Blockchain, Law, and Business Supply Chains: The Need for Governance and Legal Frameworks to Achieve Sustainability

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ABSTRACT

Blockchain technology has been hailed as the next disruptive leap forward in data sciences. Most legal scholarship related to the topic has focused on its relevance to finance, but it could revolutionize business supply chains. Specifically, blockchain-enabled solutions are expected to improve the reliability of data related to supply chains and to help businesses eliminate waste and harms to people and the environment. Despite the hype, this paper will explain why the promise of distributed electronic ledgers will only be realized in the context of effective governance and legal frameworks. Another goal of this paper is to identify the weaknesses of blockchain technology in the context of supply chains and its vaunted potential to help firms reduce harms. This paper will highlight the risk of placing blind faith in the technology as far as outcomes. Achieving true sustainability through the use of blockchain-enabled solutions—reducing or entirely eliminating the damaging side effects of business—is, again, a question of private and public governance: it requires a shift of mindset and deliberately setting and enforcing ambitious and measurable outcomes. Blockchain only matters, therefore, to the extent that it is coupled with meaningful goals and enabling frameworks of law.

I. INTRODUCTION

Blockchain technology—distributed electronic ledgers allegedly immune to forgery and errors—is being hailed as the next disruptive leap forward in data sciences, on a par with the advent of the Internet itself.[1]

Although most commonly associated with Bitcoin and other cryptocurrencies, early deployments of blockchain technology in business enterprises have tested its potential in combatting fraud and theft and assuring quality in the context of supply chains.[2] It has reportedly functioned well, for example, in the timber industry.[3] Global companies gain more efficient traceability and reduce loss and theft while societies and governments benefit from increased tax revenues, reduced corruption, and—especially when blockchain is coupled with certification schemes—environmental benefits from encouraging sustainable practices.[4]

However, high profile hacks suggests that some blockchain applications can be as unhackable as the Titanic was unsinkable.[5] Based on limitations, some argue that blockchain is, at

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[1] Laura Shin, *How The Blockchain Will Transform Everything From Banking To Government To Our Identities*, FORBES (May 26, 2016), https://www.forbes.com/sites/laurashin/2016/05/26/how-the-blockchain-will-transform-everything-from-banking-to-government-to-our-identities/#17ed4cfc558e.

[2] Heather Clancy, *The blockchain's emerging role in sustainability*, GREENBIZ (February 6, 2017), https://www.greenbiz.com/article/blockchains-emerging-role-sustainability; Steve Banker, *Blockchain In The Supply Chain: Too Much Hype*, FORBES (September 1, 2017), https://www.forbes.com/sites/stevebanker/2017/09/01/blockchain-in-the-supply-chain-too-much-hype/#4e4510f9198c.

[3] Boris Düdder, and Omri Ross, *Timber Tracking: Reducing Complexity of Due Diligence by Using Blockchain Technology* (August 8, 2017), https://ssrn.com/abstract=3015219.

[4] *Id.*

[5] Swati Khandelwal, *Hackers Stole $32 Million in Ethereum; 3rd Heist in 20 Days*, THE HACKER NEWS (July 19, 2017), https://thehackernews.com/2017/07/ethereum-cryptocurrency-hacking.html.

best, a solution in search of a problem, while others write it off as simply overhyped.[6] Even if the technology works flawlessly, fundamental problems include both human fallibility and corruption when creating the underlying records and enforcing consequences.[7]

This leads some to argue that the true potential of blockchain technology can only be realized when coupled with effective governance. According to one perspective, "wholly divorced from legal enforcement, blockchain-based systems may be counterproductive or even dangerous."[8] This is somewhat in tension with what blockchain evangelists call "trustless trust."[9] Some critics question the premise that blockchain-based systems can bypass any kind of public or institutional governance.[10]

Blockchain's potential role in supply chain optimization includes matters such as proof-of-provenance, sustainability data tracking and reporting, self-executing digital contracts, and devices that can be controlled over the Internet. An open question is whether these uses of the technology will result in a new subset of law—or whether they can function in the absence of legal frameworks.[11]

This paper endeavors to evaluate the promise and perils of blockchain in advancing sustainable business supply chains. A key question to be considered is whether blockchain applications are likely to obviate the need for lawyers and legal frameworks, as some have prognosticated. We conclude that legal frameworks are essential and that a role for attorneys will remain.

Finally, as with other advancements related to data—such as the Internet itself and mobile devices—a more powerful tool related to information does not assure a reduction in humanity's environmental footprint. Again, sound governance—the deliberate setting of clear and measurable and enforceable outcomes—is necessary if the potential of blockchain is to be realized. The nascent blockchain revolution could turn out to be meaningless in the absence of a change of mindset and the setting and achievement of a collective goal of zero net environmental footprint.

II. BLOCKCHAIN BASICS

Stated most simply, blockchain is a form of record keeping. It is a digital ledger distributed among nodes in a network, meaning that no one central authority controls the data. Rather, "everyone can maintain a copy of a dynamically-updated ledger, but all those copies remain the

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[6] Joseph Young, *Blockchain is Overhyped and Not Quite Applicable: VC Andrew Parker,* THE COINTELEGRAPH (March 23, 2017), https://cointelegraph.com/news/blockchain-is-overhyped-and-not-quite-applicable-vc-andrew-parker.

[7] THE ECONOMIST, *The great chain of being sure about things* (October 31, 2015), https://www.economist.com/news/briefing/21677228-technology-behind-bitcoin-lets-people-who-do-not-know-or-trust-each-other-build-dependable.

