



Centre for Maritime Law
Faculty of Law

NUS Centre for Maritime Law Annual Report 18/03

SHIPPING AND TECHNOLOGY

Mr Elson Ong

Research Associate, Centre for Maritime Law

1 Introduction

Blockchain has been a buzzword of late and can be attributed to the unbelievable surge in the value of Bitcoin and other cryptocurrencies in late-2017. This generated considerable public interest in the mysterious blockchain technology behind these cryptocurrencies. The blockchain was once a work of fiction, described as The God Protocols.¹ Today, it is a technological reality. It has been described as the second generation of the Internet² and identified to be a key driver of the Fourth Industrial Revolution³. While the blockchain was designed to solve global problems with applications across several industries, including the maritime industry, it was born of lofty ideals which may or may not be compatible with the legal system. Therein lies an opportunity to undertake research at the intersection between the blockchain technology and the law. It is timely for us to work, and research, on the developing legal framework today.

2 Blockchain technology and Singapore

Singapore, as an aspiring smart maritime nation, should seize this research opportunity to cement its position as a thought leader in maritime law, supporting its vision as an International Maritime Centre (IMC). This will be an essential step towards strengthening the global perception that Singapore is the premier technologically progressive international maritime city of the future. This is more important today than ever, as Singapore assumes the ASEAN Chairmanship, which counts deepening economic integration and improving regional trade facilitation, especially in e-commerce, as one of its responsibilities.⁴

The digital transformation of the Singapore maritime industry will bring immediate benefits through greater efficiency.⁵ The digitalisation of trade and maritime documents, such as bills of lading, which could involve the use of blockchain technology, is being actively considered by

¹ Nick Szabo, 'The God Protocols' (*The God Protocols*, 1997) <<http://nakamotoinstitute.org/the-god-protocols/>>.

² Don Tapscott and Alex Tapscott, *Blockchain Revolution: How the technology behind bitcoin is changing money, business and the world* (Portfolio Penguin 2016) 12.

³ Klaus Schwab, *The Fourth Industrial Revolution* (Portfolio Penguin 2017) 19.

⁴ Vivian Balakrishnan, 'Commentary: ASEAN is at an inflection point' (*Channel NewsAsia*, 05 Feb 2018) <<https://www.channelnewsasia.com/news/singapore/commentary-asean-is-at-an-inflection-point-9926476>>.

⁵ Marex, 'Singapore Boosts Maritime Digitalization' (*The Maritime Executive*, 14 January 2018) <<https://www.maritime-executive.com/article/singapore-boosts-maritime-digitalization>>.

stakeholders such as the Maritime and Port Authority of Singapore (MPA), Port of Authority of Singapore (PSA), Singapore Customs, and Singapore Shipping Association (SSA).⁶ Furthermore, the blockchain technology relates to other innovative technologies employed by the maritime sector. High technology automated equipment is currently deployed at the Pasir Panjang Terminal, and slated for upscale at the Next Generation Tuas Port. The consolidated mega port will adopt similar innovations, and additionally involve the Internet of Things⁷, to stay ahead of the competition.⁸ It is oft-cited that the Internet of Things needs a ledger of things⁹, the ledger being associated with the blockchain technology. With these developments, it is anticipated that the blockchain technology will play an increasingly important role in Singapore.

3 Blockchain technology and law

The allure of the blockchain technology has been met with some ambivalence. While touted as the messiah which will miraculously eradicate the financial ills of the high seas, and also free up congestion at ports¹⁰, this elusive technology is a stranger to many and not very well understood by lawyers. Moreover, there is a nagging apprehension surrounding the interaction of blockchain technology with trusted legal concepts. Yet, the blockchain-based bills of lading may be that promising technological solution we need to resolve the inherent difficulties of paper documentation in international trade.¹¹

The uncertainty surrounding the legal value of electronic transferable records constitutes a hindrance to international commerce and, for this reason, the United Nations Commission on International Trade Law (UNCITRAL) recently adopted the Model Law on Electronic Transferable Records (MLETR) at its fiftieth session on 13 July 2017. Member states of the United Nations,

⁶ Ibid.

