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IN BLOCKCHAIN WE TRUST? CERTIFICATES OF ORIGIN AS A CASE FOR DISTRIBUTED-LEDGER TECHNOLOGIES

ABSTRACT

Certificates of Origin are one of the most important documents in cross-border trade. They evidence that goods are wholly produced or manufactured in the issuing country, which makes them eligible for specific treatment, be it non-preferential (for example most-favored-nation treatment) or preferential (for example reduction or elimination of tariffs). The procedure of obtaining a Certificate of Origin is still largely manual and paper-based, which makes it time-consuming, costly and vulnerable to errors and fraud. Documents for processing the Certificate need to be handed in by multiple actors and each submission is coupled with the risk of being false or even fraudulently produced. To improve security and transparency, in recent years, states and private parties alike started experimenting with digitalising the whole procedure in order to streamline and facilitate it. However, even promising projects with e-Certificates did not entirely solve the underlying fundamental problem of the lack of trust between the parties involved in the process. With the rise of blockchain from 2008 onwards, all eyes are on this new technology which is supposed to fix exactly this issue: establishing trust between unknown parties, or even operating without trust between the parties as they only need to trust the code. Blockchain provides a fully traceable, auditable and transparent record of transactions and with the possibility of adding smart contracts it promises to fully automatize entire processes in order to significantly reduce cost, time and human resources needed for almost any kind of procedure. This technology sounds like a promising solution for the challenges Certificates of Origin are facing. Yet, it should not be blindly implemented. This paper therefore evaluates whether Certificates of Origin are indeed a case for blockchain and if so, which framework would need to be established in order to fully enjoy the benefits that the blockchain technology provides. It concludes that Certificates of Origin are a case for blockchain technology, albeit not in all cases. To fruitfully implement blockchain, a case-by-case evaluation of the individual project, including a balancing of the advantages and disadvantages, is necessary. Furthermore, a regional framework which enables the cross-border utilisation of blockchain in the issuing process must be established in order to reap the full benefits of the technology.

The methodological approach of this paper is twofold: on the question whether Certificates of Origin are a case for blockchain, a literature review as well as case studies were conducted. On the question of regulation, current regulatory attempts and discussions in international

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organisations, such as the WCO and the ICC, were examined to identify the areas of regulatory need. Based on the findings, regulatory considerations are drawn and presented.

JEL CLASSIFICATION: K22, K24, K33

SUMMARY

1 Introduction

Certificates of Origin (CoO) are essential documents of international trade which are required to prove the origin of a certain good to determine whether preferential treatment under existing Free Trade Agreements may be applied,[1] although some countries require them also as proof for non-preferential treatment.[2] Depending on the Agreement, CoO are either issued by the importer, the exporter or a specific governmental authority.[3] The issuance of a CoO oftentimes proves to be time-consuming and costly.[4] Furthermore, the risk of forgery is always present.[5] Regularly, authorities discover CoO which were produced fraudulently in order to benefit from preferential treatment in cases it would not be applicable or to circumvent embargoes or sanctions.[6] Even though there is the possibility to verify the authenticity and/or validity of a CoO, the current verification procedures require administrative cooperation between the relevant authorities, which comes with further challenges, such as the need for bi- or multilateral agreements that allow for the exchange of the necessary information.[7] A further common challenge for CoO is that usually only the producer and/or exporter has sufficiently detailed knowledge and information about the originating status of the good.[8]

[1] World Customs Organisation (WCO), 'Comparative Study on Certification of Origin' (June 2020) <www.wcoomd.org/-/media/wco/public/global/pdf/topics/origin/instruments-and-tools/comparative-study/related-documents/comparative-study-on-certification-of-origin_2020.pdf?db=web> accessed 27 July 2021, 11 ff.
[2] ibid 6, 8 ff.
[3] ibid 17.
[4] ibid 11.
[5] See for example United Nations Economic and Social Commission for Asia and the Pacific, 'Enhancing Regional Connectivity: Towards a Regional Arrangement for the Facilitation of Cross-Border Paperless Trade' (ESCAP Studies in Trade and Investment No. 78, 2016) 93.
[6] See Camarda, 'Blockchain-based Certificates of Origin Begin Moving into International Trade' <www.americanexpress.com/us/foreign-exchange/articles/blockchain-in-certificate-of-origin/> accessed 25 April 2021; cf Christine McDaniel and Hanna Norberg, 'Can Blockchain Technology Facilitate International Trade? (Mercatus Center at George Mason University, Trade and Immigration, Research Papers, April 2019) <www.mercatus.org/system/files/mcdaniel-blockchain-trade-mercatus-research-v2.pdf> accessed 25 April 2021, 13.
[7] Cf WCO, 'Comparative Study on Certification of Origin' (n 1) 11.
[8] ibid 20.

In recent years, an increasing number of private undertakings and governments aim to solve the challenges of CoO by introducing e-certificates based on distributed-ledger technology (DLT), most commonly referred to as blockchains. In 2018, the Singapore International Chamber of Commerce launched the first blockchain-based e-CoO.[9] Other countries followed, and there are several pilot projects and surveys currently being conducted to research the benefits of moving CoO entirely online.[10] Even though these projects appear promising, skepticism towards the usage of DLT for CoO remains, especially concerning its still insufficient regulation.[11]

This paper aims to shed light on the question whether the implementation of DLT, especially blockchain, can improve the issuing process and quality of CoO and the question which regulations would be necessary to pave the way for effectively implementing blockchain in the procedure.

2 Certificates of Origin – a case for blockchain?

Even though blockchain appears appealing as a solution to the various problems the concept of CoO faces in international trade it remains questionable whether CoO actually are a case for a Blockchain project. Considering that oftentimes new technologies are met with an overwhelming enthusiasm and stakeholders wish to apply said technology to every aspect possible, it is worth considering whether it actually makes sense to implement the respective technology in the chosen sector (or even a part of it).[12] A common justification for using blockchain is already seen in cases where multiple parties need to have access to the same data but mistrust each other in sharing them.[13] The United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) finds blockchain valuable when it supports either new and improved services, faster processes and/or implementation or more economical processes and/or implementation and provides a "decision tree".[14] Wüst and Gervais consider blockchain as feasible in cases where there are multiple mistrusting entities, and there

[9] eTrade for all, 'Singapore International Chamber of Commerce launches world's first blockchain-based e-Certificate of Origin' (14 May 2018) <https://etradeforall.org/news/singapore-international-chamber-of-commerce-launches-worlds-first-blockchain-based-e-certificate-of-origin/> accessed 27 July 2021.
[10] See WCO, 'Comparative Study on Certification of Origin' (n 1) 20 ff.; Camarda (n 6).
[11] Marc Barley, 'UK certificate of origin blockchain pilot' (Ledger Insights, 13 June 2018) < www.ledgerinsights.com/uk-certificate-origin-blockchain/> accessed 29 July 2021.
[12] See also Jorien Kerstens and James Canham, 'Blockchain: mapping new trade routes to trust' (WCO News 87, Focus, October 2018) <https://mag.wcoomd.org/magazine/wco-news-87/blockchain-mapping-new-trade-routes-to-trust/> accessed 16 July 2021, who assess the feasibility by evaluating four key areas of trade, namely proof of identity, asset transfer, pathfinder and border collaboration.
[13] Zahouani Saadaoui, 'Digitisation of ATA Carnets: how the Blockchain could enhance trust', ibid <https://mag.wcoomd.org/magazine/wco-news-87/digitisation-ata-carnets/> accessed 17 July 2021.
[14] United Nations Economic Commission for Europe/United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT), *Blockchain in Trade Facilitation* (White Paper, ECE/TRADE/457, Geneva, 2020) <https://unece.org/DAM/trade/Publications/ECE-TRADE-457E_WPBlockchainTF.pdf> accessed 29 July 2021, 16 ff.

is no agreement on who is an online trusted third party, there are multiple writers of data and there is data to be stored and the multiple mistrusting entities must want to interact and change the state of a system.[15] Lindman et al. propose a test for analyzing potential blockchain use cases. The test follows the rationale of whether blockchain for the specific project is viable (i.e. a viable solution considering the scope and limits of the technology); if so, whether it is valuable (does blockchain have clear benefits for the project?); and if so, whether it is vital (does blockchain have unique properties needed to implement the service?).[16] Only if these criteria are fulfilled cumulatively do Lindman et al. consider a project to be a blockchain use case. This test allows for a multi-layered in-depth evaluation, which is why it is considered appropriate for the evaluation of the compatibility of blockchain and CoO.

2.1 The challenges of Certificates of Origin

CoO are used since almost a century in cross-border trade; they establish trust between the traders and allow the parties involved from benefitting from trade agreements between their respective states as well as assisting authorities to monitor compliance with their internal regulations. As this function requires a high amount of legal certainty and reliability, the process of issuing a Certificate of Origin needs to be regulated and carefully executed. False CoO do not only damage the reputation of the trader but have a direct impact on the state's revenue in the form of loss of custom duties or taxes and are even used to cover illicit trade activities.[17] While the careful certification process is certainly necessary and understandable, it equally hinders the free cross-border-flow of goods and creates hurdles especially for small and medium-sised enterprises[18] and might even amount to a distortion of or a *de facto* barrier to trade.[19] Obtaining a Certificate of Origin proves to be costly and time-consuming,[20] even more so due the complexity of the procedure: there is a great variety of procedures to obtain a Certificate of Origin[21], involving varying competent authorities, documentation and requirements – procedural and formal alike. The increasing number of free trade

[15] Karl Wüst and Arthur Gervais, 'Do you need a Blockchain?' (Crypto Valley Conference on Blockchain Technology (CVCBT), 2018) 46 <https://eprint.iacr.org/2017/375.pdf> accessed 29 July 2021.
[16] Juho Lindman and others, 'The uncertain promise of blockchain for government' (2020) OECD Working Papers on Public Governance No. 43, 12.
[17] Cf UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 48.
[18] Cf Emanuelle Ganne, *Can Blockchain revolutionize international trade?* (WTO Publications 2018) 83.
[19] International Chamber of Commerce, 'Non-Preferential Rules of Origin for Commercial Policy Purposes' (Policy Statement, Document No 104-80, June 2015) <https://iccwbo.org/publication/icc-policy-statement-on-non-preferential-rules-of-origin-for-commercial-policy-purposes/> accessed 26 July 2021, 1.
[20] Cf WCO, 'Guidelines on Certification of Origin' (July 2014, updated June 2018) <www.wcoomd.org/-/media/wco/public/global/pdf/topics/key-issues/revenue-package/guidelines-on-certification.pdf?la=fr> accessed 27 July 2021 7 ff; cf Luc Pugliatti and Bill Gain, 'Can Blockchain Revolutionize Trade?' (World Bank Blogs, 5 June 2018) <https://blogs.worldbank.org/trade/can-blockchain-revolutionize-trade> accessed 2 July 2021.
[21] WCO, 'Guidelines on Certification of Origin' (n 20) 7 ff.

agreements, each with its own rules of origin, creates a serious challenge for the issuing process.[22] There might even be different origin procedures for the same good in the same country as each trade agreement is negotiated differently with different trading partners. This complexity creates an administrative challenge for authorities and traders of all sizes alike.[23] Already for multinational companies identifying the correct procedure for the individual shipment is not an easy task and requires a great amount of resources.[24] It is unlike harder for small and medium-sised enterprises which cannot resort to comparable resources as multinational companies.[25] A further challenge is the lack of capacity on the side of the issuing competent authorities, be it in human or other resources, which is inextricably linked to the continuing increase of international trade.[26] Combined with the difficulty of having different stakeholders at the issuing and the receiving side,[27] this challenge adds a further layer to the already complex procedure.

