

Blockchain: China's Leading E-commerce Players Innovate in Traceability

Carmen Bălan

The Bucharest University of Economic Studies

carmen.balan@mk.ase.ro

Abstract

The purpose of the research presented in this paper is to identify the answer to the following question: “RQ: Which is the present stage of the innovative blockchain-enabled traceability initiatives of China's leading e-commerce players?”. A literature survey in prominent databases revealed that such review question is raised for the first time. The use of blockchain for goods traceability is extremely recent. The topic is almost absent in the research literature on logistics and supply chain. Consequently, an exploratory research design was applied. The research focused on the Alibaba Group and JD.com, China's leading e-commerce players. Both players seized the opportunities of the new technology to improve goods traceability and supply chain transparency. They took initiatives and launched projects on blockchain-enhanced traceability. The present stage is pilot testing and a business ecosystem paradigm is applied. Implications for the e-commerce players that intend to use blockchain to enhance traceability are presented. They range from project aim and scope to strong partnerships and standardisation. The paper addresses a research question in the nascent study field of blockchain-enabled traceability. Specific implications for practice are disclosed. A substantial agenda for further research is suggested.

Keywords: blockchain, traceability, transparent supply chain, e-commerce, innovation, food safety.

JEL Classification: M31, L81, O39.

1. Introduction

The term “blockchain” refers to a hyped technology usually associated with cryptocurrencies. While the use of the term is recent, the core idea is related to the “Merkle tree” of late 1970s (Merkle, 1988). Blockchain is also related to bitcoin and implicitly to the name Satoshi Nakamoto – unidentified person that authored the first whitepaper on bitcoin (Nakamoto, 2008).

Blockchain is a decentralized ledger that allows information sharing between the members of a network. The members view and write data that cannot be modified.

The basic principles of the blockchain technology refer to distributed database, peer-to-peer transmission, transparency with pseudonymity, irreversibility of records and computational logic (Casey & Wong, 2017).

Blockchains may be classified based on the permission criterion (Bussmann, 2017). The permissionless blockchain is an open platform that everyone may join. In contrast, in the permissioned blockchain, the access is granted by an authority to increase confidence and security. At present, there is a trend towards developing blockchains that are able to combine the benefits of both types of chains.

There are various domains of blockchain applications, besides the financial field. Recently, companies started to consider the use of this technology in logistics and supply chains to improve traceability and transparency.

The research presented in this paper refers to the innovative initiatives of China's leading e-commerce players in the field of blockchain-enabled traceability. The paper brings several contributions to the extant research literature. Firstly, it addresses innovation in an area of high logistic importance, respectively traceability. Secondly, the contribution of the paper consists in addressing the use of blockchain, a disruptive technology in an area that traditionally was ineffectively managed by many companies to the detriment of final consumers. Thirdly, the paper highlights logistics developments related to China, a market of substantial scale and with high growth potential, which is not always analysed in-depth. Fourthly, the specific

contribution consists in an overview that relies on the most recent information on blockchain-enabled traceability. Finally, the paper discloses the implications for practice and advocates a substantial agenda for further research. Potential research directions and questions are suggested.

2. Blockchain in the research literature

The use of the term “blockchain” has a very recent history in the research literature. This term started to be used in published documents in 2013. The previous mentions of the term do not actually refer to the blockchain technology (they relate to other aspects such as graphs etc.).

The published research literature points out various domains in which blockchain may be used, besides the financial field and cryptocurrencies. Examples of new application domains are the following: manufacturing and smart factory (Angrish *et al.*, 2018; Li *et al.*, 2018; Lin *et al.*, 2018); online social networks (Bahri *et al.*, 2018); Internet of Things security (Banerjee *et al.*, 2018; Kumar and Mallick, 2018); network security and authentication (Boireau, 2018; Hammi *et al.*, 2018); cybersecurity and privacy (Kshetri, 2017); digital rights management (Ma *et al.*, 2018); digital identity (Sullivan, 2018); e-residency (Sullivan & Burger, 2017); medical field and electronic health records (Beninger & Ibara, 2016; Brogan *et al.*, 2018; Dagher *et al.*, 2018; Zhang *et al.*, 2018), legal field and intellectual property law (Castell, 2018; Gürkaynak *et al.*, 2018; Millard, 2018; Savelyev, 2018); sharing economy (Hawlitschek *et al.*, 2018; Huckle *et al.*, 2016; Pazaitis *et al.*, 2017); customer loyalty programs (Kowalewski *et al.*, 2017); energy field (Khaqqi *et al.*, 2018); construction management (Turk & Klinc, 2017); large-scale elections (Wang *et al.*, 2018); resources conservation and recycling (Saber, *et al.*, 2018; Smetana *et al.*, 2018); smart cities (Sharma & Park, 2018). Besides these fields, supply chain emerges as significant domain of potential blockchain application (Casado-Vara *et al.*, 2018; Casey & Wong, 2017; Foerstl *et al.*, 2017; Hofmann & Rüsch, 2017; Leng *et al.*, 2018; Ndraha *et al.*, 2018).

In logistics and supply chain, blockchain technology may be used to enhance product traceability, among other applications.

3. Potential benefits of blockchain-enabled traceability

Traceability developed as research topic during the last decades. The concept was applied in various industries from food to IT. However, there is no common definition accepted by the research community, even in the same industry.

In essence, traceability refers to the ability to follow the “flow of material and information within a company and/or through a supply chain” (Karlsen *et al.*, 2013). In the food sector, traceability allows the identification of the causes of safety failures that occur in the supply chains (Ringsberg, 2014). Record keeping is an essential aspect of traceability (Olsen & Borit, 2013).

Traceability information is one of the three important dimensions of supply chain transparency. The other two dimensions are the sustainability conditions of suppliers and their purchasing practices (Zandén *et al.*, 2015).

Blockchain-enabled traceability provides benefits to all the supply chain members. For companies, the main benefits are the following:

- maintaining and expanding customer portfolio by meeting quality and safety expectations;
- reduced costs and faster recall/withdrawal by tracing the problematic batches and avoiding the removal of all inventories within the supply chain;
- increased trust and security due to the “end-to-end” transparency in supply chains;
- mitigating the risk of sourcing and selling counterfeit products.

Consumers also benefit from the blockchain-enabled traceability:

- peace of mind in terms of the quality and safety of the products and brands they buy;

- enhanced power in the relations with suppliers, being able to make informed choices;
- efficient money spending on authentic products, not on counterfeit goods;
- increased trust in the brands that participate in blockchain-enabled traceability programs.

4. Research methodology

The need for the research presented in this paper evolves from the fact that blockchain technology was associated with logistics applications extremely recently. Worldwide, the debate on blockchain started in relation to cryptocurrencies. However, the benefits of this technology make it relevant to various fields besides finance. The potential use of the blockchain technology for product traceability is a novel topic in logistics and supply chain.

The research presented in this paper was based on the question: “*RQ: Which is the present stage of the innovative blockchain-enabled traceability initiatives of China’s leading e-commerce players?*”. The study had an exploratory nature justified by the scarcity of the information available in the research literature to answer the question. The need for an exploratory research was uncovered following a literature survey in prominent international databases.