⁷ IMC 2030 Advisory Committee, 'IMC 2030 Strategic Review Report' <https://www.gov.sg/~sgpcmedia/media_releases/mpa/press_release/P-20170922-2/attachment/IMC%202030%20Strategic%20Report.PDF>.

⁸ Royston Sim, 'Keeping the ships sailing in – why the Tuas mega port matters' (*The Straits Times*, 10 December 2017) <<http://www.straitstimes.com/singapore/keeping-the-ships-sailing-in-why-the-mega-port-matters>>.

⁹ Don Tapscott and Alex Tapscott, *Blockchain Revolution: How the technology behind bitcoin is changing money, business and the world* (Portfolio Penguin 2016) 152.

¹⁰ See Elson Ong, 'Call a bill a bill: *The Star Quest*' (2017) 23 *Journal of International Maritime Law* 328, 335.

¹¹ Ibid.

including Singapore,¹² are in the midst of considering whether to enact domestic legislation to give effect to the MLETR. However, we are treading new waters and there is, understandably, considerable hesitancy in letting the genie out of the bottle.

I single out one such ideal of the blockchain technology which encapsulates cognitive dissonance: ‘code is law’.¹³ This is especially prevalent among developers of smart contracts¹⁴ and, in a way, reflects the disparity between how lawyers perceive the code and how coders perceive the law. While there is some confluence between the legal system and the information system, each is not in perfectly harmony with the other, at least with today’s understanding of each system. In the shipping and technology conference reports that follow, we will witness a number of discourses, sometimes reasoned, other times impassioned, from fervent believers of each system.

4 Future of Law Conference: The Internet of Things, Smart Contracts and Intelligent Machines¹⁵

This conference kickstarted with a welcome address by Simon Beswick, International CEO of Osborne Clarke, and was followed by a speech by the guest of honour, Mr Ng How Yue, Permanent Secretary of Ministry of Law, who discussed how the Internet, artificial intelligence, and blockchain threatened the ring fences of the practice of law and how lawyers could respond to this. Professor Ian Kerr, University of Ottawa, opined that it required a leap of faith¹⁶ to

¹² The Info-communications Media Development Authority (IMDA) and the Attorney-General’s Chambers (AGC) are conducting a review of the Electronic Transactions Act (Cap 88) (ETA) and considering whether Singapore should adopt the provisions of the draft MLETR which would, amongst other things, allow an electronic bill of lading created under the enacted MLETR to enjoy the same legal recognition as a paper bill of lading. For more information, see IMDA and AGC, ‘Joint IMDA-AGC Review of the Electronic Transaction Act (CAP. 88) - Review of Draft UNCITRAL Model Law on Electronic Transferable Records (Public Consultation Paper)’ <https://www.imda.gov.sg/-/media/imda/files/inner/pcdg/consultations/consultation-paper/public-consultation-paper---uncitral-model-law-on-etr_10-march-2017.pdf>.

¹³ ‘Code is law’ refers to the idea that, with the advent of digital technology, code has progressively established itself as the predominant way to regulate the behavior of Internet users.

¹⁴ Smart contracts are the application layer that makes much of the promise of blockchain technology a reality. For more information, see Mark Walport, ‘Distributed Ledger Technology: beyond block chain’ <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf>, 22-24.

¹⁵ 26-27 October 2017, SMU Law School (organised by Osborne Clarke and the Centre for Cross-Border Commercial Law in Asia (CEBCLA), SMU Law School).

¹⁶ This phrase originates from Søren Kierkegaard.

overcome human resistance to rely on artificial intelligence. One way to breach this resistance was to use anthropomorphic design to project trust in machines. He identified the four levels of artificial intelligence and singled out artificial narrow intelligence (ANI) for discussion. The three characteristics of ANI, autonomy¹⁷, emergence¹⁸ and social valence¹⁹, will lead to legal questions for the next generation of lawyers to answer. Mr Koh Chia Ling, Managing Director of Osborne Clarke, discussed the biased propensity and self-reinforcing behaviour of artificial intelligence (AI) which was in contrast to the human unpredictability. This could lead to AI achieving a result that might be unacceptable by human standards and begged the question whether AI had to be regulated or not. Professor Sharon K Sandeen, Mitchell Hamline School of Law, indicated that wrongful acquisition tort in cyberspace did not exist yet because it was difficult to identify the harm. Since the costs of information lockdown information were high, some wrongful acquisition might have to be tolerated. Dr Cristiana Sappa, IÉSEG School of Management, considered that in a sharing-based paradigm like that in the Internet of Things (IoT), it was difficult to fulfil the requirements for trade secret protection, especially since individual data might be trivial and not of commercial value.

