



Blockchain Technology for Sustainability in Supply Chains: A

Legal Assessment

Full Paper

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Abstract: *This paper seeks to answer whether the use of blockchain technology enhances sustainability in supply chains during e-procurement. This paper takes the issue from a legal perspective and discusses whether the benefits of public e-procurement may constitute possible means to enhance sustainability with the use of blockchain technology. It investigates blockchain technology and its features to improve data protection and transparency in the area of public procurement. It further addresses whether States have the obligation to ensure sustainability in their public e-procurement processes, whilst maintaining data protection and confidentiality. The paper is based on a survey of primary sources of law, best practice and available literature, adopting the legal analytical method. The paper is limited to suggesting the use of blockchain technology to disclose history and processes of suppliers to ensure their alignment with sustainability. It does not attempt to include identified States, rather it adopts a holistic approach to the issue.*

Keywords: blockchain technology, supply chain, sustainability, EU e- procurement, confidentiality, transparency.

1. Introduction

Public procurement refers to the process by which public authorities, such as government departments or local authorities, purchase work, goods or services from companies. It has evolved from a simple concept of purchasing simple goods, works or services to advanced

governmental activities. Public procurement is a complex process in which authorities' purchases are conducted to serve the best interest of the public and to improve life and economy. In fact, it is considered as a public process, if functioning properly, that improves citizens' life standards.¹ Today, public procurement is the collective name for the complex processes, in which contracting authorities of a State purchase goods, labor and services, and it constitutes a large share of the European Union's (EU) Member States economy, contextualized in billions of Euros annually. To put it in context, public procurement is estimated to account for approximately 14% of the total European Union GDP (around €2 trillion per year) on the purchase of services, works and supplies.² Thus, it is strictly regulated within the EU legal framework. It is subject to the fundamental principles of non-discrimination, equality of treatment, transparency, mutual recognition and proportionality.³ These principles that are fundamental in the EU and protected by its founding treaties.⁴ In addition to these principles, the EU also requires that the EU internal market, within the field of public procurement, serves the work for sustainable economic development in line with Article 3 (3) of the Treaty on European Union (TEU).⁵ The Article provides:

The Union shall establish an internal market. It shall work for the sustainable development of Europe based on balanced economic growth and price stability, a highly competitive social market economy, aiming at full employment and social progress,

¹ Khan, Naushad (red.), *Public procurement fundamentals: lessons from and for the field (includes a simple step-by-step generic procurement manual)*, Emerald Publishing Limited, Bingley, U.K., 2018 p. 2

² EU, 'Why public procurement is important' < https://single-market-economy.ec.europa.eu/single-market/public-procurement_en > accessed 12 April 2024

³ Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC Text with EEA relevance OJ L 94

⁴ Consolidated Version of the Treaty on European Union [2012] OJ C 326/01, see Articles 2 and 3.

⁵ *ibid* Article 1

and a high level of protection and improvement of the quality of the environment. It shall promote scientific and technological advance.⁶

In recent years, by way of example, the volume of public procurement has drastically increased in line with the rapid economic development. The rapid increase in volume has increased access to information and awareness of citizens about their rights. Information on EU public procurement is mostly available for public through Tenders Electronic Daily (TED), an online portal which publishes around 520 000 public procurement notices per year, worth more than €420 billion.⁷ This has put an immense pressure on EU institutions to conduct their activities according to the established legal rules and norms. This pressure also calls for modernization of public procurement to improve the economy, efficiency, transparency and fairness.⁸ Most importantly, public procurement is coupled with supply chains, promising that all EU institutions – more inclusively, this also includes State Members – must conduct their economic activities in the light of resilience and sustainability goals. Only lately, public procurement started to be digitalized and automated with the use of new technologies,⁹ (known today as e-procurement) and it has already proven to offer an enhanced level of efficacy and transparency. In this regard, the use of blockchain technology has been on the rise with the promising, yet challenging, features that this technology offers.

Against this background, the main premise of this paper is answer whether the use of blockchain technology enhances sustainability in supply chains during e-procurement within the EU institutions, for example, the EU Parliament, the EU Commission ...etc. This premise

⁶ Ibid Article 3 (3)

⁷ See: European Commission, Tenders Electronic Daily. Online https://single-market-economy.ec.europa.eu/single-market/public-procurement/digital-procurement/tenders-electronic-daily_en [accessed 11 April 2024]

⁸ Khan, Naushad (red.), *Public procurement fundamentals: lessons from and for the field (includes a simple step-by-step generic procurement manual)*, Emerald Publishing Limited, Bingley, U.K., 2018 p. 85

⁹ *ibid* p. 86

will not include e-procurements of the EU Member States or their national conduct. This paper attempts to take the issue from a legal perspective and discusses whether the benefits of public e-procurement may constitute possible means to enhance sustainability with the use of blockchain technology. The paper investigates blockchain technology and its features to improve confidentiality and transparency in public procurement. It finally argues that blockchain-based e-procurement has great to enhance sustainability in supply chain across EU institutions.

