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Collison of Blockchain and Construction

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Cryptocurrency has had newsworthy boom and busts, but what (if anything) does that mean for blockchain technology and the construction industry? This paper aims to go beyond the basics of blockchain technology and its current uses to explore the current, near and longer-term possibilities for the intersection between blockchain and construction. Blockchain's decentralized nature and ability to link "chains" of transactions into ledgers creates better ways for construction stakeholders to track the flow and delivery of goods, services, and contract deliverables, apply building information modeling (BIM), use project documents, adhere to code-required processes, complete accurate field reporting and as-builts, and track payments. By automating the usually manual processes for these tasks, blockchain allows for real-time, transparent management of construction projects. This paper will consider the why and how of blockchain in construction as well as its potential legal pitfalls and risks to ascertain whether it has a earned a permanent place in the construction industry's future. [1]

I. INTRODUCTION

Blockchain has garnered significant coverage over the past several years following the advent of cryptocurrencies like Bitcoin and the ensuing booms, busts, investigations, and general confusion that these novel currencies brought with them. The blockchain protocol is actually much older than Bitcoin and was first described in a 1982 dissertation by American computer scientist David Chaum.[2] Chaum set forth most of the elements that would later be detailed in the Bitcoin whitepaper, and even developed a digital currency through his company, DigiCash.[3] Chaum was, however, ahead of his time, and DigiCash ultimately went bankrupt in 1999.[4] It took another decade from Chaum's attempt for the first decentralized blockchain, and the advent of the modern blockchain era, was implemented as a core component of Bitcoin in 2009, and was developed to serve as the public ledger for all transactions on the network.[5] Though blockchain

has close ties to cryptocurrency, and was initially employed to support the reliable transfer of digital assets for cryptocurrency, its implications are much, much broader, and it has the potential to work its way into virtually every industry that utilizes digital records keeping.[6]

But what is blockchain? At its core, blockchain is a distributed ledger of information with growing lists of records (blocks) that are securely linked together via cryptographic hashes[7] (essentially a code or string of unique characters for the data that acts as its fingerprint tracing it back to that specific data). Or, in plainer terms, a blockchain is a database that is distributed across a network of computers, each of which can independently verify the data's validity by comparing it with a local copy. New data is added in the form of blocks, which are linked using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data. The linked blocks form a chain, not unlike a chain of title maintained by a municipal records department, except that this chain is distributed across a vast network of users and based on its cryptographic and decentralized nature, is immutable. Essentially, blockchain allows for parties who do not know or trust each other to maintain an immutable database and ledger of time-stamped transactions and can be used as the foundation of not only digital currencies, but also information exchange, project management and accountability, and payment.[8] The implications and opportunities are nearly limitless, and in fact have already permeated the construction industry.

Within the past decade, we have seen an upsurge of design and construction related technologies, promising to address the various inefficiencies that have long plagued the industry and to deliver projects faster and with fewer resources.[9] According to McKinsey research, construction productivity has been flat for decades, while in manufacturing productivity has nearly doubled over the same time period.[10] Construction projects often involve hundreds of

entities and generate over hundreds of thousands, if not millions, of documents, with many companies and individuals still using spreadsheets and manual records to keep track of it all. A 2018 study by PlanGrid and FMI estimated that "rework caused by miscommunication and poor project data cost the U.S. construction industry more than $31 billion in 2018." [11] Virtually every problem, every claim, and all the challenges to scheduling and budgeting originate from the inability to access the right information at the right time. It is no surprise then that blockchain has made its debut on the construction technology scene, offering improved transparency and communication, increased efficiency, and enhanced security.