The second day started with Dr Jonathan Galloway, Newcastle Law School, who mentioned that there were two needs in a digital age thriving on innovation. The first was for society to trust the regulators. The second was for the regulators to be transparent to have legitimacy in its processes, and identify problematic innovation and design competitive regulatory frameworks with the capability of protecting societal interests. Dr Gary Low, SMU Law School, showed that the online marketplace can be regulated by transparency of information, trust, and technology. As studies showed under-reporting of negative reviews in online reviews, reputational systems might not be trusted notwithstanding that seventy per cent of consumers were shown to trust online reviews. Mr Simon Spooner, Osborne Clarke, identified four disruptors to mobility: connectivity, autonomy, sharing economy, and electrification. He identified two key issues: whether there was a responsibility or duty to share mobility testing data and the need to rethink the idea of social contracts (as, for example, with pedestrians on the road). Mr Aviv Gaon, Osgoode Hall Law School, identified the difficulty of defining artificial intelligence and explored

¹⁷ This refers to the artificial intelligence being able to sense, think and act independently of any human intervention.

¹⁸ This refers to the artificial intelligence being able to perform tasks that are unintended.

¹⁹ This refers to the artificial intelligence being able to be perceived less like an object and more like a social being.

whether artificial intelligence could be captured by references to 'person' in copyright legislation. He proposed that we should not turn to legal fictions in answering this question. He also recommended that copyright and patent protection be given, depending on the level of intelligence or originality. The programmer should reserve all rights, economic and moral, when the creation was assisted by computer. The programmer should share the rights with the public domain, when the creation was generated by computer. The programmer should not have any rights, when the creation was generated by artificial intelligence, and the economic rights should vest in the public domain with moral rights for the artificial intelligence. Dr Alexandra George, University of New South Wales, noted that there had been no change to intellectual property's fundamental concepts and functions in the face of dramatic technological changes. Based on past trends, she expected little change to intellectual property law in the age of blockchain and IoT, except some tinkering around the edges, particularly where territoriality was concerned. Prof Katja Lindroos, University of Eastern Finland, explained Lessig's theory of governance, which consisted of five parts: technology, law, social norms, market, and supply and demand. She explained that while technology was neutral, social norms were enforced by the players. While blockchain had the potential to solve the double spending problem, good technology would fail if people stop believing in it. Moreover, illegal activities using blockchain technology had affected the brand. Her concern was that the use of technology without human oversight might lead to unforeseeable problems and concluded that the law must be superior to technology. Ms Mizuki Hashiguchi, Oh-Ebashi LPC & Partners, spoke on proximate cause for intelligent machines. While enigmatic error by an intelligent machine could be characterised as unforeseeable because it was designed to work meticulously, it could also be characterised as foreseeable.

The second half of the second day focused on commercial law matters. Professor Chris Reed, Queen Mary University of London, explained that off-chain assets exist outside the ledger both physically (land, goods) and as legal rights and claims (bonds, shares, carbon credits, etc). While the blockchain was an immutable ledger, with no one being able make changes unilaterally, law and regulation could act on the asset outside the ledger. Thus, the ledger needed to contain legal impurities, even though they were technologically unnecessary for the system to work.²⁰

²⁰ For more information, see Chris Reed and others, 'Beyond BitCoin – legal impurities and off-chain assets' [2017] Queen Mary University of London, School of Law < <https://ssrn.com/abstract=3058945>>.

