions along the supply chain and track products for traceability in a more efficient way by using IoT tools, the system-wide interconnection and advanced data analytics. Supply chain design should be able to see across the entire business to optimize the true end-to-end supply chain and not just a specific business unit or business function. (Wu et al., 2016)

The Internet of Things related technologies can provide tremendous amount of value for companies. In manufacturing it can be used for example to predict asset maintenance needs, while sensors allow logistics service providers to monitor the environment of sensitive packages in order to predict potential supply issues while still in transit. It can be also used for enhanced traceability which can give greater insight to businesses into where their shipments are, where they came from and when they will get to their destination. This is vital for regulatory compliance, improved customer service and better visibility overall. (Wu et al. 2016)

ICT can enable supply chain integration and enhance effective information flow (Rai et al., 2006; Yu, 2015), thus generating additional capabilities through IoT technologies resulting in the facilitation of the information capture and sharing (Ben-Daya et al., 2017; Tu, 2018). Thus, IoT has the capability to affect supply chain processes, improving visibility, accuracy, traceability, interoperability and collaborative decisions along the chains (Reaidy et al., 2015). According to several authors supply chains in general are one of the most important application domain of IoT technologies (Borgia, 2014) and there is evidence for the positive effect of supply chain integration on its performance (Ataseven-Nair, 2017; Flynn et al, 2010; Huo, 2012).

The changes indicated by the technological solutions if IoT are already affecting our own everyday life, such as home management and appliance maintenance (Weinberger et al., 2016, Babamir, 2012) and beyond the possible industrial benefits have a potential to address greater global issues in the future as well. (Kafle et al., 2016)

IoT based technologies are already existing on many fields within the industrial world and manufacturing. They help in “preventive maintenance, remote control, manufacturing analytic tools and services, management of process quality as well as smart retrofitting of machinery (...), and it will allow to integrate whole supply chains, tracking and tracing inter and intra plant logistics” (Weinberger et al., 2016, 701). In addition, the advances in IoT may help to “monitor and visualize various wireless sensor networks applications in manufacturing environments such as automated workcells, transportation systems, logistic, and storage systems” (Bi et al., 2016, 377).

In this context, real-time data and delivery of the product in the right place at the right time (Sivamani et al., 2014) are streamlined, even allowing the creation of new services and the improvement of business processes (Appel et al., 2014) and business models. Regarding IoT applications, based on the research done by Veiga Mendes (2017) food supply chains were one of the most studied applications for IoT in supply chain management because transporting perishable goods represents notable challenges that global companies have to face during their operations.

IoT technologies can be also used for loss protection because if everything is tracked with internet-connected sensors, it's much more difficult for products to go missing while in

transit. When loss does occur, it's easier for the business to determine when and where it happened. Key objectives of a smart supply chain include mitigating supply chain risk, accelerating decision making processes, improving efficiency, and monitoring performance across functions. In the end, making supply chains smarter is going to be an increasingly important element of making them better.

As we can see digital technologies are providing opportunities to better support the customers with proactive location and delivery information. They also give a better insight into the performance of the supply chain itself. (Fawcett-Waller, 2014) The technological advancement ultimately will impact the supply chains in several ways. Thanks to the Internet of Things the inventory management can be improved significantly because the real-time visibility of the inventory can be achieved and manual errors made by workers can be reduced with the advanced data collection methods.

While the methods of supply chain management are already heavily supported by various IT solutions, the Internet of Things can be of great value by providing additional information. But the results of the qualitative study done by Mengru Tu (2018) also identify uncertainties and issues regarding firms' intention to accept or reject IoT technology in logistics and supply chain management, including the benefit and cost aspects of adopting IoT, uncertainties about the trustworthiness of IoT technology, and the external motivating force to embrace IoT.

According to Mahsa et al. there are several challenges in supply chain management regarding the application of IoT technologies. In this literature review analysis the authors collected and categorized many articles connected to IoT and supply chain management and they found that the main categories of these challenges are: Operational Challenges, Integration Challenges, Environmental Challenges, and Social Challenges which have to be dealt with sooner or later.