Among its other benefits, blockchain offers improved transparency and collaboration to an industry that critically requires it. When project data is added to the blockchain, every participant in the chain gains access to verified, complete, updated, and accurate project information to work with. Facilitating open and easy access to the same information in real-time will result in better communication and collaboration. This approach is geared at reducing ambiguities, improving efficiencies, and avoiding errors. And because the blockchain can reliably identify the entity or individual responsible for specific entries, stakeholders, here the project participants, can track participation and accountability via a transparent and real-time platform. Thus, blockchain can be used to relieve various concerns that participants typically have, such as ownership of IP, liability, project oversight, data access, and traceability.[12]

Blockchain also offers increased efficiency with respect to project management. Using this technology, construction companies can automate processes and reduce the need for intermediaries. For example, smart contracts can be used to tie specific processes to a BIM model to improve efficiency in supply chain transactions, confirm key process events, track weather conditions in real time, confirm change orders, provide notice, and automatically release

funds when specific milestones are met.[13] This can help to speed up the construction process and reduce delays caused by these steps passing through multiple (human) hands. And as more design information is modeled using BIM (Building Information Modeling), blockchain will play a role in creating the information record on who did what and when, providing a basis for future disputes concerning liability[14] and arguably a way to avoid the dispute or more directly resolve them.

A third benefit of blockchain is the enhanced security through its use of cryptography and the inherently decentralized and immutable nature of the record. Cryptographic algorithms make it almost impossible for unauthorized parties to corrupt, delete, or overwrite the data, and because each block contains a record of previous transactions and is stored across multiple computers, tampering with the data is extremely difficult and highly unlikely.[15]

Despite the many benefits that blockchain technology offers to the construction industry, there are still some potential challenges and risks that are unfolding. Legal questions exist related to using blockchain in any application including construction. These include the uncertain and in-flux regulatory landscape; the jurisdiction, choice of laws and evidence issues when using the blockchain records in binding dispute resolution, and cybersecurity risks. Blockchain is also a relatively new technology, which means not all construction and design companies can find the right-sized blockchain solutions to implement for their projects or justify the costs (including devoting the resources to learn and implement the technology). Finally, it is important to note that the decentralized and immutable nature of blockchain can also raise issues of liability and accountability in case of any illegal or malicious activities. None of the risks and challenges are insurmountable and all signs point to blockchain is here and here to stay.

Blockchain has the potential to revolutionize the construction industry. By offering improved transparency, increased efficiency, and enhanced security, blockchain can help to streamline construction processes and improve the overall quality of construction projects. While there are still challenges to be addressed, the benefits of blockchain technology in construction are clear, and it is likely the industry will move to adopt more of this technology in the near and long term future. The following highlight examples of this technology in practice and then this paper turns to the current challenges and risks and possible ways to address them.

II. ROLE OF BLOCKCHAIN IN DESIGN DOCUMENTS

As discussed above, blockchain is changing the way that stakeholders collaborate on construction projects, and one area of particular significance is that of project development and design. By utilizing blockchain's ability to securely record and share data across a decentralized network, architects, engineers, and builders can work together more efficiently and effectively, in real time. This means that architects and engineers can work on building designs and immediately share them with contractors and fabricators for review and input, which in turn greatly speeds up the design process and ensures that all stakeholders are on the same page before work begins.

The core value of blockchain is its ability to protect the integrity and security of the data being shared, mitigating many of the concerns that often surround the sharing of intellectual property. Operating in a decentralized system, it is almost impossible for any party to tamper with or simply use the wrong outdated data. This imparts a level of trust for stakeholders that the data they are working with is accurate and reliable. Take for example an architecture firm that wishes to use a cloud-based data management and archiving system, maintained either by them or via a third party on their behalf. While they may share information from this database, and

even grant access to other stakeholders, these stakeholders will not accept assertions of authenticity for the content or timing of data sharing if there is a dispute. As a result, each of the parties will maintain separate, often incomplete copies of the same data, leading to data confusion.[16] Blockchain offers a streamlined alternative – a single digital thread that unifies the data for stakeholders.