[8] Kevin D. Werbach, *Trust, But Verify: Why the Blockchain Needs the Law,* BERKELEY TECH. L. J., *forthcoming*, https://ssrn.com/abstract=2844409, at 1.

[9] Reid Hoffman, *Why the Block Chain Matters*, WIRED (May 15, 2015).

[10] Lawrence Lessig. Presentation: *Thinking Through Law and Code*, COALA's Blockchain Workshops (Sydney, 2015), http://www.blockchaintechnologynews.com/thinking-through-law-and-code-again-lawrence-lessig-coalas-blockchain-workshops-sydney-2015/.

[11] *See* Aaron Wright and Primavera De Filippi, *Decentralized Blockchain Technology and the Rise of Lex Cryptographia* (March 12, 2015), https://ssrn.com/abstract=2580664. *See also* Lawrence J. Trautman, *Is Disruptive Blockchain Technology the Future of Financial Services?* 69 CONS. FIN. L.Q. REP., 232 (2016); Max Raskin, *The Law and Legality of Smart Contracts*, 1 GA. L. TECH. REV. 304 (2017); Kevin D. Werbach and Nicolas Cornell, *Contracts Ex Machina*, 67 DUKE L. J., 313 (2017).

same, even without a central administrator or master version."[12] It is typically characterized as "a digital, tamper-proof record of information, accessible to everyone."[13] As astutely pointed out by Aaron Wright and Primavera De Filippi, it is an "incremental improvement" over earlier steps since the late 1970s in encryption, peer-to-peer applications, consensus mechanisms, and decentralized, distributed data storage.[14] As they optimistically put it, the combination of these technologies provides "a way for people to agree on a particular state of affairs and record that agreement in a secure and verifiable manner."[15]

Ironically, the short-term hype and speculation about cryptocurrencies may be exaggerated, while the long-term impact on business—especially supply chains—may be underappreciated and epochal.[16]

Blockchains can be public or private. A public blockchain—or permissionless or 'unpermissioned' ledger—has no single owner and allows anyone to add information or hold a copy of the record, making permissionless blockchains censorship-resistant and hard to hack.[17] Cryptocurrencies such as Bitcoin and Ether from Ethereum are examples of public blockchains.

Private blockchains—permissioned ledgers—are created for private groups to share information or transactions. Hyperledger from Linux Foundation and Corda from the R3 financial services consortium are two examples.[18] Distributed private ledgers could track transactions across and between enterprises without the overhead of a central system. According to Goldman Sachs, this market opportunity could be worth $2.5-7 billion annually.[19]

Moving up through a spectrum of complexity, smart contracts use blockchain ledgers to create "self-executing" agreements—a series of "if-then" conditions that purportedly remove some of the human discretion involved in contracting.[20] By combining smart contracts, a Distributed Autonomous Organization (DAO) could use blockchain technology to encode arrangements of debt, equity, and governance,[21] effectively creating an enterprise that would be to some extent run on autopilot.

III. THE POTENTIAL OF BLOCKCHAIN AS IT RELATES TO SUSTAINABILITY AND BUSINESS SUPPLY CHAINS

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[12] Werbach, *supra* note 9.

[13] Jochem Verberne, *How can blockchain serve society?* WORLD ECONOMIC FORUM (February 1, 2018), https://www.weforum.org/agenda/2018/02/blockchain-ocean-fishing-sustainable-risk-environment/.

[14] Wright and De Filippi, *supra* note 12, at note 15 and supporting citations.

[15] Wright and De Filippi, *supra* note 12, at 5.

[16] Marco Iansiti and Karim R. Lakhani, *The Truth About Blockchain*, HARV. BUS. REV. (January/February) (describing the vast potential of the blockchain as a "foundational technology" which will only be fully realized over the long-term).

[17] Michèle Finck, *Blockchain Regulation*, GERMAN L. J., 2018, *Forthcoming* (Max Planck Institute for Innovation & Competition Research Paper No. 17-13), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3014641, at 6.

[18] Todd Benzies, *Tech and Banking Giants Ditch Bitcoin for Their Own Blockchain*, WIRED.com (December 17, 2015), https://www.hyperledger.org/news/2015/12/17/wired-tech-and-banking-giants-ditch-bitcoin-for-their-own-blockchain.

[19] James Schneider et al. *Blockchain: Putting Theory into Practice, Goldman Sachs Equity Research Report* (May 24, 2016), https://www.unlock-bc.com/news/2017-05-25/blockchain-putting-theory-into-practice.

[20] Raskin, *supra* note 12, at 309-311, (2017). Some call into characterizing such arrangements as truly qualifying as either smart or contracts. *See* Finck, *supra* note 18, at 6.

[21] Vitalik Buterin, *Bootstrapping A Decentralized Autonomous Corporation: Part I,* BITCOIN MAG. (September 19, 2013), https://bitcoinmagazine.com/articles/bootstrapping-a-decentralized-autonomous-corporation-part-i-1379644274/

Despite blockchain and Bitcoin earlier being nearly synonymous with each other, Bitcoin's near-synonymy with cryptocurrency, and the association of these buzzwords with the infamous online black market Silk Road, blockchain has lately emerged as a data sciences innovation with massive potential to disrupt all of commerce. "Perhaps of all the new technologies that comprise the Fourth Industrial Revolution, blockchain shows the most promise for radical disruption."[22] While others have identified blockchain as furiously overhyped, there is, at the least, a consensus that the full potential of blockchain to alter the business world lies ahead.[23]

A major aspect of business that could be optimized out of concern for both individual and enterprise goals—as well as public policy aims—would be supply chain optimization related to sustainability. First, some consumers care about the origins and health and environmental impacts of the products and services that they purchase—and uncertainty, ambiguity, deliberate obfuscation, and outright fraud persist in this arena. Second, some retailers see an opportunity in reliably meeting these demands from consumers. Third, enterprises could prosper by eliminating waste and inefficiency. Fourth, environmental degradation is an existential threat to civilization, meaning that efficient and environmentally benign supply chains are consistent with good public policy.

