CEOs' understanding of blockchain technology and its adoption in export-oriented companies in West Sweden: a survey

CEOs' understanding of blockchain technology and its adoption in export-oriented companies in West Sweden: a survey

Viktor Elliot, Jonas Floden, Conny Overland and Zeeshan Raza
Department of Business Administration, School of Business Economics and Law, University of Gothenburg, Goteborg, Sweden

Miroslaw Staron
Department of Computer Science and Engineering, University of Gothenburg, Goteborg, Sweden

Johan Woxenius
Department of Business Administration, School of Business Economics and Law, University of Gothenburg, Goteborg, Sweden

Abhinayan Basu and Trisha Rajput
Department of Law, School of Business Economics and Law, University of Gothenburg, Goteborg, Sweden

Gerardo Schneider
Department of Computer Science and Engineering, University of Gothenburg, Goteborg, Sweden, and

Gunnar Stefansson
Department of Technology Management and Economics, Chalmers University of Technology, Gothenburg, Sweden

Received 21 July 2020
Revised 20 December 2020
Accepted 28 January 2021

Abstract

Purpose – The purpose of this paper is to study current practices in adopting blockchain technology amongst export companies in West Sweden and to capture their CEOs' knowledge of and attitudes towards blockchains.

Design/methodology/approach – Factors enabling or hindering the adoption of blockchains were identified from a comprehensive literature review and a survey of 72 chief executive officers (CEOs) of export-oriented firms in West Sweden, all with turnovers exceeding €2m, regarding their knowledge of and attitudes towards blockchains.

Journal of Global Operations and Strategic Sourcing
Emerald Publishing Limited
2398-5364
DOI 10.1108/JGOSS-07-2020-0038

Findings – Blockchain technology is not currently perceived to provide benefits that would outweigh the costs of introducing it into West Sweden's export firms. Nevertheless, the findings suggest that such technology, though currently too immature to meet today's industrial requirements, could experience more widespread use if certain key factors (i.e. lower cost, traceability, improved security or trustworthiness and new blockchain-enabled business models) are prioritised.

Research limitations/implications – Answered by 72 CEOs, the survey achieved a response rate of 6%, meaning that the findings are only exploratory. Even so, they offer new insights into CEOs' attitudes towards blockchain technology.

Practical implications – The CEOs reported comparatively limited knowledge of and experience with implementing blockchains, the lack of which has hampered their large-scale implementation in multi-actor supply chains.

Social implications – Negative sentiment amongst CEOs towards blockchain technology may lower on-the-job satisfaction amongst tech personnel aspiring to develop and implement blockchain applications in their firms.

Originality/value – Knowledge of and attitudes towards blockchain technology amongst top-level managers, as well as about factors enabling or hindering its adoption, guide managers in crafting strategies for implementing blockchains in their organisations and maximising the benefits therein. Unlike past studies focussing on technological aspects or views of experts and middle-management, the study was designed to capture the views of CEOs.

Keywords Adoption, Survey, CEO, Blockchain, Both, BCT, Attitude, Chief executive officer, Implementation, Manager, Supply chain management

Paper type Research paper

1. Introduction

Blockchain technology (BCT) supports transparency, security and flexibility in information-sharing amongst multiple actors in various supply chains (Francisco and Swanson, 2018). BCT's simple underlying technical solutions combined with modern cryptography provide ready platforms for developing digitalised, distributed databases to replace current centralised solutions (Dhillon *et al.*, 2017). In BCT, the distribution of information promotes trust in the quality and correctness of that information without requiring trusted agents to manage centralised databases (Gupta, 2018). Cryptography-intensive protocols for adding new information that prohibit modifying information currently in the blockchain (BC), provide the security needed in supply chains (SCs), financial transactions, energy distribution (Hwang *et al.*, 2017) and even clinical records (Benchoufi *et al.*, 2017). One of the most prominent uses of BCT today is the digital currency Bitcoin (Crosby *et al.*, 2016; Yaga *et al.*, 2019).

Although BCT has been adopted in finance and data exchange, it remains in its infancy in supply chain management (SCM) and transport. As Büyüközkan and Göçer (2018) have shown, today's SCs generally embrace some forms of digital technology due to their potential to enhance the speed, intelligence, transparency and scalability of SC operations. Nevertheless, several factors hinder the adoption of digital SCs, including their limited integration with non-digital SCs and the lack of collaboration between actors in the SCs. Although Büyüközkan and Göçer did not mention BCT by name, the challenges identified indicate that BCT could be a promising technology for more efficient SCM, even if others, including Sternberg *et al.* (2020), have observed multiple obstacles that continue to stifle the implementation of BCT. In support, Korpela *et al.* (2017) have identified SC processes in which BCT could theoretically be used – for instance, in defining data models, processing smart contracts and maintaining electronic ledgers. Because the complexity of managing SCs intensifies as they expand and add actors, international SCs face particular pressure from the added complexity of different legal requirements, longer transport distances and

diverse business cultures, amongst other factors. Such trends can strain access to high-quality data, which enables stakeholders in SCs to make more informed, proactive decisions that improve the performance of their SCs, as literature addressing SCM has firmly established (Christopher, 2011). After all, SCs today, especially long ones, often lack visibility and transparency, which forces actors therein to make decisions based on limited, narrow data, usually at the expense of the SC's efficiency (Heutger and Kückelhaus, 2018). Such obstacles could be overcome, however, by taking advantage of BCT (Ko *et al.*, 2018; Kshetri, 2018) and its potential to boost transparency, traceability and security (Benton *et al.*, 2018).

At the same time, the benefits of BCT come with a price: The computing power needed to create the cryptographic keys grows exponentially with the level of security needed. Although developing a basic BC solution is relatively simple, developing one that is secure and scales up to multiple agents, as is necessary with SCs, can be quite costly. Beyond that, whether using BCT is even practical on such large scales continues to be debated (Wüst and Gervais, 2018). Even if so because current SCs have already been developed and are already functioning, the cost of introducing new solutions or integrating them with existing ones can be prohibitive.

Despite those setbacks, popular media and literature addressing SCM, including Madir (2000), Saveen and Radmehr (2016) and Feng (2017), increasingly showcase BC-based solutions that have been proposed or even developed, some for materials and consumables. In those cases, the solutions typically focus on four key properties: the material's nature (i.e. what it is), quality (i.e. how it is), quantity (i.e. how much of it there is) and ownership (i.e. whose it is at any moment). Because a BC consists of a set of recorded data distributed within a computer network where each participant (or "node") holds the (identical) set of records, the data held can be static (e.g. as in databases), dynamic (e.g. as on trading platforms) or executable (e.g. as in smart contracts). In that context, a *smart contract* is an agreement made automatable by computer, although some parts may require human input and control and enforceable by either the legal enforcement of rights and obligations or the tamper-proof execution of computer code (Madir, 2000; Morabito, 2017; Ryan, 2017).

Given the hype surrounding BCT, it is important to understand the potential benefits and key challenges associated with its adoption. Research on BC applications in logistics and SCM remains underdeveloped, however, and knowledge regarding its adoption in such organisations is, therefore, limited (Wamba and Queiroz, 2020). In a bid to counter that deficit, we set out to investigate whether BCT is regarded as a viable alternative for SCs in export-oriented industries. To that end, the following research question is formulated:

Q1. To what extent has blockchain technology been adopted in West Sweden's export-oriented industry and how is the technology understood by the industry's Chief Executive Officers?

We conducted our study in Sweden, recognised by the OECD (2018) and Gürdür *et al.* (2019), amongst others, as a leader in digital infrastructure and digital innovation. Data collection targeted West Sweden, especially the highly trade-focussed Västra Götaland County, home to some 1.7 million citizens, which we deemed to have a scope relevant to studying BCT in SCM. To collect data, we designed a survey about the adoption of BCT and Chief Executive Officers (CEOs)' understanding of the technology, which we distributed to export-oriented companies throughout West Sweden. The West Sweden Chamber of Commerce (WSCC) assisted with distributing the survey to the CEOs of member firms that met our criteria.

As a result of our study, this article focussed on clarifying top-level management's understanding of and attitudes towards BCT fills a gap in literature that largely focusses on

the technical aspects of BCT (Risius, 2017) and potential uses (Casino *et al.*, 2019; Queiroz *et al.*, 2019; Wang *et al.*, 2019a). Although barriers to its implementation have been investigated, such studies have previously not taken the perspective of top-level management. As other studies have shown, initiatives for cultivating innovations and developing new products and/or services require top-level management's support to succeed (Fui-Hoon Nah *et al.*, 2001; Oke, 2004) and applying BCT is no exception (Bag *et al.*, 2020). Against that background, we strove to pinpoint the degree to which actions to adopt and implement BCT are anchored in company strategy and central decision-making overseen by top-level managers – namely, CEOs.

