Capstone Project: Blockchain for Gun Safety

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Abstract

This paper discusses the need and proposed solution for a revamped monitoring system of the manufacturing, selling, and tracking of firearms in America by utilizing Blockchain technology. The paper addresses the ways in which America's gun system has failed, allowing America's gun violence to reach all time peaks. For the sake of this paper, the phrase "America's gun system" refers to the current manner in which the country tracks guns and conducts mandatory background checks required for gun purchasing. The proposed solution focuses on using the emerging technology Blockchain's capabilities to conduct more accurate background checks, integrate expansive public and private data sources, to produce actionable intelligence regarding America's gun population and their owners. This being a Not-for-Profit project, the primary goal is making our country safer by decreasing gun violence. It does not seek an economic return on investment. Yet the project also has economic benefits that this paper addresses. Since firearms are a divisive political topic in America, one of the main strengths of this solution is that no gun laws have to change. Instead, intelligence integration/sharing will enhance their enforcement . The solution is politically-neutral at its core. The paper also will address the legal and ethical ramifications of using Blockchain in this manner and will highlight the capabilities of Blockchain technology that distinguish it from alternative solutions.

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Introduction and Need

Problem Statement

The same characteristics that make Blockchain an attractive technology for enabling currency, such as BitCoin and other cryptocurrencies, make it a promising platform for creating a decentralized and incorruptible database capable of maximizing gun safety without impeding individual privacy rights--a frequent complaint cited against traditional gun control recommendations. A gun system that prioritizes both safety and privacy is critical for getting Americans of all demographics and political affiliations to buy into it, which is what Blockchain technology can provide.

Research Process

The project used a standard research methodology involving several steps in developing the proposed solution.

- Conducted extensive research on gun-violence trends in America and causes of its growth;
- Researched the current gun safety process in America, to include programs intended to ensure that unsuitable people can not purchase firearms, and tracking the manufacture and sale of guns;
- Identified key information gaps and system weaknesses;
- Assessed Blockchain capabilities and functionality to determine if it offers opportunities to close information gaps, and improve system weaknesses

    - Reviewed Blockchain experts analyses on potential applications for not only gun control, but other applications
    - Interviewed professors and business professionals on the application of Blockchain to gun control
- Interviewed an employee of NICS (National Instant Criminal Background Check System) to gain a thorough understanding of the current background investigation and gun control process in the United States;
- Developed a concept of operations and technical architecture for a Blockchain solution;
- Conducted a high level financial analysis of implementing that solution;
- Assessed key impacts including, stakeholder concerns, risks, legal, environmental, and ethical considerations;
- Developed KPIs
- Developed this report.

Market Demand and Research Information

The safety of society is a key consideration when analyzing any emerging technology. One of the most hot-button topics in American society today is gun-violence and, consequently, gun control. The recent increase in mass shootings in America has caused our country to completely reexamine its policies that have existed since the Bill of Rights.

It is not an exaggeration to state that America has a gun problem. Despite accounting for only 4.4% of the world's population, America has 31% of the world's mass-

shooters, 42% of the world's civilian owned guns, and since 2012 there have been 239 school shootings in America alone (Fisher, 2017). Americans are looking for an answer to this problem and have not been able to find one, as the political debates have further divided people. Where politics has failed, technology can potentially succeed.

The primary goal of our nation's gun policy is to ensure that guns end up only in the hands of responsible people without impeding our inalienable right to own firearms. While today's laws do require a background check to purchase a gun, the system is centralized, which makes it vulnerable to hacks and recording errors. A centralized database comes with safety risks from privacy threats. Households that do not own guns could become targets for crime if hacked information fell into the wrong hands. Additionally, about 3000 people who should be barred from buying guns pass the current background check every year (Johnson, 2017). This means that thousands of people unequipped to handle guns responsibly and safely gain gun access annually (Johnson, 2017). These individuals make up the majority of gun crime offenders in our country.

