Blockchain, Decentralisation and the Public Interest:

The need for a Decentralisation Conceptual Framework for dApps

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Introduction

Blockchain and Distributed Ledger Technology (DLT) enable for disintermediation of services and decentralisation of the software processes enabling them. By doing so, processes can become transparent, verifiable, tamper-proof, and immutable. They have the capacity to provide an unchangeable history, or log, of all actions that have taken place which could be traced back to specific stakeholders.

It can be said that such features allow for the implementation of use-cases that strive towards the common good such as financial inclusion, ethical supply chains, and community empowerment – however, decentralisation may not always work towards the common good (Ellul & Pace, 2018).

The question of whether and how exactly blockchain can help towards the common good is, indeed, too wide-ranging. What exactly the term *common good* is has changed, and has been debated since Aristotelian times (Dupré, 1993). In this paper a narrower concept, *public interest,* and its relation to decentralisation will be explored, after which we aim to provide a conceptual framework that can aid in visualising the decentralisation complexities of DLT. The proposed conceptual framework can thereafter aid in determining a system's relevance to de/centralisation goals in aid of the public interest.

Indeed, much debate has surrounded what public interest constitutes (Box, 2007), and it is not the intention of this paper to add to this debate. Yet the relevance of decentralisation to public interest will be discussed, and how decentralised blockchain systems can be expressed to help determine if the system is congruent with public interest goals.

The remainder of this paper is organized as follows. Section 2 will discuss decentralisation and its relation to democracy and the

public interest and will close off with a conceptual framework proposed to describe decentralisation of a political-administration system. In Section 3 technology related decentralisation issues will be discussed. Then Section 4 will follow with this paper's proposed decentralisation conceptual framework for dApps, and then conclude in Section 5.

Issues of De/centralisation

Many believe and state that decentralisation brings democracy along with it, whether implicitly or explicitly, as stated by Barkan (1998), "the closer representative government is brought to the citizens of a society, both spatially and physically, the more it approximates 'real' democracy. Conversely, the more distant and less accessible representative government is to the citizenry, the less it is democratic" (cited in Hutchcroft, 2001, p.33). Furthermore, democracy is also often said to be a harbinger of public interest. Therefore, it is no surprise that the DLT community often voice the need to *decentralise everything* (Mougayar, 2016; Maloney, 2015).

Yet, Hutchcroft highlights that further analysis is required to determine whether decentralisation necessarily brings democracy, and goes on to show otherwise – that decentralisation can also be a useful tool in an autocracy and conversely that centralisation "measures could be an effective force for democratisation" (Hutchcroft, 2001, p.33). Also, whilst democracy is often associated with the public interest, "theory and experience indicate that there is no necessary connection between democratic procedures and the advancement of common interests" (Barry, 1995, p. 260).

The debate in regard to whether decentralisation or centralisation works towards the public interest is a long-standing one (Shah, 2006). Some state that localisation (through decentralisation) leads to more corruption (Shah, 2006), which in turn has negative repercussions on GDP growth, quality of public infrastructure, and health services (Shah, 2006) – which justifies why one side of the debate claims decentralisation works against the public interest. However, the other side of the debate argues that decentralisation can help fight against corruption by "breaking the monopoly of power at the national level" but care must be taken to ensure that local elites do not cease powers (Shah, 2006, p.1).

This debate cannot be answered in such a generalised form, in which neither is the public interest well-defined, nor is there a clear-cut answer in respect to what configuration of de/centralisation across the various aspects of administration, politics and governance works best for the wide range of nations and peoples. Indeed, there is no silver bullet. Whether or not de/centralisation is a good/bad thing depends upon many different factors, as put by Charbit in an Organisation for Economic Co-Operation and Development (OECD)working paper:

> **There is no "yes or no" answer to whether or not decentralisation is a "good idea." Centralised and decentralised approaches can work relatively well, or relatively poorly, depending on a country's historical, cultural and political context, as well as on its ability to exploit inherent strengths and minimize potential weaknesses (Charbit, 2011, p.14).**