The aim of the literature survey was to spot documents (e.g. research articles in peer-reviewed journals, conference papers, books etc.) focused on the topic under investigation. The design of the literature survey started from the research question. The string of search terms was the following: *blockchain AND (traceability OR tracing OR trace OR tracking) AND (good OR product) AND China*. The searched databases were (in alphabetical order): Emerald Insight, Science Direct, Scopus and Web of Science. The search was made on 19 August 2018 and targeted only documents that include the search terms in the title, abstract or keywords, respectively in the topic addressed. The search process led to the identification of one published document related to the investigated topic, respectively the conference paper of Tse *et al.* (2017). This paper is abstracted in Scopus and Web of Science databases. The search in the Emerald Insight and Science Direct databases did not lead to any result.

The exploratory research focused on the Alibaba Group and JD.com, China’s leading e-commerce players. It is based on secondary sources of information available online in English language. The information on the investigated topic is recent, mostly from 2017 and 2018. Whenever available, corporate sources of information were preferred to other sources.

5. Research findings

This section refers to the blockchain-based innovations in traceability in China’s e-commerce. The findings focus on the initiatives of the Alibaba Group and JD.com, key players in this field.

5.1. The Alibaba Group

The Alibaba Group is based on the concept of platform and marketplace. In the fiscal year ended on March 31, 2018, the revenue of the group reached RMB 250,266 million (USD 39,898 million), 58% higher than in the previous fiscal year (Alibaba Group, 2018a). The core commerce achieved a revenue of RMB 214,020 million (USD 34,120 million) and a growth of 60% over the previous fiscal year. The main sources of revenue were: core commerce (85.52% of the total revenue), cloud computing (5.35%), digital media and entertainment (7.82%), innovation initiatives and others (1.31%). The company announced that the number of active customers of the Alibaba Group’s China retail marketplaces was 522 million, marking an increase of 98 million compared to the fiscal year that ended on March 31, 2017 (Alibaba Group, 2018a). The group is listed on the New York Stock Exchange.

The Alibaba Group had several initiatives related to the blockchain-enabled traceability:

a) Active involvement in blockchain research and patent filing

The database of the World Intellectual Property Organisation revealed that 406 blockchain-related patent applications were filed in 2017. Out of these, 225 were filed by China (compared to 59 in 2016), 91 by the USA and 13 by Australia (Noonan, 2018). Thus, China ranks first worldwide in terms of the number of blockchain patents filed.

In 2017, in China, *the People's Bank of China* filed 68 patents, followed by the Alibaba Group with 43 patents (Smith, 2018). Data show that the Alibaba Group is very active in the blockchain research.

Not all blockchain technologies are protected by means of patents. Some organisations do not disclose their blockchain technologies. At the same time, the patent application fees are high. Consequently, a large number of patents may indicate a high importance attached to the market potential of the patented blockchain technologies (Chiu, 2017). The number of patents filed by the Alibaba Group indicate not only a substantial investment in blockchain research, but also great expectations relative to blockchain in generating competitive advantage and profit.

The late adopters of the blockchain technology will potentially face entry barriers created by the existing patents, as well as high costs and dependency on the patent owners.

The fact that a company owns such patents may be a positive sign for investors.

b) Creation of the Food Trust Framework

In April 2018, Alibaba announced the creation of the consortium Food Trust Network (Hsu, 2018). The aim of the consortium is to establish a blockchain-enabled food tracing system in the context of cross-border trade and to prevent food fraud. The Food Trust Network focuses on products sourced from Australia and New Zealand to China.

Besides the Alibaba Group, four organisations are members of the consortium, respectively two important exporters to China and two providers of postal services that have large logistic infrastructures. The organisations from New Zealand are Fonterra – world's largest dairy exporter (Fonterra, 2018) - and New Zealand Post. The organisations from Australia are Blackmores - Australia's leading natural health company (Blackmores, 2018) - and Australia Post.

In the Food Trust Framework, supply chain transparency is ensured by means of the blockchain technology. Information on all the supply chain stages is available to the Chinese customers that buy from Tmall Global, Alibaba's international online marketplace. In March 2018, the Tmall Global facilitated the access of the Chinese consumers to 18,000 brands from 74 countries and regions (Alibaba Group, 2018a).

In the first semester of 2018, the project entered the pilot stage (Sharma, 2018). At the beginning, the blockchain-enabled traceability will be used for the Odourless Fish Oil products of Blackmores and Anchor dairy products of Fonterra.

Based on the results of the pilot project, the Alibaba Group could consider expanding the framework to all its e-commerce markets (PwC China, 2017).

The project has a twofold goal to ensure product traceability in cross-border transactions and to prevent counterfeiting and fraud within the framework of e-commerce.

c) Forming partnership between major businesses of the Alibaba Group for blockchain project

Another blockchain initiative is the creation of a partnership between two major businesses of the group, respectively Tmall and the Cainiao Network. The aim is to ensure traceability and to prevent counterfeit products.

Tmall is a platform launched by the Group in 2008 for Chinese consumers looking for premium brands and shopping experience. In 2017, Tmall became China's largest third-party platform for brands and retailers in terms of gross merchandise value (Alibaba Group, 2018b). On March 31, 2018, there were over 150,000 brands on the Tmall platform (Alibaba Group, 2018b).

Cainiao Smart Logistics Network Ltd. was founded as an affiliated company by an Alibaba-led consortium in 2013. At present, the Alibaba Group has a stake of 51% in Cainiao (Chen,

2017). This is the logistics data platform operator that connects e-commerce companies and logistics operators. The platform processes data on 77% of all the parcels delivered in China, respectively 100 million out of 130 million parcels per day (Chou, 2018). It collaborates with more than 90 domestic and international partners (Cainiao Network, 2016). The target objective is to reach single-day delivery across China and 72-hour delivery to the rest of the world (Chou, 2018).

In February 2018, Tmall and Cainiao Network announced a project that will consist in applying blockchain technology to all imported products on the Tmall platform (Sunny, 2018). The traceability information will refer to aspects such as: country of origin, shipping port, transport method, arrival port, customs and inspection details. Consequently, the information will be provided by various stakeholders such as companies selling by means of an online store on the platform, ports, transport operators, custom authorities etc.

This project aims to provide traceability information on 30,000 products from 50 countries. The initiative targets 80% of the sellers on the Tmall platform. The project will be applied to several ports among which range Shanghai, Shenzhen, Guangzhou, Hangzhou and Tianjin (Megget, 2018).

Online buyers will access and analyse traceability information. The blockchain initiative will support the efforts of Tmall to fight counterfeit products.

The Alibaba Group has numerous other initiatives to fight counterfeit products. These projects rely on innovative approaches like cloud and big data analytics.

5.2. JD.com

JD.com, Inc. is the largest e-commerce company in China by revenue and ranks the 28th in the Top 250 global powers of retailing (Deloitte, 2018). In the fiscal year (FY) 2016, the retail revenue of JD.com. Inc. was USD 35,177 million achieved in non-store retailing, in one country only, respectively China.

Lately, the company witnessed a tremendous growth that ranked it second among the Top 250 retailers worldwide. The compound annual growth rate (CAGR) of the retail revenue of JD.com for the period 2011-2016 reached 62.6%. In comparison, Amazon.com. Inc. - direct competitor of JD.com – holds the rank 6 by revenue, but registered a CAGR of 17.6%, lower than that of JD.com. The fast evolution of JD.com is the result of the substantial increase in the number of customers, from 155 million in FY 2015 to 226 million in FY 2016 (Deloitte, 2018). At present, JD.com has over 300 million active customer and is China's leading one-stop e-commerce platform (JD.com, 2018a). JD.com is member of the NASDAQ 100 and a Fortune Global 500 company.