To identify previous research on the topic, we conducted a literature search in Scopus with the keywords "blockchain" and "survey" and "management" or "president" or "CEO" or "top management" or "executive" in the article title, abstract or keywords. The search returned 181 articles, which we screened for their titles and abstracts. Ultimately, we selected 15 articles to read in detail for further analysis.

While most studies have targeted experts in either BCT or a specific field (e.g. logistics), none have actively pursued the perspective of top-level managers and the ones that have involved "managers" have rarely reported their level of management. Amongst the exceptions, Saberi *et al.* (2019a) reported that 9% of their respondents were "upper level" management, while Durach *et al.* (2020) reported that 62% of theirs were "executive managers". To be included in our review, articles needed to expressly state that at least 50% of the respondents were top-level management (e.g. "top-level managers" or "CEOs"). Although three articles addressed the perceptions of top-level management (Table 1), none purposely considered their perspectives. Thus, this article partly fills a gap in the literature by capturing CEOs' knowledge of BCT and their attitudes towards adopting it at their organisations.

The remainder of this article is organised as follows. In Section 2, we review the literature addressing the potential value of BCT and its current applications, after which we summarise major challenges in adopting and implementing BCT in Section 3. Next, we describe our study's methodology in Section 4 and present our results in Section 5. In Section 6, we discuss our principal findings in relation to the literature, after which we articulate our conclusions in Section 7.

2. Blockchain technology: applications and advantages

Viewing BC-based applications in SCM from a theoretical perspective, several recent review articles – for example, by Queiroz *et al.* (2019) and Wang *et al.* (2019a) – have covered the extensive publication of findings about BCs and BCT in general. In particular, Queiroz *et al.* (2019) revealed that BCT, despite its vast potential, has an overall low rate of adoption across sectors, with the notable outlier of the energy sector, owing to its widespread use of smart contracts.

Beyond that, however, the scope of research on adopting BCT has been rather limited. In work performed in the past three years, van Hoek (2019a) examined three companies, one in logistics, that conducted a pilot implementation of a BC solution. Although the trial's results demonstrated the promise of the technology, the solution never progressed beyond the pilot projects. Along similar lines, Dobrovnik *et al.* (2018) observed the massive potential for BCT's adoption, which was nevertheless often stymied by a lack of knowledge and empirical data (e.g. from use cases and case scenarios). Petersen *et al.* (2018) and Sternberg *et al.* (2020) published results in the same direction, as did Gausdal *et al.* (2018); all of their studies involved interviews in Norway's maritime industry. Prasad *et al.* (2018), by contrast, conducted a literature review that yielded 19 factors identified as driving the successful

Study	Purpose and method	Findings
Durach *et al.* (2020)	Studied the adoption of BCT in SCM with a survey of managers in Germany, 62% of whom were executive managers and not separated in the analysis	The authors identified 13 areas in SCM in which BCT could be applied, ranked by likelihood of adoption, time frame and business impact. Respondents considered the areas to likely have BCT but not in the near future
Zhou *et al.* (2020)	Examined factors of BCT's success in Singapore's maritime industry with a survey of 30 respondents, 29 of whom were top-level managers	The authors identified six critical factors for BCT's success, of which lack of capital is the largest obstacle, followed by staff training and legislation
Yang (2019)	Gauged the possible use of BCT in maritime SCM in Taiwan's shipping industry with a survey of 121 respondents, 55% of whom were vice-presidents or directors, if not higher	Despite promising applications in customs clearance and management, the digitalisation of paperwork and standardising and developing platforms, respondents in higher positions had less intention to use BCT

Table 1. Summary of studies on BCT involving top-level managers in supply chain management (SCM)

adoption of BCT. By extension, they stressed that to sustain the success of BC-based services, industrial and technological efforts should prioritise improving regulatory clarity, driving industry collaboration, building a rich ecosystem, developing industry standards, investing in BCT and engaging and educating leaders about BCs' capability and applications. Similarly, Hoxha and Sadiku (2019) identified transparency, security and cost reduction in real estate transactions as important drivers for BCT's adoption in Kosovo. More recently, Ghode *et al.* (2020a, 2020b), drawing from a literature review and interviews with five BC experts, ranked inter-organisational trust, relational governance, interoperability, data transparency, data immutability and behavioural intention amongst the key challenges hindering the adoption of BCT.

In other work, van Hoek (2019b) held a workshop with senior executives who discussed adopting BCT in the logistics sector. Despite revealing a low rate of adoption and a lack of business cases, as well as competence, the workshop also showed that the major drivers of adoption were improving security and process visibility. Conversely, the biggest impediments to the adoption of BCT were its integration with the current processes and an unknown cost-benefit ratio. Offering a rosier outlook, Morkunas *et al.* (2019) demonstrated BCT's potential to benefit companies' business models, customer relations, distribution channels and similar elements of business development. In the same vein, Sheel and Nath (2019), who conducted a survey amongst Indian SC managers, determined that adopting BCT can give firms the competitive advantage of agility, particularly by reducing manufacturing lead times, improving the frequency of new product development, expanding delivery capabilities and increasing customer satisfaction. On top of that, they found that adopting BCT can boost the reliability of transactions and, in turn, increase transparency, especially by supplying a tamper-proof source of data recording and retrieval that better enables firms to track inventory items. Needless to say, all of those attributes of BCT can enhance firms' performance. By extension, Boukis (2019), who considered the implications of adopting BCT for brands and consumers, found that adoption can help brands to become more authentic, transparent and trustworthy and, as a result, acquire new customers and improve brand image.

To exploit benefits offered by BCT, a range of BC-based initiatives have been taken across sectors, including shipping, food and retail, pharmaceuticals and even diamonds and luxury products (Queiroz *et al.*, 2019). For a better understanding of recent developments in the field, Table 2 summarises blockchain initiatives that have been undertaken in various industries to date.

As demonstrated by the initiatives described in Table 2, SCs for crucial goods, including foods and pharmaceutical products and luxury goods such as diamonds, have become hotspots for BC-based initiatives due to the urgent need for reliable traceability and product provenance. Knowing the origin and the footprint of products as they have travelled throughout SCs offers not only commercial benefits, including improved legitimacy and consumer confidence in brands but can also enhance safety, as in the enhanced traceability of medicine and foods (Wang *et al.*, 2019a) and the obstructed distribution of so-called "blood diamonds".

3. Challenges in adopting blockchain technology

Despite the numerous applications and advantages of BCs identified in the literature, the adoption of BCT confronts various technological, organisational, governance, operational, legal and policy-related challenges (Saberi *et al.*, 2019b; Wang *et al.*, 2019a). For that reason, organisations contemplating adopting BCT need to consider several factors to make informed decisions about whether to proceed with adoption.

Although the decentralised, distributed characteristics of BCs make them highly resilient compared with traditional databases, the secure use of BCs continues to be a major challenge (Wang *et al.*, 2019b). Particularly notorious are the gaps in security in BCT applied to cryptocurrencies, in terms of both guarantees and vulnerabilities (Lim *et al.*, 2014). According to Patel *et al.* (2017) because hacking into a public (permission-less) BC requires significant financial and computational power, a permission BC may be more vulnerable to cyberattack. To overcome such weaknesses, different solutions have been proposed, though their efficacy has yet to be evaluated (Yli-Huumo *et al.*, 2016). In the meantime, it remains critical to identify potential security problems for the application specifically targeted by the organisation.

As a relatively immature technology, BCT is considered to have an underdeveloped capacity for scalability and handling large volumes of transactions (Croman *et al.*, 2016; Yli-Huumo *et al.*, 2016). For example, compared with payment processors such as Visa that can process an average of 2,000 transactions per second (tps) at peaks of 56,000 tps, public BCs such as Bitcoin's network process approximately 7 tps on average (Croman *et al.*, 2016; Ganne, 2018). As a consequence, increased rates of BC transactions can create congestion and cause delays in the validation of transactions. However, against that trend, Hyperledger Fabric, a distributed operations system behind permissioned BCs, can process up to 3,500 tps (Androulaki *et al.*, 2018). Clearly, permissioned BCs typically used in international trade do not face the same restricted scalability as public BCs do (Ganne, 2018). For that reason, it is essential for businesses and other BC stakeholders to consider their scalability-related needs to maintain the efficiency and relevance of their BC-based systems over time.