One company engaged in the development of reliable blockchain systems for the exact purpose of design and construction is Concert VDC.[17] Concert was formed to create a mechanism where architects and engineers could ensure the integrity of their authorized design data. But it also more generally creates a platform for other design, construction and real-estate stakeholders can share project data.[18] Take for example the SoFi Stadium project in Inglewood California. SoFi Stadium is the pinnacle of large-scale entertainment design. Created to support two NFL football teams, an MLS soccer team, and regular large-scale concerts and performance events, this 100,000-seat stadium is a new wonder of the world. SoFi sits between the final approach corridors for LAX airport, the fifth busiest airport in the world. To maintain the required clearances for air traffic, the stadium had to be built 100' underground. The team owners and developers wanted to create a facility that could be used in all weather conditions, but still take advantage of the "open-air" climate of southern California. HKS, the project designer and architect of record, designed a broad sweeping roof that reaches over all aspects of the facility, touching the ground at only four major intersections. At the same time, this massive roof had to feel light, almost as if it were flowing like a wave over all aspects of the venue. The resulting arched roof structure spans more than 450' and is covered with more than 35,000 custom aluminum panels, no two of which are the same. Traditionally, this would have been a cost prohibitive and complex problem to solve.

Concert's blockchain technology used to professionally certify and authenticate more than 35,000 digital files that were used to fabricate the anodized aluminum panels for the roof structure. Direct digital sharing between the design team, city code officials, and all the fabricators involved in creating the roof facilitated the required communication to realize a complex design solution in a timely and cost-effective manner. While the outcome was a success, there initial challenges related to getting the state and local code authorities to accept the digital submission and signature. Even with the acceptance of the digital information, hardcopy (PDFs) of the traditional plans also had to be submitted to the local officials. Ultimately, however, Concert's core software was responsible for the digital authorization, professional signature, permitting, fabrication, and installation of this mind-bending wonder of the world.

III. ROLE OF BLOCKCHAIN IN PROJECT REPORTING

Another aspect of the industry primed for blockchain is progress-tracking. The development of a digital record of all the transactions that take place during the construction process allows stakeholders to easily see where the project stands and what still needs to be done in real time. This can help to prevent delays and ensure that the project stays on track. There are several startups already offering project reporting platforms maintained via blockchain technology.

Weldchain LLC[19] is one such startup, intended specifically for use by and between contractors and welding subcontractors. This platform was developed to collect, verify and store information relating to certified welding, and the application (or app) only applies to information related to the welding itself. Through the platform, contractors can post information concerning weld jobs to be completed, and welders can report job status as well as any issues or suggested

modifications. Inspectors can then confirm that all welds are performed up to code, which can be demonstrated to contractors, customers, etc.

Weldchain incentivizes stakeholders to record information in a timely and accurate manner through the use of an earning (token/voucher/credit) system, eliminating waste associated with paper records. This system is particularly effective for those aspects of a project that are highly regulated and require additional oversight and inspection. In many cases, welding codes require specific process steps or Standard Operating Procedures (SOPs). These codes are not just specific to construction in the biopharmaceutical sector they impact various other types of construction from automotive, railroad, robotics, aerospace, structural welding.[20] If the prescribed steps are not followed, the final product (in this case a weld) will be non-compliant and will require removal and replacement. These applications include water for injection as well as medical gas oxygen piping.[21] Weldchain's system, harnesses blockchain technology by awarding credits for various discrete actions taken in the field, requires adequate completion of each step on the application in order to move on to the next. The application contains inherent automations to verify methods and required credentials. Credits are made available by the project owner and are required for the owner to gain access to the reported information. In essence, tokens flow from those who need the information to those who provide the information. The platform also provides a permanent and immutable record for contractors and subcontractors, which in turn provides the record of contractors' performance.

Startups like Weldchain offer stakeholders a truly paradigm-shifting progress-tracking platform based on blockchain technology. Improved transparency, increased efficiency, cost savings, verifiable ownership, and enhanced security are a few of the numerous benefits that these platforms offer to construction projects.

IV. ROLE OF BLOCKCHAIN IN PAYMENTS AND TRANSACTIONS

Blockchain technology also has the potential to shake up the traditional methods of conducting transactions and making payments in the industry. Late payments and the relating cash flow issues are innate to these traditional methods. Average payment times for construction companies, especially those further down the payment chain from the owner, can exceed hundreds of days, which puts financial pressures on those contractors and suppliers arguably less able to absorb it and thereby endangers the entire project.[22] With its ability to offer secure, fast, and transparent transactions, blockchain offers an appealing alternative to current methods.