2. Method and modes of research

This paper adopts the doctrinal research method, the dominant mode of research and writing on EU law, that is “based on adherence to legal positivism: writing about EU law means exposing which norms of EU law exist on a given subject, how they interact, and how they are put into practice by the legal system.”¹⁰ In pursuant to doctrinal research, analytical analysis is combined in order to aim at “exposition of law and legal concepts by looking at its source, the power behind it, the interconnections with norms at different hierarchies, and the force behind it which may reflect social recognition.”¹¹ In fact, legal analysis takes the discourse on the source of law or the authority in support of it as a point of departure.¹² Therefore, this paper is based on a survey of primary sources of law, best practice and available literature. This includes TEU and Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement (Directive on public procurement) as legally binding sources upon EU institutions and relevant case-law, as well as literature on the relationship between blockchain, sustainability and procurement.

¹⁰ De Witte, Bruno. “Legal Methods for the Study of EU Institutional Practice.” *European Constitutional Law Review* 18, no. 4 (2022): 637–656, 637

¹¹ Bhat, P. Ishwara, “Analytical Legal Research for Expounding the Legal Wor(l)d.” *Idea and Methods of Legal Research* (Delhi, 2020; online edn, Oxford Academic, 23 Jan. 2020), 169-197

¹² *ibid.*, p 169

The paper is limited to suggesting the use of blockchain technology to disclose history and processes of suppliers to ensure their alignment with sustainability requirements. It does not attempt to include identified Member States of the EU, rather it approaches the issue within the context of the EU institutions.

3. Confidentiality in public e-procurement

Confidentiality is an essential part of public procurement and may prove essential for sustainability in supply chains. It is tightly coupled with data protection and privacy. There are two main aspects that will be addressed within this area that are of utmost importance. First, the aspect of confidentiality in respect of sensitive information that may circulate during a procurement process will be addressed. Secondly, security controls when authorising the parties to a procurement process will be addressed. A brief introduction to each subject will be provided and then the benefits of blockchain in these areas will be discussed.

2.1. Confidentiality in public procurement

Data storage and non-disclosure of information are two of the main facets of confidentiality. These two facets are the focus in this sub-section. During a public procurement process there is confidential information that must not be disclosed. Article 21 of EU Directive on public procurement provides that there are certain parts of a procurement process that needs to be confidential for the procurement to fulfil its purpose.¹³ Though, the first sentence of Article 21 provides that “if otherwise is provided by this directive or in a national law, such information may not be subject to confidentiality”. Moreover, the duty to ensure the confidentiality of such information is stipulated in Article 22 (3) of the Directive.¹⁴ The Article stipulates that all

¹³ Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC Text with EEA relevance OJ L 94, Article 6

¹⁴ Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC Text with EEA relevance OJ L 94, Article 7

communications, exchanges, and storages of information shall be ensured the integrity of data and confidentiality of tenders by the contracting authorities. The duty to ensure this lies upon the contracting authorities.

When rethinking confidentiality in public procurement, it is important to emphasise two different scenarios.¹⁵ The first is to protect the sole integrity of public procurement process. The economic operators or tenderers subjecting themselves to the risk of disclosing sensitive information or commercial to their market rivals when entering a public procurement. Therefore, confidentiality is needed to protect such information to be received by competitors or market rivals. The second scenario in which confidentiality is important is related to the first one. If the contracting authority would fully disclose all the bids in a procurement process, many tenderers would stop participating in procurements due to the fear of being exposed to the market from a business perspective.¹⁶ The Court of Justice of the European Union (CJEU) has balanced transparency and confidentiality. In case *Varec* the CJEU held that:

In order to attain that objective, it is important that the contracting authorities do not release information relating to contract award procedures which could be used to distort competition, whether in an ongoing procurement procedure or in subsequent procedures.¹⁷

In other words, safeguarding confidentiality is an important necessity to maintain competition which sometimes seem to triumph the necessity of transparency in public procurement at certain stages of the procedure. Additionally, the contracting institution may well be required to disclose information on the award procedures, which may surpass the requirements set forth

¹⁵ Deividas Soloveicik, 'Rethinking the confidentiality in public procurement: does public mean naked public?' (2018) 1 reprint from Procurement Law Journal p. 13

¹⁶ Ibid

¹⁷ Case C-450/06 *Varec SA v. Belgian State* [2008] ECLI:EU:C: 2008:91, para 35

in the EU directive.¹⁸ These requirements can certainly serve as a tool to prevent corruption in public procurements.¹⁹ This approach also aims at creating a level of scrutiny for all contracts that authorities engage in. While it is crucial to ensure fair and transparent competition, it is important to prevent distortion of competition. By safeguarding sensitive details of the contract award procedures, the contracting authorities seek to uphold integrity and prevent any undue advantage that could compromise the fairness of the process.