The complexity of the procedure combined with it being manual and paper-based results in "blind-spots"[28] which present entry points for false information which may be exploited to fraudulently obtain a Certificate of Origin. The amount of documentation needed from multiple actors comes with the inherent risk of data inconsistencies which may result in false certifications.[29] In recent years a number of cases were reported which included forged CoO, such as Chinese zippers with declared origin in Indonesia to benefit from lower tariffs[30] or 80 cases of origin fraud in Vietnam within one year[31], with many aimed at evading trade sanctions or restrictions.[32]

[22] WCO, 'WCO Origin Compendium' (May 2017) <www.wcoomd.org/-/media/wco/public/global/pdf/topics/origin/instruments-and-tools/guidelines/origin_compendium.pdf?db=web> accessed 27 July 2021, p. 23; WCO, 'Guidelines on Certification of Origin' (n 20) 8; International Chamber of Commerce, 'Non-Preferential Rules of Origin for Commercial Policy Purposes' (n 19) 1.
[23] Leonardo Macedo, 'Blockchain for trade facilitation: Ethereum, eWTP, COs and regulatory issues' (2018) 12(2) World Customs Journal 87, 90; WCO, 'WCO Origin Compendium' (n 22) 23; International Chamber of Commerce, 'Non-Preferential Rules of Origin for Commercial Policy Purposes' (n 19) 1.
[24] The cost of handling the paperwork might even exceed the cost of transport, McDaniel and Norberg (n 6) 11 (with further reference).
[25] Ganne (n 18) 83.
[26] WCO, 'Guidelines on Certification of Origin' (n 20) 8.
[27] United Nations Economic and Social Commission for Asia and the Pacific (n 5) 93.
[28] Huseyin Yaren, 'Implementing blockchain technology in the customs environment to support the SAFE Framework of Standards' (2020) 14(1) World Customs Journal 127, 131.
[29] Cf Stewart Jeacocke and Norbert Kouwenhoven, 'TradeLens uses blockchain to help Customs authorities facilitate trade and increase compliance' (WCO News 87, Focus, October 2018) <https://mag.wcoomd.org/magazine/wco-news-87/tradelens/> accessed 17 July 2021.
[30] Jalelah Abu Baker, 'Company director fined $434,000 for submitting false information to Singapore Customs' *The Straits Times* (Singapore, 14 July 2015) <www.straitstimes.com/singapore/courts-crime/company-director-fined-434000-for-submitting-false-information-to-singapore> accessed 27 July 2021.
[31] Vietnam Law & Legal Forum, 'Origin Fraud Still Runs Rampant' *Vietnam.Net Bridge* (5 July 2013) <http://english.vietnamnet.vn/fms/business/78277/origin-certificate-fraud-still-runs-rampant.html>, accessed 27 July 2021.
[32] Camarda (n 6).

At the core of all these issues specific to the certification problems lies the problem of a general lack of trust in cross-border transactions.[33] This can not only be seen in the complex procedures in place – some countries, for example, require a paper document to be stamped by an embassy or consulate[34] – but also in the generally prevailing unwillingness or inability to find consensus to simplify processing of goods at the border.[35]

The aforementioned problems have been explicitly recognised by the members of the World Customs Organisation, which, in 2016, acknowledged that the development of a global system for paperless information exchange would be desirable, however that several obstacles, namely (a) legal issues; (b) data security and protection concerns; (c) a general lack of trust; (d) the need for an organisation that will be responsible for the system; (e) the complexity of setting up and financing such a system; and (f) the absence of initial investment funds would currently prevent the establishment of such a system.[36]

2.2 Viable

For a project to be a case for blockchain technology, the technology must first be a viable solution to the problem to be solved. Whether or not blockchain is a viable solution is to be determined based on the scope and limits of the technology, its general implementability and ultimately the compatibility with the needs of the project. The threshold for viability is not high; as soon as the project can be made to work by deploying the technology the requirement of viability is met.[37]

2.2.1 The scope and limits of the blockchain technology

Even though blockchain technology has been developed since more than a decade now, some consider it still to be in a nascent stage.[38] The huge community working on and with the technology constantly aims for the improvement and enhancement of

[33] Macedo (n 23) 91.
[34] United Nations Economic and Social Commission for Asia and the Pacific (n 5) 46, 95.
[35] ibid, 46.
[36] ibid.
[37] Lindman and others (n 16) 12.
[38] For example, Horst Treiblmaier, 'Toward More Rigorous Blockchain Research: Recommendations for Writing Blockchain Case Studies' in Horst Treiblmaier and Trevor Clohessy (eds), *Blockchain and Distributed-ledger Technology Use Cases. Applications and Lessons Learned* (Springer 2020) 1, 3; Lokke Moerel, 'Blockchain and Data Protection' in Larry DiMatteo, Michel Cannarsa and Cristina Poncibo (eds), *The Cambridge Handbook of Smart Contracts, Blockchain Technology and Digital Platforms* (CUP 2019) 213, 232; Marco Iansiti and Karim Lakhani, 'The Truth About Blockchain' (January-September 2017) Harvard Business Review 118 <https://hbr.org/2017/01/the-truth-about-blockchain> accessed 18 July 2021.

DLTs in order to solve issues connected to the increasing usage such as interoperability and scalability (see *infra*) and unlocks new means of application at great velocity. With this support and the willingness of the private and public sector to apply the technology whenever possible, the scope of blockchain seems virtually limitless. As can be seen in the great variety of projects based on the technology, there seems to be no part of international trade which could not be revolutionised by blockchain. Be it in the financial sector, transport, supply chain management, insurances or customs, most of the areas are already equipped with at least one pilot project in order to explore the implications of DLT in trade.[39]

Yet, the technology has its limits. Blockchain per se is not able to check the validity of the information added to the chain. While this might be mitigated by including smart contracts[40] in the process, blockchain is still limited to what is uploaded by its users. The technology is not by itself able to prevent false information from being fed into the ledger.[41] With the risk of having fraudulent documentation or information uploaded on the chain comes the issue that such information may not be deleted due to the immutability of the information added to the chain.[42] Hereby, the whole chain related to that specific transaction may be spoiled resulting in a deterioration of the trust established by the usage of blockchain in the first place.

The technology is – as of now – also not entirely secure. For example, there remains the risk of so-called 50+1 attacks whereby data may be tampered with when more than fifty percent of the nodes are taken over by a single entity which then is empowered to provide consensus for a transaction by itself.[43] Admittedly, the risk is small, as the computational power needed to execute such an attack and the cost related to it is high;[44] it is furthermore a risk rather specific to public permissionless than private and/or permissioned chains.[45]

Bearing this in mind, the benefits of the technology may only materialize as long as the information provided on the chain is correct.[46] This does not mean that the technology is not beneficial, it just needs to be kept in mind as a limit to the service blockchain provides for cross-border trade.

[39] For an overview see for example Valentina Gatteschi, Fabrizio Lamberti and Claudio Demartini, 'Blockchain Technology Use Cases', in Shiho Kim and Ganesh Deka (eds), *Advanced Applications of Blockchain Technology* (Springer 2020) 91, 94 ff.
[40] Ganne (n 18) 6.
[41] Eliza Mik, 'Blockchains: A Technology for Decentralised Marketplaces' in DiMatteo, Cannarsa and Poncibo (n 38) 160, 172 ff.; Pugliatti and Gain (n 20); cf UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 19.
[42] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14), 20, 30; cf Philip Asuquo and others, 'Blockchain Meets Cybersecurity: Security, Privacy, Challenges, and Opportunity' in Kim and Deka (n 39) 115, 124.
[43] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 7.
[44] ibid.
[45] Ganne (n 18) 7; cf UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 9.
[46] Cf UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 19.

What blockchain can provide is undoubtedly an easily identifiable record of data which, once added to the chain, is almost tamper-proof. It can therefore establish a transparent, traceable and accessible record keeping, resulting in ensured and secured storage of documents[47] which enables a trust-relationship between strangers, a characteristic which cannot be underestimated in globalised trade.

2.2.2 Implementability with Certificates of Origin

To assess whether blockchain is a viable solution for CoO, it must be evaluated if CoO are compatible with the concept of blockchain. Here, it is of relevance whether, generally, the technology is implementable in this procedure and whether it is complementary to the needs of it.

For this it is necessary to recall the specificities of CoO. CoO are documents which are exchanged in international trade transactions to provide the trading partner and third parties, such as customs authorities, with evidence of origin in order to benefit from a specific treatment attached to a goods' origin, such as preferential tariffs or the exemption from sanctions or export bans (see *supra*, II.1.). The documentation is necessary to validate not only the specific conditions of the transaction, but also to establish trust between the parties: as liabilities in these relationship in connection to false documentation are generally clarified, the respective parties – at least theoretically – can rely on the provided documentation. CoO are key documents in cross-border trade, which makes them essential features, but equally makes them attractive targets for forgery or other fraudulent behavior in order to benefit from a certain originating status. In sum, CoO are vital elements for the integrity of cross-border processing, especially customs procedures.

Following these considerations, it is apparent that blockchain is implementable in the processing of CoO. Every step necessary in order to obtain such a certificate can be digitalised – a step already taken in some countries which rely on e-certification. There is no ultimate need for human interaction for the issuance of a Certificate of Origin. Generally, there is also no need for a physical inspection of the relevant goods which would hinder the digitisation of the procedure. Also, recalling the features of blockchain, all procedural steps for the certification process can be subjected to validation within a network. The certification process could also be (partially) automated, whereby the process could not only be transferred on-chain, but even complemented with smart contracts – whether or not that would be a feasible way to process certification requests.

[47] Singapore Customs, 'Going beyond the national Single Window' (WCO News 87, Focus, October 2018) <https://mag.wcoomd.org/magazine/wco-news-87/going-beyond-the-single-window/> accessed 17 July 2021.