Professor Reed identified two main classes of legal impurities that might be necessary. First, identity disclosures to counterparties and to third parties (regulator and other system participants). Second, modification of the ledger by third parties, rectification (eg for fraud), and delaying or preventing transactions. It was not as simple as coding the law; legal impurities clashed with the objective to maintain the integrity of the ledger. It might not be possible to code the law to find intention. For example, fraud, which depended on external evidence of intention and subjective state of mind of the victim, could vitiate transactions. Things happen within the blockchain but things happen outside the ledger as well and someone must have the power to fix that. The other option was to change the law substantively, especially in areas where technology regulated human interactions, which were messy and not easily computable (e.g. abolish money laundering control and introduce a completely new concept of property ownership). Dr Miriam Goldby explained that in order for paper bills of lading to be replaced by electronic alternatives, such an alternative had to perform the bill of lading's evidentiary function to record the relevant rights. The use of a centralised registry required the assurance that the third party was trustworthy. Distributed ledger technologies offered a consensus mechanism which allowed parties to a shared fact to know that the fact they saw was the same as the fact that other stakeholders saw and applied across the Internet among mutually untrusting parties. This could, in some way, perform the role of trust. Dr Goldby discussed the requirements for electronic records under the Model Law on Electronic Commerce, the Rotterdam Rules, and the Model Law on Electronic Transferable Records. She concluded that the electronic bill of lading would probably have to be on a closed ledger, rather than open (distributed) ledger, which relied on a consensus mechanism. Mr Jen Krebs, University of Portsmouth, explained that the digitising of the bill of lading caused a problem akin to double spending which could, in a similar way, be resolved with blockchain technology. In closing, Professor Roger Brownsword of King's College London explored the various challenges facing regulators and concluded that the appropriate response to emerging technology should not be to overregulate or underregulate, but to regulate it just right. He recommended that regulators support instead of stifle beneficial innovation.

5 Singapore Registry of Ships Forum 2017: Innovation in Challenging Times²¹

The theme for the SRS Forum 2017 was 'Innovation in Challenging Times'. This focused on how companies could leverage on innovative practices such as blockchain and e-certification to improve work processes.

Mr Andrew Tan, CEO of the Maritime and Port Authority of Singapore (MPA), explained how technology was opening great opportunities, such as intelligent ships and IoT. MPA would now issue e-certificates (E-Certs) directly to Singapore-registered ships in addition to those issued by recognised organisations.²² The MPA had also expanded Marinet, its Internet-based e-commerce system, to include two new online services. The first would apply for ship registration and the appointment of managers. The second would apply to various documents issued by the SRS. The expansion would provide timely issuance of certificates and declarations to the vessel. Additionally, aerial drones armed with cameras and ship inspecting robots were increasingly being used for ship surveys and were safer and could save time and costs for shipowners.

ABS then explained cybersecurity, what implications this had for vessels, and the need for good cyberhygiene. Mr Edgar Chin, Incisive Law, identified possible cybersecurity issues that could arise with autonomous shipping, such as ransomware. Professor David Lee, Singapore University of Social Sciences (SUSS), explained that blockchain was the driver of the Fourth Industrial Revolution and was unstoppable. He explained the workings of blockchain technology and its application across different domains. The design of the blockchain was such that it was resilient to centralised authority, with cryptocurrencies being the product of people who were unhappy with the financial system. Mr Tang Sau Weng, SG Smart Tech, opined that blockchain could turn the whole ship chartering industry into a paperless paradise.

²¹ 17 November 2017, Amara Singapore.

²² These certificates are proof that the vessels are compliant with the various regulations or conventions applicable to them. The use of E-Certs would save time and costs, reduce the need for hard copies, allow for instantaneous and simultaneous transmissions of documents, and reduce the risk of fraud.

6 The Future is Crypto? An interdisciplinary workshop on the blockchain revolution²³

Mr Juan Llanos, Consensys, gave a presentation on 'Reinventing Regulation for the 21st Century: How Smart Contracts and Blockchain Are Reshaping Policymaking, Regulation & Compliance'. He questioned the rationale of regulating the blockchain when other protocols such as HTTP or SMTP were not regulated. In his view, innovation required permission to fail and that we went from the rule of law to the rule of lawyers. He contended that one should not judge a nine year old institution, blockchain technology, with an institution with 5000 years of history, law. He stressed that it was important for lawyers not to just sit in the ivory tower of policy making but to understand technology.

