Blockchain Technology for a Firearm Registry

Digna Bharath Soni [a], Martin Lukas Mahler [b]

[a]*Auckland Institute of Studies, New Zealand*
[b]*Auckland Institute of Studies, New Zealand*
martinm@ais.ac.nz

Abstract

Blockchain technology has the potential to facilitate an effective firearm registry allowing for real-time traceability and visibility, with the ultimate goal of decreasing gun violence. The need for a firearm registry has been identified in New Zealand following the 2019 mosque shootings in Christchurch. Blockchain technology is proposed as an effective firearm registry system as it possesses the capability to record information in a decentralised and unalterable ledger that provides visibility, transparency, traceability and authenticity by reducing the complexity, making for an efficient process. Some of the complexities confronted are having access to real-time data / information, tracking and tracing, which will be effectively addressed using a firearms registry system. This article provides an in-depth examination of blockchain technology and its introduction globally, examining as to whether blockchain technology, having received recognition through 'bitcoin', is a credible decentralised solution that can go beyond a secure method of payment. As part of this article, processes are looked into that would allow for an effective firearm registry and what components make it effective to ensure key elements include security, accessibility as well as the feasibility of having access to data on a real-time basis.

***Keywords*:** Blockchain, Firearm Registry, Internet of Things, Ledger, New Zealand

Introduction

The need for a firearms registry in New Zealand became apparent after the gruesome Al Noor Mosque and Linwood Islamic Centre shootings in Christchurch (New Zealand) on 15 March 2019 (Daalder, 2020). There have been considerable objections to a firearm registry in the past, with a prior push towards a firearm registry in New Zealand scrapped because it was decentralised and on paper (Daalder, 2020). Blockchain as a technology is often used as a substitute for cryptocurrencies with there being a lack of appreciation for blockchain as an effective means to trace items. Extensive research on the effectiveness of such tracing in the supply chain industry had been conducted (Majta, 2012; Pettey, 2018). For the supply chain industry, this is something that has become essential, given supply chains have become increasingly complicated, prompting the need for a real-time ledger, which exists in the form of blockchain technology. Supply chain tracing requires similar elements to what would be needed from a firearm registry, notably the visibility of real-time data / information, tracking, tracing and the capability to pre-empt the risks and address them effectively (Majta, 2012). Blockchain technology satisfies said requirements as a decentralised and unalterable ledger that provides visibility, transparency, traceability and authenticity by reducing complexity (Pettey, 2018).

Blockchain technology

Stuart Haber and Scott Stornetta created the concept of blockchain technology through a publication in the year 1991, with a mere focus on timestamping the documents on a digital platform without having the feature of editing (Beyer, 2018). In 2008, the Bitcoin white paper was released (Nakamoto, 2008) followed by the subsequent release of the now well-known cryptocurrency, Bitcoin (Beyer, 2018). The white paper referred to Bitcoin as a peer-to-peer electronic cash system that would allow online transactions without the involvement of financial institutions using a system that allows timestamping of transactions (Nakamoto, 2008). The peer-to-peer network timestamps the transaction and proposes a solution to the double-spending problem by hashing them and creating an ongoing chain of hash-based proof-of-work (Nakamoto, 2008).

The fact that blockchain is informative and records a series of actions in a systematic manner that is not related to the financial sphere alone can be identified from the definition stated by Vitalik Buterin (Pilkington, 2016). While his definition does not refer to ledger or transactions, it focusses on the essential features of the key applications in blockchain beyond cryptocurrencies as a distributed storage system, proof-of-location, decentralised voting system and so forth (Pilkington, 2016). As part of the Ethereum platform in the year 2014, developments took place meaning that transactions would occur only if conditions were met and this framework on conditions is embedded in the blockchain through the smart contracts that validate the special nodes on the network (Bambara et al, 2018). Using that logic, 'Decentralised Autonomous Organization' (DAO) applications can be built that will connect peer-to-peer parties using unique transactions that 'Enterprise Organisation Structure' (EOS) can use for smart contracts, that validates the nodes and executes the transactions irrespective of it being on a public or private network (Bambara et al, 2018). Smart contracts are a transaction protocol or computer programme that automatically execute, control or document legally relevant actions according to the terms of the agreement (Bambara et al, 2018).