The most well-known example of blockchain technology being employed for financial transactions is undoubtedly cryptocurrencies. As discussed above, cryptocurrencies are digital currencies that are decentralized and secure, and they can be used to make fast and secure payments anywhere in the world. The most popular cryptocurrency, Bitcoin, has been used for years to make online purchases and send money to friends and family. More recently, of course, Bitcoin and others dealing in cryptocurrency, such as Ethereum and FTX, have experienced a glut of lawsuits for failure to register as securities and worse, including fraud, which have resulted in seizures of cryptocurrency assets by the US government.[23]

However, blockchain technology itself offers alternative means of conducting payment transactions outside the realm of the traditional cryptocurrency (e.g. Weldchain's use of credits as incentive for accurate and timely reporting). A transaction conducted via blockchain technology might look something like this: (1) First the transaction is initiated between the parties; (2) this transaction is "written" as unique data and broadcasted to the whole network for validation; (3) during the validation, among other things, the transaction is reviewed for duplicity and the identities of sender/ receiver are confirmed; (4) once the network reaches consensus, the

validation is done, and the hashed transaction information is included in a "block" creating a tamper-proof record; (5) then the blockchain is updated with the new block and in this way the whole network has its own up-to-date copy of the blockchain as well; (6) finally, the transaction is concluded, the transferred digital asset, data, or order, etc. is received with the immutable record of its origin and the fact of the transfer.[24]

Such transactions come with significant benefits. First, they are less susceptible to fraud, misstatement, and human error because the payment system is decentralized and each transaction is verified by multiple users. In addition, blockchain technology offers lower transaction fees compared to traditional payment methods by eliminating the need for intermediaries such as banks and payment processors, reducing the costs associated with these intermediaries. Finally, blockchain technology offers greater transparency in payment transactions, as all transactions are recorded on a public ledger that is accessible to anyone. This makes it easier for stakeholders to keep track of their payments and reduces the risk of disputes.

Blockchain also provides the framework for smart contracts, which have the potential to revolutionize digital payment transactions. A smart contract is a self-executing contract with the terms of the agreement between buyer and seller being directly written into lines of code. This eliminates the need for intermediaries and makes the transaction faster and more secure. Smart contracts are computer programs or transaction protocols stored on a blockchain that are intended to automatically execute, control or document events and actions according to the terms of a contract or an agreement, when certain predetermined conditions are met.[25] They typically are used to automate the execution of an agreement so that all participants can be immediately certain of the outcome, without any intermediary's involvement or time loss.[26] This eliminates the need for intermediaries and makes the transaction faster and more secure.

As a hypothetical, consider the following: at a construction site every laborer who enters the site swipes his or her ID card or other scan for security, as well as health and safety reasons. The information about who entered and how much time they spent on site working is captured and registered on a blockchain enabled distributed ledger accessible to and maintained between the client, the consultant and the contractor. In this way there is no additional administration needed to validate this information, no digging through daily time cards or verifying work reports, as the information has already been logged on the blockchain in realtime. Based on the agreed terms with regards to the number of worked hours on site, a smart contract can initiate payment and send payment certifications for all parties as needed.[27]

Blockchain technology has the potential to revolutionize the way industry members conduct transactions, make payments, protect data, and verify ownership. It can reduce costs, increase transparency, and streamline processes in various industries such as real estate, transportation, education, and energy.[28] As a secure, fast, and transparent platform, it facilitates and integrated payment process that is easier, faster, and more secure for everyone. As the technology evolves and more businesses adopt it, we can expect to see blockchain begin to annex more of the transaction and payments market, including within the construction industry.[29]

V. DISCUSSION OF LEGAL IMPLICATIONS RELATED TO USING BLOCKCHAIN IN CONSTRUCTION

As construction lawyers, we are tasked with understanding at least the basics of the blockchain technologies so we can help our clients navigate the identified and future legal risks as applied on construction and design projects. At present, there are legal questions including choice of laws issues and the uncertain regulatory landscape, cybersecurity risks, and evidentiary and proof issues. Perhaps looming in the longer term future with respect to construction and design are even standard of care and standards of meeting good industry practice raised by *not*

using blockchain for certain applications. None of the questions are insurmountable but require attention by practitioners.