2.2. Could blockchain improve confidentiality?

Stored data and confidential information are of great importance in public procurement. Today the protection of confidential information in public procurement cannot be seen as adequately safeguarded. The usage of today's centralized Information and Communication Technologies (ICTs) may be subjected to cyberattacks.²⁰ If cyberattacks would be targeted at the data storages of public procurement, it would impose an immense threat to public procurement and its integrity. The consequences of a breach in the system could result in manipulation, forgery, or disclosure of sensitive information in a procurement process.²¹ Since public procurement is an area where large amounts of money flows, this could be of interest for companies competing against each other to pull off. Therefore, adequately safeguarding confidential information and protecting data is of utmost interest within the area of public procurement to attain the objectives sought out in Article 3 (3) of the Treaty on European Union (TEU).²²

¹⁸ European Commission, "Notice on tools to fight collusion in public procurement and on guidance on how to apply the related exclusion ground (2021/C 91/01), Official Journal of the European Union (18 March 2021), 4.

¹⁹ OECD, "Preventing Corruption in Public Procurements", OECD 2016, <https://www.oecd.org/gov/ethics/Corruption-Public-Procurement-Brochure.pdf>.

²⁰ Tahereh Nodehi and others (eds), '*EBDF: The enterprise blockchain design framework and its application to an e-procurement ecosystem*' (2022) 171 Computers & Industrial Engineering p. 13

²¹ Marek Swierczynski, '*Critical Evaluation of New Council of Europe Guidelines concerning Digital Courts*' (2022) 48 Rev Eur & Comp L p. 133.

²² Consolidated Version of the Treaty on European Union [2012] OJ C 326/01, Article 3

Before discussing the benefits of blockchain technology, a brief introduction to blockchain technology and its types is provided. Blockchain is a “ledger of transactions, or blocks, that form to make a systematic, linear chain of all transactions ever made... the blocks themselves are highly encrypted and anonymized.”²³ The main relevant characteristics or features are i) decentralization, ii) cryptography and iii) immutability, iv) traceability and v) anonymity. These features offer potential benefits in providing for both confidentiality and transparency of the procurement processes and enhances the approach to fulfil sustainability requirements through tracking of supply chain. This will be examined later in this article.

There are several different available blockchain technologies used in procurements. Depending on the nature of the procurement, for which blockchain is more suitable could possibly vary. There are four main types of blockchains. The blockchains can either be public-permissionless, public-permissioned, private-permissionless or private-permissioned.²⁴ Each of these varies in their features, as does the chosen public procurement method. In accordance with Directive 2014/24/EU Articles 27 – 32, there are several ways of procuring.²⁵ A public procurement procedure can either be open, restricted, competitive, and so on. Though, the technologies that are most likely to be suitable to public procurement generally can be any of the permissioned blockchains.²⁶ The feature that differs between public-permissioned and private-permissioned is authorization (who is authorized is access and approve transactions). A public-permissioned blockchain is open to the public to run consensus but only to those who meet specific

²³ Hughes, Alex, Park, Andrew, Kietzmann, Jan, & Archer-Brown, Chris, *Beyond Bitcoin: What blockchain and distributed ledger technologies mean for firms*, (2019) Business Horizons 62(3), 273–281, 274.

²⁴ Nodehi, Tahereh et al (eds), ‘*EBDF: The enterprise blockchain design framework and its application to an e-procurement ecosystem*’ (2022) 171 Computers & Industrial Engineering p. 3

²⁵ Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC Text with EEA relevance OJ L 94, Articles 27-32

²⁶ Tahereh Nodehi and others (eds), ‘*EBDF: The enterprise blockchain design framework and its application to an e-procurement ecosystem*’ (2022) 171 Computers & Industrial Engineering p. 11

predefined criteria. Private-permissioned blockchain is closed blockchain designed only for defined participants that are pre-approved, most likely tenderers and contracting authorities.²⁷

If the EU were to introduce blockchain technology in the area of public procurement, security and transparency levels would most certainly increase. The intention behind the development of blockchain has been to provide higher levels of integrity, transparency, efficiency and data accuracy.²⁸ Blockchain is both a system to store information and a system to validate information. It could allow a contracting authority to send, receive and store information on a blockchain. The blockchain as a peer-to-peer network of several computers traces every step (transaction) in the process and is recorded on a “block” in the blockchain only after all peers in the distributed network has ratified the validity of that step.²⁹ Since the data is stored in the blocks in the blockchain itself, it becomes a decentralized system. Each action is immutable and traceable on the blockchain which ensures the integrity of the data stored.³⁰