Both market mechanisms involving consumer choice and regulatory restrictions can only work if information is both available and reliable. Otherwise, asymmetries of information remain one of the widely acknowledged reasons for market failures.[24] More broadly, better tracking of goods and material can improve efficiency and reduce theft, loss, or spoilage.[25] Reducing such costs and related negative externalities is clearly in the interest of both business and enlightened public policy.

Blockchain's applications for improving supply chains so as to achieve greater sustainability include the following. Proof-of-provenance is a concern for businesses or entire regions that suffer as a result of goods whose loci of production are fraudulently labeled. For example, counterfeit Italian wines cost the economy of Italy 2 million Euro per year; a blockchain-enabled proof-of-provenance experiment has proven to be successful in this context,[26] as well as in the olive oil industry.[27]

Closely related to simply proving the geographic origin of a product is assuring that its means of production minimized harm to people and the environment. The tuna industry has successfully experimented with blockchain-enabled tracking that verifies fish are caught without the use of forced labor and with minimal bycatch.[28] Illegal fishing is a $23 billion cost to the $2.5 trillion ocean economy; a platform called Global Fishing Watch is attempting to address this. Separately, a partnership of the World Wildlife Fund, ConsenSys, TraSeable, and fishing company

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[22] Verberne, *supra* note 14.

[23] *See* Melanie Swan, BLOCKCHAIN: BLUEPRINT FOR A NEW ECONOMY (New York, NY: O'Reilly, 2015).

[24] *See* Joseph E. Stiglitz, *Markets, Market Failures, and Development*, 79 AM. ECON. REV. 2, Papers and Proceedings of the Hundred and First Annual Meeting of the American Economic Association (May 1989), 197, 197-203.

[25] Philip Boucher, HOW BLOCKCHAIN TECHNOLOGY COULD CHANGE OUR LIVES, European Parliamentary Research Service, February 2017, http://www.europarl.europa.eu/RegData/etudes/IDAN/2017/581948/EPRS_IDA(2017)581948_EN.pdf.

[26] Phil Taylor, *EY partners with EZLab on blockchain wine security project*, SECURING INDUSTRY (April 18, 2017), https://www.securingindustry.com/food-and-beverage/ey-partners-with-ezlab-on-blockchain-wine-security-project/s104/a4014/#.WvenBogvw2w.

[27] Kristoffer Just, *Blockchain as a supply chain* (February 2, 2018), https://kristofferjust.com/2018/02/02/blockchain-as-a-supply-chain/.

[28] *From shore to plate: Tracking tuna on the blockchain*, PROVENANCE (15 July 2016), https://www.provenance.org/tracking-tuna-on-the-blockchain.

Sea Quest Fiji has tested a blockchain-enabled application that allows consumers to scan a product and see when and where the fish was caught and by what means.[29] In the context of conflict minerals—raw material purchased from parties associated with unsavory and illicit violence—blockchain-enabled proof-of-ethical sourcing of diamonds has similarly functioned well.[30]

In both cases, once a record—the certification—is generated, it is distributed across a network. As explained above, and just as with a record of a cryptocurrency transfer, each movement of a certified good through the supply chain—or chain of custody—is accompanied by an update in the distributed ledger. Companies have recently started offering enterprise-grade blockchain solutions,[31] of whom many focus on proof-of-provenance and supply chains.[32] Illustrations of how blockchain-enabled solutions function together have been produced by Josh Nussbaum of Blockchain Project Ecosystem, Lawrence Lundy-Bryan of Token Ecosystem Map, and Jordan Odinsky of Logistics Market Landscape.[33] These processes enhance the credibility of the certification later in the supply chain.[34] Combined with other trends such as green consumerism,[35] some have suggested that blockchain will increase our ability to solve the world's sustainability problems.[36]

Prognostications from 2015-2016, or the early adoption phase of blockchain, have largely proven correct, in that start-ups have deployed and tested applications of blockchain.[37] According to Euroclear and Oliver Wyman, early experiments with cryptocurrencies were to precede disruptive innovations and niche applications, with long-term mass adoption following in about 2025.[38]

According to a recent report by McKinsey & Company, there is reason to believe that blockchain could be adopted and scaled more rapidly, and have material impact on commerce between 2020 and 2022.[39] The firm identified several dozen nascent use cases.[40] However,

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[29] Verberne, *supra* note 14.

[30] *Promise and Peril: Blockchain, Bitcoin and the Fight Against Corruption*, TRANSPARENCY INT'L (January 31, 2018). https://www.transparency.org/news/feature/blockchain_bitcoin_and_the_fight_against_corruption?utm_medium=email&utm_campaign=DCN%206%20February&utm_content=DCN%206%20February+CID_d4d314a078d06552312ae2cea57b3134&utm_source=Email%20marketing%20software&utm_term=Promise%20and%20peril%20Blockchain%20bitcoin%20and%20the%20fight%20against%20corruption.