2.2.3 Compatibility with the needs of Certificates of Origin

As a general implementation is possible, it needs to be evaluated whether the technology can cater for the specific needs of CoO in light of their challenges.

What becomes apparent when considering the characteristics of the blockchain technology in light of the challenges CoO are facing is that, without going into further detail concerning the value of implementing the technology as a solution (see on this matter below), the challenges could be tackled by the features that blockchain would provide. Blockchain has the capacity to significantly reduce the time needed to process transactions, especially when combined with smart contracts for automated facilitation of contractual agreements. As automated facilitation based on verified data also requires less human intervention, the resources needed to effectuate a transaction would significantly decrease as well, and hereby the costs attached to it. Furthermore, due to the immutability and tamper-proof nature of the technology, the matter of general lack of trust in cross-border transactions can be effectively tackled. As every stakeholder of a cross-border transaction could theoretically have access to the data stored on the chain and would hereby be enabled to follow the information on the processing of the certificate in real-time the need for verification would be reduced and the process.[48] The digital nature of the process could not only be a great time-safer, but also ensure that no document would be lost and that documents which are required for more than one certificate, such as a valid exporter license, could be stored indefinitely in order to have it ready for any future transaction. This could also reduce the complexity of the procedure:[49] if regulations and procedures get harmonised, the process would be significantly streamlined which would grant easier access, especially for small and medium-sised enterprises.[50]

2.2.4 Conclusion

The foregoing considerations show that the scope and limits of the blockchain technology can encompass CoO. The technology would also generally be implementable, as the procedure itself contains no features which would prevent an entirely digitised processing, which is especially visible in e-certifications already used in several countries. When evaluated in light of the current challenges faced by CoO, the

[48] Blockchain would, essentially, improve the current ICC Certificates of Origin verification platform (for the latter see International Chamber of Commerce, 'Certificates of Origin verification website' <https://iccwbo.org/resources-for-business/certificates-of-origin/certificates-origin-verification-website/> accessed 26 July 2021.
[49] Cf Wout Hofman, 'Supply Chain Visibility Ledger' in Treiblmaier and Clohessy (n 38) 305, 327 (on supply chains).
[50] Ganne (note 18), p. 85.

specific needs could theoretically (and without further valuation) be met by the characteristics of the technology. In conclusion it is apparent that blockchain is a viable solution for the challenges of CoO.

2.3 Valuable

As it can be established that blockchain is a viable technology for CoO, it has to be assessed whether it also presents a valuable solution. For this assessment considerations have to be made as to whether blockchain comes with clear benefits. This point follows the idea "just because something can be used does not mean it should be used."[51] To establish clear benefits, the disadvantages which would come with the introduction of the new technology need to be balanced against the benefits in order to establish whether the benefits outweigh the disadvantages. Only in such cases can blockchain be considered a valuable solution.

2.3.1 value added

Blockchain technology is praised for its many advantages in relationships which are established between parties without mutual trust. To establish whether or not these advantages would materialize in the specific case of CoO it needs to be evaluated whether the benefits of blockchain would be valuable for CoO and whether they are capable of actually improving the process.

Introducing blockchain technology into the certification process would make the processing faster,[52] paperless[53] and less costly.[54] Removing the need of physical documentation would also decrease the possibilities for fraud and errors[55] and possibly reduce cross-border trade frictions.[56] While these benefits are clearly valuable for the certification process, they are not unique to the blockchain technology and may be achieved by other forms of digitising CoO.[57] With the reduction of cost and time needed

[51] See also Kerstens and Canham (n 12); Iansiti and Lakhani (n 38); Gatteschi, Lamberti and Demartino (n 39) 105 ff.
[52] Kerstens and Canham (n 12).
[53] Yotaro Okazaki, 'Unveiling the Potential of Blockchain for Customs' (WCO Research Paper No. 45, June 2018) <www.wcoomd.org/-/media/wco/public/global/pdf/topics/research/research-paper-series/45_yotaro_okazaki_unveiling_the_potential_of_blockchain_for_customs.pdf?la=en> accessed 27 July 2021, 15; cf. Jeacocke and Kouwenhoven (n 29).
[54] Macedo (n 23) 88; McDaniel and Norberg (n 6) 14, who estimate a cost reduction by 16.5 percent for low income countries, by 17.4 percent for lower-middle-income countries, by 14.6 percent for upper-middle-income countries, and by 11.8 percent for countries belonging to the Organisation for Economic Co-operation and Development.
[55] A finding validated by the IBM pilot, see Macedo (n 23) 90.
[56] Kerstens and Canham (n 12).
[57] See for example the case of TradeNet and e-Certifications: United Nations Economic and Social Commission for Asia and the Pacific (n 5) 14.

to process CoO the procedure would become less burdensome especially for small and medium-sised enterprises.[58] Especially when blockchain records are accepted as the single source of truth security will improve,[59] not least because immutable, digital, verified data improve the quality of risk assessments.[60] It might even improve cross-border collaboration between customs authorities by sharing information on malicious traders.[61] Using blockchain for CoO would create an immutable certification register with unlimited storage due to its decentralised nature with high security standards due to cryptography; when combined with smart contracts, the technological solution could pave the way for blockchain single windows and eHubs.[62] Another benefit which is valuable for the process is the timestamping feature of the technology, which leads to easier auditability and greater data authenticity and hence is beneficial when truthful records are needed.[63] The improvement of the auditability is further enhanced by the easy traceability of data,[64] which also results in greater transparency for customs clearance.[65] Due to the immutability, verification and timestamping data integrity is established; the accuracy and quality of data accessible to the relevant parties would improve[66] when compared with the current manual and paper-based procedure. Through all these features, the benefits of blockchains for CoO can improve the process insofar as it becomes more transparent, traceable, less costly, less time-consuming, enhances compliance with regulations and documentation and less vulnerable to fraud.[67] Finally, one of the most important values added is the establishment of mutual trust in relationships where there is none;[68] the more trustworthiness is needed, the more value could blockchain add.[69] The transparent and inclusive manner and the high reliability[70] which blockchain would bring into the certification process enables a trust-basis between unknown parties in cross-border trade, for example by establishing a traceable digital identity.[71] With the establishment of mutual trust, the number of intermediaries who are used in the majority of international trade (for example, 90% of

[58] Ganne (n 18) 85; this is the main idea of the eWTP initiative that aims at reducing trade costs for SMEs by creating virtual free trade hubs, see Macedo (n 23) 89.
[59] Pugliatti and Gain (n 20); Yaren (n 28) 134.
[60] Yaren (n 28) 131, 134.
[61] Kerstens and Canham (n 12).
[62] Macedo (n 23) 91.
[63] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 30; Yaren (n 28) 129.
[64] Okazaki (n 53) 10.
[65] Yaren (n 28) 133 (with further references).
[66] Okazaki (n 53) 17; Pugliatti and Gain (n 20); Yaren (n 28) 129 (concerning supply chains).
[67] See also Yaren (n 28) 133 (with further references).
[68] Okazaki (n 53) 10; Macedo (n 23) 90.
[69] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 16.
[70] ibid 2; UN/CEFACT, *White Paper on the technical applications of Blockchain to United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) deliverables* (ECE/TRADE/C/CEFACT/2019/8, 17 January 2019) <https://unece.org/DAM/cefact/cf_plenary/2019_plenary/ECE_TRADE_C_CEFACT_2019_08E.pdf> accessed 30 July 2021, 2; cf WCO, 'Guidelines on Certification of Origin' (n 20) 2.
[71] Kerstens and Canham (n 12).

declarations involve a broker[72]) and the corresponding cost[73] and risk of errors could be significantly reduced.

2.3.2 disadvantages and challenges

Even though blockchain is considered to entirely disrupt transactions as we know it and the hype surrounding the technology pushes it into virtually every aspect of international trade, some meet it with careful criticism. Despite all its benefits, the usage of blockchain comes with disadvantages and challenges which need consideration.

The major concerns raised in relation to blockchain are scalability, sustainability, interoperability, data protection and privacy, mutual recognition, regulation and liabilities.

Especially due to the increasing prominence of blockchain the issue of scalability is often raised. Scalability is as of yet a not clearly defined term;[74] it may be defined as a system's capability of handling a growing amount of work,[75] which in the case of blockchain is still limited[76] and a specific problem of public blockchains[77] and barely an issue for consortium permissioned blockchains.[78] Scalability decreases the more nodes operate in the network.[79]

The issue of interoperability is raised when there is more than one blockchain involved, which would most likely be the case should blockchain become a standard-technology in international trade relations.[80] Interoperability may be defined as the "ability of two or more systems or applications to exchange information and to mutually use the information that has been exchanged"[81] or "the capacity of a system, product, or service to communicate and function together (that is, to be compatible) with other

[72] ibid.
[73] Treiblmaier (n 38) 6; McDaniel and Norberg (n 6) 13 (who also hold Blockchain to be able to hereby reduce corruption).
[74] For a discussion of the technical matters see for example Zhijie Ren, 'What does "scalability" really mean in Blockchain?' (15 May 2019) <https://medium.com/vechain-foundation/what-does-scalability-really-mean-in-blockchain-b8b13b3181c6> accessed 27 July 2021.
[75] André Bondi, 'Characteristics of Scalability and Their Impact on Performance' in Association for Computing Machinery, *WOSP '00: Proceedings of the 2nd international workshop on Software and performance* (2020) 195 <https://dl.acm.org/doi/10.1145/350391.350432>, accessed 27 July 2021.
[76] Gatteschi, Lamberti and Demartino (n 39) 92.
[77] Treiblmaier (n 38) 7 ff; cf. UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 7; Ganne (n 18) 90.
[78] Ganne (n 18) 91.
[79] Fabian Knirsch, Andreas Unterweger and Dominik Engel, 'Implementing a blockchain from scratch: why, how, and what we learned' (2019) EURASIP Journal on Information Security 2019 <https://jis-eurasipjournals.springeropen.com/articles/10.1186/s13635-019-0085-3#citeas> accessed 27 July 2021.
[80] UN/CEFACT, *White Paper on the technical applications of Blockchain* (n 70) 7 ff.
[81] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 15 (with reference to the ISO/IEC standard and the International Telecommunications Union).

systems, products, or services which are technically different."[82] The various ledgers in operation usually perform different forms data transactions and handle different amounts of data processing. Generally, transmission of data between the various blockchain networks is not possible[83] which effectively prevents the users to enjoy the full benefits of DLT and creates a *de facto* technical boundary.[84]

Concerns on sustainability are in majority connected to public permissionless chains.[85] As the increasing amount of users requires an increasing amount of computational power in order to validate a transaction, the energy expense of blockchain transactions, especially in validations by Proof of Work, is high.[86] However, this appears to be a specific problem of public permissionless blockchains, especially Bitcoin;[87] as the forms of blockchain which would most likely be implemented in international trade would be permissioned and/or private, the disadvantage of sustainability would be – partially – mitigated as permissioned blockchains[88] and blockchains using other consensus mechanisms[89] require significantly less computational power.