To simplify it, today's ICTs are based on a single computer of either a third-party company or of the contracting authority, on the one hand. Blockchain, on the other hand, is maintained and updated by numerous computers, where the information is stored on the blockchain and not a single computer. It is important to note that blockchain is not totally immune from cyberattacks, but it creates a space for data storage at a very higher level of trust.³¹ Supposedly, since the blockchain is not stored on a single computer, they may not be targeted for a cyberattack in the same sense as today's ICTs stored on single computers. Blockchain is maintained by an algorithm and not by some central authority. It constantly replicates information each time a

²⁷ Ibid p. 4

²⁸ Raquel Carvalho ‘*Blockchain and Public Procurement*’ (2019) 6 (2) European Journal of Comparative Law and Governance p. 188

²⁹ Corrales, Marcelo, Fenwick, Mark & Haapio, Helena (red.), *Legal tech, smart contracts and blockchain*, Springer Nature Singapore Pte Ltd, Singapore, 2019 p. 3

³⁰ Raquel Carvalho ‘*Blockchain and Public Procurement*’ (2019) 6 (2) European Journal of Comparative Law and Governance p. 189-190

³¹ *ibid*

new block is added. Additionally, if one of the computers or peers would suddenly fail or be a target for a cyberattack, the data would still be preserved on the blockchain through the replication of data on each block. This system prevents, at some level, cyberattacks from successfully damaging a blockchain system.³² The features of immutability and traceability of blockchain makes hard to disclose, manipulate or forge information stored on it. Every action executed on the blockchain leaves a mark. More precisely, “a blockchain database retains the complete and indelible history of all transactions, assets, and instructions executed since the very first one.”³³ With the traceability of actions executed in a blockchain and the multiple entities or computers monitoring and validating each action, one could also suggest that the risks of corruption or wrongdoing in public procurement significantly decrease.

Introducing blockchain technology in public procurement to safeguard confidentiality and data protection could from a legal point of view increase the compliance with EUs legal framework. As already discussed, and accounted for, there are benefits of using blockchain technology within this area contra the ICTs used today which are centralized. Blockchain with its decentralization, immutability and traceability creates a more secure data protection and ability to protect confidential information. The network of computers and peers validating information creates a system which severely harder to manipulate as well. A tender that is placed cannot be changed nor can anyone without access retrieve information of such tender. Moreover, these aspects could contribute to the enhancement of sustainability in supply chains as well. This will be discussed in latter sections. The disadvantage of these systems and technology could possibly be that bids and tenders created on the blockchain cannot be erased or changed, hence,

³² *ibid*

³³ John Killmeyer and others (eds) ‘Will Blockchain transform the public sector?’ (*Blockchain basics for government*, 2017) < https://www2.deloitte.com/content/dam/insights/us/articles/4185_blockchain-public-sector/DUP_will-blockchain-transform-public-sector.pdf > accessed 12 April 2024

the information that is put into the blockchain must be correct for it to fulfil transparency requirements.

2.3. Authorization and security controls in blockchain technology

In relation to the issue of confidentiality and data protection already accounted for, secure authorizations and security controls are important when using public and private-permissioned blockchain. In the light of Article 2 of Directive 2014/24/EU on public procurement, there can be numerous entities involved in a public procurement. Mainly there are a contracting authority, which in accordance with Article 2 (1) of the directive is either the State, regional or local authorities.³⁴ On the other side of a procurement, there are tenderers or candidates. To know who is operating in a public procurement and who is to be allowed to take part of confidential information or a tender, the verification of each participant could be important. It could also be highly relevant to be able to identify that the participants are the ones who are invited to take part in a procurement.

Blockchain could most certainly leverage the security when it comes to authorization of procurement participants. If blockchain would be integrated into public procurement, there are some methods that could increase the level of security. One discussed method for authentication and authorization is the so-called PKI, or public key infrastructure. Using this method, participants in a public procurement are given a private key that is used to authenticate, authorize, and encrypt communication. Information stored using PKI can only be accessed by whom is permitted access.³⁵ This kind of in essence eliminates the risks of disclosing sensitive information during procurement processes where confidentiality is needed. The problem which

³⁴ Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC Text with EEA relevance OJ L 94, Article 2

³⁵ Raquel Carvalho ‘*Blockchain and Public Procurement*’ (2019) 6 (2) European Journal of Comparative Law and Governance p. 192-193

may occur using this method is if someone gains unlawful or unauthorized access to the private key.³⁶ This problem would arguably remain no matter what kind of key is being used. If a physical key would be used, then the risk of that being lost occurs. If the key is to be a digital key, then how does one protect that key from being accessed through a cyberattack? The answer to that question remains unanswered and this problem will remain for further examination – which is beyond the scope of this article – if this method is to be deployed. There are shortcomings to this method, but arguably its advantages are prominent especially in restricted or competitive procurement procedures where disclosure is something to avoid by tenderers.