Furthermore, centralisation and decentralisation are not binary options, but as described by Fesler provide a centralisation-decentralisation continuum "whose poles are beyond the range of any real political system" (Fesler, 1968, p.371). Thus, to really establish an answer to whether de/centralisation works towards the public interest, it would be required to understand not only how the various factors may influence the successfulness of potential de/centralised approaches, but also to what levels the aspects within the centralised-decentralised continuum are de/centralised. Whilst indeed this does add to the complexity of establishing the usefulness of de/centralisation, Hutchcroft (2001, p.31) highlights that the utility of the continuum "lies in its ability to capture variation." Hutchcroft (2001) goes on to establish a conceptual framework for describing how de/centralised a particular system is by combining two centralised-decentralised continua into a two dimensional matrix, one axis defining how de/centralised the political system is, and another axis defining how de/centralised the administration is. This framework could then be used to help align aspects of a system with the ideal decentralised targets that are deemed to be beneficial for the public interest (within the respective cultural and political context). A reproduction of the framework and use-cases follows.

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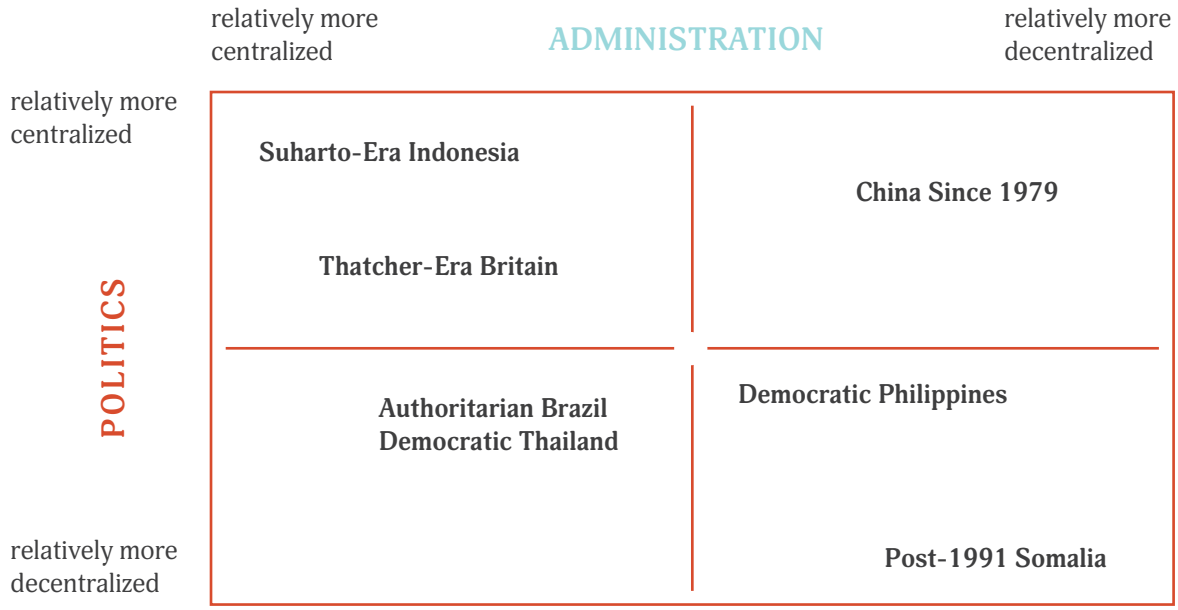


Figure 1: *Hutchcroft's conceptual framework for a system's political and administration's de/centralisation. Reproduced from Hutchcroft, 2001.*

De/centralisation and Technology

In 350 BC, Aristotle proposed the concept of publicly visible ledgers. Aristotle had argued that any money issued should be done "openly in front of the whole city" and that accounts should be made publicly accessible from "various wards" in order to fight corruption (Aristotle, as cited in Shah, p.479).

Whilst public accounts and auditing activities help to minimise instances of fraud and can bring to light irregular and illegal actions, they may suffer from numerous agency problems (Watts & Zimmerman, 1983). Indeed, rather than rely (solely) on appointed auditors, more information could be made publicly available (as Aristotle suggested) – especially with modern-day technology.

Consider that such a ledger is made public through a web-based system developed and maintained by the government itself (or the institution in question). Indeed, the accounts would then be available for the public to see. However, what guarantees are there regarding the veracity of the data? How can the public be sure that the data has not changed, or was manipulated? One could suggest that the system is outsourced or maintained by a reputable firm and audited – but the problem still remains, and trust is shifted to another entity. Digital systems used up till the late 2000s required inherent trust in the digital service provider (whoever it may be).