Furthermore, concerns about data protection and data privacy are raised, especially concerning business critical information.[90] The data affected are different depending on the chain used; for example, in public chains, concerns evolve rather around data connected to the transaction,[91] such as production volumes, as the participants operate anonymously.[92] Nevertheless, it is also possible to identify users in public blockchains.[93] In relation to data protection regulations, it is argued that the technology may not be compliant with the General Data Protection Regulation of the European Union[94] which,

[82] Paolo Tasca and Riccardo Piselli, The Blockchain Paradox, in Philip Hacker and others (eds), *Regulating Blockchain: Techno-Social and Legal Challenges* (OUP 2019) 27 35 (with further reference).
[83] ibid, 36 ff.
[84] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 15.
[85] Ganne (n 18) 92.
[86] Rosario Girasa, *Regulation of Cryptocurrencies and Blockchain Technologies. National and International Perspectives* (Palgrave McMillan 2018) 32; Ganne (n 18) 7; Knirsch, Unterweger and Engel (n 79).
[87] A study conducted by Guan Dabo at Tsinghua University in Beijing, China, and his colleagues calculated that the total carbon footprint of bitcoin mining in China will peak in 2024, releasing around 130 million metric tonnes of carbon (Donna Lu, 'Bitcoin mining emissions in China will hit 130 million tonnes by 2024' *New Scientist* (6 April 2021) <www.newscientist.com/article/2273672-bitcoin-mining-emissions-in-china-will-hit-130-million-tonnes-by-2024/#ixzz70bZ52cdf> accessed 27 July 2021) and a study by Cambridge researchers found that Bitcoin mining already uses more electricity annually than Argentina (Cristina Criddle, 'Bitcoin consumes "more electricity than Argentina"' *BBC News* (10 February 2021) <www.bbc.com/news/technology-56012952>, accessed 27 July 2021).
[88] Ganne (n 18) 10.
[89] Cf UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 22.
[90] Wüst and Gervais (n 15)48; Treiblmaier (n 38) 6.
[91] Neha Gupta, 'Security and Privacy Issues of Blockchain Technology' in Kim and Deka (n 39) 207, 217; cf. Wüst and Gervais (n 15) 48.
[92] Or, more correctly, pseudonymously, Treiblmaier (n 38) 6.
[93] ibid; UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 32 ff; Michèle Finck, *Blockchain Regulation and Governance in Europe*, (CUP 2018) 53 ff.
[94] Wolfgang Radinger-Peer and Bernhard Kolm, 'A Blockchain-Driven Approach to Fulfill the GDPR Recording Requirements' in Treiblmaier and Clohessy (n 38) 133, 137 ff; Stefan Wunderlich and David Saive, 'The Electronic Bill of

should this be the case, might negatively affect the implementation in the European Union and herewith a big part of globalised trade. A major concern here is the immutability of the data, which, ironically, is one of the praised features of blockchain, because it interferes with the right of having one's data deleted (i.e., the right to be forgotten).[95] As modification of a chain is only possible with the consent of the majority of its users,[96] this might indeed present a problem.[97] Yet, of course, it would not be unsolvable, for example by implementing forks,[98] or at least implement an application that allows for new entries which will delete the impact of inaccurate data.[99] However, as these solutions do not entirely delete the data, alternatives such as redactable blockchains should be explored.[100] A further concern is the problem of cross-border paperless data exchange, a hot topic since years which in large parts still remains unsolved.[101] Furthermore, the level of security decreases the smaller the network of the ledger gets; especially permissioned chains are not as resistant against attacks as a public permissionless ledger.[102] Apart from hacking, security concerns evolve around for example 50%+1 attacks, double spending, mining pool attacks, forking or transaction privacy leakage.[103]

Especially in the realm of blockchain and CoO there are challenges concerning the question of mutual recognition and acceptance of e-certificates as well as the authenticity and accuracy of data. Along with these unanswered question goes the question of liability, which is clear in the current procedure but would need serious re-consideration with the introduction of blockchain.

2.3.3 Evaluation

Despite the great benefits of blockchain, which would be valuable for the issuing of CoO, there are disadvantages which cannot be ignored. Yet, most of the disadvantages can be mitigated by careful planning and execution of a blockchain-based certification process. The issue of scalability can be tackled by including smart contracts on the

Lading. Challenges of Paperless Trade' in Javier Prieto and others (eds), *Blockchain and Applications. 2nd International Congress* (Springer 2020) 93, 97; in disagreement: Moerel (n 38) 217 ff.

[95] Radinger-Peer and Kolm (n 94) 136 ff; Treiblmaier (n 38) 10; cf Gupta (n 91) 217 ff; Wunderlich and Saive (n 94) 97; it has to be borne in mind, however, that this right is not absolute, see on this matter Moerel (n 38) 228.

[96] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 9.

[97] Gupta (n 91) 218.

[98] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 9 ff.

[99] ibid, 30 ff.

[100] Wunderlich and Saive (n 94) 97.

[101] UN/CEFACT, *White Paper on the technical applications of Blockchain* (n 70) 8; cf. United Nations Economic and Social Commission for Asia and the Pacific (n 5) 37 ff.

[102] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 10 f.; Id., *White Paper on the technical applications of Blockchain* (n 70) 8.

[103] Treiblmaier (n 38) 9; see for details Gupta (n 91) 210 ff, 218 ff.

chain[104] or implementing technologies which improve the scalability.[105] The question of interoperability is currently being worked on by expert groups and discussed in literature[106] as is the concern of "50%+1 attacks"[107] and other security concerns,[108] with promising solutions that can be implemented in future projects. Privacy concerns, especially when smart contracts are used, can be met with appropriate techniques, such as Hawk contracts, code obfuscation, application hardening or computing with trust[109] or privacy-by-design options.[110] The concerns raised about the sustainability of the technology would only be pressing should the project use a public and/or permissionless chain, a scenario unlikely in the context of CoO;[111] the question of sustainability is also subject to current developments.[112] The question of cost needs further evaluation, as implementing blockchain might trigger significant investments[113] and there will likely be transaction fees;[114] yet, it can be expected that in the long run the technology would safe more cost than its introduction and operation would require.[115] Questions of data protection and security are solvable through fitting regulations and can build on a basis of pre-existing data security frameworks which are already operational.[116] Also, the questions on mutual recognition and liabilities are solvable through specific (inter)state regulations.

In conclusion, the benefits of introducing blockchain into CoO clearly outweigh its disadvantages, not least because the disadvantages do not proof to be unsolvable with considerate planning and regulation.

[104] Macedo (n 23) 88.
[105] See for an overview Ren (n 74).
[106] For example, the UN/CEFACT proposes a inter-ledger notary protocol, see UN/CEFACT, *White Paper on the technical applications of Blockchain* (n 70) 11 ff. Also, in the case of TradeLens: Jeacocke and Kouwenhoven (n 29). See also the development of Cross Chain Technology: Diego Geroni, 'Blockchain Interoperability: Why Is Cross Chain Technology Important?' (101Blockchains, 13 August 2021) <https://101blockchains.com/blockchain-interoperability/> accessed 18 July 2021; UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 12; Yucen He and others, 'A Novel Cross-Chain Mechanism for Blockchains' in Meikang Qiu (ed), *Smart Blockchain: First International Conference, SmartBlock 2018 Tokyo, Japan, December 10–12, 2018, Proceedings* (Springer 2018) 139; critically: Tasca and Piselli (n 82) 38 ff.
[107] For example, by Buterin, 'A Guide to 99% Fault Tolerant Consensus' (Vitalik Buterin's Website, 7 August 2018) <https://vitalik.ca/general/2018/08/07/99_fault_tolerant.html> accessed 24 July 2021.
[108] Gupta (n 91) 221 ff.
[109] ibid 224 ff.
[110] Moerel (n 38) 228 ff.
[111] Cf Gatteschi, Lamberti and Demartino (n 39) 106; Okazaki (n 53) 17.
[112] Girasa (n 86) 32; Gupta (n 91) 225.
[113] Gatteschi, Lamberti and Demartino (n 39) 106; UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 17, 21 ff.
[114] Ganne (n 18) 93.
[115] ibid, 82 ff.
[116] See for example United Nations Economic and Social Commission for Asia and the Pacific (n 5) 35.

2.4 Vital

Finally, blockchain should be a vital solution for CoO. For the technology to be vital it needs to hold unique properties beneficial for the needs of the project. This is the case if the project could not successfully run without the technology. Here, considerations need to be made as to whether there are easier solutions at a lower cost which could achieve the same result as implementing blockchain would.[117] Whether or not blockchain is a vital solution is the most relevant and critical part of the assessment as most projects with a solid concept can be considered viable and valuable.[118]

2.4.1 Unique properties of blockchain in relation to Certificates of Origin

Not all benefits of the blockchain technology are unique features. Some of them, like cost and paper reduction as well as timestamping, encryption, hashing or digital signatures, can also be found in other technologies.[119] Whether or not CoO are indeed a case for blockchain depends on its unique features and if they are advantageous to other technologies in a sense that the usage of other technologies would be neither technologically nor cost-wise be more beneficial than blockchain.

Unique features of blockchain are that the technology is nearly unhackable, the data trail is easily traceable and that it provides greater transparency and auditability[120] compared to other technologies. It enables the user to create an information pipeline with the possibility of digitised and automated filing of paperwork, the possibility of real-time tracking the progress and ensures that the data on the chain cannot be modified without the consensus and hereby knowledge of the network.[121] blockchain creates a complete visibility of all necessary data; competent authorities would be able to see the relevant data with accurate information, for example on the seller, buyer, price, quantity of the goods, carrier, the financing, the insurance, relevant licensed etc., that are directly linked to the goods[122] which would simplify the formalities of the certification process and reduce uncertainties as to the origin of the goods.[123] With the accuracy of data and the complete visibility of the goods' line of production[124] and transportation, the need for (manual) verification of the origin would be eradicated.[125]

[117] Lindman and others (n 16) 12; see also UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 16.
[118] Lindman and others (n 16) 13.
[119] Ganne (n 18) 116.
[120] Yaren (n 28) 135.
[121] Okazaki (n 53) 14.
[122] ibid, 16.
[123] Pugliatti and Gain (n 20).
[124] Which leads to a holistic product life-cycle data management: Okazaki (n 53) 17.
[125] ibid.

Validations would be a matter of minutes instead of hours or days,[126] albeit it is expected that validation procedures would be rare if not non-existent with the introduction of blockchain. In the specific case of certificates blockchain ensures that the certificate is appropriately issued, properly (digitally) signed by a valid competent authority mandated for issuing the certificate and that the certificate cannot be altered or manipulated during the process.[127] This ensures that the applicant receives a valid certificate with ensured integrity of its content.