A. Regulatory Landscape

Legal counsel to construction industry companies must be aware that governmental regulation of blockchain remains in the nascent stages. For the most part, the regulatory discussions concern the *cryptocurrency* application of blockchain. But even in that space federal legislation is limited. Congress has left enforcement and regulation to the agencies[30] —Securities and Exchange Commission (SEC), Commodity Futures Trading Commission (CFTC) and the Treasury which have all issued rules and guidance—and the states have weighed in as well.[31] To date the challenges with regulation stem from how to categorize what the blockchain asset really is – property, security, or commodity. "At the start of 2023, the SEC and CFTC are at odds regarding whether ether is a security or commodity, which would determine which is the primary regulator."[32] However, in March 2023, the New York Attorney General pursued Ethereum in a lawsuit for not registering as a security, which has "injected fresh confusion into the legal debate."[33] The overarching view about cryptocurrency is that "regulators are warranted in stepping in to provide restrictions due to initial coin offering scams, Ponzi-based projects, misrepresentations and faulty token designs that can cost investors billions dollars. The recent string of bankruptcies, highlighted by the collapse of FTX, underscores the need to protect consumers in this volatile industry."[34] In sum, regulation of cryptocurrency is on the horizon. How those regulations could potentially impact *all* uses of blockchain technology and whether there will be standardization of blockchain rules and procedures remains in flux.[35]

B. Jurisdiction & Conflict of Laws

Should a dispute related to blockchain asset arise, jurisdictional questions exist about where the blockchain resides as there is no central repository. The nodes of the blockchain and the transactions themselves can be located in multiple locations around the world. As a result, there are "laws that govern the platform regarding the multiple jurisdictions that may or may not apply."[36] For example, in the matters *Shaw v. Vircurex* and more recently in 2023 in *Cox v. CoinMarketCap OpCo LLC*, the court dismissed the cases for lack of personal jurisdiction because the plaintiff could not show the necessary contacts with the forum for a digital currency exchange.[37] The federal district court decided the *Cox* case in early 2023, so a Federal Circuit Court decision is on this important issue is on the horizon.

While to date the reported cases on jurisdiction concern cryptocurrencies, cases implicating blockchain technologies more broadly and used in the construction can raise similar issues. Consider that ownership and control of data was the subject of a United Kingdom case *Trant Engineering Limited v Mott MacDonald Limited*.[38] Trant engaged Mott to provide a number of consultant services, including BIM and a data environment (an arguable analogy to blockchain). As a result Mott controlled the data. The parties ended up in a payment dispute and Mott shut down Trant's access to the data and the model. Trant moved for an injunction. While the case was decided without incident relative to proper jurisdiction in the British Technology and Construction Court, the subject matter and issues preview that access to crucial blockchain assets could in the future raise such jurisdictional problems. Practitioners can work to address these issues with proper contract drafting and implementing proper project controls.[39]

C. Validity of Smart Contracts

There are also issues surrounding smart contracts and their legal status. Smart contracts are self-executing contracts with the terms of the agreement between buyer (owner, general contractor) and seller (general contractor, subcontractor, supplier) being directly written into lines of code. However, it is still uncertain whether smart contracts are enforceable and immutable to ambiguity.[40]

"In practice, smart contracts don't eliminate the need for a written contract that specifies the terms of the agreement between the parties."[41] Rather the "smart" part of the contract are prepared by computer programmers "who are tasked with translating previously agreed upon terms into executable code."[42] The risk and challege is that the programmer is not otherwise involved in the transaction. "In a nutshell, no computer program can determine its own semantics. The program may have a fixed, objective syntax. But the act of giving meaning to that syntax — whether by talking about the program or by running it — requires something outside the program itself."[43] As a result, "if something goes awry in a transaction, technical experts would be required to explain how the computer code accurately captured the intent of the parties."[44] That, of course, can lead to disputes.