Now consider a public procurement system that is meant to accept tendering bids up till a closing time. If such a system provided functionality that allowed staff to manipulate bid submission times

(whether intentionally, or not), then the public, bidders and other stakeholders would not be able to ascertain that the process was not rigged and a favourable bid submitted after the closing time. No matter what level of de/centralisation of the political-administration framework, any processes that are governed by such traditional digital systems are ultimately centralised under the control of the digital service operator.

This is where Blockchain and DLT come in. In a manner similar to how Aristotle posed that copies of accounts should be made public, Satoshi Nakamoto (whoever they may be) proposed that to be able to remove centralised control of a ledger, it be publicly available for all to see, replicate, and verify, without there being a single operator or computer (or centralised groups thereof) that own or maintain it exclusively. However, enabling for replication and making data public was not a new concept. What Nakamoto proposed which was ground-breaking was a way to ensure that no one could change their copy of the ledger in a manner that breaks the rules of the system and is considered to be valid, and that changes could only take place by one computer at a time, so as to ensure that there is only one canonical version of the true ledger replicated amongst all participating computers.

In essence, Nakamoto (2008) proposed Bitcoin, "a peer to peer electronic cash system", the first cryptocurrency. This cryptocurrency is realised by creating a decentralised and distributed ledger (of ownership of Bitcoin). In order to ensure that no one can manipulate the ledger in an invalid manner, a mechanism which provides the guarantees above was proposed. We now call this mechanism *blockchain*, which is one way of implementing a distributed ledger, and other ways to create such a ledger exist using different DLTs.

Later, it was proposed that blockchain and DLT could be

used for more than cryptocurrencies. In 2013, a new blockchain platform, Ethereum (Wood, 2014), was proposed that not only allowed for the implementation of a cryptocurrency, but also allowed for other custom written software applications to execute on top of the blockchain. Since these applications execute on a blockchain, the data and process are publicly available, transparent, and verifiable. We call these applications *Smart Contracts* – software applications that: (i) will do exactly what they are written to do; (ii) allow external parties to interact with them (as per the encoded logic) in a manner that cannot be manipulated; and (iii) can both receive payments and make cryptocurrency payments.

For example, consider that you would like to raise 'money' to be able to develop a project, yet you can only develop the project if you raise enough cryptocurrency, and want to give a guarantee to investors that they will retrieve their investment back if you do not manage to raise enough funds – you can write a smart contract to do exactly this. If written correctly, neither yourself nor anyone else would be able to get access to the funds unless enough funds were raised on time. Even if you wanted to, there's no company or individual you can call that will be able to manipulate the data or software, there's no computer you can hack to make the required change, there's nothing you can do to stop the smart contract from doing exactly what it was written to do.

Recall the public procurement use-case described above – using smart contracts, the procurement system's digital process can be decentralised. Such a decentralised digital system would make it impossible for anyone to manipulate the process or data. More so, such a system (if implemented correctly) could be made to not even leave room for external critique/questions to be raised, since the process and data could be publicly available and verifiable[1].

[1]Indeed, not all data should be made public for various reasons and for such cases different techniques can be used to make that part of the process and data visible, whilst keeping other parts centralised whilst still providing various assurances. In such a manner the technology can be implemented in such

A Decentralisation Conceptual Framework for dApps

Much like the decentralisation continuum discussed by Hutchcroft (2001), blockchain, DLT and smart contracts do not provide a binary option in regard to whether their implementation is totally decentralised, or completely centralised.

In fact, one could argue that most of the decentralised platforms being deployed are not completely decentralised (due to their reliance on existing Internet infrastructure that has a number of centralised points of trust). When we refer to such a system as being decentralised in this manner, we refer to it as a decentralised Application (dApp) which is (typically) comprised of and built on:

i. **Off-DLT Application**: some degree of application logic which executes outside of the blockchain or DLT – typically includes a web server, browser and web page code (JavaScript + HTML) that executes and renders in the web browser;

ii. **DLT Application**: some degree of application logic executing on the blockchain or DLT – such as smart contracts;

iii. **DLT Platform**: the blockchain or DLT implementation itself; and

iv. **Networking Infrastructure**: the underlying infrastructure which the blockchain or DLT uses to establish and communicate with other networked nodes in the system.