Professor Dan Hunter, Founding Dean of Swinburne Law School in Melbourne, gave a presentation on 'The Legal Significance of the Blockchain'. Previously, the only way to get around the double spend problem was through intermediaries. Today, there was another solution to the double spend problem, which was to have everyone share the ledger. He then compared the pros and cons between permissioned and permissionless blockchains. Professor Hunter went on to expound on smart contracts that take over the enforcement mechanism. He expected that registries were among the legal fields to be disrupted. For example, there could be a ledger for recording asset ownership, provenance and transactions which would be a proof of existence for a copyright licensing system. Moreover, there could be an automated tracking of licenses and assignments via tokens, and the registration of copyright ownership and licenses via smart contracts.

Associate Professor Kelvin Low and Assistant Professor Eliza Mik of SMU gave a presentation on 'Pause the Blockchain Legal Revolution'. They averred that the coders are ideologists, whose main contention was that centralisation was bad while decentralisation was good. They explained that decentralising systems were self-emerging with no single point of control and hence no one would be able to fix it when something went wrong. Furthermore, they were unable to accept the argument that just because decentralising systems were trustless, they were superior. They also pointed out that while it was possible to code contractual rights, how

²³ 2 February 2018, SMU Law School. This conference was organised by Applied Research Centre for Intellectual Assets and the Law in Asia (ARCIALA), SMU Law School.

were concepts like proprietary rights and bona fide purchaser for value without notice coded? Moreover, software was not bug free.

They revealed that in asset registries, blockchains relied on oracles to supply the data feed from the external real world.

Finally, they communicated that users would have to trust other people who had read the code and the code itself. However, the code was not perfect. They cited the attack on The DAO in 2016, resulting in a hard fork. Mr Juan Llanos replied that The DAO was a prototype and the code would improve over time.

7 Blockchain, Distributed Ledger & Smart Contracts: Understanding The Law & Regulation For 'Industry 4.0'²⁴

The principal speaker was Malcolm Dowden of Womble Bond Dickinson. Mr Dowden explained that blockchain was applicable to a wider range of sectors than just cryptocurrencies. While there might be concerns about the environmental impact of the blockchain technology underlying the Bitcoin, the technological processes were showing signs of becoming more efficient. Cryptocurrencies were creating a medium of exchange without trusting intermediaries using consensus. Rather than replacing the need for trust, blockchain relocated trust to the technology and to the programmers of the technology. The validity or security of the blockchain was as good as the coding. Governments were clamouring to regulate something which did not wish to be regulated. Governments were determined, however, to draw blockchain into the regulatory perimeter.

Smart contracts that sit on top blockchains and fully smart contracts had coded every element using if-then statements. The question arose whether such smart contracts were actually contracts. They would first have to meet the formality requirements (e.g. land contracts) and must be valid and existing as a recognisable contract before they could be augmented by automation. It would be difficult to have a global smart contract because of jurisdictional

²⁴ 23 February 2018, Amara Singapore. This conference was organised by Thomson Reuters and Asian Legal Business.

differences between legal systems.

Additionally, IoT could eliminate evidential gaps. In October 2016, 88 bales of cotton were traded using a blockchain-based smart contract. GPS tracked the geographic location of the goods in transit. On arrival at their final destination, the smart contract automatically triggered the release of funds. Mr Dowden shared other use cases. Presently, the only way to figure out how much cargo was damaged was to physically open the container and inspect the cargo itself. With IoT, instead of opening up the shipping container and seeing physical surveys, low cost sensors could measure the humidity to reliably infer data. If those environmental perimeters were met, this would trigger a price adjustment within relevant bands of humidity. While this would not always produce a perfect answer, it was at least better than what we had at present, where we just guess.

From his discussions with computer scientists from the University of Southampton, coders could code every element in smart contracts. However, he questioned whether they could code reasonable endeavours. The computer scientists' response was this would be possible using an 'if-then' statement. However, there had to be some external data feed. The scientists looked at payment terms because payment terms in a smart or data driven contracts were executed by the agreed data feed, triggered for example by using the if-then statement to trigger payment when the goods arrived at the specified destination using GPS data. In a similar way, earthquake data could provide the data feed to be the force majeure trigger. However, reliance on the data feed to track commercial consequences might have legal implications. If there was a cargo which was susceptible to late delivery and you could see from the data day by day that it was going too slowly to arrive on time, should that accelerate the point at which contractual consequences (damages) should flow? Was the buyer free at that point to call or was it obliged to say that if delivery was late, we were going to claim our full contractual damages. If no claim was made, did this constitute a waiver? Would this result in an estoppel? Did it affect the remedies that accrued?