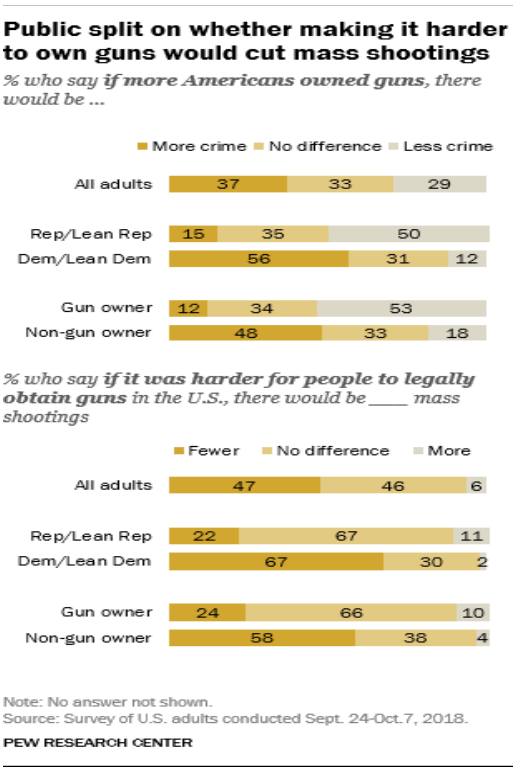
Data Analysis

The data regarding guns in our country is incomplete and inconsistent. This fact alone highlights the need for a Blockchain solution. Additionally, the data that is out there regarding gun ownership, gun laws, and gun violence is not very optimistic and points toward the fact that our gun system needs dramatic change.

Despite how politically divided the issue of guns is in our country, almost all Americans can agree on several aspects. According to a survey conducted by Pew Research Center in Fall 2018, 89% of both Democrats and Republicans believe denying people with

mental illnesses from having gun access is a priority (*Gun Policy Remains Divisive*…, 2019). Additionally, 86% of Democrats and 83% of Republicans support banning people on federal no-fly lists from purchasing firearms (*Gun Policy Remains Divisive*…, 2019). 91% of democrats and 79% of Republicans favor background checks for both public and private gun sales (*Gun Policy Remains Divisive*…, 2019). Despite how divided Republicans and Democrats generally are on gun issues, there is an overlap of belief between the two groups. Focusing on changing gun laws on the divided issues, such as the status of assault-style weapons and concealed carry qualifications is a stalemate..

The gun law debate t has seen little change legally and has done nothing to limit the amount of gun violence and gun deaths, with gun deaths in 2017 being the highest in decades in America (*Gun Policy Remains Divisive*…, 2019). The same Pew survey highlighted that the public is completely split on whether making gun laws stricter would even cut mass shootings, shown below in the chart (*Gun Policy Remains Divisive*…, 2019).



This information proves that instead of continuing this squabble on gun law reformation that has gone nowhere for many years, perhaps the country should focus on improving the quality of the existing system. Even though almost all Americans believe those with mental health issues or those in criminal databases should not have gun access, people in these groups are still gaining gun access and using them violently. The background check system in our country is weak, highlighted by the fact that thousands of people ill-suited to possess guns pass background checks every year.

Implementing Blockchain has the potential to dramatically increase the effectiveness of background checks and gun-tracking, which as shown by the aforementioned data analysis, is something both political sides support.

Definition and Design

Project Scope

The scope of this project is strictly limited to the creation and implementation of a Blockchain based gun system for the relevant organizations within the federal government and law enforcement agencies around the country. The proposal also highlights market demand data that illustrates the necessity of such an effort, as well as the legal and ethical implications of the project should it come to fruition.

The following subjects are out of scope for this project as of now: state implementation, user acceptance testing, quality assurance, user training, operational support, and maintenance. These are topics and steps that need to eventually be added to the project, but at this moment are not a part of the proposal. The topics that are addressed in this paper are of the utmost importance to getting the project started so that America can begin to be safer when it comes to gun violence.