2. TRACEABILITY AND TRANSPARENCY

As we can see IoT technologies can be related to supply chain management in many ways. If we are speaking about traceability, several tracking options occur such as the locations of raw materials, inventory, and finished products. But how can we define transparency and traceability in case of the supply chains?

Awaysheh and Klassen (2010) identify transparency as the measure of information availability to both counterparties in an exchange and also to outside observers. In the context of supply chains, transparency refers to information available to companies involved in a supply network. In this context supply chain traceability leverages transparency to determine and execute organizational goals related to raw material origins and provide context to a final product or service. (Awaysheh- Klassen, 2010)

As an indispensable element of the development of information technologies, data traffic has also increased, so it was necessary to develop technologies and systems that facilitate quick and efficient identification and tracking. Modern logistics systems and supply chains would be inconceivable without the use of such technological solutions.

Nowadays, when we prefer the Just in Time logistics solutions, manufacturers are trying to reduce their own costs by minimizing inventory and work-in-process materials, so it is vital that production and transportation is smooth and unobstructed, and this would not be feasible without the use of such logistic technologies.

Skilton and Robinson (2009) in their article found that optimizing transparency and traceability are correlated. They define traceability as the ability to identify and verify the components and the chronology of events in all steps of a process chain. They state that the relationship between supply chain transparency and traceability is not linear because while having more available information may lead to increased traceability but increased

traceability not necessarily lead to increased transparency especially when there are only a few participants with loose affiliations in the supply chain, (Skilton-Robinson, 2009) and traceability is limited by the complexity within the supply network. (Markman-Krause, 2014)

As the need of traceability has grown numerous types of electronic identification systems have emerged in the previous decades. One of the most important of these methods was the bar code. The biggest advantage of the barcode was the unified standard, the low production cost, the easy manufacturing method, and the high speed readability, and versatility. However, the barcode also had its own disadvantages, such as limited information capability, the possibility of forgery, and the risk of loss of information due to vulnerability. (Magyar, 1995)

As the technology became more advanced a new type of solution emerged what we call RFID (Radio Frequency IDentification). RFID systems are considered as the new generation of barcodes. The advantage of RFID over the barcode is that we can capture huge amounts of product data in seconds, excluding human error. With RFID we can identify and track stocks, vehicles, crops, food products, and even people and they can be also used to create access control systems.

For its operation an electromagnetic reader is used to read the information stored in its memory. This memory also has enormous advantages over the barcode's one-time information storage capability, as it can be rewritten, so RFID chips can be reused on a variety of different products. (Bohács, 2004) Thus, instead of identifying items individually, with RFID technology we can identify a whole pallet of different commodities at a time, without physical contact or sight. In an RFID application, tags are attached or embedded in objects that need to be recognized or tracked. When the tags are read a consulting background database is provided which enables alignment between IDs and objects.

We know that many manufacturers rely on a number of suppliers to deliver ordered materials on time. When the suppliers can use RFID tags on materials, everyone knows the route, the times, and the actual delivery to the manufacturer. This provides full transparency at both ends of the chain. We can also use them to track the locations of materials once delivered. When the manufacturing facility is large and shipments are arriving continuously, finding a specific shipment could be a hard challenge but the embedded RFID tags can solve this issue easily. Last but not least we can track materials and products within a facility as well. Its usage can prevent materials displacement which could result in production problems, delays and unhappy customers.

But there is one more tool which can be even more useful in case of supply chains to become more traceable and transparent and this is the blockchain technology. Blockchain technology is commonly associated with the Bitcoin and other cryptocurrencies, but the technology's usefulness is potentially even wider than RFID's. Basically it is an open-source, decentralized, distributed database for storing transaction information.