Sequence of blockchain

Blockchain is the arrangement of blocks that are created by recording the series of transactions in a similar manner as a traditional ledger that is further distributed (Bambara et al, 2018). A block is essentially a page of a ledger, which is completed once it reaches a specified number of approved transactions, upon which, a new block is formed. The steps involved in the flow of blockchain begins when a block is created detailing the nature of dealing, when one party has a request for a transaction from another party. This is broadcasted to all the nodes on the network along with the responsibility that validates the block and the transaction, which is coherent with the protocol, further ensuring that there is no duplication (Bambara et al, 2018). Upon validation, these nodes are added to the chain enabling verification, accelerating the process and completing the transaction (Bambara et al, 2018). The primary block in a blockchain is referred to as genesis and the blocks in the chain are related with the previous blocks hash function and the value of all the transactions in the block is referred to as the Merkle tree root hash (Zheng, Xie, Dai, Chen, & Wang, 2017).

Features of blockchain

Over the years there has been significant development in the system of blockchain and the current system is classified into three types of blockchain including; public, consortium and

private blockchain, based on the following key features (Zheng, Xie, Dai, Chen, & Wang, 2017).

a) Consensus determination: Since there is no leader in blockchain, a mechanism is used to derive a decision in agreement with a group of people and further supports the decision benefitting all the parties involved (Maple & Jackson, 2018). In a public blockchain, all nodes could take part in the process whereas, in a private blockchain, the same is not the case as only the nodes that are part of the organisation are permitted to derive at the consensus. In the case of consortium blockchain, the nodes that are selected on the network validating the block, partake in the decision-making process (Zheng, Xie, Dai, Chen, & Wang, 2017).
b) Read permission: Blockchain is a distributed ledger and in this network, every node is free from the external control but, interconnected with each other. Thus, in a public blockchain, the ledger is open and distributed making the transactions visible to those on the network. However, this can differ in the case of consortium or private blockchain depending on the access or restriction granted on the block (Zheng, Xie, Dai, Chen, & Wang, 2017).
c) Immutability: With immutability, there is no central control and a copy of the transaction is shared with all the nodes on the network which is further timestamped (Hofmann et al., 2017). On a public blockchain, the transaction cannot be altered as the partakers on the network is extensive (Sayelyev, 2018). However, the participants on private and consortium networks are limited.
d) Efficiency: With the help of smart contracts, enterprises can now rely on the system and quickly make settlements. Due to the limited number of nodes on the network in private and consortium blockchain, the process is quicker and more efficient. However, in the case of a public blockchain, the number of nodes to validate the transaction is extensive and can make the settlements slower with the efficiency being lower (Zheng, Xie, Dai, Chen, & Wang, 2017).
e) Centralised: Decentralised means that nodes on the network responsible for validation do not have any central authority and control is provided based on the private or public key (Nair & Sebastian, 2017. While the public blockchain has a decentralised network, a consortium blockchain uses both the networks. Private blockchain uses a centralised network providing the user with complete control (Zheng, Xie, Dai, Chen, & Wang, 2017).
f) Consensus process: According to the blockchain consensus guide, public blockchain is permission-less and everyone can join the network to partake in the decision-making process. Consortium blockchain and private blockchain is permissioned to have the participants included in the network. While consortium blockchain can be applied in the business applications, the Hyperledger that is a support system for non-financial and industrial applications is developing the frameworks (Hyperledger, 2020).

Despite the advancing features, there is a lack of understanding of the technology, as blockchain is a fairly new technology that is constantly evolving. Scalability is one of these challenges, managing the growing number of blocks in the system that requires the nodes to store the transaction and validate them, which is a lengthy process and consumes large amounts of energy (Zheng, Xie, Dai, Chen, & Wang, 2017). Constant regulatory changes in different countries also pose as a barrier. Further, privacy and security issues in blockchain is another concern as the information is available publicly. Leakage of information is still controllable in private and consortium blockchain, but the concern remains for public blockchains (Vaghela, 2019).

Transformation of blockchain in diverse verticals

While blockchain was initially known and identified for the cryptocurrency bitcoin, the technology has made its way to various business applications. The nascent technology has the

capability to manage extensive datasets, contracts and can further disrupt existing processes, technologies and services. Blockchain technology is often misunderstood as it is mostly referred to as cryptocurrency leading to many enterprises initially refused to invest blockchain technology. However, the use has become evident with large enterprises such as Walmart, Microsoft, IBM, Samsung either having arranged for their own blockchain or joined ownership for the use of the technology (Bambara et al., 2018). Particularly the use of smart contracts through blockchain technology makes the technology useful for enterprises and demonstrates a transformation in various fields that relate to currency, asset management, contracts, data management and peer-to-peer with applications in fields including governmental services, law and crime fighting among many others (Attaran & Gunasekaran, 2019).