JD.com had numerous initiatives centred on the blockchain technology. In August 2018, the company announced the application of blockchain tracing for 400 brands and 11,000 SKUs on JD.com (JD.com, 2018e). Important strides towards blockchain-enabled traceability were made by JD.com in 2017 and 2018. The initiatives of JD.com are presented hereinafter:

a) Creation of the JD Tracing and Anti-Counterfeiting Alliance

In 2017, JD.com set up the JD Tracing and Anti-Counterfeiting Alliance. The company partnered with the China's Ministry of Agriculture, the State Quality Inspection Administration, the Ministry of Industry and Information Technology, the China Quality Certification Center, as well as with several fresh food and consumer brands (Marbridge Consulting, 2017). The blockchain-enabled platform that will be used by the alliance aims to provide buyers of fresh foods the opportunity to access information on product source. In June 2017, the number of brands that joined the alliance reached 27. Among them range global brands like Mars, Nestlé, Evian and Huggies (JD.com, 2017a). For the future, JD.com plans to add wine, baby care, luxury and fashion brands.

b) Pilot testing the new blockchain-enabled traceability system with Chinese suppliers

In the context of this alliance and of tracking food products, JD.com pilot tested the new traceability model in partnership with the Chinese production company Kerchin that provides beef and dairy products (JD.com, 2017a). The two companies developed a list of criteria for the tracking of the beef sold on JD.com. Each slaughtered cow was associated a serial number for tracking. Thus, supply chain transparency became reality based on “end-to-end” information including data on cow origin, beef meat handling, quality control and transport. The level of detail is significant, including information such as: breed, age and weight of the cow; farm of origin; cow diet; results of the tests for bacteria, water content and growth promoters; place and date of packaging etc.

The architecture of the blockchain designed and developed by JD.com is an adaptation of the open-source project Hyperledger. The data collected and stored by Kerchin are provided to JD.com which writes the information in blockchain. While Kerchin has the responsibility to ensure the authenticity of product information that will be presented to consumers, JD.com will periodically check how Kerchin records information and if information validity is ensured. Any change in the information registered in blockchain is possible only if a digital signature is provided and if both parties are informed (Huang, 2017). Consumers access traceability information by scanning with the JD app the QR code existing on the label of the beef package that is delivered by JD.com. The webpage that opens in the app’s browser provides information under a title like “The wonderful journey of the beef” (Huang, 2017).

The blockchain-enabled traceability system of JD.com and Kerchin involved only the two parties. Thus, it did not reflect the issues related to multiple participants in the supply chain, in the case of international/global trade. The pilot testing was limited to a group of Chinese cities, including the capital Beijing, Shanghai and Guangzhou (Huang, 2018). This pilot testing provided JD information for further improvement of the blockchain-enabled traceability.

c) Development of the new system through strategic partnerships with strong international brands

The focus on blockchain-enabled traceability led to the development of strategic partnerships with international suppliers of goods for the Chinese consumers. An example is the partnership with InterAgri, leading exporter of Australian meat products (JD.com, 2018b). The partnership centred on the blockchain-enabled traceability system for premium quality fresh food, respectively pure black Angus beef. The complexity of the project is higher than in the pilot project with the Chinese company Kerchin. The main reason is the larger number of the supply chain members that make logistics transparency more difficult. The pure black Angus beef is sourced from the Australian exporter InterAgri that buys from the Australian exporter HW Greenham & Sons Pty Ltd which procures beef from Australian farms in Tasmania, Victoria etc. The system will enhance supply chain transparency and provide consumers access to information on: animals; farm of origin; raising methods; meat processing; transportation etc. Another example of strategic partnership is that concluded by JD.com with the Osborne Group, leading Spanish food and beverage provider. The two parties planned to use blockchain-enabled traceability from production to delivery for the Cinco Jotas (5J) ham (JD.com, 2018c). The 5J ham is 100% acorn-fed free-range Iberian ham produced through an artisanal process. The product is available not only on the e-commerce platform of JD.com, but also in the “7Fresh” premium offline supermarket of JD.com.

d) Forming the Blockchain Food Safety Alliance (BFSA) together with other partners

In December 2017, the BFSA was established by several partners: Walmart, JD.com, IBM and Tsinghua University National Engineering Laboratory for E-Commerce Technologies. The aim of this alliance is to increase transparency along the food supply chain, as well as to improve product safety (JD.com, 2017b). The four organisations have the ambitious objective to provide real-time traceability by means of the blockchain technology. They will develop a standards-based method for the collection of data like product origin, safety and authenticity.

The need for such a novel approach to traceability stems from the various safety and counterfeiting issues that occurred in the offline and online commerce and from the gradual increase in the expectations of consumers. This innovative project is a progress compared to the former fragmented information and limited transparency in the food supply chains in China. Each member brings specific expertise to the alliance. IBM has technological expertise and the IBM Blockchain Platform. The Tsinghua University Engineering Laboratory for E-Commerce Technologies has technical expertise and knowledge of the Chinese food safety ecosystem. Walmart and JD.com bring their knowledge of offline and online retailing, as well as of food supply chains.

Walmart Stores, Inc. operates in 29 countries and ranks first in the Top 250 global powers of retailing (Deloitte, 2018). The operational formats are hypermarkets, supercentres and superstores. In the fiscal year (FY) 2016, the revenues of Walmart Stores, Inc. reached USD 485,873 million, four times higher than those of Costco Wholesale Corporation that ranked second in the Top 250, with a revenue of USD 118,719 million achieved in the cash & carry warehouse clubs operated in 10 countries.

In 2016, Walmart opened the Walmart Food Safety Collaboration Centre in Beijing (IBM, 2016). Walmart planned to invest USD 25 million until 2020, for technological innovation able to enhance food safety in China (Megget, 2017). The company also started a collaboration with IBM and Tsinghua University with the aim to generate transparency and efficiency in supply chain record-keeping using blockchain.

The standards, solutions and partnerships that will be developed within the BFSa aim to enable a broad-based food safety ecosystem in China (JD.com, 2017b). The founding members of the alliance plan to attract the suppliers and retailers existing in the food supply chains and to collaborate with the regulatory bodies. Thus, the efforts deployed by BFSa will benefit not only the four initial members, but a wide range of organisations, as well as Chinese consumers. The BFSa planned to provide to each company that will join the alliance, the possibility to select from several standards-based traceability solutions the one that best suits own specific needs and legacy situation.

e) Launch of the AI Catapult accelerator

JD.com demonstrates an active and strong interest in the disruptive technologies such as artificial intelligence (AI), blockchain, drones etc. In November 2017, JD.com announced the launch of SAIL-JD programme (Dehua, 2017). This is a joint initiative of JD.com and Stanford Artificial Intelligence Laboratory (SAIL). The initiative focuses on research in artificial intelligence technologies, such as machine learning, deep learning, robots, natural language processing and computer vision.

In February 2018, JD.com launched AI Catapult, a new accelerator for the development of the AI and blockchain technologies (JD.com, 2018d). The new accelerator will be based in Beijing. Multiple operational teams of JD.com will partner with innovative blockchain start-ups. The accelerator aims to build new businesses, as well as to develop and test their blockchain technology applications at scale. The AI Catapult program will help JD.com to improve its logistics and supply chain performance. This accelerator could support the efforts of the company to expand in the offline fresh-food retailing (Xiaochun, 2018).