Amongst other challenges for organisations interested in implementing BC-based solutions, Mougayarm (2016) has identified the lack of technical expertise, knowledge and understanding about business models and best practices in successfully implementing those solutions. To be sure, adopting BC-based solutions can imply designing an entirely new IT solution and the corresponding process of overhauling part, if not all, of the current system. Because the endeavour can require new roles, responsibilities and expertise to support different facets of BCT's implementation in the organisation (Wang *et al.*, 2019a),

Table 2. Summary of pilot projects and initiatives for implementing BCT

Drivers of BCT's deployment	base	Case description	Source
To achieve end-to-end supply chain (SC) visibility, increase trust and digitalise global trade documents and processes	IBM–Maersk	Nearly 100 stakeholders involved in global trade have registered on the BC platform TradeLens jointly initiated by IBM and Maersk that promises to reduce fraud and administrative costs while improving the traceability and efficiency of cargo transport	Maersk (2019)
To increase food safety and improve transparency and traceability	IBM and consumer products and food businesses	To increase the traceability and safety of food products, Walmart and Carrefour have joined the IBM Food Trust solution built on IBM's BC platform, which various other retailers, suppliers and growers of such products (e.g. Dole Food Company, Driscoll's, Kroger, Nestlé, Tyson Foods, Unilever, Wakefern Food Corporation and Topco) have also begun using	Galvin (2019)
To increase authenticity and ensure the provenance of products	Provenance	Provenance, a UK-based company offering BC-enabled solutions, offers the tracking and tracing of products for more than 200 retailers and producers in various industries, including food, beverages and fashion	Provenance (2019)
To track the origin, authenticity, quality and ownership of luxury products	Everledger	UK-based Everledger's BC solution aims to track and trace the authenticated origin of various high-value products (e.g. diamonds, art, rare wines and luxury goods) and detect fraud in their sale and purchase	Everledger (2020)
To replace paper-based documentation with smart contracts	BP–Royal Dutch Shell	A consortium of companies, including energy giants BP and Royal Dutch Shell, have developed VAKT, a global BC-based digital platform for energy-commodity trading that is expected to reduce trading errors and cut costs	VAKT (2020)
To deliver enhanced transparency in automotive SCs	Icertis–Daimler AG	Daimler AG has partnered with Icertis to use BCT to enhance transparency in Daimler's complex SCs	Daimler (2020)
To increase the legitimacy and integrity of medicines	Accenture–DHL	DHL and Accenture have run a BC-based pilot project to detect the tampering of pharmaceutical products and reduce the risk of counterfeit medicines	DHL and Accenture (2018)

organisational culture is necessarily affected and resistance from management is not uncommon (Wang *et al.*, 2017). Outside the organisation, institutional actors such as banks and other SC intermediaries that economically benefit from existing systems may regard BCT as a threat to their revenue streams, and thus refuse to coordinate BC-based transactions (Michelman, 2017; Zhao *et al.*, 2016).

At the same time, even if BCT is an important technology for the market, organisations may have priorities other than adopting it. In such cases, organisations need to be provided with additional resources to develop an interest in BCs. Adopting BC-based solutions requires financial, human and logistical resources to conduct feasibility studies and invest in related software and hardware, which can be difficult for firms facing financial straits. In particular, small and medium-sized companies may struggle to join BC platforms due to the financial cost (Tapscott and Tapscott, 2016; Wang *et al.*, 2017). For example, Haraldson *et al.* (2020) have illustrated how smaller ports can play pivotal roles in transport chains but possess limited resources for fulfilling larger firms' expectations of connecting electronically to various administrative systems.

Although transparency and verifiability are important for improving the performance of SCs, some organisations remain unwilling to disseminate their business information over BC platforms (Kembro *et al.*, 2014). After all, the open nature of the platforms does not necessarily prevent sensitive information from leaking to competitors (Saberi *et al.*, 2019b). In that light, a reluctance to reveal critical information with other partners in an SC may hinder the implementation of BCT across the entire chain. At the same time, privacy in the context of BCs remains poorly understood and organisations may fear potential leaks simply because information about the built-in privacy designs and backup mechanisms is limited. According to Krombholz *et al.* (2017), concerns with data privacy can pose implications for governance. If electronic health-care records, for instance, are entered into a BC network, then the users face severe consequences if those records are breached. Thus, to control the governance of data and compliance, location privacy should be ensured for all users (Biswas and Gupta, 2019).

Despite the many studies and initiatives on BCs and BCT, their successful commercial implementations have been few (Queiroz *et al.*, 2019; Sternberg *et al.*, 2020). In global SCs, the successful implementation of BCT requires collaboration amongst all stakeholders, who may be based in various locations, and hence subject to different jurisdictions and, as Casey and Wong (2017) have indicated, the complexity of diverse operating environments can easily hinder the smooth implementation of BCT in SC processes.

Although BCs are tamper-resistant, decentralised, distributed digital records of transactions that engender trust precisely because of those characteristics, they do not always accurately reflect the movement of materials in SCs or prevent false information from entering the system (Apte and Petrovsky, 2016). In fact, BCs are vulnerable to contingent errors, conflicts of interest, corruption and malicious attacks (Boucher *et al.*, 2017).

The incompatibility and lack of interoperability of different BCs are other practical deterrents to their use. Currently, to satisfy the specific needs of different industries, different BC systems have been developed with different technical interfaces and algorithms and, as a consequence, cannot communicate with each other. For example, systems launched by IBM and Everledger are built on Hyperledger Fabric, whereas Microsoft and Provenance – the start-up offering BC-based solutions to track products and enhance SC transparency – use Ethereum (Wang *et al.*, 2019b). Although each BC is independently of interest, the incompatibility and/or lack of interoperability between them can restrict the scalability and use of their platforms. Thus, the chief goal of using BC – in short, to integrate

processes in transparent, dynamic ways – becomes impossible, particularly in international trade, in which an international shipment can impact a dozen different ledgers. For seamless data transfer, the interoperability of different BCs needs to be improved (Collomb and Sok, 2016; Ganne, 2018; Wang *et al.*, 2017).

For yet another shortcoming, BCs have been criticised for the high level of energy needed to operate the networks (Ganne, 2018). While environmental concerns currently top the global policy agenda, the increased use of BCs can harm the environment by increasing CO_2 emissions.

Specific legal regulations concerning BCs – for example, about which information can be publicly available – may also be unclear, including those regarding the use of BCT. Contradictions in policies issued by different governments about Bitcoin have raised concerns amongst organisations and markets around the world, which can affect the broader use of BCs amongst businesses and SC networks (Mougayarm, 2016). Taxation rules are especially unclear for BC-enabled transactions paid with cryptocurrencies and, to date, governments have struggled to impose monetary policy concerning BCs and tax the income or value-added services offered under BC-based transactions (Akins *et al.*, 2015).

Due to the independent nature of BCs, aspects of IT governance such as decision-making rights, accountability and incentives can also affect applicable laws (Beck *et al.*, 2018). For instance, firms using BC networks are not required to comply with data privacy laws such as the US Federal Information Security Management Act of 2002 and the General Data Protection Regulation 2018 in the European Union. As a consequence, businesses being built on BC platforms may face new regulatory challenges once country-wide regulations are adopted (Beck *et al.*, 2018; Grant and Hogan, 2015). In the case of global SCs, their massive scale and geographical spread have increasingly rendered them opaque to regulators and law enforcement agencies across jurisdictions have found it difficult to implement laws concerning, for example, counterfeit goods, forced labour, poor working conditions and connections to criminal activities. Internationally, lawmakers have sought solutions that could increase the visibility of SCs and, to that purpose, many believe that BCs and other distributed ledger technologies may be valuable.

Dealing with BCT and smart contracts entails a host of legal issues related to immutability – for instance, dealing with changes, hacks, unforeseen circumstances and renegotiations – that act as a double-edged sword (Cooper and Nash, 2000). Even so, in global SCs, more generic legal issues pose even greater challenges to the use of BCs. Businesses in such SCs that trade across borders have to navigate shipping regulations, embargo laws and regulations, export sanctions, anti-corruption and foreign corrupt practices laws, anti-money laundering requirements, anti-boycott laws and trade remedy regulations. Implementing BC-based solutions by using smart contracts in international SCs, therefore, requires careful consideration of jurisdiction-specific laws that apply to SC actors as a means to ensure that relevant regulatory obligations are met (UN-ECE, 2019). Table 3 summarises the various challenges that hinder the adoption of BCs and BCT.

From earlier studies, we identified four particularly important areas to understanding firms' willingness to adopt BCT. Firstly, any successful adoption of BCT requires *knowledge and understanding of BCT* and several studies have likewise pinpointed lack of knowledge as an important obstacle to adopting BCT (Dobrovnik *et al.*, 2018; van Hoek, 2019b).