[31] Elena Mesropyan, *30 Companies Providing Enterprise-Grade Blockchain Solutions*, MEDICI (February 19, 2017), https://gomedici.com/companies-providing-enterprise-grade-blockchain-solutions/.

[32] Artur Safaryan, *Blockchain projects aiming to reinvent the Supply Chain: Landscape Map*, HACKERNOON (November 9, 2017), https://hackernoon.com/blockchain-projects-aiming-to-reinvent-the-supply-chain-landscape-map-cf28ba9557d1.

[33] *Id.*

[34] Margaret D. Fowler, *Linking the Public Benefit to the Corporation: Blockchain as a Solution for Certification in an Age of "Do-Good" Business*, 20 VAND. J. ENT. & TECH. L. 3 (2018), 881.

[35] William Young, Kumju Hwang, Seonaidh McDonald, and Caroline J. Oates, *Sustainable consumption: green consumer behaviour when purchasing products*, SUST. DEV. 18 (2010), 1, 18-31.

[36] Catherine Early, *Blockchain, regenerative farming and mobility as a service: global trends hold key to sustainability,* ECOLOGIST (February 9, 2018), https://theecologist.org/2018/feb/09/blockchain-regenerative-farming-and-mobility-global-trends-hold-key-sustainability.

[37] *See* Trautman, *supra*, note 12.

[38] Euroclear & Oliver Wyman, *Blockchain in Capital Markets: The Prize and the Journey*, at 12 (February 2016), http://www.oliverwyman.com/content/dam/oliver-wyman/global/en/2016/feb/BlockChain-In-Capital-Markets.pdf.

[39] McKinsey & Company, *Blockchain and the Insurance Sector*, Quarterly meeting of the Federal Advisory Committee on Insurance (FACI), (January 5, 2017), http://www.the-blockchain.com/docs/McKinsey%20-%20Blockchain%20Technology%20in%20the%20Insurance%20Sector.pdf at 2.

[40] *Id.* at 1.

McKinsey concluded that most of blockchain's initial $80-110 billion impact would be in the finance and insurance industries, in which most of early venture capital and established financial institutions' investments were made.[41] Ironically, therefore, it can be said that large and centralized institutions are pushing the adoption of this decentralized approach to data. Other sources have independently concluded that blockchain is poised to move from experimental to mainstream adoption between the immediate future and a time horizon of five to ten years, or roughly 2023-2028.[42]

Despite the potential of blockchain to correct for "imbalances caused by asymmetric information and opaque supply chains"[43] a 2016 study found that academic publications had, like venture capital, focused on the technology's relevance to finance, with scarcely a mention of its application in the field of logistics.[44]

Blockchain could also help to track quantities, cost, and impact of materials—Plastic Bank is an example of an application that could help turn supply chains into supply loops.[45] Other applications such as Electric Chain involve decentralized micro-grids so that local producers and consumers can exchange power without intermediaries.[46] LO3 is a company with a similar technology supporting the Brooklyn microgrid.[47] Finally, by tracking emissions against targets and limits, blockchain could help in the monitoring and regulation of climate-altering gases, regardless of whether the governance framework is self-regulation, regulation-by-disclosure, credit trading, or some system of pay-to-pollute.[48]

In this paper, we choose to limit the scope of our inquiry to the promise and limitations of the deployment of blockchain technology to reduce the harms and inefficiencies associated with supply chains. Specifically, we discuss the relatively unexplored question (in this context) of whether and how legal frameworks will remain relevant, the topic to which we next turn our attention.

IV. WILL LAWYERS AND LEGAL FRAMEWORKS REALLY BE RENDERED OBSOLETE?

The potential implications of blockchain technology for the law has spurred a range of analyses since 2015, with a variety of issues raised and opinions proffered. Some suggest that both the law and attorneys will be rendered largely obsolete or irrelevant.[49] There is the debate over

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[41] *Id.* at 6-9.

[42] Jay Samit, *4 Technology Trends that Will Transform Our World in 2018*, FORTUNE (December 2017), http://fortune.com/2017/12/26/4-technology-trends-2018/.

[43] Amina Badzar, *Blockchain for securing sustainable transport contracts and supply chain transparency – An explorative study of blockchain in logistics*. Masters Thesis, Lund University Libraries (2016), 19-22. https://lup.lub.lu.se/student-papers/search/publication/8880383.

[44] *Id*.

[45] *Project Breakthrough*, U.N. GLOBAL COMPACT (2016), http://breakthrough.unglobalcompact.org/breakthrough-business-models/closed-loop/.

[46] Srinivasan Keshav, *How blockchain can democratize green power,* THE CONVERSATION (January 7, 2018), https://theconversation.com/how-blockchain-can-democratize-green-power-87861.

[47] Elizabeth Woyke, *Blockchain Is Helping to Build a New Kind of Energy Grid*, MIT TECHNOLOGY REVIEW (April 19, 2017), https://www.technologyreview.com/s/604227/blockchain-is-helping-to-build-a-new-kind-of-energy-grid/.

[48] Tom Bauman, *What Is Blockchain GHG Management*, GHG MANAGEMENT INSTITUTE (October 18, 2017), http://ghginstitute.org/2017/10/18/what-is-blockchain-ghg-management/.