The list of initial partners included five companies: Bankorou – Chinese fintech pioneer; CanYa – leader in cryptocurrency in Australia; Bluezelle – blockchain-powered database service located in Singapore; Nuggests – e-commerce payments and ID platform centred on blockchain, company based in the United Kingdom; Devery – startup focused on secure product verification and protection against counterfeiting (Devery.io being an open-source product verification protocol powered by blockchain on the Ethereum network) (JD.com, 2018d).

f) Setting-up the JD Blockchain Open Platform

In August 2018, JD.com announced the launch the JD Blockchain Open Platform dedicated to business customers (JD.com, 2018e). The aim is to support companies to build, host and use new blockchain applications in order to improve operations management. The platform reflects the “business as a service” strategy of JD.com. The platform includes an application store that provides users various tools and software developed in-house by JD.com or by independent software vendors. The users may select the tools and software which are suitable to their needs and may adapt them. The first customer that used the platform was the China Pacific Insurance Company (CPIC), in order to ensure the traceability of e-invoices, based on a unique blockchain ID associated with each document.

g) Involvement in the development of blockchain standards

JD.com demonstrates interest in the elaboration of standards related to the blockchain technologies. A relevant example is related to JD Logistics, a business group within JD.com that owns one of the largest logistics infrastructures of an e-commerce company worldwide.

In February 2018, JD Logistics joined the Blockchain in Transport Alliance (BITA) (Freightwaves.com, 2018). This is the first Chinese domestic logistics enterprise to become member of BITA.

BITA was founded in August 2017 and is the largest blockchain commercial alliance in the world. The number of members reaches hundreds of global freight transportation companies with combined revenues of more than USD 1 trillion (Freightwaves.com, 2018).

The aim of BITA is twofold. The former is to develop blockchain technology standards for global freight and logistics companies. The latter is to improve the security and safety of global supply-chains.

6. Discussion

The research question was “*RQ: Which is the present stage of the innovative blockchain-enabled traceability initiatives of China’s leading e-commerce players?*”. The answer to this question encompasses several aspects:

- a) Seized opportunities.** The Alibaba Group and JD.com seized the opportunities of the new technology to improve goods traceability and supply chain transparency. Experts estimate a significant growth of the global blockchain technology in the supply chain management market. The forecast points out an increase from USD 40.99 million in 2017 to USD 666.61 million in 2024 by a compound annual growth rate of 49.16% (Globe Newswire, 2018).
- b) Innovative initiatives.** Each of the two leading players in China’s e-commerce developed a set of innovative initiatives related to the blockchain-enabled traceability. For the Alibaba Group, this is a confirmation of the fact that company ranges among the most innovative 50 companies in China, in 2018 (Forbes China, 2018). At the same time, the Alibaba Group ranges among the 50 largest public companies that explore blockchain (Del Castillo, 2018). The number of patents related to blockchain applications that were filed by the group in 2017 contributed significantly to this ranking. Even if JD.com does not match own research and development efforts of the Alibaba Group, the company stands out by pioneering the use of this technology and jump-starting its evolution in logistics.
- c) Pilot testing.** The information released by the two major players reveals that their projects are rather in a pilot testing stage. Many efforts should be deployed in the supply chains until the large-scale use of blockchain for traceability and transparency is achieved. This could be in line with the estimates made by Gartner in 2017 that blockchain technology will reach mainstream adoption in 5-10 years (Gartner, 2017). Within the “hype cycle for emerging technologies 2017” Gartner estimated that blockchain was in the second stage labelled “peak of inflated expectations” and close to the entry in the third stage called “through of disillusionment”. However, the research findings on blockchain-enabled

traceability do not provide enough information to compare expected with actual results obtained in use cases. It is too early to assess if results will be above or below expectations. The pilot testing stage is also in line with the recommendations for a pragmatic incremental approach (Deloitte, 2017) in applying blockchain to supply chain, respectively to start small, to try and fail and to scale progressively.

- d) **Business ecosystem paradigm.** The initiatives taken and projects launched by the Alibaba Group and JD.com have as common feature the paradigm of “business ecosystem” coined by Moore (1993). These innovative initiatives involve a community of stakeholders interested in the use of this revolutionary technology for traceability and transparency purposes. Besides the traditional typology of supply chain members (that includes producers, processors, distributors, logistic service providers, ports etc.), the business ecosystem associated with the blockchain-enabled traceability also comprises: reputed providers of blockchain technology platforms; innovative start-ups (at first glance potential competitors of the initiative owners); universities with strong research capabilities; public authorities etc. The findings of the exploratory research revealed that blockchain initiatives of the two leading e-commerce players are founded on alliances, consortia and partnerships. Such an approach is not only compatible, but it is a must for revolutionising traceability and transparency along all the stages of the supply chains.

The present stage of the innovative blockchain-enabled traceability projects of the two leading e-commerce players generate expectations for continued actions in the near future. The initiatives taken will pave the way to blockchain application and progressive scalability.

7. Conclusions

China's leading e-commerce players seized the opportunities provided by the blockchain technologies for traceability and transparency in supply chains. Their initiatives are a reference for other e-commerce players in China and worldwide.

The present exploratory research has several limitations. Firstly, only sources of information in English language were used. Secondly, the available data are rather few because the topic addressed refers to a technology that was very recently associated with logistics in general and goods traceability in particular. Thirdly, the available information consists in published data, while the status of the projects managed by the leading players could be more advanced than that reflected by the information released by the Alibaba Group and JD.com. Ultimately, quantitative data on the efficacy and efficiency of the use of blockchain for goods traceability in China is not publicly available.

7.1. Implications for practice

The findings of the exploratory research reveal several implications for the e-commerce players that intend to use blockchain technology for product traceability. The organisations that initiate or participate in blockchain-enabled traceability projects could consider the following recommendations:

- a) **Project aim.** The aim of the project should not be limited to the promotion and use of this innovative technology or to facilitating product tracing to ultimate buyers. The actual aim is to ensure transparency of the entire supply chain, as well as to prevent fraud and goods counterfeiting. The transparent information immutably recorded in the blockchain should not refer only to product origin, but to all the stages of the supply chain and to the various operations carried out in relation to a specific product/brand along the entire network (such as processing, packaging, quality control, handling, storage, transportation etc.), as well as to the time coordinates and to the logistic conditions (e.g. storage temperature).