Secondly, implementing BCT requires *a sense of BCT's importance for future value creation*. Projects motivated by BCs have, thus, been important in addressing specific challenges to, for example, ensuring the quality and origin of diamonds (Hackius and Petersen, 2017), increasing food safety (Galvin, 2019) and replacing paper-based documentation with smart contracts (Khatri, 2018). Even so, the lack of convincing cases of

Table 3. Summary of challenges in adopting BC and BCT

Type of challenge	Challenge	Description	Source(s)
Technological			
	Data security	BCs may pose data security risks and be vulnerable to cyberattacks	Patel *et al.* (2017) and Wang *et al.* (2019b)
	Performance and scalability	BCT is in its early development and considered to be immature in terms of scalability and capacity to process large volumes of transactions	Croman *et al.* (2016) and Yli-Huumo *et al.* (2016)
	Incompatibility and/or lack of interoperability	The incompatibility and/or lack of interoperability between BCs can restrict the scalability and use of BCT	Collomb and Sok (2016), Ganne (2018), Wang *et al.* (2017), Prasad *et al.* (2018) and Ghode *et al.* (2020b)
	High energy needs	A high level of energy is required to operate a BC network	Ganne (2018)
Governance or organisational			
	Lack of relevant expertise and incumbency	Technical expertise, knowledge or understanding of business models and best practices in successfully implementing BCT may be lacking	Mougayarm (2016)
	Organisational culture	Replacing or adapting current IT solutions may face resistance from management and affect organisational culture. Resistant attitudes towards adopting BCT amongst collaborating organisations can be problematic	Wang *et al.* (2017, 2019a) and Ghode *et al.* (2020a, 2020b)
	Institutional actors	Institutional actors such as banks may regard BCs as a threat to their revenue streams	Michelman (2017) and Zhao *et al.* (2016)
	Trust and corporate secrets	Some organisations are unwilling to disseminate their secret business information on BC platforms. Developing inter-organisational trust is, thus, a major challenge	Kembro *et al.* (2014), Prasad *et al.* (2018) and Ghode *et al.* (2020a, 2020b)
	Privacy	Organisations may fear potential privacy leaks due to a lack of information about the built-in privacy-sensitive designs of BCs. Privacy-related concerns can pose implications for governance	Krombholz *et al.* (2017), Biswas and Gupta (2019) and Ghode *et al.* (2020a)
	Immutability	BC is vulnerable to contingent errors, conflicts of interest, corruption and malicious attacks	Boucher *et al.* (2017) and Ghode *et al.* (2020a, 2020b)

(*continued*)

Table 3.

Type of challenge	Challenge	Description	Source(s)
Operational			
	Lack of resources in the company	Adopting BCT requires financial, human and logistical resources	Mougayarm (2016)
	Lack of convincing applications of BC	Successful commercial implementations of BC-based solutions have been few	Queiroz *et al.* (2019) and Sternberg *et al.* (2020)
	Complexity of operating environment	Complex operating environments hinder the smooth implementation of BCT in SC processes	Casey and Wong (2017)
Legal			
	Unclear policies and regulations	Contradiction and a lack of clarity characterise policies by different governments	Mougayarm (2016), Ghode *et al.* (2020b)
	Unclear taxation rules	Taxation rules for BC-enabled transactions are unclear	Akins *et al.* (2015)
	Issues regarding the compulsory dimensions of IT governance	Challenges regarding different dimensions of IT governance such as decision rights, accountability and incentives persisted	Beck *et al.* (2018)

BCT's implementation in commercial settings continues to impede its implementation in general (van Hoek (2019b).

Thirdly, *factors that cause companies to introduce BCT* is a major theme across the literature, which largely suggests that companies pursue BC-based solutions to lower costs (Hoxha and Sadiku, 2019; Khatri, 2018; Prasad *et al.*, 2018; Wang *et al.*, 2019b), reduce risk (DHL and Accenture, 2018), increase traceability and transparency in the value chain (Thomasson, 2019), increase speed (Galvin, 2019; McKenzie, 2018) and identify new business models or sources of income (Morkunas *et al.*, 2019).

Fourthly and finally, the literature is concerned with *factors that prevent companies from introducing BCT*. Such factors include a lack of relevant organisational competence (Dobrovnik *et al.*, 2018; Ghode *et al.*, 2020a, 2020b, Mougayarm, 2016; Petersen *et al.*, 2018; Sternberg *et al.*, 2020) or resources (Haraldson *et al.*, 2020; Tapscott and Tapscott, 2016; Wang *et al.*, 2017), a shortage of applications or business cases (Prasad *et al.*, 2018), legal obstacles (Prasad *et al.*, 2018), security risks or potential information leaks (Ghode *et al.*, 2020a, 2020b, Lim *et al.*, 2014; Saberi *et al.*, 2019a, Yli-Huumo *et al.*, 2016), technological uncertainty (Croman *et al.*, 2016; Yli-Huumo *et al.*, 2016) and problems with implementation when replacing or adapting systems already in place (Ghode *et al.*, 2020a, 2020b, Wang *et al.*, 2017; Wang *et al.*, 2019a).

Although all four of those topics have been addressed by studying particular cases or settings in which BCT has been piloted, less attention has been given to how top-level managers view BCs in general and perceive the advantages and obstacles of implementing BCT.

4. Design of the survey

Our research question (i.e. To what extent has BCT been adopted in West Sweden's export-oriented industry and how is the technology understood by the industry's CEOs?) stems from the current lack of results about whether industrial firms use BCT to any degree and, if so, then why and how. We addressed that question by conducting a survey reflecting the four abovementioned areas related to the organisational adoption of BCT identified in the literature:

- knowledge and understanding of BCT,
- a sense of BCT's importance for future value creation,
- factors that cause companies to introduce BCT and
- factors that prevent companies from introducing BCT.

The lack of research encouraged us to adopt an exploratory survey methodology (Åhlström and Westbrook (1999) that emphasises descriptive results. For a setting, we chose Sweden, considered to be a forerunner in adopting digital technologies (Gürdür *et al.*, 2019; OECD, 2018), one with a very high rate of digitalisation. This makes it a potentially critical case as a forerunner in the field.

We conducted the online survey in collaboration with the WSCC in April 2019. The survey was emailed by the WSCC, with the University of Gothenburg and Chalmers University of Technology named alongside WSCC as senders, to 1,393 Swedish export-oriented companies with an annual turnover of more than 20m SEK (approximately €2m) [1] or about 45% of the WSCC's approximately 3,000 members. The mailing list targeting the CEOs of WSCC members is normally used by the WSCC to distribute information and newsletters, amongst other things. The sample was selected because:

- it was relevant to our research topic,

- cooperation with the WSCC implied a direct channel to the CEOs of a large number of firms in our target group and
- an email from the WSCC was expected to generate a better response rate.

The approach of using the member lists of industrial organisations has also been used by Saberi *et al.* (2019a), amongst other authors.

Of the 1,393 surveys distributed, 72 were returned, for a response rate of 5.2%. Because research on BCs has only recently begun to emerge, studies on the topic have endured fairly low response rates – for example, Queiroz *et al.* (2019) achieved a response rate of only 6% amongst US professionals, despite utilising a leading market research provider. Another factor was that the survey was distributed to a general email list of CEOs with substantial time constraints and addressed a narrow, rather technical field. Our comparison of early and late respondents indicated a slight difference but largely consistent results. The earliest 15% and last 15% of respondents were compared regarding their answers to questions concerning their understanding and perception of BCs (Tables 5-7) and the median difference (absolute value) was only 0.43 (max 1.2, min 0.0).

All respondents were CEOs or equivalent (e.g. president or owner) and came from a broad spectrum of industries (Table 4). The median number of employees at their firms was 37, ranging from five to 24,000 employees and the firms had a median annual turnover of €6.1m, ranging from €1.4 to €1,130m.

Due to the survey's exploratory nature and considering the time constraints of the targeted managers, we kept the survey brief. It was divided into three parts and written in Swedish (see the Appendix for an English translation). The first part consisted of general questions about the respondent, the corresponding firm and their overall understanding of BCT. Next, the second part consisted of questions addressing the respondent's personal experience with BCT, after which the third part contained questions about the respondent's experience with working with BCT within their firm. The questions were based on literature addressing BCT and our experience with the topic. For most questions, the response options were designed as five-point Likert scales along with the option "I don't know".

Although the survey admittedly suffered from a low response rate, that result in itself could be interpreted to indicate that few companies currently use BCT. A non-response bias analysis made comparing early and late respondents showed no major difference in their BCT-related knowledge or experience. Another risk was that companies interested in BCT were more likely to answer the survey than others. Nevertheless, those limitations should be viewed in light of considerable interest in BCT and the near-complete lack of empirical evidence on the topic. In any case because the few studies that have been conducted

Table 4. Respondents by industry

Industry	Share of respondents (%)
Manufacturing	25
Construction	19
Retail and trade	15
Other	11
IT	8
Transport	7
Life sciences	4
Tourism and events	4
Finance	3
Marketing and communications	3

represent case-based, mostly prescriptive research, more systematic data collection has been needed and our survey was an early attempt in that direction.