[49] *See* Mark Fenwick, Wulf A. Kaal, Erik P.M.Vermmeulen. *Legal Education in the Blockchain Revolution,* U. of St. Thomas (Minnesota) Legal Studies Research Paper No. 17-05 (March 23, 2017), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2939127.

whether a new body of law will emerge, and whether blockchain-enabled solutions could become another tool of centralized authorities.[50] Another way of characterizing forecasts is to distinguish between those foreseeing a greater degree of obsolescence of law as we know it, and those holding that legal frameworks will remain relevant and necessary. Ultimately, there is a nascent consensus, persuasively based on lessons of recent history, that existing legal institutions may adapt and will be needed to provide a framework for enforcing consequences.[51]

Mark Fenwick, Wulf Kaal, and Erik Vermeulen have clearly articulated how a combination of technologies—including but not limited to blockchain—threaten the current role of attorneys and law firms.[52] Their reasoning is largely based on the observation that existing training and structures do not prepare attorneys and organizations to be agile and adaptable.[53] Further, they cite others who see most roles for attorneys being automated[54] by technologies such as blockchain.[55] However, their ultimate thesis is that the education and role of lawyers can be tweaked, saving at least a select few from total obsolescence.[56] Deal-making and other tasks that require ambiguity and flexibility—including, as Nick Szabo would put it, translating the "wet code" of human norms into the "dry code" of programming languages—still leaves room for human attorneys.[57]

Wright and De Philippi have suggested that a "lex cryptographia" will emerge, consisting of "rules administered through self-executing smart contracts and decentralized (autonomous) organizations."[58] However, a thorough reading of their article does not propose substantive details and actually provides historical precedent and arguments for why conventional regulation is likely to continue in a blockchain-enabled world. Like other scholars, Wright and De Philippi review the scholarly debate between professors Frank Easterbrook[59] and Lawrence Lessig[60] over whether "cyberlaw"[61] is truly a separate field of law, or just a context in which generalizable principles are applied. Wright and De Filippi also explain why the blockchain "is—and will fundamentally remain—a regulatable technology" because of centralized chokepoints.[62] They point out that this is a task that has been facilitated by the recent concentration and centralization of Internet services.[63]

Kevin Werbach's review of the history of the theory and practice of regulation of the Internet further lends credibility to the view that some amount of regulation is possible, desirable, and inevitable in the coming age of blockchain.[64] Simply put, the law has always won; it has incorporated every disruptive technology for the sharing of ideas and value in the history of

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[50] *See* Wright and De Filippi, *supra* note 12, at 44-56.
[51] Michèle Finck, Carla L. Reyes, and Kevin Werbach have, to date, provided the best synopses and articulations of this emerging scholarly consensus. *See,* respectively, *supra* note 18, *infra* note 80, and *supra* note 9.
[52] Fenwick et al., *supra* note 46 at 6.
[53] *Id*. at 5.
[54] *See, e.g.,* John O. McGinnis and Russell G. Pearce, *The Great Disruption: How Machine Intelligence Will Transform the Role of Lawyers in the Delivery of Legal Services*, 82 FORD. L. REV. 6, 3041 (2014).
[55] *See, e.g.,* Benjamin Barton, *The Lawyer's Monopoly — What Goes and What Stays*, 82 FORD. L. REV. 6, 101 (2014).
[56] Fenwick et al., *supra* note 50.
[57] Nick Szabo, *Wet Code and Dry*, Unenumerated (August 24, 2008), http://unenumerated.blogspot.com/2006/11/wet-code-and-dry.html.
[58] Wright and De Filippi, *supra* note 12 at 4.
[59] Frank H. Easterbrook, *Cyberspace and the Law of the Horse*, 1996 U. CHI. LEGAL F. 207 (1996).
[60] Lawrence Lessig, *The Law of the Horse: What Cyberlaw Might Teach*, 113 HARV. L. REV. 501 (1999).
[61] Wright and De Filippi, *supra* note 12 at 47.
[62] Wright and De Filippi, *supra* note 12, at 51.
[63] Jack Goldsmith and Tim Wu, WHO CONTROLS THE INTERNET? ILLUSIONS OF A BORDERLESS WORLD (2006), at 65-86.
[64] Werbach, *supra* note 9 at 30-36.

humanity.[65] Witness the cyber-libertarian manifesto,[66] scholarly musings,[67] and actions to assert sovereign-less zones of the 1990s.[68] On the contrary: instead of the Internet providing a haven from government oversight and control, it became a channel of oversight[69] and control,[70] or, at worse, a weapon of manipulation[71] and war.[72] The Internet has been tamed and consolidated and controlled.[73]

Although Max Raskin's analysis is limited to smart contracts, his conclusions about the role of law in the age of blockchain are generalizable.[74] He notes that the role of self-executing smart contracts is a form of preemptive self-help that should not be discouraged by legislatures or courts.[75] However, he concludes that government and conventional legal frameworks will be needed to intervene and prevent enforcement of unconscionable contracts—or, more broadly, arrangements that are against sound public policy[76]—and that adopting existing frameworks to new blockchain-enabled technologies is possible and will encourage their adoption.[77]

Michele Finck has outlined an excellent typology of regulatory approaches already adopted in similar contexts.[78] Finck agrees with Kevin Werbach that innovators stand to gain from the certainty that a regulatory framework can provide. Finck urges a flexible and co-regulatory approach, citing successful examples of governments explicitly allowing the sandboxing—or experimentation in specified contexts—of blockchain applications.[79] If nothing else, regulation could at least provide a common lexicon and settled terminology. For example, Angela Walch has pointed out that it is not yet completely resolved whether a blockchain is the same as a distributed ledger,[80] nor, as Werbach points out, is it even settled whether one should write "blockchain" or "block chain."[81] Certainty is a good thing, and co-regulation was a constructive phenomenon in the context of the Internet; as Werbach has highlighted, "if anything, the innovators stand to lose the most by delaying the involvement of government in adopting reasonable solutions."[82]