Each component in the dApp can be to some degree de/centralised with respect to the technology implementation and can also be de/centralised with respect to the social structures that govern the technology. Therefore, in order to aid determining whether a particular dApp may work towards the public interest, and given that different contextual political and cultural de/centralisation levels may or may not work towards the public interest, a means of expressing the various degrees of de/centralisation of a dApp (and its different components), is herein proposed. Figure 2 depicts a conceptual framework, a two-dimensional technology-social governance continua de/centralisation stack.

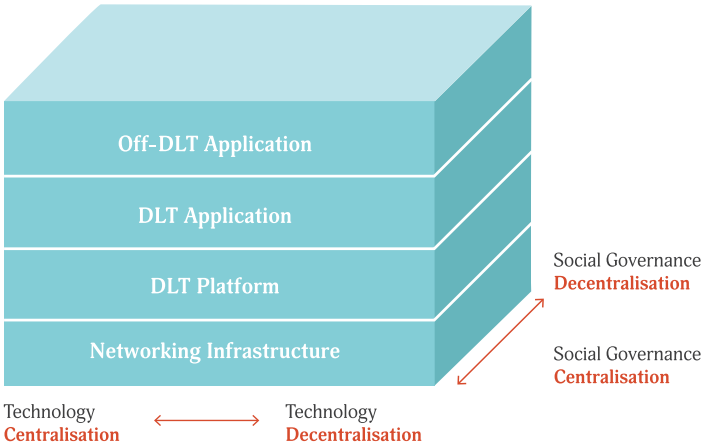


Figure 2: Two-dimensional technology-social governance continua de/centralisation stack.

The model can then be used to describe to what extent each component of a dApp is de/centralised with respect to both technology as well as any social governing structures, whilst also depicting software component dependency by having one component built on another. Consider the public procurement system again. The associated dApp de/centralisation stack follows in Figure 3.

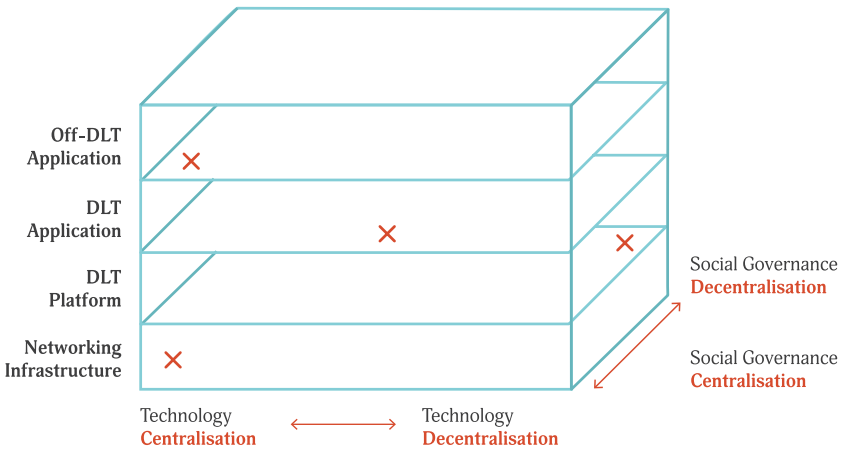


Figure 3: Public procurement dApp de/centralisation stack.

a way that its de/centralised parts map directly onto the centralised-decentralised continua of the associated political-administration process it is being used for.

Such a system would likely make use of existing Internet infrastructure to ensure ease of access. The Internet and supporting infrastructure are heavily centralised. To use this system, one's computer would need to communicate through one's Internet service provider (ISP) – a central point of trust). The Internet works by creating point-to-point links between the computer and ISP; ISP to any national or other international infrastructure, and any intermediate links, until a link is made to the destination computer's ISP, and finally to the destination computer itself. Once more, it is point-to-point, i.e. each point being a central point of trust. Each point is also governed by a particular entity. So as can be seen above (in the Networking Infrastructure component), both the technology and the social governance are heavily centralised.