- b) **Project scope.** The blockchain technology has the potential to support end-to-end traceability in supply chains of various degrees of complexity. It may be applied to supply chains in which the e-commerce players source directly from a producer/processor operating on the local market (see the partnership between JD.com and the Chinese producer Kerchin). The technology can be applied to supply chains involving cross-border transactions and several parties (see the Food Trust Network of the Alibaba Group).
- c) **Setting-up alliances and consortia.** The experience of the Alibaba Group and of JD.com - China's leading e-commerce players - shows that alliances and consortia represent an effective strategic approach to initiate and launch projects for blockchain-enabled traceability. The knowledge and expertise brought by the members may facilitate the achievement of the project objectives.
- d) **Initiator of the alliances, consortia or collaborations.** According to one of the approaches, the initiator is the e-commerce player. Examples in this respect are the Alibaba Group for the Food Trust Network and JD.com for the JD Tracing and Anti-Counterfeiting Alliance. Another approach is the initiation of the alliance/consortium/collaboration by other prominent global players. This is the case of Walmart that created the Food Safety Collaboration Centre in Beijing, started a collaboration with IBM and Tsinghua University and afterwards jointly created the Blockchain Food Safety Alliance with a group of partners (IBM, JD.com and Tsinghua University).
- e) **Typology of the alliance/consortium members.** According to the specific aim of the alliance/consortium, the members are two or more categories of project stakeholders that have direct or indirect interest in the successful completion of the project. For instance, the Food Trust Network comprises the Alibaba Group - the e-commerce player that owns the Tmall International, two exporters of products and brands valued by the Chinese consumers (Blackmores from Australia and Fonterra from New Zealand), as well as two postal service providers that were selected for their logistic infrastructure in the countries of origin of the two exporters. A more complex member typology is specific to the JD Tracing and Anti-Counterfeiting Alliance initiated by JD.com. Besides JD.com and global companies with outstanding brands, the alliance includes public authorities as stakeholders from China, respectively the China's Ministry of Agriculture, the State Quality Inspection Administration, the Ministry of Industry and Information Technology, the China Quality Certification Centre. Universities and innovative start-ups are also two important types of members that can bring important knowledge and applied expertise in the technological field. Complex typologies are not an end in themselves. The types of participating members must be related to the aim and specific objectives of the project.
- f) **Pilot testing.** The practitioners started to consider the use of blockchain for traceability and transparency purposes fairly recently. As any other disruptive technology, blockchain requires pilot testing in order to identify the specific issues to be solved in relation to its use at real-world scale. Pilot tests were also achieved by the Alibaba Group and JD.com. For example, the Alibaba Group launched the pilot test in the first semester of 2018, for the traceability of the Odourless Fish Oil products of Blackmores (Australia) and Anchor dairy products of Fonterra (New Zealand). Similarly, JD.com pilot-tested blockchain with the Chinese company Kerchin for beef. The results of the pilot tests may indicate the necessary changes to further expand the blockchain application to a larger portfolio of domestic or imported brands.
- g) **Own research and patents.** Innovative companies that invest in research in blockchain technologies and identify applications with significant market value may protect them

by means of patents. Even if applying for a patent is costly, protection by means of patents would be recommended if the estimated revenue is high. Leading e-commerce companies could consider research and patents as the Alibaba Group. The innovators and early adopters can enjoy advantages over the early majority and late majority adopters. The patents may lead to entry barriers for latecomers.

- h) **Accelerate innovation.** Besides the research and development efforts deployed internally by companies, the creation of accelerators could be beneficial. A relevant example is provided by JD.com that created the AI Catapult accelerator. Innovative start-ups will partner with internal teams of JD.com to develop and test new disruptive technology applications.
- i) **Strong partnerships between business units.** A company that decides to initiate or participate in a blockchain-enabled traceability project must ensure a direct and strong collaboration between the business units or between these and the affiliated companies (that represent a “logistic arm”) that will be involved in the project. Project success depends on seamless collaboration. Such an example is provided by the partnership between Tmall and Cainiao, in the case of the Alibaba Group.
- j) **Joint efforts to develop and promote standards.** The application of blockchain to achieve traceability and transparency along the supply chain requires technological solutions that will be applied by all the members of the supply chain. Standards are necessary due either to the specific requirements of a country’s authorities or to an industry initiative. For instance, China’s goal is to develop national blockchain standards by 2019 (Smith, 2018). Worldwide, in the field of logistics, there are organisations that aim to develop such blockchain standards. For example, Blockchain in Transport Alliance (BITA) planned to develop and publish its first blockchain standards in freight in 2018 (BITA, 2018).
- k) **Joint endeavour to train human resources.** The interval 2018-2020 will probably be a period of early adoption of the blockchain technologies. Further waves of adoption require training programs to develop awareness and knowledge of blockchain and its various applications besides the financial domain. Communication of the potential benefits and applications in the supply chains, as well as of actual business cases may contribute to the progressive adoption of blockchain by companies to enhance product traceability, to improve supply chain transparency and to fight fraud and counterfeiting.

7.2. Future research agenda

The way from proof of concept to real-life implementation of a new technology like blockchain is not spared of challenges. Research may contribute to the effective and efficient application by a thorough evaluation of the implications for logistics and supply chains. Potential directions for further research and suggested research questions are the following:

- a) **Concept of blockchain-enabled traceability.** The research literature could benefit from a clear definition of the concept of blockchain-enabled traceability. Examples of research questions are:
 - What specific differences exist between the traditional concept of traceability in the supply chains and the concept of blockchain-enabled traceability?
 - Which are the dimensions of this concept?
 - What additional concepts should be clarified in relation to the blockchain-enabled traceability?
- b) **Specific benefits.** The interest in the use of the blockchain technology to ensure traceability and transparency in supply chains is based on the clear understanding of specific benefits. The main research questions are the following:

- What added value does blockchain bring in terms of traceability, compared to the traditional methods and the technologies applied until present?
 - What specific benefits does blockchain bring to each level of the supply chain?
 - What methods can be applied to quantitatively assess the benefits of blockchain-enabled traceability for each organisation and respectively for the entire supply chain?
 - How do the benefits differ from one industry to another?
 - What factors influence the intensity of the benefits for each level and for the entire supply chain?
- c) **Application mechanism.** There is a need for research on the application mechanism at the entire supply chain level and at each stage within the network. Several research questions may be raised:
- What types of factors influence the effectiveness of the blockchain use for traceability and transparency purposes in the supply chains?
 - How could alliances/partnerships be designed and developed to generate effective blockchain application to enhance traceability and transparency along the entire supply chains?
 - What joint strategies should the partners apply for the successful use of the blockchain technology?
 - What types of tools could partners use to achieve the objectives of their common projects?
 - Is there a need for a “project champion”, an organization that could initiate a supply-chain-wise project and involve the other organisations of the network in the application process?
 - What types of supply chain members (leading producers, distributors, key retailers, logistics providers etc.) or other members of the ecosystem (state authorities, quality control authorities etc.) are better suited for the role of “project champion”?
 - What role and functions should the “project champion” accomplish?
 - What dimensions does process management have in relation to the application of the blockchain-enabled traceability?
- d) **Traceability information management.** This is an important area of future research because it is the essence of the blockchain solutions. Many research questions may be formulated, among which range the following:
- What categories of traceability information should be recorded in the blockchain?
 - What expectations do the various levels of the supply chain have relative to traceability and transparency?
 - Which is the level of information granularity necessary to effectively manage traceability and to which a token / electronic seal will be attached?
 - How should blockchain be integrated with the Internet of Things to improve information management?
 - How will disruptive technologies such as blockchain, cloud computing and big data be interconnected to enhance product traceability and to prevent counterfeiting?
 - What control mechanisms may be applied to ensure that information recorded in the blockchain by each supply chain member is accurate (fully reflects reality)?
- e) **Risk management.** In logistics, the blockchain is a nascent technology. There may be associated risks that have not been identified and assessed yet. Several research questions may be raised:
- What types of risks should supply chain members envision before starting a blockchain-enabled supply chain?