5. Results

Revealing a general openness to and curiosity about BCs and BCT, the results of the survey highlighted that respondents believed that BCT would heavily impact their industry. At the same time, they admitted that their general level of understanding about BCT was quite low, very few companies had any projects regarding BCT and the understanding of how BCT could be used in their own organisations was low (Table 5).

The average reported understanding of BCs was strikingly low. Although 79% of respondents had heard the word "blockchain" before, only 57% claimed to know what one was. Furthermore, only 11% of respondents claimed to be knowledgeable or very knowledgeable about the topic. Similarly, 78% claimed to have no experience with working with BCs, while only 4% had extensive or considerably extensive experience.

At the same time, the respondents believed that BCs would have rather high importance in the future. Nearly half or 48%, believed that BCs would have large or very large importance for the industry in general, although the importance was expected to be less for their line of business and their companies in particular. Meanwhile, 33% believed that the importance for their companies would be large or very large, although the share of uncertain respondents was greater when it came to their own companies (Table 6).

Remarkably, however, the respondents rated the impact on their own companies as smaller, possibly indicating their positive perception of BCs but lack of immediate evidence about real-world applications. In addition, the respondents indicated that very few of their competitors, customers or suppliers work with BCT and 48% of them agreed to that claim to a very low extent (Table 7). Agreement was also low with the statements that BCT would alter their businesses and that they would lose competitive advantage if they did not begin using BCT. Even so, respondents were more certain that BCT are not mere hype and will be generally accepted in time. Respondents also strongly agreed that BCT enable new business models and new sources of income, which again showed a rather divided view amongst

Table 5.
Average knowledge and understanding of BCs amongst the sample's CEOs on a 1–5 scale (1 = none, 5 = a great deal)

Knowledge and experience of BCs	None (%)	Limited (%)	Some (%)	A lot (%)	A great deal (%)	M	SD
Knowledge of BCs	39	33	17	9	2	2.0	1.1
Experience of working with BCs in practice	78	13	6	2	2	1.4	0.8

Table 6.
Average importance of BCs for the future on a 1–5 scale (1 = very small, 5 = very large), excluding "I don't know"

Importance of BCs for the future for . . .	Very small (%)	Small (%)	Medium (%)	Large (%)	Very large (%)	I donot know (%)	M	SD
Your company	9	21	18	24	9	21	3.0	1.2
Your line of business	7	21	17	34	7	14	3.2	1.1
Industry in general	7	10	21	34	14	14	3.4	1.2
Society in general	7	4	39	25	11	14	3.3	1.0

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I donot know	MSD
Our suppliers, customers and/or competitors are discussing or working on BC-based solutions	42	21	12	12	0	12	1.91.1
BCs give us no advantages compared with other current systems	29	18	18	0	7	29	2.21.3
BCs will completely change our line of business	19	26	16	10	3	26	2.31.2
BCs lower our costs	0	25	7	21	14	32	3.41.2
BCs raise our business certainty	10	14	10	14	28	24	3.51.5
BCs boost our transparency	4	11	14	25	14	32	3.51.2
BCs lower our business risk	4	7	21	11	18	39	3.51.2
BCs will eventually be widely accepted and implemented	0	3	32	26	19	19	3.80.9
BCs increase our traceability in the value chain	4	11	18	14	36	18	3.81.3
BCs are faster than other current systems	3	6	12	21	24	33	3.91.2
BCs enable new sources of income	0	10	21	17	31	21	3.91.1
BC-based technology is scalable	3	0	13	26	23	35	4.01.0
BCs enable new business models	3	0	19	19	39	19	4.11.1

Table 7. Average agreement with statements regarding BCs in % on a 1–5 scale (1 = strongly disagree, 5 = strongly agree)

respondents between failing to see the direct impact of BCT on their business but nevertheless perceiving the spread of BCT as inevitable. That picture can be strengthened by examining the different advantages that BCT is expected to afford and the generally positive view of BCs' potential benefits amongst respondents. Overall, the respondents, thus, foresaw a rather large impact from BCT but more for other companies than their own.

The respondents' uncertainties regarding BCs became more evident when they were asked more detailed, technical questions. For one such question regarding the level of technical security, many respondents reported that they had no understanding of the topic, whereas ones who did tend to agree with the idea that BCs offer a high level of security. By contrast, 3% stated that BCs are much more insecure than today's technologies, 6% that they are simply more insecure, 19% that there is no difference, 25% that they are more secure and 9% that they are much more secure, while 38% did not know. On the most detailed level, when asked about their understanding of technical terminology – namely, "permission-less", "private" (i.e. "permission"), "forks", "block mining", "verified transactions", "peer-2-peer networks", "hash codes" and "hashing function", "public-key cryptography", "signature" or "signing algorithm", "race attack", "Finney attack", "majority attack" and "digital wallets" – all respondents claimed to have no knowledge.

At the company level, 9% of respondents reported that they currently used BCs, especially in free-text comments indicating that most such cases have involved tests only and that not all projects were in fact BC-based applications. Of the companies not using BCs today, 10% were discussing or planning to start BC-based projects for payments, SC-based collaboration, tracking, digital registers and/or digital currencies.

When asked what would make them implement BCT, respondents indicated that lower costs were clearly the most important factor but that the potential for new business models and, in particular, increased security and reduced risk were important as well (Table 8).

Table 8.
Average rankings of factors that could make the company introduce BCT on a 1–5 scale in % (1 = very unimportant, 5 = very important agree)

Factors	Very unimportant	Unimportant	Neither important nor unimportant	Important	Very important	I donot know	MSD
If BCT gave us lower costs	0	0	21	21	29	29	4.10.9
If BCT gave us better business certainty	14	7	7	21	36	14	3.71.6
If BCT gave us lower technical risk	14	0	21	21	29	14	3.61.4
If BCT helped us to find new business models	7	7	21	36	14	14	3.51.2
If BCT gave us a lower business risk	7	0	36	29	14	14	3.51.1
If BCT gave us increased traceability in the value chain	14	7	14	36	14	14	3.31.4
If BCT helped us to find new sources of income	7	21	14	29	14	14	3.31.3
If BCT gave us increased speed	13	27	7	20	20	13	3.11.5
If BCT gave us increased transparency	21	0	36	14	14	14	3.01.4
There is nothing that could convince us to implement BCT	43	14	0	0	14	29	2.01.6

Clearly, respondents had a business-oriented perspective on BCs, which have to contribute to the company's profitability and success to gain priority. Respondents also rejected the claim that nothing could make them implement BCT, thereby displaying their willingness to adopt BCT, provided that the reasons were convincing. Even so, two of traditionally strong arguments for BCT – transparency and speed – ranked low.

Respondents also seemed to perceive several challenges with introducing BCT, the most important of which related to practical company-internal issues, including a lack of resources, that BCT was not a company priority and a lack of convincing applications of BCT (Table 9).

Table 9.
Average rankings of factors preventing the company from introducing BCT on a 1–5 scale in % (1 = very large obstacle, 5 = no obstacle)

Factors	Very large obstacle	Large obstacle	Neutral	Small obstacle	No obstacle	I donot know	MSD
Lack of relevant competence in our organisation	14	29	7	21	7	21	2.71.3
BCT not amongst our company's priorities	21	7	36	14	7	14	2.81.3
No convincing application of blockchain	21	14	21	21	7	14	2.81.4
Lack of internal resources	14	21	29	14	7	14	2.81.2
No obstacles	15	15	23	23	8	15	2.91.3
Legal framework	0	27	13	13	7	40	3.01.1
Potential security risks	7	14	29	14	7	29	3.01.2
Unproven technology	8	31	15	31	8	8	3.01.2
Concerns that the company's sensitive information may be leaked	15	31	15	0	31	8	3.01.6
Implementing, replacing or adapting old systems	0	14	36	14	7	29	3.20.9

The legal challenges surrounding BCs also appeared to be largely unknown to the respondents, with 40% of respondents selecting "I don't know". In fact, respondents seemed to be more concerned about how to use BCs and their competence in supporting them than about the technology itself. However, respondents also did not appear not to have very strong opinions about the obstacles, possibly respondents were rarely involved in BC-based projects, and thus had less knowledge about the obstacles.