The key idea behind the PKI has great potential in ensuring a level of security and protection. If each participant in a procurement procedure would be granted some sort of certified identity, and such an identity is required to participate in the procurement, then procurement procedures would eliminate the occurrence of a fraudulent tenderer.³⁷ It would be a reinforced system against corruption or fraud in the public e-procurement and the objective of the EU would most certainly become easier to comply with and fulfil.

3. Transparency, public e-procurement and blockchain

Transparency plays a vital role concerning supply chains and sustainability, as well as in public procurements. While the principles of confidentiality and data protection are important, on the one hand. Transparency defeats the purpose of these principles, on the other hand. The notion of transparency is something public procurement is heavily influenced by and is of great importance within this area. There are several provisions within the EU that safeguards transparency in its public administration. Article 1 of the Treaty on European Union (TEU)

³⁶ *ibid*

³⁷ Tahereh Nodehi and others (eds), *EBDF: The enterprise blockchain design framework and its application to an e-procurement ecosystem* (2022) 171 *Computers & Industrial Engineering*, p. 12

provides the principle of “openness”, that decisions taken in the Union shall be as open and close to the citizens as possible.³⁸

Moreover, Article 15(3) of the Treaty on the Functioning of the European Union (TFEU) provides that everyone within the EU shall have a right to access of documents of the EU, including documents of public procurement.³⁹ This right shall be ensured except where there is public or private interest overriding this right. It is also stipulated in this article that all EU institution, body, office or agency must ensure that their proceedings are transparent. Finally, probably the one mostly linked to public procurement is Article 18(1) of Directive 2014/24/EU.⁴⁰ This article stipulates that “contracting authorities shall treat economic operators equally and without discrimination and shall act in a transparent and proportionate manner”. These are the main regulations establishing the need for transparency within public procurement. With this as a legal basis there are two aspects that must be addressed. The first aspect asks why transparency is important in public procurement and the second aspect asks whether blockchain technology can improve the promise of the principle of transparency to ensure that supply chains align with sustainability. In other words, would it be possible to build transparency in supply chains using blockchain technology? Can blockchain technology offer and enhance trust, efficiency and speed in supply chain to achieve sustainability?

3.1 The importance of transparency within public e-procurement

Before developing on why transparency is of great importance within the area of public e-procurement, an attempt to define the term is provided. While there is no well-established or

³⁸ Consolidated Version of the Treaty on European Union [2012] OJ C 326/01, Article 1

³⁹ Consolidated Version of the Treaty on the Functioning of the European Union [2012] OJ C 326/01, Article 15

⁴⁰ Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC Text with EEA relevance OJ L 94, Article 18

common definition of the term transparency, there are several efforts attempting to define it.⁴¹ To catch the essence of the term this section will rely on the definition provided by Irena Georgieva in her book “*Using Transparency Against Corruption in Public Procurement*”.⁴² The notion of transparency summarized as:

A concept, used in national and international legal systems to ensure the public’s right to the availability and accessibility of a certain level of information about (institutional) norms, rules, procedures and regimes, and the actions of participants; where the information provided should be presented in an understandable and clear manner and should always be sufficient to facilitate monitoring, verification and assessment.⁴³

The two central features of transparency within public procurement are both representation and control. The representative features consist of elements such as proving the legitimacy of governmental authorities and demonstrating a government’s will to work openly and close to the public which undoubtedly strengthens the horizontal relationship between a EU public institutions and EU citizens.⁴⁴ The control features are mainly consisting of the possibility of the public to monitor and verify the actions of governmental bodies.⁴⁵ These tools together with the sole notion of transparency serves as measure of democracy as well. It is a way for the public to dictate and monitor that the activities of governmental bodies, agencies and institutions are performed with the purpose of enhancing the public good in an effective and economical sustainable way.⁴⁶

⁴¹ Georgieva, Irena., *Using Transparency Against Corruption in Public Procurement A Comparative Analysis of the Transparency Rules and their Failure to Combat Corruption*, Springer International Publishing, Cham, 2017, p. 11

⁴² Ibid

⁴³ Ibid p. 13

⁴⁴ Ibid.

⁴⁵ Ibid.