D. Admissibility of Blockchain Records in Binding Dispute Resolution

What if a dispute arises relative to records stored in the blockchain – whether the design, project data or the payment records. Surely those records will be admissible as the immutable record of truth and accuracy. However, some commentators have noted that based upon the "applicable principles of the law of evidence . . , blockchain reports are only admissible in federal court in limited circumstances through the residual exception to hearsay enshrined in FRE 809."[45] Of course, the oft response is that these are, of course, all textbook business

records kept in the ordinary course justifying an exception to hearsay rules. However, that may not be true. Courts have held that "[a] qualified witness is simply one who can explain and be cross-examined concerning the manner in which the records are made and kept."[46] In the context of blockchain, however, this is not routine in part because a number of project stakeholders (some of whom may be adverse to each other) have all had a hand in creating or authenticating the record. As a result "to be 'qualified' under that [federal evidentiary] standard, a potential witness would need to be competent not only to testify to the manner in which the data entered into the blockchain was gathered by the user, but also to the specifics of how the specific blockchain at issue processed that data to produce the record. In many instances, identifying such a uniquely competent witness will prove impossible."[47] As a result, it the usual exceptions for business records may not be available.

But there certain schools of thought, specifically the Department of Justice, believe the Federal Rules of Evidence are flexible enough to address and allow admissibility. In particular, "if court determines that the virtual currency transactions [or other blockchain transactions] are hearsay-eligible statements of the sender rather than computer generated records [or compilations], the "someone with knowledge" would be the sender himself, who transmitted the information to the other members of the virtual currency [blockchain] network upon signing and announcing the transaction."[48] Furthermore, this commentator pointed to the "the advisory committee notes to Rule 803(6) comment, there is no requirement that the witness be involved as a participant in the matters reported. Rather, the records may be admitted through someone acting merely as an observer."[49] This interpretation would permit advancing the evidence without the awkward situation of having to put forward an adverse party possibly unwilling to authenticate.

As with many of these blockchain legal issues, the law is still catching up and data. At least one state, Vermont, "has classified blockchain evidence as self-authenticating and it therefore qualifies as a business record."[50]

E. Standard of Care and Good Industry Practice

Finally, while blockchain is new-er on the scene presently, that will not always be the case and the uses will become varied and widespread. Practitioners should keep in mind that the failure to properly adopt, implement and protect using cybersecurity the blockchains methods that are intended to serve as the immutable source of truth for construction project data may itself be considered a breach good industry practice or failing to meet the standard of care. [51]

VI. CONCLUSION

Blockchain has been described as the "biggest innovation since the internet. Billions of dollars have been invested into projects that are building technology on the blockchain."[52] Without question, blockchain has already collided with the construction industry. Cutting edge technologies and new business ventures, such as Weldchain LLC and Concert VDC as featured in this paper, are harnessing its uses. How the law will apply and adapt to these technologies is largely untested but for certain that will be part of the future.

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[1] The author thanks M. Lynne Cooper of WeldChain LLC and Tim Dufault of ConcertVDC for their insights preparing this paper.

[2] Alan T. Sherman et al., *On the Origins and Variations of Blockchain Technologies*, 17 IEEE Security & Privacy 72 (2019). Chaum's 1982 Berkeley dissertation proposed every element of the blockchain found in Bitcoin except proof of work. The proposed vault system lays out a plan for achieving consensus state between nodes, chaining the history of consensus in blocks, and immutably time-stamping the chained data. The paper also lays out the specific code to implement such a protocol.

[3] Id.

[4] Julie Pitta, *Requiem for a Bright Idea*, Forbes, Nov. 1, 1999, https://www.forbes.com/forbes/1999/1101/6411390a.html?sh=78d681cc715f.

[5] *The Great Chain of Being Sure About Things*, The Economist, Oct. 31, 2015, https://www.economist.com/briefing/2015/10/31/the-great-chain-of-being-sure-about-things.

[6] Ibrahim Alkurd, What Is the Blockchain And why Does It Matter?, FORBES, available at https://www.forbes.com/sites/theyec/2020/05/18/what-is-the-blockchain-and-why-does-it-matter/?sh=3428439548a1

[7] Nathaniel Popper, *A Venture Fund With Plenty of Virtual Capital, but No Capitalist*, The New York Times, May 22, 2016, https://www.nytimes.com/2016/05/22/business/dealbook/crypto-ether-bitcoin-currency.html.