Development of blockchain in firearms

A firearms registry process brings with it considerable complexities, as it requires extensive documentation and authorisation from various departments such as training and education certifications, medical and mental health records, police clearance records, and reference checks from licensed gun users (New Zealand Police, 2020). The current process lacks tracking and traceability of the weapons that are in possession of civilians as well as the ability to identify the owners of a weapon, which is currently an extensive search process for law enforcement (Seitz, 2018). Blockchain technology can resolve the issue of the registry and tracking the firearms without disrupting the existing laws based on the conceptual framework established by Thomas Heston in his white paper released in 2018. The author identified aspects that could facilitate the tracking of guns, improve the background checks through a centralised system by utilising distributed ledger and smart contracts, enabled through blockchain technology (Heston, 2018).

The smart contract enabled blockchain technology has the ability to develop and manage a database to track the guns from the stage of manufacturing until the transfer of ownership to the end-user by sharing the information on the network accessible to retailers, consumers and regulators (Houser, 2018). By developing a database through the use of blockchain, retailers and consumers are provided with an ‘electronic gun safe’ on a digital platform, which can be accessed through biometric or retina scan, and transfer of ownership occurs only after the consumer has passed the verification process (Houser, 2018). Both parties share the information on the network where the retailer uploads the ballistics information and the consumer shares criminal and mental health records for the verification process to occur.

Available framework for detecting and tracking firearms

In 2019, a system and method for the tracking and safe-keeping of firearms was invented by David Paolo, with a patent granted to Paolo using RFID tags permanently embedded in firearms and in the permit holders identification card, which will enable the remote tracking of firearms with the help of long-range RFID readers (Paolo, 2019). This would automatically detect the activity of a weapon, with the data to be relayed to law enforcement as part of crime investigations. The assumption would be that this could be a sufficient deterrent to decrease violent incidents involving firearms. Further, this would mean that RFID tags can be installed in firearms by manufacturers or retailers before it reaches the customer, to track the movement of the firearm (Paolo, 2019). The system and approach designed connects the application of RFID in three main aspects, largely having it embedded in the firearms, then in the identification card and the high-range readers installed in public places that can assist to efficiently monitor and detect their activity. Simultaneously, the details of the firearm from the beginning of its origin until the transfer of ownership along with the owners and their license

details are recorded on the blockchain in a decentralised and distributed ledger system that is accessible only by authorised users and only when needed (Paolo, 2019). The data is recorded in a distributed ledger which is not controlled by any governing body and the data is stored in a secure manner and the privacy of the firearm and owner is protected, requiring permission to access (Paolo, 2019). The transactions will be recorded in the ledger using smart contracts in a decentralised blockchain and distributed ledger creating a database application (Dapp) (Paolo, 2019).

Gun registry process

The gun control regulations are the laws that control and regulate on who is authorised to sell firearms, the set of background checks that need to be undertaken prior to the sale, storage requirements, a duty of rules and responsibility to abide by both the buyer and seller and restrictions on firearms that cannot be in the possession of a civilian (Pérez-Peña, 2015). Tracking and tracing cannot be performed with gun control laws alone and the process to trace back the weapon to its owner are not only extensive but often not possible. A firearm registry is a system that registers the details of the manufacturer, importer, seller, along with the details of the gun owners. This includes their name, date of birth, address and other specifics along with the details of the firearm owned, enabling the governmental institution to have a record of civilians who own a firearm along with its description (Holter, 2018). Along with the other gun control measures, the introduction of firearm registries has been a success in Australia and Europe, developing a sense of responsibility and accountability for the gun owners, while at the same time averting spikes in the rate of violent crimes, assisting with investigations by tracking the weapon to its origin (Yasbek & Loan, 2019). Canada had initially introduced a firearm registry; however, it was abandoned in 2012 due to the high resistance from gun owners and the high cost to taxpayers (Yasbek & Loan, 2019). The registration system of firearms had proved that it does improve safety, as gun violence in Canada between 2009 - 2013 had decreased (Statistics Canada, 2018). However, after the gun registry was abandoned, gun related crimes had once again increased (Statistics Canada, n.d.).
The gun laws in New Zealand were relatively relaxed, where a gun owner can own individual weapons without having them registered (Every-Palmer, 2020). However, to own a weapon, a firearm license is required which is obtained after completing a background check, which includes criminal and mental health records (Every-Palmer, 2020). After the mass shootings in Christchurch on 15 March 2019, killing 51 and injuring 49, there was an immediate gun buy-back programme that was introduced (Crothers & O'Brien, 2020). At that time, it was also announced that the government will introduce a firearm registry, similar to the vehicle registry, maintaining the complete details of the individual against the weapon(s) owned, with this enabling the tracking and tracing of weapons and assist with crime investigations (Crothers & O'Brien, 2020).