When it comes to the DLT platform an open, publicly-accessible, and transparent system that can provide guarantees in regard to the digital processes and data would likely be used (say, for instance, Ethereum). Such a DLT platform should be decentralised in regard to who governs it to ensure that the government cannot alter the platform or remove any guarantees, and the technology should also be decentralised for the same reason – and therefore the DLT platform is depicted above as decentralised in both dimensions. Indeed, there is debate in regard to a number of centralised points that exist in such types of DLT platforms both with respect to the technology and social governance[2]; however, they are beyond the scope of this article.

The DLT Application would likely be implemented as smart contracts to provide required guarantees, e.g. that no tendering bid is accepted after the tendering process has closed. Whilst smart contracts will do exactly what they are written to do –this could provide completely-centralised logic that allows for a single administrator to use the smart contract, or could allow any member of the public to have a say, for example equal voting rights. In the public procurement use-case certain aspects of the procurement process implemented in the technology would likely be centralised (e.g. reissuing a tender), whereas some aspects would likely be decentralised (e.g. access to submission times for each bid) and therefore the technology de/centralisation marker is placed somewhere in the middle of the continuum. However, social governance over the smart contracts (e.g. ability to deploy new smart contracts for new types of tenders) would be completely centralised to the government.

In order to provide users ease of access to the dApp, an Off-DLT Application component would be used and comprised of a standard web page framework that interacts

[2] For example. a computer node makes a connection to the decentralised network by relying on a number of central points of trust (DNS servers, domain name administrators, seed nodes, and so on)and often a DLT platform has a group of core developers that decide on what software upgrades to the platform (proposed by anyone) are accepted, or not.

with the users' browsers to provide an easy-to-use interface. Both the technology, and social governing structures are, of course, centralised in this case. Even though this final layer that the user interacts with is centralised in both dimensions, the decentralisation achieved using the DLT Platform and Application provides the guarantees required.

Indeed, different dApp architectures may exist which potentially make use of a number of different DLT systems or any other configuration. Therefore, the stacked components could be modelled differently for such varying architectures.

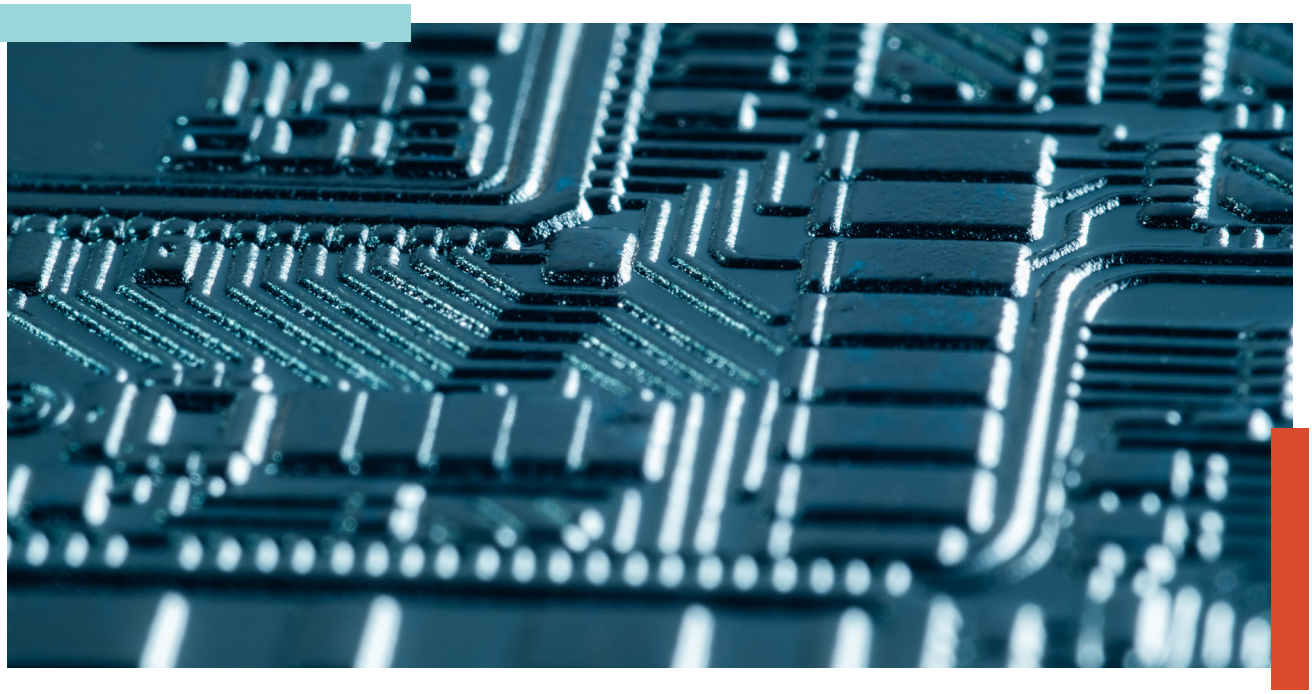
The conceptual framework can then provide insight and be compared against the de/centralisation targets for the particular political and cultural context. For example, for a particular political and cultural context it may be the case decentralise various activities of the government, yet to centralise ISPs. Similarly in one context a Government-backed digital centralised monetary system may work better towards the public interest, whilst in another a decentralised monetary system based on an open and public cryptocurrency may work better – both of which may be operating using centralised ISPs and infrastructure which may work best towards the public interest as well. The conceptual framework above can be used to depict a system's multiple levels of technology-social governance de/centralisation.