On the technical level, the uniqueness of blockchain stems from small but significant alterations of previous technologies in order to increase security, integrity and immutability.[128] This is achieved by, for example, including hash pointers in the added block that include the hash of the data inside the foregoing block, whereby a change of one block will cause a change in every previous block. Also, the manner of time stamping differs, from previously "trusted time-stamping" to distributed and tamper-proof time- tamping.[129]

Overall, blockchain can be an appropriate technology for solving the challenges of the Certificate of Origin issuing process. According to criteria for suitability of the technology, as established by the U.S. Department of Homeland Security, blockchain is appropriate when, for example, the project needs shared consistent data storage, more than one entity contributes to data, immutability, does not contain sensitive data, has issues related to changes in data storage control, and needs tamper-proof logging.[130] All these criteria are fulfilled in the case of CoO, as has been established earlier. The unique features of blockchain certainly carry a value which can be vital for the success of streamlining and simplifying the certification process.

2.4.2 Alternatives to blockchain

Finally, to determine whether or not blockchain would be a vital solution to the challenges of CoO, existing alternatives to the technology must be evaluated.[131] If the analysis shows that there are possibilities which are cheaper and easier to implement but would provide the same benefits, blockchain would not be vital. There is variety of projects that are piloting or even running since years to simplify certain processes which provide a valuable insight into alternatives to blockchain for a variety of services.

[126] As can be deduced from, for example, the rapid tracking of tainted products when Blockchain technology is used, a finding from a trial run by Walmart and IBM, see Ganne (n 18) 79.
[127] Okazaki (n 53) 17.
[128] Ganne (n 18) 117.
[129] ibid.
[130] Lindman and others (n 16) 29 ff.
[131] See also UN/CEFACT, *White Paper on the technical applications of Blockchain* (no 70) 3, with an overview over other technologies at 5 ff.

The findings from these projects are helpful in determining whether there are viable alternative technologies that could be used instead of blockchain. For this, in the following, a selection of alternatives is evaluated.

A first example would be the Estonian Information Systems Authority. It is an early example of a blockchain-backed public service which uses a permissioned blockchain to store data for integral government serviced like the succession and health registry.[132] Initial versions of the registry already run since 2012 under the name of hash-linked time-stamping. It deviates from the current form of blockchain projects as it does not store the data itself on the chain but rather hashes that provide the integrity of the underlying data.[133] This form of blockchain-backed service guarantees the integrity of data and logs changes of data; however, it does not store data. Essentially, this results in off-chain data with proof for their existence on-chain.[134] While this version of implementing blockchain might mitigate the challenges of data security and privacy,[135] it would also mitigate the benefit of faster processing, as the data provided still need to be cross-checked which results in possible blind-spots.[136] Hence, as long as a blockchain-backed version would only be needed as a complementary in a sense that it versions and archives it is not vital;[137] if used as the only means it would not provide the full benefits of the technology for CoO.

A comparable possibility was proposed by Okazaki, where customs' databases would not take the form of a distributed-ledger but rather be interfaced with blockchain-based platforms. He considers that this would increase customs' visibility in the supply chain and would enable them to cross-check discrepancies between the data submitted by traders and the data on the public ledger.[138] Yet, these options would not provide the automation process which would significantly reduce the resources needed to certify.[139] Also, there remains the option of using a centralised database instead of a blockchain.[140] However, traditional databases are not immutable and do not have a consensus mechanism to validate transactions.[141] Furthermore, a blockchain solution might even be quicker and/or cheaper to implement.[142] A centralised database also needs to be

[132] Lindman and others (n 16) 9.
[133] ibid, 11, 54.
[134] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 11.
[135] Saadaoui (n 13); UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 11, 31.
[136] This issue might be mitigated by applying smart contracts for consistency checks as used in the PoC project, Saadaoui (n 13).
[137] Lindman and others (n 16) 54; apparently considered to be the most likely scenario by UN/CEFACT: see its *White Paper on the technical applications of Blockchain* (n 70) 13.
[138] Lindman and others (n 16) 18.
[139] ibid.
[140] Wüst and Gervais (n 15) compare Blockchain to centralised databases and provide a thorough analysis on when Blockchain technology makes sense.
[141] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 10.
[142] ibid 17.

regularly backed up as it can be lost or destroyed.[143] Hence, also these options would not be equally beneficial.

Another technology which does not (yet) rely on blockchain technology is the current process of issuing of e-certificates. Several states explore the option and some have successfully implemented it in their certification procedure.[144] One successful example is the use of cross-border electronic CoO between the Republic of Korea and Taiwan Province of China.[145] It became known as a best practice for paperless cross-border trade and proved to be greatly cost- and time saving (a total of USD 205 and three days per shipment).[146] Yet, one major lesson learned from the process which has relevance for the present analysis is that the full benefit of the procedure could not be achieved without documentation covering the full international supply chain, which the procedure as is could not provide.[147] Such a complete visibility and traceability would be easily achievable when using blockchain.[148]

Apart from digitised procedures there remains the possibility of relying on established procedures in simplified forms.[149] The self-certification procedure, encouraged as the primary certification procedure by the World Customs Organisation,[150] would also reduce time and cost of the certification process. Equally, the Approved Exporter System could be beneficial in these matters.[151] The introduction of fully exporter[152] or fully importer[153] based systems could be beneficial to reduce the complexity of the certification process. However, these "classical" possibilities of simplification and the usage of blockchain are not mutually exclusive. For example, in the case of Authorised Economic Operators (AEO), blockchain is considered to even be beneficial as the AEO could easily provide a full record of compliance with Customs requirements and customs administrations could easily evaluate mutual recognition of the AEO status.[154] Without the usage of blockchain, the aforementioned simplified

[143] ibid 30.
[144] For examples of paperless-trade-projects see United Nations Economic and Social Commission for Asia and the Pacific (n 5) 11 ff.
[145] For a thorough analysis see ibid 89 ff.
[146] ibid 97 f.
[147] ibid 99.
[148] Cf Ganne (n 18) 80.
[149] For an overview over current certification procedures under Free Trade Agreements see WCO, 'Comparative Study on Certification of Origin' (n 1) 13 ff.
[150] WCO, 'Guidelines on Certification of Origin' (n 20) 8 f.
[151] Sandra Corcuera Santamaria, 'CADENA, a blockchain enabled solution for the implementation of Mutual Recognition Arrangements/Agreements' (WCO News 87, Focus, October 2018) <https://mag.wcoomd.org/magazine/wco-news-87/cadena-a-blockchain-enabled-solution-for-the-implementation-of-mutual-recognition-arrangements-agreements/> accessed 17 July 2021; WCO, 'Guidelines on Certification of Origin' (n 20) 9.
[152] WCO, 'Guidelines on Certification of Origin' (n 20) 9.
[153] ibid 9 ff.
[154] A conclusion validated by the current CADENA initiative, see Corcuera Santamaria (n 151); see also Yaren (n 28) 134.

procedures are unable to provide the benefits of, for example, immutability and time-stamping. Hence, they cannot be considered feasible alternatives.

2.4.3 Pilot Projects

Several pilots in the private and public domain have been initiated in recent years to test the feasibility of the blockchain technology in customs procedures, for example the US Customs and Border Protection's intention to apply blockchain technology to NAFTA and CAFTA CoO[155] or the blockchain model for the exchange of CoO between Korea and Vietnam.[156] In the following, a few initiatives for DLT backed e-CoO which are at least in the piloting stage shall be presented to evaluate the state of the art and validate the finding based on the foregoing considerations that blockchain is a viable, valuable and vital solution.

In 2018, the Singapore International Chamber of Commerce in collaboration with cross-border trade facilitator vCargo Cloud unveiled the first blockchain-based platform for electronic CoO.[157] The platform hosts information on trade transactions on a private blockchain[158] built with Ethereum infrastructure[159] which can be authenticated and accessed by different users of the platform.[160] It also utilizes QR codes which can be scanned by smart phones and printed in a limited number to avoid duplicates.[161] Hereby, the paper-based procedure is not entirely eliminated, which helps in trade with less digitalised nations; however, this solution does not unfold the full potential of blockchain, as paper-based an digital run parallel and there is still the need for visual sightings by chamber staff to identify counterfeits.[162] The platform is expected to provide higher security, efficiency and flexibility while improving efficiency and minimising cost. In a press release, the initiative is titled as "a quantum leap in

[155] See U.S. Customs and Border Protection, 'NAFTA/CAFTA Proof of Concept' (Whats' New Innovation, September 2018) <www.cbp.gov/trade/ace/whats-new-innovation> accessed 26 July 2021.
[156] Tae Il Kang, *Korea pilots blockchain technology as it prepares for the future*, (WCO news 88, Dossier, February 2019) <https://mag.wcoomd.org/magazine/wco-news-88/korea-pilots-blockchain-technology-as-it-prepares-for-the-future/> accessed 19 July 2021.
[157] Singapore International Chamber of Commerce and vCargo Cloud Pte. Ltd. (SICC/VCC), 'Singapore International Chamber of Commerce and vCargo Cloud Launch World's First Blockchain-Based eCertificate of Origin ("eCO")' (Press Release, 8 May 2018) <https://www.vcargocloud.com/wp-content/uploads/2018/05/Singapore-International-Chamber-of-Commerce-and-vCargo-Cloud-Launch-Worlds-First-Blockchain-Based-e-Certificate-of-Origin.pdf> accessed 27 July 2021.
[158] Company Announcement, 'Singapore: World's First Blockchain-Based e-Certificate of Origin' (Fintech News Singapore, 9 May 2018) <https://fintechnews.sg/19677/blockchain/blockchain-based-e-certificate-of-origin-singapore-chamber-of-commerce/> accessed 19 July 2021.
[159] Finbarr Bermingham, 'Singapore chamber brings trade documents onto blockchain' (General Trade Review News, 9 May 2018) <https://www.gtreview.com/news/asia/singapore-chamber-of-commerce-brings-trade-documents-onto-blockchain/> accessed 19 July 2021.
[160] SICC/VCC (n 157) 1.
[161] ibid 2.
[162] Bermingham, 'Singapore chamber brings trade documents onto blockchain' (n 159).

processing trade-related documents"[163] and a "a 21st century system."[164] vCargo Cloud currently works on implementing its concept in other states, reportedly Japan, Myanmar and Sri Lanka;[165] in 2018, it agreed with the Kenyan National Chamber of Commerce and Industry to introduce a slightly adapted version of the program implemented in Singapore in Kenya.[166]

eCOM Asia Ltd., a B2B data integration company, developed and operates its DLT based eCOM Registry™ which provides a network for the secured sharing and exchange of trusted data. While this solution is currently used for cross-border trade connectivity between Singapore and China, as a trading and finance platform for a large Chinese food importer and a MSME trade finance solution for the Hong, it aims at being implemented for *inter alia* CoO in the cross-border trade relationship between Singapore and China. This is enabled by the legal framework between these states which allows for a bi-directional exchange of customs import and export declarations.[167]