Blockchain-based gun control application

The other innovative technology that enables the tracking of inventory, distribution and movement of the smart gun on a 24/7 real-time basis is a blockchain based application introduced by Blocksafe, that will enable the gun owners and law enforcement officers to track and monitor the movement of firearms in a secure manner by utilising RFID technology (Zelbst et al., 2019). This will enable for smart guns to be safer and improve the level of privacy for smart gun owners (Coleman, 2016). The intent of this technology is to track weapons to create a sense of responsibility, accountability and by preventing it from falling into wrong hands. While the gun owners can receive automatic notifications if the firearm is used and fired by an

unauthorised user, they can also locate the whereabouts of their weapon and remotely disable it through the Blocksafe application. This tracking mechanism provides a sense of self-possession and security to the owners, but does not go as far as being able to identify the actual shooter (Crothers & O'Brien, 2020).

Resistance, challenges and drawbacks

Political resistance: Though the smart gun technology is available which creates a system of registration and a mechanism of tracking and tracing, the technology is still not available on the market due to the backlash received from the gun lovers (Carey, 2018). The application of blockchain technology in gun control was highly debated in the United States. While Missouri is preparing a bill to ban the use of blockchain in firearms gun control, Arizona has already banned the use of blockchain in firearms (Houser, 2018).

Immature technology: The information gathered or stored in the smart gun can easily be linked to a blockchain application that can record and share information with the network that is listed on a private and permissioned blockchain, making the smart gun safer. However, the technology is still in its early stage that uses the consensus mechanism, where the reliability and security in the firearms industry remains controversial (Houser, 2018). Since the technology is still in its infancy and the market represents somewhat of a niche, finding skilled resources to develop a system that best suits the business process and workflows remain a challenge (Bambara et al, 2018).

Infrastructure issue: The application of blockchain in smart guns will not reduce the occurrence of violence from firearms or theft incidents but will enable law enforcement officers to trace the details of the firearm owner and expedite the process by searching the records of the firearm registry (Seitz, 2018), which is likely to act as a deterrent. However, the challenge faced with the application of blockchain in the firearm registry is related to the infrastructure issue rather than the network issue (Seitz, 2018), what details will be incorporated on the blockchain and how the authorities will decide on individuals who will have access to information on the blockchain. This includes considerations on whether the gun store owners or the private sellers will be authorised to access the blockchain in order to have the sale of firearms' details recorded against the firearm license of the owner, remains the question amongst other issues to address (Seitz, 2018).

Conclusion

Managing the firearm industry and its registry system becomes essential as the privacy of the firearm owner along with details of the firearm(s) owned should be assured and secured to reduce resistance to the technology. More importantly, it must be ensured that a system is introduced that takes measures by hindering firearms from reaching the wrong hands. The availability of capabilities and resources is no barrier with the potential to introduce advanced technology and systems that can safeguard future generations.

Currently, there is a lack of transparency on each firearm manufactured and its movement until it reaches the end consumer. Since there is no system in place to record each firearm manufactured, it enables illegal trade and gun related crime to occur in a manner that is not traceable. Incorporating aspects, including the tracking and tracing of firearms using blockchain, would make for an effective gun registry based on features including immutability and real-time tracking. The use of smart guns that are RFID enabled would further enhance safety given the ability to track guns, but would likely face strong resistance from gun owners.

REFERENCES

Attaran, M., & Gunasekaran, A. (2019). *Applications of blockchain technology in business: challenges and opportunities*. Springer Nature.

Bambara, J. J., Allen, P. R., Iyer, K., Madsen, R., Lederer, S., & Wuehler, M. (2018). *Blockchain: A practical guide to developing business, law, and technology solutions*. McGraw Hill Professional.

Beyer, S. (2018, August 23). *Blockchain before bitcoin: A history*. Retrieved from https://blocktelegraph.io/blockchain-before-bitcoin-history/

Carey, T. (2018, May 24). *Smart guns exist. Why aren't they on the market?* Retrieved from https://www.pbs.org/newshour/science/smart-guns-exist-why-arent-they-on-the-market

Coleman, L. (2016, July 07). Blocksafe applies blockchain tech to improve 'smart guns'. Retrieved from https://www.ccn.com/blocksafe-blockchain-smart-guns/

Crothers, C. & O'Brien, T. (2020). The Contexts of the Christchurch terror attacks: social science perspectives. *Kōtuitui: New Zealand Journal of Social Sciences Online*, 15:2, 247-259.