6. Discussion

In industries around the world, businesses have recently had to consider the capability of BCT and its potential impacts on their businesses. In parallel, research on factors that enable or impede the adoption of BCT has expanded as well (Wang *et al.*, 2019a).

Overall, our findings from CEOs reveal that the lower cost, traceability, improved security and trustworthiness of BCT, as well as the new business models enabled by BCs, rank amongst the key factors driving the adoption of BCT, as previously demonstrated (Hoxha and Sadiku, 2019; Queiroz *et al.*, 2019; Saberi *et al.*, 2019a, Sheel and Nath, 2019; Wang *et al.*, 2019b). Sheel and Nath (2019), for example, have shown how BCs can provide a tamper-proof source of data recording and retrieval and that firms can improve the traceability of inventory items as a result. By extension, throughout SCs, the improved traceability and visibility offered by BCT can optimise the flow of information and reduce costs (Queiroz *et al.*, 2019). Such potential has also been observed by Thomasson (2019) and Galvin (2019), who reported that BC initiatives could, for instance, be used to monitor food safety, reduce spoilage and waste and, in turn, lower operational costs and boost both trust amongst consumers and the sale of food products.

According to Wang *et al.* (2019b), by improving the sharing of SC-related information, BCT enhances the trustworthiness and security of processes and products by protecting against tampering, fraud and cybercrime, as illustrated by the BC-based initiatives of DHL and Accenture (2018) in the pharmaceutical industry. To achieve security, reliability and authenticity need to be established, both of which take the form of data integrity, a key attribute of BC-based ledgers (Yli-Huumo *et al.*, 2016).

Although our study has identified numerous applications and advantages of BCs, adopting BCT is clearly not without challenges. Our findings suggest that one such challenge is the lack of convincing applications of BCs in familiar contexts that can help companies to reduce costs. That result corroborates past findings from Queiroz *et al.* (2019), Sternberg *et al.* (2020) and Ghode *et al.* (2020a), all of whom indicated a lack of successful commercial implementations of BCT. A prohibitive factor may be that the successful implementation of BCs requires collaboration amongst all stakeholders, who may be based in different locations, and thus subject to different jurisdictions. As Casey and Wong (2017) have stated, such complexity in operating environments hinders the smooth implementation of BCT in SC processes.

The lack of resources is another important factor that impedes the adoption of BCT. Tapscott and Tapscott (2016), as well as Wang *et al.* (2017) have found that adopting BCT requires financial, human and logistical resources to conduct feasibility studies and invest in relevant software and hardware. In particular, small and medium-sized companies may find it more difficult to join a BC platform due to financial limitations. In line with Prasad *et al.* (2018), we found that a lack of relevant competence in organisations discourages the adoption of BCT. Limited technical expertise and knowledge about using BCT bar the adoption of such new technology (Mougayarm, 2016). Our results additionally support research by Kembro *et al.* (2014) concerning how the leakage of sensitive corporate information to competitors due to the openness of BC platforms may hinder the adoption of

BCT. Therefore, reluctance to revealing critical information with other SC partners may hinder the successful implementation of BCT.

Last, similar to the past research (Beck *et al.*, 2018; Ghode *et al.*, 2020b, Grant and Hogan, 2015; Mougayarm, 2016), legal regulations were regarded as a challenge in BCT adoption by the CEOs in our study. This is evident from contradictions in policies issued by different governments about Bitcoin that have raised concerns amongst organisations and markets around the world, which can eventually affect the broader use of BCs amongst businesses and SC networks (Mougayarm, 2016). Although currently regulations regarding BCT are unclear but businesses being built on BC platforms may face new regulatory challenges once country-wide regulations are adopted (Beck *et al.*, 2018; Grant and Hogan, 2015).

7. Conclusions

BCs represent a relatively new technology that is nevertheless relatively well-known because of its commercial application in Bitcoin. However, by offering a digitalised, distributed database, the technology provides a wider spectrum of applications to actors involved and promises to be impenetrable to hackers because of cryptography and distributed databases.

In this article, we set out to study whether BCT is understood and applied in export-oriented industries, with a focus on CEOs in export-intensive companies in West Sweden. Our results showed a generally low level of adoption and few initiatives and implementations concerning BCT. Although BCT does not seem to be widely used at present, companies clearly see its potential in the future and appear to have faith in it. Perhaps, most notably, our study contributes top-level management's perspective on adopting BCT, which highlights the importance a business-oriented rationale as an overarching priority of CEOs.

To facilitate BC-based advantages such as lower costs, increased traceability, new sources of income increased security and procedural efficiency, managers should craft strategies to overcome the risks and challenges associated with adopting BCT identified in our study. We found that despite practitioners' positive impressions of BCT, they perceived difficulties with implementing it and struggled to recognise its impact on their respective businesses. Our results also reveal similar patterns in the integration of processes and the lack of certainty surrounding the cost-benefit ratios that van Hoek (2019b) observed. Beyond that, they align well with findings of how heavily hyped technologies are usually received. According to the stages of the Gartner hype curve (Gartner, 2018), new technologies are subject to a so-called "peak of inflated expectations", at which they are expected to change the world, followed by a "trough of disillusionment", at which great expectations are not fulfilled. In time, a "slope of enlightenment" occurs, when the technology finds productive space before achieving a "plateau of productivity". Although BCT began creating significant hype in late 2017, its attraction has recently declined. A survey amongst Swedish IT-consultant recently revealed that none of the firms ranked BCT as a "hot" field (Malmqvist, 2020). That trend was reflected by our respondents who, despite not considering BCs to be hype, struggle to imagine the productive use of BCT. Such patterns put BCT on a downward slope following its initial hype. Despite retaining some key elements of hype, its real practical uses are being increasingly questioned.

This article's valuable insights are not without limitations including a low response rate preventing more sophisticated statistical analyses. Moreover, respondents represented multiple industries, but in practice, each industry has unique needs that promote different strategic choices. For that reason, the types of perceived advantages and challenges of implementing BCT may have also varied across industries. In response, it is imperative to develop different applications for different SCs according to their needs and to test different adoption models. Industry-specific surveys about

adopting BCs may also generate different results and, in that case, be useful to industry-specific managers and researchers. Finally, respondents' answers were based on their subjective understanding of BC and BCT, which in most cases did not include any actual practical experience. In the future, qualitative studies and in-depth interviews of managers who have implemented BCT in their companies and have practical experience could provide more in-depth insights regarding top-level management's understanding of BCs and BCT.

8. Acknowledgement

Authors wish to thanks the West Sweden Chamber of Commerce for its cooperation in distributing the survey and Árni Halldórsson comments on the early versions of the paper. The project was funded by the Strategic Research Area Transport, a research programme at the University of Gothenburg and Chalmers University of Technology.

Note

1. In the statutes of the WSCC, *West Sweden* is defined as the county of Västra Götaland and the municipalities of Kungsbacka and Varberg. Although no exact account of the number of export-oriented firms in the area exists, the total number of firms with a turnover of more than 20m SEK (approximately €2m) is 8,200. In Sweden overall, 15% of the total number of firms or 1230 firms, are considered to be export-oriented; see Tillväxtverket (2018). Thus, the target sample included the vast majority of export-oriented firms in West Sweden.

References

Åhlström, P. and Westbrook, R. (1999), "Implications of mass customization for operations management", *International Journal of Operations and Production Management*, Vol. 19 No. 3, pp. 262-275.

Akins, B.W., Chapman, J.L. and Gordon, J.M. (2015), "A whole new world: income tax considerations of the bitcoin economy", *Pittsburgh Tax Review*, Vol. 12 No. 1, pp. 24-56.

Androulaki, E., Barger, A., Bortnikov, V., Cachin, C., Christidis, K., Caro, A.D., Enyeart, D., Ferris, C., Laventman, G., Manevich, Y., Muralidharan, S., Murthy, C., Nguyen, B., Sethi, M., Singh, G., Smith, K., Sorniotti, A., Stathakopoulou, C., Vukolić, M., Cocco, S.W. and Yellick, J. (2018), "Hyperledger fabric: a distributed operating system for permissioned blockchains", paper presented at Proceedings of the 13th EuroSys Conference, 23-26 April, Porto, Portugal, doi: 10.1145/3190508.3190538 (accessed 13 December 2020).

Apte, S. and Petrovsky, N. (2016), "Will blockchain technology revolutionize excipient supply chain management?", *Journal of Excipients and Food Chemicals*, Vol. 7 No. 3, pp. 76-78.

Bag, S., Viktorovich Dmitriev, A., Sahu Atul, K. and Sahu Anoop, K. (2020), "Barriers to adoption of blockchain technology in green supply chain management", *Journal of Global Operations and Strategic Sourcing*.