- Are risks similar at every stage within the supply chain?
 - How should organisations manage the risks associated with the inaccurate information recorded in the blockchain compared to the real-life situation?
 - What additional risks exist in the case of blockchain-enabled traceability in comparison to the traditional traceability methods?
 - How can the supply chain members mitigate the new risks identified?
- f) **Case studies.** Research methods are diverse. In the present stage of development of the blockchain-enabled traceability, the exploratory investigations based on case analysis may be beneficial to supply chain members and potential investors. Several research questions may be addressed:
- What types of challenges face the organisations that pioneer the blockchain-enabled traceability?
 - What implications have these cases for further research?
 - How can the benchmarking between the company/industry cases help to enhance traceability in supply chains?
- g) **Standardisation process.** The blockchain technology implies a decentralized ledger approach. At first glance, standardisation may seem irrelevant. Nevertheless, several research questions could lead to helpful answers:
- How may standardisation help to enhance blockchain-enabled traceability in the supply chains?
 - What aspects related to the blockchain may be standardised?
 - Should the same standard be applied to all the supply chains in an industry (e.g. food, automotive etc.)?
- h) **Scalability problems.** The use of blockchain for traceability and transparency is in a preliminary stage. The way to real-life scale may be full of challenges. Some of the possible research questions are:
- What factors influence the evolution from proof of concept to real-life scale?
 - How should blockchain solutions for traceability be successfully and progressively scaled?
- i) **Costs entailed.** The adoption of the new technologies may be limited by cost factors. Research of the actual costs generated by the blockchain-enabled traceability is necessary. The following research questions may be considered:
- What additional costs are entailed by the use of the blockchain technology for product traceability compared to the existing traceability systems?
 - Which are the major categories of costs generated by the use of blockchain to enhance traceability and transparency?
 - How could costs/investments be shared among the supply chain members?
 - What factors influence the cost levels and cost structure?
 - How costs are influenced by the type of infrastructure required to use the blockchain technology?
- j) **Return on investment (ROI).** Worldwide, the use of blockchain to enhance traceability and transparency in supply chains is in an early stage of development. Nevertheless, practitioners need information on the estimated ROI in order to evaluate if deploying resources for the blockchain-enhanced traceability is worthwhile. Potential research questions are:
- How can the triple bottom line (financial, environmental and social) model be applied to the use of the blockchain technology for traceability and transparency in supply chains?
 - What is the ROI of the blockchain-enabled traceability at each supply chain level?

- What factors influence the ROI of the blockchain-enabled traceability system at organisational level and at the entire supply chain level?
- Is the ROI of blockchain-enabled traceability above or below the ROI of the present investments in traceability?
- How does the use of blockchain-enabled traceability by major brands impact brand equity?

k) Impact on consumers/users. Organisations are interested in traceability especially in cases of product recall or withdrawal. Nevertheless, the impact on consumers/users is also important. The research questions may be the following:

- What types of traceability data are perceived most useful by the different consumer/user segments?
- How blockchain-enabled traceability influences the buying decisions of the final customers?
- Under what circumstances such traceability may positively influence consumer/user loyalty?

Additional research directions and research questions may be progressively identified as the blockchain technology develops in the field of traceability.

China's major e-commerce players – the Alibaba Group and JD.com - are both pioneering the blockchain-enabled traceability innovations. Their initiatives are excellent examples for other companies that attempt to use this disruptive technology to enhance traceability and transparency in supply chains. The present stage of development for these powerful players is pilot testing, while other companies are not even aware of the benefits of the blockchain technology further than cryptocurrencies. Worldwide, numerous strides are still to be made until the expanded implementation along the supply chains will become real-life practice. How fast this evolution will be? Will stakeholders fully support such initiatives? Are the potential applications efficient? The answers substantially depend on the dedication of the supply chain members from various industries to make this quantum leap in blockchain-enabled transparency.

References

- ALIBABA GROUP 2018a. Alibaba Group Announces March Quarter 2018 Results and Full Fiscal Year 2018 Results, available at: https://www.alibabagroup.com/en/news/press_pdf/p180504.pdf (accessed 20 August 2018).
- ALIBABA GROUP (2018b), Our businesses, available at: <https://www.alibabagroup.com/en/about/businesses> (accessed 20 August 2018).
- ANGRISH, A., CRAVER B., HASAN, M. & STARLY, B. 2018. A Case Study for Blockchain in Manufacturing: "FabRec": A Prototype for Peer-to-Peer Network of Manufacturing Nodes, *Procedia Manufacturing*, 26, 1180-1192.
- BAHRI, L., CARMINAT, B. & FERRARI, E. 2018. Decentralized privacy preserving services for Online Social Networks, *Online Social Networks and Media*, 6, 18-25.
- BANERJEE, M., LEE, J. & CHOO, K.-K. R. 2018. A blockchain future for internet of things security: a position paper, *Digital Communications and Networks*, 4(3), 149-160.
- BENINGER, P. & IBARA, M.A. 2016. Pharmacovigilance and Biomedical Informatics: A Model for Future Development, *Clinical Therapeutics*, 38(12), 2514-2525.
- BITA 2018. Blockchain Standards in Freight, available at: <https://bita.studio/blockchain-standards/> (accessed 20 August 2018).
- BLACKMORES 2018. About Blackmores, available at: <https://www.blackmores.com.au/about-us/company-information/about-blackmores> (accessed 20 August 2018).

- BOIREAU, O. 2018. Securing the blockchain against hackers, *Network Security*, 2018(1), 8-11.
- BROGAN, J., BASKARAN, I. & RAMACHANDRAN, N. 2018. Authenticating Health Activity Data Using Distributed Ledger Technologies, *Computational and Structural Biotechnology Journal*, 16, 257-266.
- BUSSMAN, O. 2017. BankThink A public or private blockchain? New Ethereum project could mean both, available at: <https://www.americanbanker.com/opinion/a-public-or-private-blockchain-new-ethereum-project-could-mean-both> (accessed 20 August 2018).
- CAINIAO NETWORK 2016. Cainiao Network Overview, available at: <https://www.alizila.com/wp-content/uploads/2016/09/Cainiao-Factsheet.pdf?x95431> (accessed 20 August 2018).
- CASADO-VARA, R., PRIETO, J., DE LA PRIETA, J. & CORCHADO, J.M. 2018. How blockchain improves the supply chain: case study alimentary supply chain, *Procedia Computer Science*, 134, 393-398.
- CASEY, M.J. & WONG, P. 2017. Global supply chains are about to get better, thanks to blockchain, available at: <https://hbr.org/2017/03/global-supply-chains-are-about-to-get-better-thanks-to-blockchain> (accessed 20 August 2018).
- CASTELL, S. 2018. The future decisions of RoboJudge HHJ Arthur Ian Blockchain: Dread, delight or derision?, *Computer Law & Security Review*, 34(4), 739-753.
- CHEN, L.Y. 2017. Alibaba takes control of delivery business at center of U.S. probe, available at: <https://www.bloomberg.com/news/articles/2017-09-26/alibaba-takes-control-of-loss-making-delivery-business-cainiao> (accessed 20 August 2018).
- CHIU, H. 2017. An Overview of the Blockchain Patent Landscape, available at: <https://clarivate.com/blog/overview-blockchain-patent-landscape/> (accessed 20 August 2018).
- CHOU, C. 2018. Jack Ma: Alibaba bets big on logistics, available at: <https://www.alizila.com/jack-ma-alibaba-bets-big-on-logistics/> (accessed 20 August 2018).
- DAGHER, G.G., MOHLER, J., MILOJKOVIC, M. & MARELLA, P.B. 2018. Ancile: Privacy-preserving framework for access control and interoperability of electronic health records using blockchain technology, *Sustainable Cities and Society*, 39, 283-297.
- DEHUA, C. 2017. China's JD.com teams up with Stanford for AI research project, available at: <https://gbtimes.com/chinas-jdcom-teams-up-with-stanford-for-ai-research-project> (accessed 20 August 2018).
- DEL CASTILLO, M. 2018. Big Blockchain: The 50 Largest Public Companies Exploring Blockchain, available at: <https://www.forbes.com/sites/michaeldelcastillo/2018/07/03/big-blockchain-the-50-largest-public-companies-exploring-blockchain/#7c6f4d702b5b> (accessed 20 August 2018).
- DELOITTE 2017. Continuous interconnected supply chain: Using blockchain and Internet-of-Things in supply chain traceability, available at: <https://www2.deloitte.com/.../lu-blockchain-internet-things-supply-chain-traceability.pdf> (accessed 20 August 2018).
- DELOITTE 2018. Global Powers of Retailing 2018, available at: <https://www2.deloitte.com/content/dam/Deloitte/at/Documents/about-deloitte/global-powers-of-retailing-2018.pdf> (accessed 20 August 2018).
- FOERSTL, K., SCHLEPER, M.C. & HENKE, M. 2017. Purchasing and supply management: From efficiency to effectiveness in an integrated supply chain, *Journal of Purchasing and Supply Management*, 23(4), 223-228.
- FONTERRA 2018. Our markets, available at: <https://www.fonterra.com/nz/en/about/our-markets.html> (accessed 20 August 2018).