⁴⁶ Ibid p. 13

Transparency is important to monitor how public institutions pursue their administration, especially in public procurement which is of grave economic significance within the EU. Though, as transparency is of such importance, it must correlate to the need of confidentiality as well. It is therefore a necessity of both EU authorities and governmental authorities to balance the flow of information. Relevant and available information must be accessed.⁴⁷ In other words, for a public procurement to be transparent, it must only provide information of specific elements of a procurement to enable sufficiently effective control by the public. A contracting authority may only disclose an optimal quantity of information. This excludes the confidential information as discussed and examined earlier. By doing this, transparency also increases competition within public procurement since tenderers or economical operators are more likely to participate in a procurement since the procedure is more reliable. Moreover, if the optimal amount of information is enabled in a sufficiently effective way, there can be little to no room for corruption within this area since the public can control where their money is going. With a higher competition their money is most likely to end up at the most optimal tenderer as well which subsequently enhances the public good. Transparency can in other words function as a tool for enabling access to information, enhancing competition, and hindering corruption.⁴⁸ Moreover, if a satisfactory level of transparency is reached, it would most likely eliminate the risk of tenderers or economic operators to be discriminated against. Hence, the equal treatment of tenderers as Article 18(1) of Directive 18 (1) stipulates will be easier to comply with. If a procurement is transparent and actions can be traced and monitored, operators or contracting authorities would probably not expose themselves to the risk of discriminating another tenderer as this would directly be exposed to the public. A high level of

⁴⁷ Ibid p. 14

⁴⁸ Ibid p. 14

transparency would arguably enhance the compliance with Article 1 TEU regarding openness and of course Articles 15(3) and 18(1) of the Directive 2014/24/EU.

3.2 Transparency and the usage of blockchain technology

If blockchain technology were to be deployed within the area of public e-procurement, the level of transparency and reliability on information could possibly be improved. Previous literature has already argued that blockchain technology generally can provide for level of sustainability in supply chains.⁴⁹ The improvements of blockchain technology could enhance transparency and eliminate the imbalance of information amongst participants in for instance, a public procurement.⁵⁰ Blockchain allows operator to access auditable data which has been validated, time-stamped and are as earlier mentioned immutable. This information can be retrieved directly from the blockchain which could function as a data base. One of the pros of blockchain technology is that it could allow on-demand and immediate supervision of a procurement when needed, and not post-procedural supervision as of today. This allows contracting authorities to ensure legality, security, and stability on their markets. The reputation of and reliability of participating economic operators can be verified in an easier way with the blockchain due to the instant accessibility of data.⁵¹

It can be argued that depending on the nature of the public procurement and the degree of transparency and confidentiality, what blockchain technology to be used could be altered. When possible, a public-permissioned blockchain in theory seems to be a highly transparent method for public procurement. Enabling the public to not only access information about a

⁴⁹ Munir MA, Habib MS, Hussain A, Shahbaz MA, Qamar A, Masood T, Sultan M, Mujtaba MA, Imran S, Hasan M, Akhtar MS, Uzair Ayub HM and Salman CA (2022) Blockchain Adoption for Sustainable Supply Chain Management: Economic, Environmental, and Social Perspectives. 10 *Frontiers Energy* 1-24.

⁵⁰ Tomasto Aste, Paolo Tasca and Tiziana DiMatteo 'Blockchain Technologies: The Foreseeable Impact on Society and Industry' (2017) 50 (9) *COMPUTER*, p. 3

⁵¹ *Ibid* p. 2-3

public procurement, but to also participate in validating it through a consensus mechanism must for sure grant a new higher level of transparency. When it is not suitable for the public to get involved in the process of validating during sensitive stages of a public procurement, other methods are more suitable. All in all, the introduction of blockchain technology in public e-procurement for the purpose of transparency seems to entail several benefits, at least in theory.

Most importantly, transparency comes at fundamental status when the public seeks information on the ‘allegedly’ sustainable products through tracing back the product from A-Z, driven by a sustainability orientation in supply chains and logistics.⁵² While blockchain has the potential to enhance transparency, traceability, and efficiency in supply chain management, it also raises certain legal considerations. These implications can extend to pose risks to data privacy and security – given the fact that blockchain stores data in a decentralized and immutable manner, where companies and businesses will struggle to ensure compliance with data protection regulations. Moreover, consent and data minimization are two relevant principles to address.