Beck, R., Müller-Bloch, C. and King, J. (2018), "Governance in the blockchain economy: a framework and research agenda", *Journal of the Association for Information Systems*, Vol. 19 No. 10, pp. 1020-1034.

Benchoufi, M., Porcher, R. and Ravaud, P. (2017), "Blockchain protocols in clinical trials: transparency and traceability of consent", *F1000Research*, Vol. 6, p. 66.

Benton, M.C., Radziwill, N.M., Purritano, A.W. and Gerhart, C.J. (2018), "Blockchain for supply chain: improving transparency and efficiency simultaneously", *Software Quality Professional*, Vol. 20 No. 3, pp. 28-38.

Biswas, B. and Gupta, R. (2019), "Analysis of barriers to implement blockchain in industry and service sectors", *Computers and Industrial Engineering*, Vol. 136, pp. 225-241.

Boucher, P., Nascimento, S. and Kritikos, M. (2017), *How Blockchain Technology Could Change Our Lives*, European parliamentary research service, Brussels.

Boukis, A. (2019), "Exploring the implications of blockchain technology for brand–consumer relationships: a future research agenda", *Journal of Product and Brand Management*, Vol. 29 No. 3, pp. 307-320.

Büyüközkan, G. and Göçer, F. (2018), "Digital supply chain: literature review and a proposed framework for future research", *Computers in Industry*, Vol. 97, pp. 157-177.

Casey, M.J. and Wong, P. (2017), "Global supply chains are about to get better, thanks to blockchain", *Harvard Business Review*, available at: https://hbr.org/2017/03/global-supply-chains-are-about-to-get-better-thanks-to-blockchain

Casino, F., Dasaklis, T.K. and Patsakis, C. (2019), "A systematic literature review of blockchain-based applications: current status, classification and open issues", *Telematics and Informatics*, Vol. 36, pp. 55-81.

Christopher, M. (2011), *Logistics and Supply Chain Management: creating Value-Adding Networks*, 4th ed., Prentice Hall, New York, NY.

Collomb, A. and Sok, K. (2016), "Blockchain/distributed ledger technology (DLT): what impact on the financial sector?", *Communications and Strategies*, Vol. 3 No. 103, pp. 93-111.

Cooper, D. and Nash, G. (2000), "Blockchain and privacy", in Madir, J. (Ed.) *Fintech: Law and Regulation*, Elgar Financial Law and Practice, Cheltenham, pp. 232-253.

Croman, K., Decker, C., Eyal, I., Gencer, A.E., Juels, A., Kosba, A. and Song, D. (2016), "*On scaling decentralized blockchains*", in *the international conference on financial cryptography and data security*, pp. 106-125.

Crosby, M., Nachiappan, Pattanayak, P., Verma, S. and Kalyanaraman, V. (2016), "Blockchain technology: beyond bitcoin", *Applied Innovation Review (AIR)*, Vol. 6 No. 2, pp. 6-10.

Daimler (2020), "Once round the block, please!", available at: www.daimler.com/innovation/blockchain-2.html (accessed 4 December 2020).

Dhillon, V., Metcalf, D. and Hooper, M. (2017), *Blockchain Enabled Applications: Understand the Blockchain Ecosystem and How to Make It Work for You*, Apress, Secaucus, NJ.

DHL and Accenture (2018), "DHL and accenture unlock the power of blockchain in logistics", available at: https://newsroom.accenture.com/news/dhl-and-accenture-unlock-the-power-of-blockchain-in-logistics.htm (accessed 4 December 2020).

Dobrovnik, M., Herold, D., Fürst, E. and Kummer, S. (2018), "Blockchain for and in logistics: What to adopt and where to start", *Logistics*, Vol. 2 No. 3, pp. 1-14.

Durach, C.F., Blesik, T., von Düring, M. and Bick, M. (2020), "Blockchain applications in supply chain transactions", *Journal of Business Logistics*, pp. 1-18.

Everledger (2020), "Insights", available at: www.everledger.io/insights/ (accessed 4 December 2020).

Feng, T. (2017), "A supply chain traceability system for food safety based on HACCP, blockchain and internet of things", *in 2017 International Conference on Service Systems and Service Management, Dalian, 16-18 June 2017*, pp. 1-6.

Francisco, K. and Swanson, D. (2018), "The supply chain has no clothes: technology adoption of blockchain for supply chain transparency", *Logistics*, Vol. 2 No. 1.

Fui-Hoon Nah, F., Lee-Shang Lau, J. and Kuang, J. (2001), "Critical factors for successful implementation of enterprise systems", *Business Process Management Journal*, Vol. 7 No. 3, pp. 285-296.

Galvin, D. (2019), "IBM and walmart: blockchain for food safety", available at: www-01.ibm.com/events/wwe/grp/grp308.nsf/vLookupPDFs/6%20Using%20Blockchain%20for%20Food%

20Safe%202/$file/6%20Using%20Blockchain%20for%20Food%20Safe%202.pdf (accessed 6 April 2020).

Ganne, E. (2018), *Can Blockchain Revolutionize International Trade*?, WTO Publications, World Trade Organization WTO, Geneva.

Gartner (2018), "Understanding gartner's hype cycles", available at: www.gartner.com/en/documents/3887767 (accessed 4 December 2020).

Gausdal, A., Czachorowski, K. and Solesvik, M. (2018), "Applying blockchain technology: evidence from norwegian companies", *Sustainability*, Vol. 10 No. 6, pp. 1-16.

Ghode, D., Jivanrao, Y., Vinod, J. and Rakes, S.G. (2020a), "Blockchain adoption in the supply chain: an appraisal on challenges", *Journal of Manufacturing Technology Management*, Vol. 32 No. 1.

Ghode, D., Yadav, V., Jain, R. and Soni, G. (2020b), "Adoption of blockchain in supply chain: an analysis of influencing factors", *Journal of Enterprise Information Management*, Vol. 33 No. 3, pp. 437-456.

Grant, G. and Hogan, R. (2015), "Bitcoin: risks and controls", *Journal of Corporate Accounting and Finance*, Vol. 26 No. 5, pp. 29-35.

Gupta, M. (2018), *Blockchain for Dummies IBM Limited Edition*, John Wiley and Sons, Hoboken, NJ.

Gürdür, D., El-Khoury, J. and Törngren, M. (2019), "Digitalizing swedish industry: What is next?: data analytics readiness assessment of swedish industry, according to survey results", *Computers in Industry*, Vol. 105, pp. 153-163.

Hackius, N. and Petersen, M. (2017), "Blockchain in logistics and supply chain: trick or treat?", paper presented at Hamburg International Conference of Logistics, 12-14 October, Hamburg, available at: www.econstor.eu/bitstream/10419/209299/1/hicl-2017-23-003.pdf (accessed 7 December 2020).

Haraldson, S., Lind, M., Karlsson, M., Bach, A., Woxenius, J. and Gonzalez-Aregall, M. (2020), Digitalisation and automation in small and medium sized Swedish ports (SMPs), Lighthouse Reports, Lighthouse Competence Centre, Gothenburg.

Heutger, M. and Kückelhaus, M. (2018), *Blockchain in Logistics: Perspectives on the Upcoming Impact of Blockchain Technology and Use Cases for the Logistics Industry*, DHL Customer Solutions and Innovation.

Hoxha, V. and Sadiku, S. (2019), "Study of factors influencing the decision to adopt the blockchain technology in real estate transactions in Kosovo", *Property Management*, Vol. 37 No. 5, pp. 684-700.

Hwang, J., Choi, M-I., Lee, T., Jeon, S., Kim, S., Park, S. and Park, S. (2017), "Energy prosumer business model using blockchain system to ensure transparency and safety", *Energy Procedia*, Vol. 141, pp. 194-198.

Kembro, J., Selviaridis, K. and Näslund, D. (2014), "Theoretical perspectives on information sharing in supply chains: a systematic literature review and conceptual framework", *Supply Chain Management: An International Journal*, Vol. 19 No. 5/6, pp. 609-625.

Khatri, Y. (2018), "Blockchain oil trading platform backed by shell and BP is now live", available at: www.dhl.com/global-en/home/insights-and-innovation/insights/blockchain.html (accessed 4 December 2020).

Ko, T., Lee, J. and Ryu, D. (2018), "Blockchain technology and manufacturing industry: real-Time transparency and cost savings", *Sustainability*, Vol. 10 No. 11, pp. 1-20.

Korpela, K., Hallikas, J. and Dahlberg, T. (2017), "Digital supply chain transformation toward blockchain integration", *in Proceedings of the 50th HI international conference on system sciences*.