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[65] *Id.* at 31.
[66] John Perry Barlow, *A Declaration of the Independence of Cyberspace*, https://www.eff/org/cyberspace-independence.
[67] *See* David R. Johnson and David G. Post, *Law and Borders: The Rise of Law in Cyberspace*, 48 STAN. L. REV. 1367 (1996).
[68] *See* Goldsmith and Wu, *supra* note 64.
[69] *See* EVGENY MOROZOV, THE NET DELUSION (2011).
[70] *See* Jonathan Zittrain, *Internet Points of Control*, 44 B.C. L. REV. 653 (2002).
[71] Associated Press, *The Latest: McMaster: Russian meddling beyond dispute* (February 17, 2018), https://apnews.com/966d5d2cbb614e4c9da8e6200505c9f6/The-Latest:-McMaster:-Russian-meddling-beyond-dispute.
[72] Kim Zetter, *Inside the Cunning, Unprecedented Hack of Ukraine's Power Grid*,, WIRED (March 3, 2016), https://www.wired.com/2016/03/inside-cunning-unprecedented-hack-ukraines-power-grid/
[73] Marshall Brown, *Humanitarian Blockchain: Coding For A Humane, Sustainable World Marshall Brown*, FORBES (February 18 2018), https://www.forbes.com/sites/marshallbrown/2018/02/15/humanitarian-blockchain-can-we-code-for-a-humane-sustainable-world/#5bba119b6f3d.
[74] Raskin, *supra* note 12 at 305.
[75] *Id.* at 305.
[76] *Id*. at 340.
[77] *Id.* at 340-41.
[78] Finck, *supra* note 18.
[79] *Id*. at 2.
[80] Angela Walch, *The Path of the Blockchain Lexicon (and the Law*) 36, REV. OF BANKING AND FINANCE LAW (2017) at 713 (forthcoming), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2940335.
[81] Werbach *supra* note 9, at note 1.
[82] *See* Werbach, *supra* note 9.

Carla Reyes builds upon several of the lines of reasoning above to perhaps most thoroughly articulate a vision of "crypto-legal structures."[83] She foresees governments building elements of regulation into code, with international structures developing as well.[84] Significantly, Reyes explains that, beyond self-execution, predictive technology and autonomous interaction could enable law (expressed as code) to learn and adapt—on its own, endogenously—in the course of its operation.[85] Besides reducing the lag time typically associated with legislating, regulating, or adjudicating cases, this phenomenon actually could result in a body of substantive rules that actually deserve their own moniker and to be recognized as a discrete subset of law. Interestingly, Reyes does not delve deeply into the potential due process problems presented by the possibility of self-revising law-in-code. Presumably, the answer to any such objection is that code can be programmed with procedural safeguards to assure that, for example, humans receive fair notice when software code starts self-editing and trying to play the role of autonomous legislator. Nevertheless, the ultimate thesis of Reyes' scholarship is that law and government can and should play a constructive role in both driving the adoption of blockchain-enabled technologies and then enforcing the real world consequences thereof. In this view, legal professionals and institutions do not become obsolete, but rather cooperate with coders to achieve both private and public policy goals.

V. REASONS TO TEMPER EXPECTATIONS ON THE ROLE OF BLOCKCHAIN IN GREENING BUSINESS

Now that we have reviewed available literature and resolved that legal practitioners and institutions will likely remain relevant in a blockchain-enabled world, we will explore the limitations of blockchain as applied to improving supply chains so as to eliminate waste and harms to people and the environment. This will add heft to our thesis that business supply chains are most likely to be optimized and made more environmentally sustainable when blockchain-enabled solutions are married to legal frameworks, along with sound policy goals and political will.

A. Unhackable like the Titanic was unsinkable, and even less green

In mid-2016 over one-third of $150 million committed to a blockchain-based cryptocurrency was stolen.[86] The Ethereum hack on its own was proof that blockchain applications are not entirely unhackable.[87] However, what is more interesting is that the code could not distinguish between a thief and a customer; according to the software, the theft was a legitimate use.[88] Further, to stop the theft, Ethereum had to split the DAO ("executing a hard fork"), while a renegade group started operating a duplicate currency; in other words, the ongoing theft was only stopped because the code could be changed.[89] It turns out that a blockchain-enabled platform—albeit a public, non-permissioned ledger at the bleeding edge of a new technology (not a private application)—was actually hackable, and the solution to the hack, ironically, was the fact that the record was not immutable.

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[83] Carla Reyes, *Conceptualizing Cryptolaw*, 96 NEB. L. REV. 2, 384 (2017) at 18-19.
[84] *Id*. at 23.
[85] *Id*. at 31.
[86] Werbach, *supra* note 9, at 5.
[87] *Id.* at 5-6.
[88] *Id.*
[89] *Id*. at 6.

Worse, advances in quantum computing mean that blockchain encryption in public blockchains will be increasingly vulnerable.[90] Even if encryption stays a step ahead of codebreaking, there are a variety of other vulnerabilities related to permissionless blockchains, including the non-zero probability that someone can amass enough power in a network to validate fraudulent records.[91] Again, legal mandates could set minimum reasonable standards of care for coders and institutions to protect them from future accusations of being careless.[92]

Besides lingering doubts related to hackability, another bedrock question of any new technology is whether the side effects of the cure are worse than the harm it is attempting to curb. Bitcoin alone has been consuming more energy than Ireland, and was anticipated to surpass the energy demand of New Zealand.[93] It turns out that widely distributing records and the related programming needed to confirm the validity of transactions requires a tremendous amount of electricity.[94] This has soured some green business advocates on the notion that blockchain-enabled solutions could make supply chains more environmentally sustainable. However, as with the hackability question, this problem is arguably surmountable with the large-scale adoption of emissions-free sources of energy. Companies such as Apple have shown that it is possible to source electricity to meet their massive needs for energy for data storage requirements.[95] To be completely zero net impact, of course, the entire technology industry has the remaining challenge of figuring out how to source, construct, and dispose of the electronics themselves in a way that does not involve toxic materials and polluting energy sources.