- FORBES CHINA 2018. 2018 Forbes China 50 Most Innovative Companies, available at: <https://www.forbes.com/sites/forbeschina/2018/06/21/2018-forbes-china-50-most-innovative-companies-full-list/> (accessed 20 August 2018).
- FREIGHTWAVES.COM 2018. One of the world's largest e-commerce retailers joins BiTA, available at: <https://www.freightwaves.com/news/2018/jd-bita> (accessed 20 August 2018).
- GARTNER 2017. Gartner identifies three megatrends that will drive digital business into the next decade, available at: <https://www.gartner.com/en/newsroom/press-releases/2017-08-15-gartner-identifies-three-megatrends-that-will-drive-digital-business-into-the-next-decade> (accessed 20 August 2018).
- GLOBE NEWSWIRE 2018. Global Blockchain Technology in Supply Chain Management Market Will Reach USD 666.61 Million by 2024: Zion Market Research, available at: <https://globenewswire.com/news-release/2018/06/19/1526239/0/en/Global-Blockchain-Technology-in-Supply-Chain-Management-Market-Will-Reach-USD-666-61-Million-by-2024-Zion-Market-Research.html> (accessed 20 August 2018).
- GÜRKAYNAK, G., YILMAZ, I., YEŞİLALTAY, B. & BENGI, B. 2018. Intellectual property law and practice in the blockchain realm, *Computer Law & Security Review*, 34 (4), 847-862.
- HAMMI, M.T., HAMMI, B., BELLOT, B. & SERHROUCHNI, A. 2018. Bubbles of Trust: A decentralized blockchain-based authentication system for IoT, *Computers & Security*, 78, 126-142.
- HAWLITSCHKE, F., NOTHEISEN, B. & TEUBNER, T. 2018. The limits of trust-free systems: A literature review on blockchain technology and trust in the sharing economy, *Electronic Commerce Research and Applications*, 29, 50-63.
- HOFMANN, E. & RÜSCH, M. 2017. Industry 4.0 and the current status as well as future prospects on logistics, *Computers in Industry*, 89, 23-34.
- HSU, J.W. 2018. Alibaba ups food safety down under via blockchain, available at: <https://www.alizila.com/alibaba-ups-food-safety-via-blockchain/> (accessed 20 August 2018).
- HUANG, E. 2017. Blockchain could fix a key problem in China's food industry: the fear of food made in China, available at: <https://qz.com/1031861/blockchain-could-fix-a-key-problem-in-chinas-food-industry-the-fear-of-food-made-in-china/> (accessed 20 August 2018).
- HUANG, E. 2018. Blockchain will track how meat gets from Australian farms to Chinese tables, available at: <https://qz.com/1223228/jd-is-using-blockchain-to-track-how-meat-gets-from-australian-farms-to-chinese-tables/> (accessed 20 August 2018).
- HUCKLE, S., BHATTACHARYA, R., WHITE, M. & BELOFF, N. 2016. Internet of Things, Blockchain and Shared Economy Applications, *Procedia Computer Science*, 98, 461-466.
- IBM 2016. Walmart, IBM and Tsinghua University explore the use of blockchain to help bring safer food to dinner tables across China, available at: <https://www-03.ibm.com/press/us/en/pressrelease/50816.wss> (accessed 20 August 2018).
- JD.COM 2017a. Consumers Demand Supply Chain Visibility, and We Should Give it to Them, available at: <http://jdcorporateblog.com/consumers-demand-supply-chain-visibility-and-we-should-give-it-to-them/> (accessed 20 August 2018).
- JD.COM, 2017b. Walmart, JD.com and IBM launch blockchain food safety alliance, available at: <http://jdcorporateblog.com/walmart-jd-com-ibm-and-tsinghua-university-launch-a-blockchain-food-safety-alliance-in-china/> (accessed 20 August 2018).
- JD.COM 2018a. Our Business, available at: <http://corporate.jd.com/ourBusiness> (accessed 20 August 2018).