[8] *What is Blockchain Technology - IBM Blockchain*, IBM, https://www.ibm.com/topics /blockchain.

[9] Nancy Greenwald, *The New Toolbelt: BIM, Blockchain and Smart Contracts* (American Bar Association 2020).

[10] Balint Penzes, *Blockchain Technology in the Construction Industry*, Institution of Civil Engineers (2018).

[11] Nancy Greenwald, *The Digitization and Automation of Construction: AI, Robotics, and the IoT*, Surety Bond Quarterly (2022), https://www.suretybondquarterly-digital.com/ sbpq/0422_winter_2022/MobilePagedArticle.action?articleId=1839200#articleId1839200.

[12] Supra note 9.

[13] Id.

[14] Ziga Turk & Robert Klinc, *Potentials of Blockchain Technology for Construction Management*, Science Direct (2017).

[15] Note that in practice, actual file data is not stored on the blockchain, as this would be cost-prohibitive. Instead, the block contains a record of the data at the moment in time it was recorded. The actual data file can be stored anywhere. Once recorded, the data file can be compared against the record on the blockchain to determine if it is the same data. If any portion of the data in the file is changed, then the blockchain will not recognize it as the same data file. This is why blockchain works so well as the ledger, it creates an immutable record of the information, just as a financial ledger simply serves to record a financial transaction.

[16] Zach Gentry, (*Re)Building on the Promise of Blockchain*, Concert (2022), https://www.getconcert.com/rebuilding-on-the-promise-of-blockchain/?utm_source=Concert+VDC&utm_campaign=8c202c3b35-EMAIL_CAMPAIGN_2022_12_01_01_26&utm_medium=email&utm_term=0_-8c202c3b35-%5BLIST_EMAIL_ID%5D.

[17] Concert VDC, https://www.getconcert.com/

[18] Tim Dufault, *Reliance vs. Reliability: How are They Different?*, Concert (2023), https://www.getconcert.com/reliance-vs-reliability-how-are-they-different/

[19] Weldchain LLC, https://www.weldchain.net/about-the-technology

[20] Welding Codes, Wikipedia (2022), https://en.wikipedia.org/wiki/List_of_welding_codes; The American Welding Society, https://en.wikipedia.org/wiki/American_Welding_Society.

[21] Id.

[22] Balint Penzes, *Blockchain Technology in the Construction Industry*, Institution of Civil Engineers (2018).

[23] Why is Bitcoin's Price Falling, FORBES, (Mar. 23, 2023) *available at* https://www.forbes.com/advisor/investing/cryptocurrency/why-is-bitcoins-price-falling/

[24] Id.

[25] Smart contract, Wikipedia (2019), https://en.wikipedia.org/wiki/Smart_contract.

[26] *What are smart contracts on blockchain?*, IBM (2022), https://www.ibm.com/topics/smart-contracts.

[27] Balint Penzes, *Blockchain Technology in the Construction Industry*, Institution of Civil Engineers (2018).

[28] Nirmal Raj, *The Future of Blockchain Technology In Education*, eLearning Industry (2023), https://elearningindustry.com/the-future-of-blockchain-technology-in-education.

[29] Margaret Bell, *How Blockchain Technology Is Revolutionizing The Real Estate Market*, www.linkedin.com (2023), https://www.linkedin.com/pulse/how-blockchain-technology-revolutionizing-real-estate-margaret-bell.

[30] Cryptocurrency Laws and Regulations by State, May 26, 2022 https://pro.bloomberglaw.com/brief/cryptocurrency-laws-and-regulations-by-state/; Beginners Guide to Cryptocurrency Laws, March 7, 2023, https://www.forbes.com/sites/digital-assets/article/beginners-guide-to-crypto-regulation/?sh=30a208906628

[31] Blockchain and Distributed Ledger Laws: State-by-State Adoption, Practical Law Practice Note w-019-0651; see e.g. Kyle A. Conway, *Blockchain Technology: Limited Liability Companies And The Need For North Carolina Legislation,* 45 Campbell L. Rev. 127, 128 (2023)