B. Who generates the original record?

Arguably, certification has been conflated with confirmation. No matter how allegedly tamper-proof it may be, data verification is only useful if the original record is reliable. Or, put another way: "garbage in, garbage out."[96] Nothing about blockchain technology eliminates conventional problems of establishing the nature of reality at the origin of a supply chain. In other words, when a certification is first created—at the point where an individual inspects and certifies that a labor abuse or environmental harm is not being committed—how can anyone be sure the certifying individual has not been bribed or coerced? Take, for instance, the context of certifying dolphin-safe tuna caught at sea or cobalt mined in the Democratic Republic of Congo.[97] Even if

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[90] Divesh Aggarwal, Gavin K. Brennen, Troy Lee, Miklos Santha, Marco Tomamichel, *Quantum attacks on Bitcoin, and how to protect against them*, CORNELL UNIVERSITY LIBRARY, https://arxiv.org/abs/1710.10377 (October 28, 2017), as cited in *Quantum Computers Pose Imminent Threat to Bitcoin Security,* MIT TECHNOLOGY REVIEW (November 7, 2017), https://www.technologyreview.com/s/609408/quantum-computers-pose-imminent-threat-to-bitcoin-security/.

[91] Roger A. Grimes, *Hacking bitcoin and blockchain,* CSO (December 12, 2017), https://www.csoonline.com/article/3241121/cyber-attacks-espionage/hacking-bitcoin-and-blockchain.html.

[92] The alternative is to allow the common law to evolve and for courts to determine over time what constitutes an appropriate standard of care in this context—the obvious disadvantage being that retroactively a judge may divine and apply a higher standard than a programmer may anticipate. Reference redacted to preserve anonymity of the authors in the review process.

[93] Alex Hern, *Bitcoin's energy usage is huge – we can't afford to ignore it*, THE GUARDIAN (January 17, 2018); https://www.theguardian.com/technology/2018/jan/17/bitcoin-electricity-usage-huge-climate-cryptocurrency.

[94] *Id.*

[95] Keshav, *supra* note 44.

[96] Just, *supra* note 28.

[97] Annie Kelly, *Children as young as seven mining cobalt used in smartphones, says Amnesty*, THE GUARDIAN (January 18, 2016), https://www.theguardian.com/global-development/2016/jan/19/children-as-young-as-seven-mining-cobalt-for-use-in-smartphones-says-amnesty.

the chain of custody is tracked perfectly and certification is validated along the value chain, how can anyone be sure that, in the middle of an ocean or a remote jungle, the certifying individual at the source was not tricked, mistaken, coerced, or corrupted?

Based on conversations with entrepreneurs with start-ups using blockchain to certify responsible supply chains, it seems that this is an acknowledged problem with certification schemes.[98] The ultimate solution offered by these individuals is the hope that autonomous sensing equipment and artificial intelligence will develop to a point that non-corruptible and 100% reliable hardened equipment will take the place of human inspectors and certifiers.[99] Until then, one of the necessary remaining roles of conventional frameworks—both regulatory agencies and, for example, the discovery process in civil litigation—is to provide a means of detecting, deterring, and punishing fraud.

C. Self-executing is not the same as self-enforcing

The other reason to temper expectations in blockchain's potential to optimize business supply chains is that observers seem to have conflated execution and enforcement.[100] Consequences sometimes still have to be enforced in the real world by employing the assistance of entities beyond the parties to a contract. Legal frameworks will still be needed—as they are now—to resolve disputes over whether obligations are fulfilled or excused. Lawyers do not execute contracts; they have and will continue to prepare them and figure out what should happen when the unexpected occurs.[101] Conventional dispute resolution frameworks are unnecessary in a majority of cases, yet will always be needed as a backstop precisely because—despite the best of intentions and careful planning—the unexpected does happen.[102] One could argue that law seems to be nonessential or obsolete as long as things work, but that it turns out to be essential when plans fail. Then, even the staunchest libertarians will want to recover losses and embrace and hope that legal institutions are there to enforce their interests.

D. Certifications only matter if someone cares

A key assumption made by those who believe that blockchain-enabled certifications can "green" supply chains is that someone—typically consumers—will notice and care and actually base their purchase decisions on whether a product or service has been certified. This is a problematic assumption, and the problem is compounded when industry groups establish their own (and easier-to-meet) certification standards that complete with activist-generated certifications.[103] In an extreme worldview—one that imagines conventional legal frameworks as entirely obsolete and completely replaced by the rules programmed into code—there would be no role for, say, the U.S. Department of Agriculture to set boundaries and standards to clarify what a term and a

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[98] Author's conversation with blockchain entrepreneurs (March 2018). Information redacted to preserve anonymity of authors in the review process.
[99] *Id. See also* Just, *supra* note 28.
[100] *See, e.g.*, Wright & De Filippi *supra* note at 12.
[101] *See* Raskin, *supra* note 12.
[102] *Id.*
[103] *See* Tad Mutersbaugh, *Fighting Standards with Standards: Harmonization, Rents, and Social Accountability in Certified Agrofood Networks,* 37 ENVIRONMENT AND PLANNING 11, 2033-2051 (2005).