Government-backed digital centralised monetary system may work better towards the public interest...

Conclusion

Determining whether a de/centralisation works or not is dependent upon the particular political and cultural context (as discussed in Section 2). Hutchcroft proposed a conceptual framework to aid determining the political-administration de/centralisation continua (Hutchcroft, 2001). With the advent of DLT technology the complexity of de/centralisation is amplified given the various components it makes use of and that each component has an associated technology de/centralisation continuum and a social governance one.

In a manner similar to how Hutchcroft provides a tool to determine a system's de/centralisation position which can then be used to determine whether a system is congruent with de/centralisation targets that attain public interest for the particular context,in this paper we have proposed a conceptual framework to help determine the various de/centralisation levels of a blockchain or DLT system dApp which can then further be used to compare with de/centralisation targets for the particular political and cultural context it is being used within.



References

Barry, N., 1995. *An Introduction to Modern Political Theory* (3rd ed.). London: Palgrave.

Box, R. C.,2007. Redescribing the public interest. *The Social Science Journal, 44*(4), pp. 585-598.

Charbit, C., 2011. *Governance of Public Policies In Decentralised Contexts: The Multi-Level Approach*. OECD Regional Development Working Papers. Available at: <https://www.oecd-ilibrary.org/governance/governance-of-public-policies-in-decentralised-contexts_5kg883pkxkhc-en> [Accessed 10 January 2021].

Dupré, L.,1993. The common good and the open society. *The Review of Politics, 55*(4), pp. 687-712.

Ellul, J. and Pace, G., 2019. Blockchain and the Common Good Reimagined. In: The Common Good in the Digital Age.

Fesler, JW (1968) Centralization and Decentralization. In Sills, D.L. (Ed.), *International Encyclopedia of the Social Sciences*, Vol II, New York: MacMillan.

Hutchcroft, P. D.,2001. Centralization and decentralization in administration and politics: Assessing territorial dimensions of authority and power. *Governance, 14*(1), pp. 25-53.

Maloney, S., 2015. Dpush: A Scalable Decentralized Spam Resistant Unsolicited Messaging Protocol. Available at: <https://arxiv.org/abs/1509.03934> [Accessed 10 January 2021].

Mougayar, W., 2016. *The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology*. John Wiley & Sons.

Nakamoto, S., 2008. Bitcoin: A Peer-To-Peer Electronic Cash System. Available at: <https://bitcoin.org/bitcoin.pdf> [Accessed 10 January 2021].

Shah, A., 2006. Corruption and Decentralized Public Governance. Policy Research Working Paper No. 3824. Washington, DC: World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/8805 [Accessed 10 January 2021].

Watts, R. L., & Zimmerman, J. L.,1983. Agency problems, auditing, and the theory of the firm: Some evidence. *The Journal of Law and Economics, 26*(3), pp. 613-633.

Wood, G., 2014. Ethereum: A Secure Decentralised Generalised Transaction Ledger. Available at: <https://ethereum.github.io/yellowpaper/paper.pdf> [Accessed 10 January 2021].