Another private initiative is edoxOnline. It links and interconnects the parties involved in an international trade transaction and aims at digitising international trade documents to streamline the issuing process and minimize errors. edoxOnline is a permissionless ledger based on Ethereum infrastructure. It already reaches a number of stakeholders, for example worldwide exporters and importers, chambers of commerce, transport companies, customs agents and official authorities. The trade documents which are handled by edoxOnline are for example e-CoO.[168]

TradeWindow and its solution "Cube" aim at facilitating end-to-end digital trade. It is a neutral platform built on API architecture which makes it interoperable with a variety of specific platforms and applications.[169] Currently, CoO appear not to be included in the solutions TradeWindow offers (even though "TradeWindow Origin" is mentioned on its homepage, yet without further information). However, the upcoming solution "Plus" seems to include the option of e-Certificates.[170]

Furthermore, there is the Latin-American project "CADENA". While this project does not specifically deal with CoO, it is still closely connected as it digitalizes the concept of the Authorised Economic Operator.[171] Based on Mutual Recognition Agreements,

[163] SICC/VCC (n 157) 1.
[164] ibid 2.
[165] Bermingham, 'Singapore chamber brings trade documents onto blockchain' (n 159).
[166] Finbarr Bermingham, 'Blockchain-based certificates of origin come to Kenya' (Global Trade Review News, 20 June 2018) <https://www.gtreview.com/news/africa/blockchain-based-certificates-of-origin-come-to-kenya/> accessed 19 July 2021.
[167] Deepesh Patel and Emanuelle Ganne, *Blockchain & DLT in Trade: Where do we stand?* (White Paper, Trade Finance Global and WRO, November 2020) 36 ff.
[168] ibid 38.
[169] ibid 39.
[170] See the homepage of TradeWindow's website <https://tradewindow.io/tradedocs.html> accessed 19 July 2021.
[171] Corcuera Santamaria (n 151).

Customs administrations participating in CADENA can access the status of an AEO certificate in real time while the data remains protected due to high security, traceability and confidentiality standards. Equally, applicants for an AEO certificate can inform themselves about the issuing status of their certificate which increases trust and transparency. To make the individual applicants identifiable for each member of the network each AEO is assigned a unique number which relates to the relevant AEO master data. The results of the validation phase were promising: they showed an increase in efficiency, effectiveness, transparency, integrity of data and security.[172]

Already from this selection of initiatives it becomes apparent that there is an interest in DLT certification processes. A variety of private and public actors, oftentimes collaborating with each other, offer interesting solutions for the simplification and streamlining of the issuing of CoO and new projects are being launched and developed at increasing velocity. The successful initiation and continuous development of these projects indicates that blockchain indeed can not only be a viable and valuable but ultimately also a vital solution to the challenges of CoO.

2.5 Conclusion

Blockchain technology holds many benefits which could help to significantly facilitate international trade. Cross-border transactions prove to be very burdensome due to complicated, complex, costly and paper-based, manual procedures, and the risk of blind-spots which pave the way for fraud and forgery is constantly present. These challenges become especially apparent in certification processes, which also affects the issuing of CoO. The challenges of the certification process are accompanied by a general lack of trust, not only between traders, but also between traders and authorities and even between the competent authorities of different states. Following the foregoing analysis, blockchain proves to be at least a viable and valuable solution to the challenges that CoO face. It can also be considered a vital solution, albeit this finding is up to discussion. In any case, blockchain can improve the level of trust through its authentication methods which create a high level of reliability.[173] The disadvantages of the technology can be mitigated with careful planning and appropriate regulation (as addressed *infra*). What appears to be desirable – should blockchain find its way into the certification process – would be the introduction of a private permissioned chain[174]

[172] Ibid.
[173] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 2.
[174] As is used in the case of Singapore's eCertificate, see Company Announcement (n 158); generally, see Gatteschi, Lamberti and Demartino (n 39) 106; permissioned chains are used, for example, by TradeLens, see Jeacocke and Kouwenhoven (n 29); see also Okazaki (n 53) 17; for a methodological approach on the question which Blockchain would be most suitable for a project see Wüst and Gervais (n 15).

which includes all relevant actors in the certification process. As the participants are known in private blockchains this would also allow legal accountability.[175] Yet, it has to be borne in mind that permissioned blockchains are more vulnerable to attacks.[176] Naturally, it is advisable to have the same chain in operation, or at least create chains which are interoperable.[177] Considerations could be made to include bridging tools, a suggestion put forward by UN/CEFACT.[178] Whether or not smart contracts should be included would depend on the desired result. Without smart contracts, the blockchain would essentially remain a database.[179] If full automatisation of the process shall be achieved, the inclusion is advisable, even though one should remain cautious about the decrease in security.[180] If smart contracts shall be implemented, it has to be borne in mind that they cannot be changed once they are deployed.[181]

Generally, CoO are a case for blockchain.[182] The consensus-based monitoring mechanism which involves every affected party ensures the credibility of transactions, the reliability, accuracy, quality and integrity of data, traceability an auditability of the entire process and a gapless record of the entire product life-cycle and its supply chain.[183] This is not only beneficial for the traders, who themselves can review the reliability of their producers and transporters, but also for customs and competent issuing authorities as they all remain fully informed and well-prepared for the certification process due to the increased visibility of key information.[184]

For its implementation one does not need to re-invent the wheel; following the increasing number of pilots, best practices and lessons learned can be carved out and implemented,[185] for example from the blockchain-based framework for issuance of CoO proposed by Tyagi and Goyal,[186] the hypothetical example provided by UN/CEFACT[187] or

[175] Mik (n 41) 164.
[176] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 7 and 21; Id, *White Paper on the technical applications of Blockchain* (n 70) 8.
[177] Cf Hofman (n 49) 326.
[178] UN/CEFACT, *White Paper on the technical applications of Blockchain* (n 70) 12.
[179] Mik (n 41) 171.
[180] For example, DAO attacks, see Gupta (n 91) 219 f.; Gatteschi, Lamberti and Demartino (n 39) 108; Mike Orcutt, 'How secure is blockchain really? It turns out "secure" is a funny word to pin down' 2018 MIT Technology Review (The Blockchain Issue, 25 April 2018) <https://www.technologyreview.com/2018/04/25/143246/how-secure-is-blockchain-really/> accessed 19 July 2021.
[181] Mik (n 41) 175.
[182] See also UN/CEFACT, *White Paper on the technical applications of Blockchain* (n 70) 8; cf Kerstens and Canham (n 12).
[183] Cf Kerstens and Canham (n 12); see also Okazaki (n 53) 21.
[184] A benefit identified in the supply-chain management blockchain TradeLens, see Jeacocke and Kouwenhoven (n 29).
[185] For an overview over projects related to DLT digitisation of trade documents see Patel and Ganne (n 167) 34 ff.
[186] Niti Tyagi and Mukta Goyal, *Blockchain-based smart contract for the issuance of origin certificate for Indian Customs Export Clearance*, 2021 Concurrence and Computation Issue <https://onlinelibrary.wiley.com/doi/full/10.1002/cpe.6249> 8 ff, accessed 26 July 2021.
[187] UN/CEFACT, *White Paper on the technical applications of Blockchain* (n 70) 15 ff.

the (basic) idea for a digital ATA Carnet.[188] Yet, it is advisable to not use information older than 12 months as changes are made rapidly which might result in a deterioration of functionality.[189] Also, it should be borne in mind that the use of blockchain will most likely not be possible in isolation, which is why a correct "embedding" into running systems needs to be ensured.[190] In any case, international organisations with the relevant expertise, in the case of CoO for example the World Customs Organisation and the (International) Chamber(s) of Commerce, as well as experienced programmers must be involved in the development process. However, at best before going into the practical application, it is advisable to establish appropriate regulations – a matter which will be discussed in the following.

3 The matter of regulation: what should be and what can be regulated?

Whether or not blockchain technology would be a feasible option to solve the current challenges of CoO, there remains the question of regulation. In any case, there is the need for clearly established rules to guarantee a smooth procedure for cross-border transactions. Otherwise, the benefits of the technology could prospectively not materialize.[191] As is the case with any cross-border action, regulations involving more than one state will necessarily be a matter of inter-state cooperation. In the matter of blockchain it appears beneficial to not only introduce bi- or plurilateral regulations – as it is mostly the case when it comes to CoO – but rather strive for a global or at least regional framework to harmonize regulations and standards in order to benefit from the technology to the largest extend possible.[192]

3.1 Current state of regulation

Regulation on whether (preferential) CoO are required is mainly subject to bi- or plurilateral agreements between states.[193] Preferential rules of origin are considered part of a country's commercial policy.[194] They are inextricably linked to the provisions on rules of origin enshrined in several Free Trade Agreements which, if fulfilled, enable

[188] Saadaoui (n 13).
[189] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 18.
[190] ibid 24.
[191] Cf Patel and Ganne (n 167) 21.
[192] See also United Nations Economic and Social Commission for Asia and the Pacific (n 5) 66; cf UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 21.
[193] Cf WCO, 'Guidelines on Certification of Origin' (n 20) 6.
[194] WCO, 'WCO Origin Compendium' (n 22) 21.

traders of the relevant goods to enjoy preferential treatment in their cross-border transactions, mainly in the form of reduction or elimination of tariffs.