4. Blockchain-based e- procurement for sustainability in supply chain

The integration of blockchain technology has emerged as a promising solution to enhance sustainability in supply chain management. To comply with Article 3 of the TEU, the internal market of the EU shall work for sustainable development. Thus, the aspects of sustainability in supply chains, among others, become of great interest from a legal point of view.⁵³ In the EU e-procurement processes, legally speaking, blockchain can secure sustainability in supply chains, providing transparency, traceability and reliability.⁵⁴ These three aspects are regarded as key elements and main enablers for improving sustainability in various ways. This would

⁵² Ayan, Büşra, Güner, Elif and Son-Turan, Semen, ‘Blockchain Technology and Sustainability in Supply Chains and a Closer Look at Different Industries: A Mixed Method Approach’, *Logistics* 2022, 6, 85

⁵³ Consolidated Version of the Treaty on European Union [2012] OJ C 326/01, Article 3

⁵⁴ Park A and Li H, ‘The Effect of Blockchain Technology on Supply Chain Sustainability Performances’ (2021) 13 Sustainability, 3, 7

mean that citizens and EU public institutions will have all data about purchases, their origins, whether they fulfil minimum standards of sustainability, the companies and tenderers and all relevant information track back how, where and who questions. Transparent, traceable and reliable data and practices in supply chains could enhance the possibilities for stakeholders or tenderers to adhere to both regulatory standards and sustainability goals in their supply chains during procurement processes.⁵⁵ Thus, fostering public trust in the processes. There are, however, legal implication that can theoretically rise.⁵⁶ Blockchain remains to have problems regarding privacy issues, such as, “pseudo-anonymity, immutability, where failure to meet privacy requirements, responsibility, accountability and States’ obligations become an integral part of the legal discussion of blockchain technology.”⁵⁷

Blockchain’s decentralized and immutable ledger provides unparalleled transparency in supply chain transactions.⁵⁸ Each transaction, from the procurement of raw materials to the delivery of final products, is recorded in a secure and transparent manner. This transparency not only fosters trust among stakeholders and the public but also ensures compliance with ethical, human rights and sustainable practices. Concepts such as proof-of-provenance, which could be vital in a procurement process, would thus be more reliable using blockchain technology.⁵⁹ Knowingly, tenderers and goods involved in a procurement process emanate from ethical and sustainable practices, and their provenance is based on reliable, traceable and transparent data, which blockchain offers. This, hence, would entail enhancing sustainability through and public trust through blockchain. This contributes to both a more social sustainable procurement

⁵⁵ Park A and Li H, ‘The Effect of Blockchain Technology on Supply Chain Sustainability Performances’ (2021) 13 Sustainability, 6-9

⁵⁶ See: Qandeel, Mais, ‘Blockchain Application in Information Ecosystems: The Right to Privacy in Cyberspace.’ (2023) In: Magnus Kristoffersson, *Proceedings from the First Annual International FIRE CONFERENCE* (pp 177-192).

⁵⁷ *Ibid.*, 187.

⁵⁸ Jabbar, S., Lloyd, H., Hammoudeh, M. et al. ‘Blockchain-enabled supply chain: analysis, challenges, and future directions’ (2021) *Multimedia Systems* 27, 787–806

⁵⁹ Adam Sulkowski, 'Blockchain, Business Supply Chains, Sustainability, and Law: The Future of Governance, Legal Frameworks, and Lawyers' (2019) 43 Del J Corp L 303, 312

process, and a more economically sustainable efforts by reducing the large loss of money that fraudulent goods causes.⁶⁰ From a legal standpoint, the transparency afforded by blockchain technology aids in demonstrating adherence to regulatory standards and sustainability goals. Compliance with environmental regulations, fair labor practices, and ethical sourcing can be easily verified through the transparent and traceable nature of blockchain records.⁶¹ This, in turn, mitigates legal risks associated with non-compliance and promotes a legal framework that encourages sustainable business practices.

Moreover, blockchain's cryptographic principles enhance data security by design.⁶² The decentralized nature of the technology minimizes the risk of a single point of failure or unauthorized access. Legally, it might be argued that this heightened data security aligns with the requirements of data protection laws at the EU level, particularly the EU's General Data Protection Regulation (GDPR). Legal considerations surrounding data privacy in the context of blockchain-based supply chains involve ensuring compliance with relevant data protection laws. Stakeholders may have to navigate the complex interplay between the principles of blockchain transparency and the need to protect sensitive data.⁶³ Establishing legal mechanisms for data privacy within blockchain applications is crucial to building trust among consumers, suppliers, and regulators as well as to ensuring meaningful sustainability. Blockchain's ability to automate and secure transactions can streamline compliance with various regulatory standards. This may minimize the risk of legal non-compliance. Legal systems – the EU system

⁶⁰ *ibid*

⁶¹ Nikolakis, W.; John, L.; Krishnan, H. How Blockchain Can Shape Sustainable Global Value Chains: An Evidence, Verifiability, and Enforceability (EVE) Framework. *Sustainability* 2018, *10*, 3926

⁶² Alexandra Giannopoulou, 'Putting Data Protection by Design on the Blockchain', (2021) European Data Protection Law Review (EDPL) 7, no. 3, 388-399

⁶³ Yue Liu, Qinghua Lu, Guangsheng Yu, Hye-Young Paik, Liming Zhu, "Defining blockchain governance principles: A comprehensive framework" *Information Systems* 109 (2022) 102090, 1-14

here is concerned – must evolve to recognize and accommodate the intricacies of blockchain-based e-procurement.