[32] Beginners Guide to Cryptocurrency Laws, March 7, 2023, https://www.forbes.com/sites/digital-assets/article/beginners-guide-to-crypto-regulation/?sh=30a208906628

[33] Why is Bitcoin's Price Falling, FORBES, (Mar. 23, 2023) *available at* https://www.forbes.com/advisor/investing/cryptocurrency/why-is-bitcoins-price-falling/; see also Dave Michaels, N.Y. Attorney General Labels Ether a Security, Injecting Fresh Confusion Into Crypto Legal Debate, WALL STREET JOURNAL (Mar. 9, 2023)

[34] Supra note 32.

[35] Supra note 9 (noting that groups such as "International Association for Trusted Blockchain Applications (INATBA)" which includes "representatives of governmental organizations and

standard setting bodies from all over the world to promote the collaborative development of the technology. The regulatory framework for blockchain development remains in flux.")

[36] Dr Alan Ma, Emerging Legal Issues In Blockchain For Construction Supply Chains, Birmingham City University, England

[37] *Shaw v. Vircurex*, 2019 WL 2636271, at *1 (D. Colo. Feb. 21, 2019); *Cox v. CoinMarketCap OpCo LLC*, 2023 WL 1929551, at *18 (D.Ariz., 2023).

[38] Trant Engineering Limited v Mott MacDonald Limited, [2017] EWHC 2061 (TCC).

[39] Supra note 9 ("Best practices mean bringing the contract language into alignment with the workflows" and noting that "Best practices include considering a range of project governance issues that may or may not be reflected in contract terms, for example, clarifying the expectations for technology use in project governance and communications, whether incorporated into the contract or not.")

[40] Grimmelman, James, *All Smart Contracts are Ambiguous*, 2 U. Penn. J.L. & Innov. (2019) ("Smart contracts are neither smart nor contracts, but the name has stuck. Instead, they are mechanisms that enforce agreements using software rather than law. The contracting parties write a computer program that embodies their agreement. The program updates as they perform their obligations, and automatically delivers the appropriate resources to them as they become entitled to payment."); *see also* David G.W. Birch, *Blockchain Smart Contracts Aren't Smart and Aren't Contracts*, Forbes.com *available at* https://www.forbes.com/sites/davidblack/2019/02 /04/blockchain-smart- contracts-arent-smartand-arent-contracts/#3b55f2511e6a

[41] Supra note 9.

[42] Id.

[43] Grimmelman, James, *All Smart Contracts are Ambiguous*, 2 U. Penn. J.L. & Innov. at 11 (2019); Peter L. Michaelson, and Sandra A. Jeskie, *Arbitrating Disputes Involving Blockchains, Smart Contracts, And Smart Legal Contracts*, 74 Disp. Resol. J. 89, 113 (2020).

[44] Supra note 9.

[45] J. Collin Spring, The Blockchain Paradox: Almost Always Reliable, Almost Never Admissible, 72 SMU L. Rev. 925, 927(2019).

[46] Id.; *see also* Angela Guo, Blockchain Receipts: Patentability and Admissibility in Court, 16 CHI.-KENT J. INTELL. PROP. 440, 444–45 (Apr. 2017) ("[T]he admissibility of these distributed ledger receipts has not been entirely settled.")

[47] Id.

[48] See generally C. Allen Pelker et al, Using Blockchain Analysis from Investigation to Trial, 69 Dep't of Just. J. Fed. L. & Prac. 59 (2021) (noting that "examining the Federal Rules of Evidence reveals multiple clear paths to the admission of blockchain evidence.")

[49] Id.

[50] Supra note 9 (citing 12 Vt. Stat. Ann. §1913).

[51] *See generally* Peter L. Michaelson, Sandra A. Jeskie, *Where The Disputes Lie: When Blockchain Technology Will Need Help Sorting Out Its Contracts*, 39 Alternatives to High Cost Litig. 81 (2021); Nick Curley, *Blockchain Disruption: Digital Assets Are Changing How We Do Business*, 25 SMU Sci. & Tech. L. Rev. 265 (2022)

[52] Supra note 6.