Daalder, M. (2020, March 03). Gun registry 'crucial' to any reform. Retrieved from https://www.newsroom.co.nz/2020/03/03/1060020/gun-registry-crucial-to-any-reform

Heston, T. (2018). A blockchain solution to gun control. *International Journal of Scientific Research*, 7(3).

Hofmann, F., Wurster, S., Ron, E., & Böhmecke-Schwafert, M. (2017, November). The immutability concept of blockchains and benefits of early standardization. In *2017 ITU Kaleidoscope: Challenges for a Data-Driven Society (ITU K)* (pp. 1-8). IEEE.

Holter, L. (2018, June 1). *5 National gun registry pros & cons show why the debate is so Thorny*. Retrieved from https://www.bustle.com/p/5-national-gun-registry-pros-cons-show-why-the-debate-is-so-thorny-9242571

Houser, K. (2018, February 27). Here's how blockchain could be used for gun control. Retrieved from https://futurism.com/blockchain-gun-control

Hyperledger. (2020). About Hyperledger. Retrieved from https://www.hyperledger.org/about

Majta, M. (2012, Oct 04). Managing the risks of a globalized supply chain. Forbes. https://www.forbes.com/sites/ciocentral/2012/10/04/managing-the-risks-of-a-globalized-supply-chain/#90eda4539d84

Maple, C., & Jackson, J. (2018, August). Selecting effective blockchain solutions. In *European Conference on Parallel Processing* (pp. 392-403). Springer, Cham.

Nair, G., & Sebastian, S. (2017). Blockchain technology centralised ledger to distributed ledger. *International Research Journal of Engineering and Technology*, *4*(3), 2823-2827.

Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. Retrieved from https://bitcoin.org/bitcoin.pdf

New Zealand Police (2020). New Zealand firearms licence application. Retrieved from https://www.police.govt.nz/advice-services/firearms-and-safety/new-zealand-firearms-licence-application

Paolo, D. R. (2019). *U.S. Patent Application No. 16/357,389*.

Pérez-Peña, R. (2015, October 07). Gun control explained. Retrieved from https://www.nytimes.com/interactive/2015/10/07/us/gun-control-explained.html

Pettey, C. (2018, Feb 27). Gartner top 8 supply chain technology trends for 2018. Retrieved from https://www.gartner.com/smarterwithgartner/gartner-top-8-supply-chain-technology-trends-for-2018/

Pilkington, M. (2016). Blockchain technology: principles and applications. In Research handbook on digital transformations. Edward Elgar Publishing. Savelyev, A. (2018). Copyright in the blockchain era: Promises and challenges. *Computer law & security review*, 34(3), 550-561.

Seitz, D. (2018, April 2). *Could we build a blockchain for guns?* Retrieved from https://uproxx.com/technology/is-blockchain-for-guns-possible/

Statistics Canada (n.d.). Crime severity index and weighted clearance rates, Canada, provinces, territories and census metropolitan areas. Retrieved from https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3510002601&pickMembers%5B0%5D=1.1

Statistics Canada (2018). Canada's crime rate: Two decades of decline. Retrieved from https://www150.statcan.gc.ca/n1/pub/11-630-x/11-630-x2015001-eng.htm

Vaghela, Y. (2020, May 16). *4 major limitations with blockchain technology you need to know about*. Retrieved from https://www.smallbusinessbonfire.com/blockchain-limitations/

Yasbek, P., & Loan, J. (2019, November 14). Why a gun register will make us safer. Retrieved from https://www.stuff.co.nz/national/politics/opinion/117347138/why-a-gun-register-will-make-us-safer

Zelbst, P. J., Green, K. W., Sower, V. E., & Bond, P. L. (2019). The impact of RFID, IIoT, and Blockchain technologies on supply chain transparency. *Journal of Manufacturing Technology Management*, *31*(3), 441–457.

Zheng, Z., Xie, S., Dai, H., Chen, X., & Wang, H. (2017, June). An overview of blockchain technology: Architecture, consensus, and future trends. In *2017 IEEE international congress on big data (BigData congress)* (pp. 557-564). IEEE.

AUTHOR

Martin Lukas Mahler is the deputy director of the Business Administration Programmes at the Auckland Institute of Studies and is based in Auckland. His background is in marketing and business development with him having taught and developed courses in New Zealand and overseas. He currently teaches postgraduate courses in economics and marketing with research interests predominantly in the use of technology in marketing as well as on international education.