certification such as "organic" actually means. Even when certification standards are set by a non-industry entity, not every consumer actually bases purchase decisions on certification.[104]

The best answer to this dilemma from entrepreneurs with blockchain-enabled certification solutions is that the consumer is not their client; rather, they are pitching their services to retailers such as Walmart.[105] Recently, retailers such as Walmart have stepped-up efforts to ensure that their products are reliably sourced as, for example, organic.[106] So, somewhat ironically, one massive source of support for the deployment of decentralized technology are large centralized institutions such as mega-retailers.[107]As mentioned above, and in the ultimate twist of irony, the very best spur to blockchain-enabled solutions for supply chain certification would be government mandates that claims to investors and consumers be validated using distributed ledger technology––a world, as some have predicted or recommended—where decentralized solutions are coopted by centralized authorities.[108]

E. Humans—our mindsets and goals—are still the key

Even the greatest champions of blockchain highlight the essential role of the human factor in optimizing the benefits of the technology. Jonathan Verbene notes that "…beyond radical transparency, automation, smart contracting and elimination of uncertainty and blind trust, only the vision and ingenuity of people and partnerships can realize the true potential of blockchain technology for our wellbeing, future prosperity, and enterprise."[109] The thesis of this section and the foregoing content on law was articulated by professors Mainelli and Milne as follows: "achieving all the potential benefits from mutual distributed ledgers will require board level buy-in to a substantial commitment of time and resource [sic], and active regulatory support for process reform, with relatively little short-term payoff."[110]

In this regard, blockchain is neither a panacea nor a *sine qua non* for sustainability-related problems in business supply chains. Remarkably, as advances in technology and connectivity have accelerated, so has growth in the awareness that our goals and ultimately mindsets are really the level where innovation is most needed if larger systemic problems are to be solved. In management literature, Peter Senge gets the earliest credit for highlighting this need, referring to the concept of a fundamental shift of mindset as *metanoia*, a precondition for solving big problems in learning organizations.[111] A literature stream in management about the key role of business leaders in catalyzing fundamental shifts of awareness and culture with stakeholders is widely seen as having been sparked by Ed Freeman.[112] Better access to data only matters inasmuch as individuals and

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[104] *Id.*

[105] Author's conversation with blockchain entrepreneurs. Names redacted to preserve anonymity of authors in the review process.

[106] Robert Hackett, *Walmart and 9 Food Giants Team Up on IBM Blockchain Plans*, FORTUNE (August 22, 2017), http://fortune.com/2017/08/22/walmart-blockchain-ibm-food-nestle-unilever-tyson-dole/.

[107] This is an echo of the irony touched upon earlier: that large centralized financial institutions are among the largest source of bleeding-edge investment into blockchain applications. *See supra*, Section III.

[108] *See* Reyes, *supra* note 84.

[109] Verberne, *supra* note 14.

[110] Michael Mainelli & Alistair Milne, *The Impact and Potential of Blockchain on Securities Transaction Lifecycle,* SWIFT Institute Working Paper No. 2015-007, at 1 (2016), http://ssrn.com/abstract=2777404.

[111] Peter M Senge, THE FIFTH DISCIPLINE: THE ART AND PRACTICE OF THE LEARNING ORGANIZATION (New York: Doubleday/Currency, 1990). Additional reference removed to preserve anonymity of authors in the review process.

[112] R. Edward Freeman, STRATEGIC MANAGEMENT: A STAKEHOLDER APPROACH (Boston, MA: Pittman, 1984). Additional reference removed to preserve anonymity of authors in the review process.

organizations actually care, pay attention, are not deceived, and use information when they choose how to act.[113] As events and trends in the new millennium have shown, we have better access to information than ever, yet there are enormous and widespread failures in human capacities to recognize misinformation, and to care about and act upon meaningful data that serve the goals of sustainable production and consumption.

VI. CONCLUSION

This paper has reviewed the basic principles of blockchain technology and its pitfalls and potential as it relates to encouraging sustainable practices in supply chains. Undoubtedly it has the potential to increase transparency and trust. After reviewing available literature, however, the paper concludes that optimism with regard to blockchain should be tempered by three factors: first, the extent to which the computing technology and its energy requirements can be provided with no net environmental harm. Second, law will not become irrelevant; attorneys will still have a role in translating human intentions into world of code and mechanisms for enforcing consequences in physical reality will still matter. Third, the human element will still matter: someone has to create records, and consumers—or else governmental or private sector intermediaries—still have to care enough to actually forego some purchase options based on availability of negative information about a product or service. The human element also cannot be underemphasized with regard to the largest overall problem: technology on its own will not eliminate harms. It will not assure the creation of systems with net zero environmental harm or a regenerative ecological impact. It is simply a tool. The greatest factor in advancing civilization and its component organizations and individuals to functioning with net zero environmental harm is still our own mindsets: the awareness, empathy, ambition, and discipline to set and execute audacious-yet-necessary goals. Such goals can sometimes be expressed through business planning, sometimes through laws, but most necessarily through our actions and purchase decisions. Expectations of blockchain technology as a means of optimizing and greening business supply chains should be tempered with a dose of pragmatic realism. It is a tool that must be married to good governance and legal frameworks to maximize its impact.

[113] Additional reference removed to preserve anonymity of authors in the review process.