The procedure of issuing a Certificate of Origin is regulated by national laws. They regulate which formalities must be fulfilled and which authority is competent to issue the Certificate of Origin.[195]

The current regulations mostly provide for a clear distribution of liabilities. The importer is accountable for the imported goods and obligated to provide the supporting documents; in importer-based systems, the importer is also accountable for the originating status of the goods.[196] The exporter is obligated to provide appropriate supporting documents on the originating status of the goods and is liable for the accuracy of the provided information. Should there be changes in the facts, it is the responsibility of the exporter to notify the other parties. The liability of the exporter ends with conclusion of the certification process. In cases of self-certification procedures, the exporter is also responsible for the content of the certificate.[197] The competent issuing authority is responsible for the publication and dissemination of the relevant information and is the contact point for verification procedures.[198]

Digital CoO (or their implementation) are almost exclusively regulated in bi- and plurilateral frameworks, often in the form of inter-state treaties. If such a framework is in place there is usually the need to adapt national laws in order to comply with the relevant agreement.[199]

Examples of regulations applicable to e-Certificates can be found in the Australia-Chile FTA, which regulates that customs administrations "will work towards implementing an electronic system for its customs reporting requirement" (Art. 5.11, Chapter 5) and that each party will endeavor to accept an electronic version of trade administration documents used by the other Party as the legal equivalent of paper documents (Article 16.9, Chapter 16). Comparable provisions can be found in the Australia-Thailand FTA (Article 309, Chapter 3 and Article 1107, Chapter 11) and the Australia-US FTA (Article 16.7, Chapter 16). The China-Peru FTA requires in Art. 61, Chapter 4 that customs administrations endeavor to use information technology that expedites procedures for the release of goods, including the submission and processing of information and data, as well as electronic or automated systems for risk management and targeting. The Japan-Singapore New Age Economic Partnership Agreement requires that the parties recognize the advantages of electronic filing and electronic versions of documents for the efficiency of trade through reductions in cost

[195] For an overview on types of preferential origin certification systems see WCO, 'Comparative Study on Certification of Origin' (n 1), 13 ff.
[196] WCO, 'Guidelines on Certification of Origin' (n 20) 12 ff.
[197] ibid 12 ff.
[198] ibid 14.
[199] Cf United Nations Economic and Social Commission for Asia and the Pacific (n 5) 47, 61.

and time (Art. 40, Chapter 5). The Republic of Korea-Singapore FTA requires the parties to endeavor the acceptance of electronically submitted trade administration documents as the legal equivalent of the paper version (Art. 14, Chapter 14). The New Zealand-Singapore Closer Economic Partnership Agreement requires the parties to put in place an electronic environment that supports electronic business applications between their respective customs administrations and trading communities (Art. 12, Chapter 4). The New Zealand-Thailand Closer Economic Partnership Agreement requires the customs administrations to adopt, as soon as practicable, electronic procedures for all reporting requirements (Art. 10.6, Chapter 10).[200]

Even though there are quite a number of Free Trade Agreements which aim to regulate e-Certificates in international trade, a majority does not contain binding provisions on that matter. Oftentimes, the wording obliges the respective parties to "work towards" or act "in the best endeavor."[201] Yet, it shows a general openness towards the digitisation of CoO.

3.2 Matters which should be regulated

Even though some regulations touch upon the technicalities of the blockchain technology, especially data protection regulations, blockchain itself is still a largely unregulated field.[202] Yet, to effectively implement blockchain in a legally secure environment regulation which appropriately addresses relevant matters is essential.[203] Matters which need regulation before implementation are questions on how to ensure authenticity of the data which shall be shared on the blockchain, the protection of the shared data, the accuracy of the algorithm used, the cross-border exchange of data, the question of liabilities, dispute resolution and the mutual recognition of the Certificates which shall be issued.

Regulation on authenticity of data relates to the quality of the data provided. To achieve the highest quality of data possible, regulations are necessary to ensure that the data provided is accurate and complete[204] and how the data is securely entered and shared.[205] Any deterioration from relevant standards could result in loss of revenue due to a wrong declaration of the origin of the relevant goods.[206] What needs to be regulated

[200] For details see United Nations Economic and Social Commission for Asia and the Pacific (n 5) 39 ff.
[201] ibid 66.
[202] Finck (n 93) 46.
[203] Governments must strike an appropriate balance between enabling and restrictive in order not to create an uncontrollable environment (cf. Tasca and Piselli (n 82) 31; Finck (n 93) 62 ff) but still leave the technology enough room to develop (Moerel (n 38) 224 ff).
[204] As this cannot be done by the Blockchain itself, Mik (n 41) 172.
[205] Cf Ganne (n 18) 81.
[206] Cf UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 48.

is the control of the data input, the responsibility for data entries and the data processing in general,[207] including standardisation in order to align the semantics.[208] Especially relevant is regulation on submission errors and errors in the cross-border processing of data, equally to prevent errors but also concerning correction should an error occur.[209]

Standards and certifications for the algorithms used by the service providers as well as mutual recognition of certified algorithms need to be agreed upon. This ensures that the algorithms in use work accurately with the uploaded data and are in compliance with the relevant (international and national) rules. Here, there must be regulation to whether and if so how and by whom a code underlying the blockchain may be amended[210] in order to improve or erase malfunctions.

Regulations on data protection need to be harmonised. Even though there is a plethora of data protection laws worldwide, most of them differ greatly in their protective scope. As data protection and information security are inextricably linked to the usage of blockchain, harmonised regulation would significantly facilitate the cross-border exchange of data. Here, regulations which sanction unauthorised access to the data on the chain and which establish security features to protect the integrity of the involved facilities and parties need to be enacted. Furthermore, regulation is necessary concerning data storage and deletion – in the latter case arguably difficult when using blockchain. Also, a harmonised approach to the definition of "original documents" and their necessity is of relevance.[211]

Regulation on ownership of the data as well as liabilities for inaccurate data, loss of data, falsified information, errors in the programming, inaccuracies in the algorithm, unauthorised access and the general maintenance of the blockchain need to be clarified.[212] As the concept of blockchain is based on the very idea of not having a centralised oversight authority, liabilities need to be established and clearly communicated to every stakeholder. Even though it would be near impossible in a public chain,[213] private chains hold the possibility to establish liability.[214] Clear rules on liability would ensure legal security in the certification process and generally in the interactions between the parties involved in the cross-border transaction. Responsibility for the inaccuracy of data should remain with the data provider, as they

[207] Ganne (n 18) 97.
[208] ibid 96 ff.
[209] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 30; United Nations Economic and Social Commission for Asia and the Pacific (n 5) 62.
[210] Mik (n 41) 170.
[211] United Nations Economic and Social Commission for Asia and the Pacific (n 5) 62 ff.
[212] Cf Ganne (n 18) 100.
[213] Mik (n 41) 167.
[214] Finck (n 93) 46; Mik (n 41) 164, 167.

are the ones in control of the data,[215] while the maintenance of the chain, including programming failures and breakdowns of the computer system, should remain with the relevant authority as the prospective controller.[216]

Apart from the matters evolving around data per se, there needs to be regulations on the mutual recognition of certificates issued based on the data on the chain. It needs to be clarified which certification authority in the relevant country is authorised to issue a valid Certificate of Origin. Once this is determined, regulation which ensures that certificates issued by the competent authority is recognised as valid and hence accepted as evidence of origin in the receiving country.[217] The preferable option would be the inclusion of a mutual recognition agreement in the relevant regulation.[218]

Lastly, regulation on dispute resolution and enforcement must be established.[219] As cross-border transactions (and especially transactions carried out by blockchain) touch upon several jurisdictions it should be clarified which forum will be appropriate and how jurisdiction will be established.[220] Alternatively, alternative forms of dispute resolution could be introduced.[221] Apart from the appropriate forum, regulations must be enacted that contain appropriate remedies in cases of incorrect execution of the certification process, especially in cases where a Certificate of Origin is falsely issued or denied in a fully automated process (for example through the execution of a smart contract),[222] such as the possibility of reverse transactions.[223]

3.3 Current regulatory projects

With the rise of blockchain and the attention following it attempts to regulate and standardize the new technology are underway. This is equally true for the (inter)state level as well as international organisations or even private initiatives who are working on model laws, international agreements or standards in order to create legal security for the usage of the new technology or for paperless cross-border trade in general.[224]

[215] United Nations Economic and Social Commission for Asia and the Pacific (n 5) 63; cf Mik (n 41) 172.
[216] Cf Moerel (n 38) 217 ff, 226; Finck (n 93) 46.
[217] United Nations Economic and Social Commission for Asia and the Pacific (n 5) 62
[218] Cf. UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 40.
[219] Although regulation might only be needed for public Blockchains due to self-regulation by the stakeholders as is argued by *Moerel,* see Moerel (n 38) 221 ff; self-regulation is also evaluated by Finck (n 93) 167 ff.
[220] Cf Girasa (n 86) 59 ff; cf. Finck (n 93) 58 ff; cf Ganne (n 18) 100.
[221] United Nations Economic and Social Commission for Asia and the Pacific (n 5) 63.
[222] Cf UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 35 ff (referring to breaches of contract).
[223] Wunderlich and Saive (n 94) 98.
[224] For an overview (with focus on standardisation) see for example Patel and Ganne (n 167) 15 ff; for the regulatory strategies applied see Finck (n 93) 153 ff.

While some (model) laws and agreements already in existence prove to be applicable to blockchain,[225] some characteristics of blockchain require new regulation.

There is a variety of provisions which can be used to regulate blockchain in cross-border transactions. They are found in the UNCITRAL Model Law on Electronic Commerce, the UNCITRAL Model Law on Electronic Signatures, the United Nations Convention on the Use of Electronic Communications in International Contracts, and the Model Law on Electronic Transferable Records (2017). These regulations already served as bases for the regulation of paperless trade and e-certification and can equally be introduced in blockchain regulations.[226] With the implementation of their regulations into national laws, the way for cross-border paperless trade would be paved[227] and specific regulation on individual technologies could be developed.

Globally, there are surveys, studies and pilots which engage with the question of paperless cross-border trade, including regulating blockchain. The World Customs Organisation established Globally Networked Customs, including a Working Group tasked with "a comprehensive analysis of the potential to rationalize, harmonize and standardize the secure and efficient exchange of information between WCO Members."[228] Bearing in mind the current challenges of the system, the WCO aimed to establish a network which follows the lowest common denominator in order to achieve maximum acceptance with its members. Hence, the Network only contains a minimum level of automation, proposes a Unique Consignment Reference to easily track individual exchanges, expects its members to amend their national laws insofar as they enable cross-border data exchange and data protection and introduces a two-way track for data exchange, one on the commercial (systematic exchanges of Information) and one on the enforcement (exchange at the request of customs Administrations) level. The Network is split in Utility Blocks which refer to a specific part of the customs process in which Members then can exchange relevant information.[229] The Permanent Technical Committee, one of the working bodies for the GNC program, has considerations about blockchain on its agenda.[230]

[225] Cf Finck (n 93) 155 ff.
[226] Irene Ng, 'UNCITRAL E-Commerce Law 2.0: Blockchain and Smart Contracts' (2018) LawTech.Asia (Guest post, 22 April 2018) <https://devsol.etradeforall.org/uncitral-e-commerce-law-2-0-blockchain-and-smart-contracts/> at 2. and 3. accessed 18 July 2021; Ganne (n 18) 98.
[227] United Nations Economic and Social Commission for Asia and the Pacific (n 5) 54.
[228] WCO, 'Globally Networked Customs' <www.wcoomd.org/en/topics/facilitation/activities-and-programmes/gnc.aspx> accessed 27 July 2021.
[229] United Nations Economic and Social Commission for Asia and the Pacific (n 5) 46 ff; a comparable distinction is used by TradeLens in the form of channels, see Jeacocke and Kouwenhoven (n 29).
[230] WCO, *Coordinated Border Management -Globally Networked Customs – latest technologies brining momentum to the GNC*, (Permanent Technical Committee, Doc. PC0556Ea, 30 September 2019) <www.wcoomd.org/-/media/wco/public/global/pdf/topics/facilitation/ressources/permanent-technical-committee/225-226/pc0556ea.pdf?la=ru-RU> accessed 18 July 2021.