Krombholz, K., Judmayer, A., Gusenbauer, M. and Weippl, E. (2017), "The other side of the coin: user experiences with bitcoin security and privacy", in Grossklags, J.P.B. (Ed.) *Financial Cryptography and Data Security. FC 2016. Lecture Notes in Computer Science*, Springer, Berlin, pp. 555-580.

Kshetri, N. (2018), "Blockchain's roles in meeting key supply chain management objectives", *International Journal of Information Management*, Vol. 39, pp. 80-89.

Lim, I.K., Kim, Y.H., Lee, J.G., Lee, J.P., Nam-Gung, H. and Lee, J.K. (2014), "The analysis and countermeasures on security breach of bitcoin", in Murgante, B. (Ed.) *Computational Science and Its Applications – ICCSA 2014*, Springer, pp. 720-732.

McKenzie, J. (2018), "Why blockchain won't fix food safety – yet", available at: https://thecounter.org/blockchain-food-traceability-walmart-ibm/ (accessed 4 December 2020).

Madir, J. (2000), "Smart contracts", in Madir, J. (Ed.) *Fintech: Law and Regulation*, Elgar Financial Law and Practice, Cheltenham, pp. 148-170.

Maersk (2019), "Maersk and IBM introduce TradeLens blockchain shipping solution", available at: www.maersk.com/news/2018/06/29/maersk-and-ibm-introduce-tradelens-blockchain-shipping-solution (accessed 30 September 2019).

Malmqvist, M. (2020), "Hajpade tekniken som ingen vill använda – blockkedjan iskall bland konsultbolagen (the hyped technology that noone wants to use - blockchain ice cold among consulting firms)", *Computer Sweden, 2020-12-07*.

Michelman, P. (2017), "Seeing beyond the blockchain hype", *MIT Sloan Management Review*, Vol. 58 No. 4, pp. 1-17.

Morabito, V. (2017), *Business Innovation through Blockchain: The B3 Perspective*, Springer Nature, Cham.

Morkunas, V.J., Paschen, J. and Boon, E. (2019), "How blockchain technologies impact your business model", *Business Horizons*, Vol. 62 No. 3, pp. 295-306.

Mougayarm, W. (2016), *The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology*, Wiley.

OECD (2018), *OECD Reviews of Digital Transformation: Going Digital in Sweden*, OECD Publishing, Paris.

Oke, A. (2004), "Barriers to innovation management in service companies", *Journal of Change Management*, Vol. 4 No. 1, pp. 31-44.

Patel, D., Bothra, J. and Patel, V. (2017), "Blockchain exhumed", *in Asia Security and Privacy (ISEASP) conference, Surat, 29 January-1 February*, pp. 1-12.

Petersen, M., Hackius, N. and Von See, B. (2018), "Mapping the sea of opportunities: blockchain in supply chain and logistics", *it - Information Technology*, Vol. 60 Nos 5/6, pp. 263-271.

Prasad, S., Shankar, R., Gupta, R. and Roy, S. (2018), "A TISM modeling of critical success factors of blockchain based cloud services", *Journal of Advances in Management Research*, Vol. 15 No. 4, pp. 434-456.

Provenance (2019), "From shore to plate: tracking tuna on the blockchain", available at: www.provenance.org/tracking-tuna-on-the-blockchain (accessed 4 December 2020).

Queiroz, M.M., Telles, R. and Bonilla, S.H. (2019), "Blockchain and supply chain management integration: a systematic review of the literature", *Supply Chain Management: An International Journal*, Vol. 25 No. 2, pp. 241-254.

Risius, M. (2017), "A blockchain research framework what we (don't) know, where we go from here, and how we will get there", *Business and Information Systems Engineering*, Vol. 59 No. 6.

Ryan, P. (2017), "Smart contract relations in e-Commerce: legal implications of exchanges conducted on the blockchain", *Technology Innovation Management Review*, Vol. 7 No. 10, pp. 14-21.

Saberi, S., Kouhizadeh, M. and Sarkis, J. (2019a), "Blockchains and the supply chain: findings from a broad study of practitioners", *IEEE Engineering Management Review*, Vol. 47 No. 3, pp. 95-103.

Saberi, S., Kouhizadeh, M., Sarkis, J. and Shen, L. (2019b), "Blockchain technology and its relationships to sustainable supply chain management", *International Journal of Production Research*, Vol. 57 No. 7, pp. 2117-2135.

Saveen, A. and Radmehr, M. (2016), "Blockchain ready manufacturing supply chain using distributed ledger", *International Journal of Research in Engineering and Technology*, Vol. 50 No. 9, pp. 1-10.

Sheel, A. and Nath, V. (2019), "Effect of blockchain technology adoption on supply chain adaptability, agility, alignment and performance", *Management Research Review*, Vol. 42 No. 12, pp. 1353-1374.

Sternberg, H.S., Hofmann, E. and Roeck, D. (2020), "The struggle is real: insights from a supply chain blockchain case", *Journal of Business Logistics*, pp. 1-17.

Tapscott, D. and Tapscott, A. (2016), "How blockchain will change organizations", *MIT Sloan Management Review*, Vol. 58 No. 2, pp. 1-4.

Thomasson, E. (2019), "Carrefour says blockchain tracking boosting sales of some products", available at: https://uk.reuters.com/article/us-carrefour-blockchain/carrefour-says-blockchain-tracking-boosting-sales-of-some-products-idUKKCN1T42A5?rpc=401& (accessed 4 December 2020).

Tillväxtverket (2018), "Fler företag blir internationella (more firms get international)", available at: https://tillvaxtverket.se/statistik/vara-undersokningar/resultat-fovven-2017/2018-11-23-fler-foretag-blir-internationella.html (accessed 4 December 2020).

UN-ECE (2019), *Blockchain in Trade Facilitation: Sectoral Challenges and Examples*, United Nations Economic Commission for Europe, Geneva.

VAKT (2020), "Post trade management platform", available at: www.vakt.com/ (accessed 4 December 2020).

van Hoek, R. (2019a), "Developing a framework for considering blockchain pilots in the supply chain – lessons from early industry adopters", *Supply Chain Management: An International Journal*, Vol. 25 No. 1, pp. 115-121.

van Hoek, R. (2019b), "Unblocking the chain – findings from an executive workshop on blockchain in the supply chain", *Supply Chain Management: An International Journal*, Vol. 25 No. 2, pp. 255-261.

Wamba, S.F. and Queiroz, M.M. (2020), "Blockchain in the operations and supply chain management: benefits, challenges and future research opportunities", *International Journal of Information Management*, Vol. 52, pp. 1-9.

Wang, Y., Han, J.H. and Beynon-Davies, P. (2019a), "Understanding blockchain technology for future supply chains: a systematic literature review and research agenda", *Supply Chain Management: An International Journal*, Vol. 24 No. 1, pp. 62-84.

Wang, Y., Singgih, M., Wang, J. and Rit, M. (2019b), "Making sense of blockchain technology: How will it transform supply chains?", *International Journal of Production Economics*, Vol. 211, pp. 221-236.

Wang, J., Wu, P., Wang, X. and Shou, W. (2017), "The outlook of blockchain technology for construction engineering management", *Frontiers of Engineering Management*, Vol. 4 No. 1, pp. 67-75.

Wüst, K. and Gervais, A. (2018), "Do you need a blockchain?", paper presented at 2018 Crypto Valley Conference on Blockchain Technology (CVCBT), 20-22 June, Zug, Switzerland. (accessed 13 December 2020).

Yaga, D., Mell, P., Roby, N. and Scarfone, K. (2019), *Blockchain Technology Overview*, National Institute of Standards and Technology, US Department of Commerce, Gaithersburg, MD.

Yang, C.S. (2019), "Maritime shipping digitalization: blockchain-based technology applications, future improvements, and intention to use", *Transportation Research Part E: Logistics and Transportation Review*, Vol. 131, pp. 108-117.

Yli-Huumo, J., Ko, D., Choi, S., Park, S. and Smolander, K. (2016), "Where is current research on blockchain technology? - a systematic review", *Plos One*, Vol. 11 No. 10.

Zhao, J., Fan, S. and Yan, J. (2016), "Overview of business innovations and research opportunities in blockchain and introduction to the special issue", *Financial Innovation*, Vol. 2 No. 1, pp. 1-7.

Zhou, Y., Soh, Y.S., Loh, H.S. and Yuen, K.F. (2020), "The key challenges and critical success factors of blockchain implementation: policy implications for singapore's Maritime industry", *Marine Policy*, Vol. 122, pp. 1-10.

Further reading

Reporter, (2017), "Global supply chains are about to get better, thanks to blockchain", Harvard Business Review, Issue 13 March.

Appendix

The survey instrument translated into English.

Corresponding author
Viktor Elliot can be contacted at: viktor.elliot@gu.se