The presentation continued, discussing how dynamic procurement and smart contracts were going to interact. Dynamic procurement involved locating how many of a particular component was left, using minimum quantity clauses (e.g. for pallets in manufacturing). Once sensors picked

up the raw materials, the requirements were brought to a potential platform to a range of possible suppliers, and the suppliers offered a quantity of the price and the deadline for delivery. If those elements matched the requirements, an order was placed. Next, Mr Dowden illustrated how distributed ledger technologies (DLTs) could achieve frictionless trade using smart contracts.²⁵ He queried whether it was possible to make the revenue authority a party to the contract to enforce the payment terms in the smart contract or whether legislation was required.

Mr Dowden explained that because the blockchain ledger was immutable, changes could only be made to the blockchain using a fork. A fork happened when it was split into two branches. He explained that there were two types of forks: hard forks and soft forks. A hard fork was essentially a permanent divergence from previous versions on blockchain. It was a permanent and radical change to the protocol that made previously valid block invalid. The old chain ran on old rules and the new chain ran on new rules. Hard forks could prevent the abuse of the network. On the other hand, the soft fork was backward compatible, meaning that the new chain ran on new and old rules. In order to decide if and when a fork occurred and the nature of the fork, a consensus mechanism which required at least 51% of the computing power had to be brought in favour of the fork.

Mr Dowden also shared a concern that personal data recorded in a distributed ledger might not be protected under the European Union's General Data Protection Regulation (GDPR). This might occur when a new computer which joined the blockchain network was not a computer in the European Union and would receive a full replicated copy of the ledger when it joined.²⁶ He pointed out one might have an order from one country to release data, but complying with that order could be a breach of the GDPR. Moreover, it was not a defence to comply with the order of another country unless there was a treaty that this country had ratified.

²⁵ For more information, see Mark Walport, 'Distributed Ledger Technology: beyond block chain' <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf> , 69-70.

²⁶ For more information, see Christopher Holmes, 'Distributed Ledger Technologies for Public Good: leadership, collaboration and innovation' <http://chrisholmes.co.uk/wp-content/uploads/2017/11/Distributed-Ledger-Technologies-for-Public-Good_leadership-collaboration-and-innovation.pdf> , 8.

On business structures, he considered whether technology would yield to the law or whether the law would yield to technology. Would the law shift to accommodate the technology? Would decentralised autonomous organisations (DAOs) be given some form of recognition as an international corporate entity? How would a corporate identifier or an incorporation number be assigned? Could DAOs be regulated and, importantly, could they be taxed? These were questions that governments were also thinking about. The United Kingdom was looking to tax these entities on a revenue rather than a profit basis. Mr Dowden suggested that treaties amongst countries could be negotiated to govern the DAOs.

In closing, he introduced the Accord Project²⁷, a project to develop open source technology and standards for 'computational contracting' for the legal world that deployed blockchain technology and distributed ledgers.

8 Conclusion

As we witness the final vestiges of our analogue systems with the emergence and inexorable rise of the blockchain technology, it is incumbent on us to ensure that the blockchain is anchored to the law. The legal implications of the use of blockchain bills of lading is still shrouded in mystery and a robust and resilient legal framework is essential if the shift from paper bills of lading to blockchain bills of lading is to be successfully achieved. As a lawyer-researcher and tech-savvy millennial, I hope to contribute to the ongoing debate on blockchain bills of lading by researching and writing about a sensible legal framework in preparation for the introduction of blockchain bills of lading. The blockchain and the law will operate seamlessly one day, but we should approach the blockchain today with cautious optimism.

²⁷ The project is supported by Linux Foundation's Hyperledger and The International Association for Contract and Commercial Management (IACCM). Mr Dowden is part of the Accord Working Group.