- JD.COM 2018b. JD ramps up Australian imports with InterAgri partnership on pure black angus beef, available at: <https://jdcorporateblog.com/jd-ramps-australian-imports-interagri-partnership-pure-black-angus-beef/> (accessed 20 August 2018).
- JD.COM 2018c. JD.com CEO Richard Liu Shares Vision for the Future of Retail at World Retail Congress, available at: <http://jdcorporateblog.com/jd-com-ceo-richard-liu-shares-vision-for-the-future-of-retail-at-world-retail-congress/> (accessed 20 August 2018).
- JD.COM 2018d. JD.com Launches New Accelerator for Blockchain and AI Technology Development, available at: <http://jdcorporateblog.com/jd-com-launches-new-accelerator-blockchain-ai-technology-development/> (accessed 20 August 2018).
- JD.COM 2018e. JD Launches Blockchain Open Platform, available at: <https://jdcorporateblog.com/jd-launches-blockchain-open-platform/> (accessed 20 August 2018).
- KARLSEN, K.M., DREYER, B., OLSEN, P. & ELVEVOLL, E.O. 2013. Literature review: Does a common theoretical framework to implement food traceability exist?, *Food Control*, 32, 409-417.
- KHAQQUI, K.N., SIKORSKI, J.J., HADINOTO, K. & KRAFT, M. 2018. Incorporating seller/buyer reputation-based system in blockchain-enabled emission trading application, *Applied Energy*, 209, 8-19.
- KSHETRI, N. 2017. Blockchain's roles in strengthening cybersecurity and protecting privacy, *Telecommunications Policy*, 41(10), 1027-1038.
- KOWALEWSKI, D., MCLAUGHLIN, J. & HILL, A.J. 2017. Blockchain Will Transform Customer Loyalty Programs, available at: <https://hbr.org/2017/03/blockchain-will-transform-customer-loyalty-programs> (accessed 20 August 2018).
- KUMAR, N.M. & MALLICK, P.K. 2018. Blockchain technology for security issues and challenges in IoT, *Procedia Computer Science*, 132, 1815-1823.
- LENG, K., BI, Y., JING, L., FU, H.-C. & VAN NIEUWENHUYSE, I. 2018. Research on agricultural supply chain system with double chain architecture based on blockchain technology, *Future Generation Computer Systems*, 86, 641-649.
- LI, Z., BARENJI, A.V. & HUANG, G.Q. 2018. Toward a blockchain cloud manufacturing system as a peer to peer distributed network platform, *Robotics and Computer Integrated Manufacturing*, 54, 133-144.
- LIN, C., HE, D., HUANG, X., CHOO, K.-K.R. & VASILAKOS, A.V. 2018. BSeIn: A blockchain-based secure mutual authentication with fine-grained access control system for industry 4.0, *Journal of Network and Computer Applications*, 116, 42-52.
- MA, Z., JIANG, M., GAO, H. & WANG, Z. 2018. Blockchain for digital rights management, *Future Generation Computer Systems*, 89, 746-764.
- MARBRIDGE CONSULTING 2017. JD.com Forms Goods Tracking and Anti-counterfeiting Alliance, available at: https://www.marbridgeconsulting.com/marbridgedaily/2017-06-09/article/101430/jdcom_forms_goods_tracking_and_anti_counterfeiting_alliance (accessed 20 August 2018).
- MEGGET, K. 2017. Walmart expands blockchain in Chinese food supply chain, available at: <https://www.securindustry.com/food-and-beverage/walmart-expands-blockchain-in-chinese-food-supply-chain/s104/a6102/#.W3fiWnlPo2x> (accessed 20 August 2018).
- MEGGET, K. 2018. Alibaba launches blockchain initiative for T-Mall, available at: <https://www.securindustry.com/alibaba-launches-blockchain-initiative-for-t-mall-/s112/a7051/#.W3fdBHlPo2w> (accessed 20 August 2018).
- MERKLE, R.C. 1988. A digital signature based on a conventional encryption function, in Pomerance C. (eds) *Advances in Cryptology — CRYPTO '87. CRYPTO 1987. Lecture Notes in Computer Science*, 293, Springer, Berlin, Heidelberg, 369-378.

- MILLARD, C. 2018. Blockchain and law: Incompatible codes?, *Computer Law & Security Review*, 34 (4), 843-846.
- MOORE, J.F. 1993. Predators and Prey: A New Ecology of Competition, *Harvard Business Review*, 71(3), 75-86.
- NAKAMOTO, S. 2008. Bitcoin: A Peer-to-Peer Electronic Cash System, available at: <https://bitcoin.org/bitcoin.pdf> (accessed 20 August 2018).
- NDRAHA, N., HSIAO, H.-I., VLAJIC, J., YANG, M.-F. & LIN, H.-T. V. 2018. Time-temperature abuse in the food cold chain: Review of issues, challenges, and recommendations, *Food Control*, 89, 12-21.
- NOONAN, L. 2018. China leads blockchain patent applications, available at: <https://www.ft.com/content/197db4c8-2e92-11e8-9b4b-bc4b9f08f381> (accessed 20 August 2018).
- OLSEN, P. & BORIT, M. 2013. How to define traceability, *Trends in Food Science & Technology*, 29, 142-150.
- PAZAITIS, A., DE FILIPPI, P. & KOSTAKIS, V. 2017. Blockchain and value systems in the sharing economy: The illustrative case of Backfeed, *Technological Forecasting and Social Change*, 125, 105-115.
- PWC CHINA 2017. PwC explores blockchain solutions with Alibaba and food industry stakeholders to help address supply chain fraud and build trust in the food industry available at: <https://www.pwccn.com/en/press-room/press-releases/pr-240317.html> (accessed 20 August 2018).
- RINGSBERG, H. 2014. Perspectives on food traceability: A systematic literature review, *Supply Chain Management: An International Journal*, 19 (5/6), 558-576.
- SABERI, S., KOUHIZADEH, M. & SARKIS, J. 2018. Blockchain technology: A panacea or pariah for resources conservation and recycling?, *Resources, Conservation & Recycling*, 130, 80-81.
- SAVELYEV, A. 2018. Some risks of tokenization and blockchainization of private law, *Computer Law & Security Review*, 34(4), 863-869.
- SHARMA, P.K. & PARK, J.H. 2018. Blockchain based hybrid network architecture for the smart city, *Future Generation Computer Systems*, 86, 650-655.
- SHARMA, S. 2018. Alibaba launches pilot project to fight food fraud using blockchain, available at: <https://yourstory.com/2018/04/alibaba-food-trust-framework-blockchain/> (accessed 20 August 2018).
- SMETANA, S., SEEBOLD, C. & HEINZ, V. 2018. Neural network, blockchain, and modular complex system: The evolution of cyber-physical systems for material flow analysis and life cycle assessment, *Resources, Conservation and Recycling*, 133, 229-230.
- SMITH, T. 2018. Chinese Government Casts Uncertainty on Luxury Blockchain Development, available at: <https://jingdaily.com/chinese-government-luxury-blockchain/> (accessed 20 August 2018).
- SULLIVAN, C. 2018. "Digital identity – From emergent legal concept to new reality", *Computer Law & Security Review*, 34(4), 723-731.
- SULLIVAN, C. & BURGER, E. 2017. E-residency and blockchain, *Computer Law & Security Review*, 33(4), 470-481.
- SUNNY, S. 2018. Alibaba, E-Commerce Giant, considers blockchain for its T-Mall with Cainiao, available at: <https://smartereum.com/4504/alibaba-e-commerce-giant-considers-blockchain-for-its-t-mall-with-cainiao/> (accessed 20 August 2018).
- TSE, D., ZHANG, B., YANG, Y., CHENG, C. & MU, H. 2017. Blockchain application in food supply information security, *IEEE International Conference on Industrial Engineering and Engineering Management 2017-December*, Singapore, 1357-1361.

- TURK, Z. & KLINC, R. 2017. Potentials of Blockchain Technology for Construction Management, *Procedia Engineering*, 196, 638-645.
- WANG, B., SUN, J., HE, Y. PANG, D. & LU, N. 2018. Large-scale Election Based on Blockchain, *Procedia Computer Science*, 129, 234-237.
- XIAOCHUN, Z. 2018 JD.com Launching an Accelerator to Tapping into Blockchain for Chinese New Retail Battle, available at: <https://kr-asia.com/jd-com-launched-ai-and-blockchain-accelerator-for-new-retail-battle> (accessed 20 August 2018).
- ZANDÉN, N.E., HULTHÉN, K. & WULFF, G. 2015. Trade-offs in supply chain transparency: the case of Nudie Jeans Co, *Journal of Cleaner Production*, 197, 95-104.
- ZHANG, P., WHITE, J., SCHMIDT, D.C., LENZ, G. & ROSENBLOOM, S.T. 2018. FHIRChain: Applying Blockchain to Securely and Scalably Share Clinical Data, *Computational and Structural Biotechnology Journal*, 16, 267-278.