Practically, numerous “institutions are adopting blockchain in trade and finance systems to build smart contracts between participants, improve efficiency and transparency, and open up newer revenue opportunities.”⁶⁴ It has, in fact, been suggested that traceability and authenticity in supply chain enhances consumer trust.⁶⁵ Blockchain enhances traceability, redefines it, which establishes “a new theoretical benchmark for consumer trust based on transparency and immutable provenance.”⁶⁶ This could encourage companies to adhere to sustainable business in order to gain trust and thus benefit economically. The ultimate purpose of the use of blockchain technology could be a key driver for achieving sustainable development of the internal market of the EU in line with Article 3 of the TEU.

5. Concluding remarks

Blockchain technology in public procurement seem to have a rather good – at some point risky – potential in the aspects of confidentiality and transparency. This paper established that public procurement is a complex legal area of tremendous economic significance. The paper highlighted the most prominent benefits the usage of blockchain technology could entail within public e-procurement at EU institutions. In all the areas examined, the usage of blockchain technology has shown that it could enhance public procurement procedures with the EU legal framework.

⁶⁴ Mohd Javaid, Abid Haleem, Ravi Pratap Singh, Rajiv Suman, Shahbaz Khan, “A review of Blockchain Technology applications for financial services” *BenchCouncil Transactions on Benchmarks, Standards and Evaluations* 2 (2022) 100073, 1-18

⁶⁵ Abderahman Rejeb, Karim Rejeb, Steve Simske and John G. Keogh, “Exploring Blockchain Research in Supply Chain Management: A Latent Dirichlet Allocation-Driven Systematic Review”, *Information* (2023) 14, 557, 1-33

⁶⁶ *Ibid.*, p. 26

Introducing blockchain technology could possibly enhance the protection of confidential information that must not be disclosed during a procurement procedure. Moreover, due to its complex system of blocks and validation of blocks, the risk of information being manipulated is heavily decreased. Information put into the blockchain, once it is validated, is immutable, traceable and time stamped.⁶⁷ Additionally, blocks in each chain cannot be easily hacked in the same sense as today's ICTs due to its complex structure which makes it better suited to store sensitive data. This would increase the compliance with in particular the provisions of TEU and Directive 2014/24/EU.

The paper showed that the area of authorization is a tempting area to develop further for the improvement of data protection and confidentiality. Today the area has its flaws, for instance using the method of PKI entails flaws that has not yet been solved. If a bulletproof solution were to be found to authorization, the data protection and confidentiality when it comes to permissioned blockchains would undoubtedly improve, resulting in an enhanced compliance with the legal framework.

Furthermore, the paper discussed the issue of transparency and the benefits blockchain. With the usage of blockchain technology, the public procurement procedures would most likely be more transparent. This higher level of transparency would improve different aspects that the EU legal framework that safeguards sustainability requirements as well as other principles, such as competitiveness and the principle of non-discrimination. Should blockchain be used for e-procurement processes, immutable and time stamped information can be accessed by whoever is permitted access.

⁶⁷ Tahereh Nodehi and others (eds), *'EBDF: The enterprise blockchain design framework and its application to an e-procurement ecosystem'* (2022) 171 *Computers & Industrial Engineering*, p. 13

Finally, the paper identified that blockchain as a technology, with its identified potential improvements to transparency and data protection during procurement processes, could enhance sustainability in supply chains at the EU institutional level, especially regarding regulatory compliance and public trust in the processes. The main premise of this article established that blockchain, with its features such as traceability and transparency, could enhance trust in EU public procurements by encouraging companies and tenderers to adhere to sustainability goals, businesses and practices in line with the common goals of the TEU. At the same time, this ensures the necessary integrity of procurement processes among tenderers. Blockchain could, if integrated into public procurements processes in the EU, boost these processes and the legal compliance, as well as promoting sustainable supply chains. Precisely because public procurement is an area where huge sums of money flow, sustainable procurements and related supply chains would foster an even stronger sustainable development within the EU internal market, in line with the common goals of the EU institutions. From a legal point of view, however, there are issues that may arise through the deploying blockchain in public procurement within the EU to enhance sustainability, especially those related to privacy and data protection. These issues would mean that the EU legal system must evolve to recognize and accommodate the intricacies of blockchain-based e-procurement.