Seebacher and Schüritz (2017) define blockchains as follows: "A blockchain is a distributed database, which is shared among and agreed upon a peer-to-peer network. It consists of a linked sequence of blocks (a storage unit of transaction), holding timestamped transactions that are secured by public-key cryptography (i.e., "hash") and verified by the network community. Once an element is appended to the blockchain, it cannot be altered, turning a blockchain into an immutable record of past activity." (Seebacher- Schüritz, 2017, 12)

As Awaysheh and Klassen (2010) describes this technology indeed provide increased supply chain transparency, and it can also create an immutable and distributed aspect of the custody record by nature of the protocol which suits well traceability applications because this technology allows two parties to transact information directly using duplicate, linked ledgers. (Awaysheh-Klassen, 2010) "This makes transactions considerably more transparent than those provided by centralized systems. As a result, transactions are executed without relying

on explicit trust [of a third party], but on the distributed trust based on the consensus of the network (i.e., other blockchain users).” (Fransisco-Swanson, 2018, 1.)

Applying this technology to improve supply chain transparency has many possibilities. This technology can be used to track merchandise movements, record ownership of assets, record production and use of parts, and track changes of location and owners, as this information can all be recorded in a blockchain-based technology. This means that all stakeholders can access the transaction data at any time to ensure it is accurate and true. This technology solution can provide full transparency between endpoints and reduce costs as the transaction process is less and the technology can also be used to track traffic flow.

With the peer-to-peer model of blockchain, we can create new innovation channels for developing and deploying logistical applications. In this sense, blockchain technology can also emerge as a new operating system in supply chain networks that link B2B to software applications. Blockchain technology is expected to track merchandise details from commencement of orders through delivery data up to the moment of arrival and thus provide greater transparency in the supply chain for all parties by providing accurate real-time information anywhere, anytime, to all interested party.

“The process of “hashing” transforms tangible (e.g., raw material) and intangible (e.g., ownership of a file) assets into a digitally encoded “token” and can be registered, tracked, and traded with a private key on a given blockchain. Further control of an asset may be achieved and supply chain traceability may be enabled through use of tracking technologies such as RFID, NFC tags, and similar technologies enabled by the Internet of Things (IoT).” (Fransisco-Swanson, 2018, 2.)

However understanding of the technology lags well behind the hype of blockchain even despite the fact that it seems to promise major change for capital markets and other financial services as well. Some say it may ultimately prove to be as important an innovation as the internet itself but few can say exactly how or why

But with the possibilities of an artificial intelligence and other technological advancements, the future supply chain holds the promise of being completely autonomous and self-orchestrated. For example a fleet of trucks using a swarm algorithm could increase throughput in cargo yards, a trusted peer-to-peer ledger on the blockchain architecture could revolutionize the meaning of compliance in the industry, and a host of wearables, mobile robots, as well as machine learning approaches, could rapidly fasten the pace of order fulfillment. (Fagnant-Kockelman, 2015)

CONCLUSION

As we can see supply chain management is changing rapidly with new advancing technologies and digital solutions on the way in the close future. For growing small and midsize businesses, the key is to recognize these big trends and consider which ones they can feasibly implement. As the supply chains becomes more digitalized, companies will need trained employees who are capable to analyze the collected data and also advanced business intelligence tools, to help them make informed decisions.

New technologies are presenting promising opportunities for improvement across the supply chain. Using blockchain in the supply chain has the potential to improve supply chain transparency and traceability as well as reduce administrative costs. But while technology changes quickly, organizations may change much slower, and the slow speed of change makes harder to keep up with advances in technology for many organizations. As the digital transformation grows, organizations must learn how to address this new world and they must also deal with the rising complexity factors.

Technological developments are increasing the digitalization of supply chain management and changing how products and services are made and delivered. They also enable the creation and sharing of supply chain information in new ways. The new technologies allow a higher level of connectivity in supply chains and thanks to this phenomenon tracking methods used and connected by the Internet of Things allow the recording of all kinds of manufacturing information, production date, expiry date, warranty period, after sales details allowing real time and more efficient supply chain management. When it's possible to have a real-time look in the supply chain operation, production capacity can be raised, which leads to more productivity with the same investment.

Nowadays companies are digitally transforming the management of their supply chains by piloting and applying technologies such as machine learning and blockchain to traditional supply chain management activities. A blockchain technology supported supply chain can help participants to record price, date, location, quality, certification, and other relevant information to more effectively manage the supply chain. The availability of this information within a blockchain based software can increase traceability of the material supply chain, lower the possible losses from counterfeit and gray market, and improve the overall transparency of a company.

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