The United Nations Centre for Trade Facilitation and Electronic Business initiated the blockchain White Paper Project, which oversaw the publication of two white papers on the use of blockchain for trade facilitation. The first White Paper was published in January 2019,[231] a revised version of the second White Paper was published in September 2020.[232] Even though the first White Paper of 2019 dealt with blockchains' impact on the technical standards work of UN/CEFACT and specifically the implementation of blockchain in supply chains, the findings can be transferred to regulatory considerations for blockchain in international trade in general. The experts identified general provisions which they considered necessary for a successful regulatory framework. These are provisions on recognition of records in blockchains in courts of law, cross-border (cross-jurisdiction) boundary, dispute resolution, data capture, storage, ownership, sharing and security provisions, minimum standards for certification or compliance and registration of blockchains necessary.[233] The second White Paper (including its update) investigates use cases of blockchain in various sectors of international trade in order to evaluate how the technology may be used to facilitate trade and related business processes.[234] It specifically deals with legal aspects in the execution of smart contracts and proposes that developers and implementors of smart contracts consider actions that relate to the identification of variables that might change and methods for changing the variables without undermining the predictability and reliability of the underlying smart contract; identification of inputs where the possibility of errors exist and a plan for identifying, identification of where, at some point in time, a selected oracle might cease to exist or fail due to government re-organisation, bankruptcy, etc., and backup plans for their replacement if needed; identification of any instances where a smart contract might not finish execution and how such situations should be resolved; identification of the legal circumstances under which it would be necessary to identify the parties to a transaction and if, for example, this requires that the smart contract be implemented on a permissioned blockchain; designation, in advance and in a document separate from the code in the smart contract, of the applicable law, jurisdiction under which disputes should be settled; the method of dispute resolution to be used and general terms and conditions.[235]

[231] UN/CEFACT, *White Paper on the technical applications of Blockchain* (n 70).
[232] Cf UN/CEFACT, *Blockchain in Trade Facilitation* (n 14); Id, 'White Paper on Blockchain in Trade Facilitation (ECE/TRADE/457)' (Release Announcement, September 2020) <https://unece.org/trade/publications/white-paper-blockchain-trade-facilitation-ecetrade457> accessed 27 July 2021.
[233] As rightly pointed out by UN/CEFACT, *White Paper on the technical applications of Blockchain* (n 70), 13.
[234] UN/CEFACT, 'White Paper on Blockchain in Trade Facilitation (ECE/TRADE/457)' (Release Announcement) (n 233).
[235] UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 40 ff.

3.4 Regulatory Considerations

Even though a global approach would be desirable, for now a regional approach to regulation appears the most feasible option.[236] While there are already a number of national and bilateral regulations in place, the necessity of a multilateral framework in order to reap the entirety of benefits of the technology becomes apparent when considering, for example, the paperless cross-border trade project between Korea and Taiwan, where one of the lessons learned was that an international arrangement - such as a regional agreement - could have sped up the negotiation process, which, without such a framework, took almost five years until a Memorandum of Understanding was concluded.[237] As not all states are yet at a technological stage which would allow for a global introduction of the technology[238] into customs procedures and consensus in this area marked by a general lack of trust cannot be reached easily,[239] a global approach as of today does not appear feasible.[240] Yet, in the long-term, a global regulatory framework[241] under the supervision of the World Customs Organisation, advised be the International Chamber of Commerce – as one of the major competent authorities for the issuance of CoO – should be endeavored. Especially the ICC WCF International Certificate of Origin Council should be involved in the drafting process of a global framework.

Of course, a regional agreement by itself does not suffice to create an enabling environment for blockchain e-certification. Hence, individual states should pave the way for the implementation by introducing appropriate laws into their national framework,[242] for example by accepting e-CoO issued through blockchain technology as the functional equivalent of the current paper-based documentation.[243] Valuable regulations to enable blockchain technology can be found in the UNCITRAL Model Law on Electronic Commerce, the UNCITRAL Model Law on Electronic Signatures, the United Nations Convention on the Use of Electronic Communications in International Contracts, and the Model Law on Electronic Transferable Records (2017), for example in Art. 8 of the UNCITRAL Model Law on Electronic Commerce, which enables the acceptance of electronic documentation as original when the integrity of the

[236] Also in favor of a regional approach: United Nations Economic and Social Commission for Asia and the Pacific (n 5) 68 ff, 75 ff; cf Finck (n 93) 59 ff.
[237] United Nations Economic and Social Commission for Asia and the Pacific (n 5) 99.
[238] Ganne (n 18) 86 ff.
[239] Cf Kerstens and Canham (n 12).
[240] Cf UN/CEFACT, *White Paper on the technical applications of Blockchain* (n 70) 10.
[241] Ganne (n 18) 100.
[242] Cf Ng (n 226) 8; Ganne (n 18) 99.
[243] The principle of functional equivalence was for example introduced by Germany to allow electronic Bills of Lading, see Wunderlich and Saive (n 94) 95 ff.

information is assured or in Art. 12 of the UNCITRAL Model Law on Electronic Signatures, which regulates the legal effect of electronic certificates.

When drafting a regional arrangement, considerations must be made as to the specificities of the blockchain technology.[244] It is especially advisable to first fully understand the technology in order to not produce premature and hence ill-suited regulations.[245] Finck considers three questions as fundamental: "First, what is the regulatory objective? Second, what is the appropriate regulatory access point to realize that objective? Third, what regulatory technique is best suited to make the regulatory access point fulfill the objective in the most efficient manner?".[246] Macedo proposes six principles for regulation, initially proposed for the regulation of cryptocurrencies, which should be followed in order to create a proper regulatory framework for the usage of blockchain. The six principles are

(1) understanding who and what can be the subject of regulation;
(2) clearly articulating the goals of a cryptocurrency regulatory policy;
(3) only regulating persons with 'control' over consumers' cryptocurrency;
(4) cooperating with businesses to preserve visibility;
(5) treating all cryptocurrencies equally;
(6) ensuring that regulatory requirements are reasonable.[247]

Naturally, "cryptocurrencies" need to be replaced by the relevant program, or most general with "blockchain". However, these principles provide a reasonable guideline which could be followed. Provisions on recognition of records in blockchains in courts of law, cross-border (cross-jurisdiction) boundary, dispute resolution, data capture, storage, ownership, sharing and security provisions, minimum standards for certification or compliance and registration of blockchains must be included.[248] Further guidance can be found in the (draft) proposal of a regional arrangement for cross-border paperless trade authored by UN/ESCAP. Even though it does not specifically deal with blockchain it contains valuable ideas on the realisation of an enabling framework.[249]

4 Conclusion

DLTs and especially blockchain undoubtedly are on the rise, and they have the potential to fundamentally change global trade. The unique features of the technology

[244] For a thorough evaluation of the difficulties of regulating Blockchain see Finck (n 93) 58 ff.
[245] ibid 161 ff.
[246] ibid 165.
[247] Macedo (n 23) 92.
[248] As rightly pointed out by UN/CEFACT, *White Paper on the technical applications of Blockchain* (n 70) 13.
[249] United Nations Economic and Social Commission for Asia and the Pacific (n 5) 75 ff.

make it attractive for any relationship marked by a lack of trust and the need to exchange data with unknown counterparts. To validate transactions peer-to-peer makes the technology extremely inclusive and paves the way for greater transparency and reliability of paperless data exchange. CoO could benefit greatly from this new technology. It presents a prime example of a concept which needs the utmost level of reliability and accuracy of data in an environment where the involved parties are in large parts entirely unknown to each other. To bridge the lack of trust, CoO still rely heavily on paper-based and manual procedures. The documentation needed to issue a Certificate of Origin is provided by several actors which makes the issuing process vulnerable to inconsistencies and fraud. Fraudulent documentation is a problem which directly affects every party involved, be it the reputation of the trader or the revenue loss for the state. The need for accuracy and appropriate procedures to mitigate the risk of false certificates is obvious; the cost and time-consuming process, however, is not necessary. This was also recognised by various states which began to simplify and streamline the process, be it with the introduction of self-certification procedures or by digitalising the process (almost) entirely. Projects like the cross-border electronic CoO between the Republic of Korea and Taiwan Province of China or the collaboration between the Singapore International Chamber of Commerce and trade-facilitator vCloud show that digitalising cross-border trade holds many benefits. An increasing number of States follow their example with different technologies. Distributed-ledgers are now at the center of attention, quite understandably, given the benefits it has to offer. Yet, its implementation should be carefully considered, and benefits and disadvantages weighed against each other. Due to the hype surrounding the technology quite a few projects are initiated not aimed at solving a specific problem; rather, the initiators want to implement the technology and search for a project to apply it.[250] It should not be disregarded that blockchain comes with challenges and disadvantages that need to be addressed. First and foremost, blockchain needs regulation, definitely on the level of national regulations, desirably also on a regional or global level.

In conclusion, the initial question of this paper can be answered as follows. The introduction of DLT into CoO holds the potential to improve not only the quality of the certificates, but also to streamline and significantly simplify the issuing process, which would be very beneficial not only for the traders, and here especially small- and medium-sised enterprises, but also to the competent authorities. Yet, the implementation must be preceded by a careful and thorough consideration of the benefits and challenges for each individual project. Due to the great differences in the technological development of states there cannot be a one-size-fits-all solution for blockchain-based e-Certificates. In some cases, the disadvantages (for example costs)

[250] Cf UN/CEFACT, *Blockchain in Trade Facilitation* (n 14) 127.

may outweigh the advantages; in such cases, implementing blockchain would not be beneficial. Generally, blockchain provides a viable, valuable and vital solution for the challenges CoO are facing. To reap the benefits of this technology, appropriate regulations need to be enacted to create an enabling framework, preferably on the inter-state level. At least provisions on mutual recognition of digital documents, cross-border (cross-jurisdiction) boundary, dispute resolution, data capture, storage, ownership, sharing and security provisions, minimum standards for certification or compliance, registration of blockchains are necessary, liabilities and the accuracy of the data and the algorithm are necessary. Considering that e-certificates issued based on blockchain will always be a matter of cross-border relations, states should endeavor to create at least regional frameworks which regulate the fundamentals of blockchain based trade.

While the enthusiasm surrounding blockchain is certainly understandable, it might not be perfect for every aspect of international trade. This paper advocates for a positive but careful approach to its implementation. Only where the technology is applied with the appropriate rationale and to cases in which it provides clear benefits it most certainly will prove to be revolutionary and very advantageous.