Project Schedule and Timeline

This project entails implementing a custom blockchain. Assuming the project is accepted, here are the project steps that follow:

Adding a data structure:

- The first step is defining data requirements and assessing the availability of those requirements. This is important because this is the data that will be stored in the Blockchain network. Estimated time: 3 months.

Collecting the data:

- Collecting the data from the various data sources is a large task that would take significant time. This is the initial data capture from existing sources. Post implementation data gathering will be automated in the Blockchain system. Estimated time: 12 months.

Defining the operations:

- Define a concept of operations for linking necessary data from stakeholder organizations to the system. Estimated time: 5 months.

Executing the operations:

- Implement the concept of operations. Estimated time: 6 months.

Deploying and setting up the network:

- This will likely be an ongoing process. There will be kinks to work out and obstacles to overcome. The system will be agile so that changes are not difficult to integrate. The system should be diverse so that it is able to collaborate with many different organizations. Estimated time: ongoing.

Solution Differentiators

Blockchain has a number of inherent traits that make it desirable for a project such as this. At its most simple form, Blockchain is "a decentralized ledger that is validated and secured by a network of peer to peer nodes" (Sharma, 2018). Because of the decentralized nature of Blockchain, many refer to it as the "trust protocol of the internet" (Sharma, 2018).

As a decentralized and immutable database, no central database can be corrupted or targeted. The ledger of gun transactions and the list of guns that would exist in Blockchain would be almost impossible to hack. No government or terrorist outfit would be able to

abuse the information in any way. In the current system, the registry is hackable and this puts civilians at great risk because hackers could essentially delete guns off of the list or even identify people who do not have weapons to target for criminal purposes.

Proof of Work, an important aspect of Blockchain technology, is “a mechanism that is currently used to synchronize millions of decentralized nodes” that uses “computing power to solve complex mathematical puzzles” (Sharma, 2018). This ensures that information and other contents in the Blockchain gun system are always safe. In order to change previous ledger entries in Blockchain, the attacker has to overpower the entire network of miners protecting the system. This would cost far too much money for any hacker to do for such little reward. The fact that Blockchain makes hacking essentially impossible is one of the biggest solution differentiators.

In a similar way that Bitcoins are sent and received, the Smart Contract technology of BlockChain allows for reliably performed and safe gun transactions. Smart Contracts are “a set of promises, specified in digital form, including protocols within which the parties perform on these promises” (Smart Contracts: 12 Use Cases…, 2016). Smart Contracts can act as “multisig” accounts so that transfers only go through when a required number of parties agree and sign (Hertig, 2018). In this case the required number would be two for a seller and a buyer of the gun or guns. Their signatures are maintained within the system. These are just the main capabilities that make Blockchain technology so attractive for developing a gun system in America.

Data Sources

Each individual's electronic gun safe must include each gun's identification. This can be done using ballistic fingerprinting or microstamping, but that aspect is out of the scope of this project. Additionally the safe needs to include the individual's history of illegal activity, parole status, domestic violence history, military history, immigration status, drug history, and mental health issues. Depending on privacy concerns, this safe could also contain data including ballistic fingerprinting, retina scans, microstamping, and the individual's Internet browsing history. Companies such as Amazon, Google, and FaceBook all currently collect their customers' browsing history for marketing data.

So where will this data be retrieved? Criminal history can be acquired from the Interstate Identification Index. This is a large repository of criminal convictions that many government agencies use. The National Crime Information Center is a similar repository that also includes pertinent information of this manner, including protective orders and disposition records. There are also the National Instant Criminal Background Check System's (NICS) indices. The NICS indices include all of the records that the federal, state, and local agencies have submitted. It contains a list of all individuals who have been flagged and prohibited from buying a gun. The NTC also maintains at least five databases of specific firearms and their owners. These databases include Multiple Sale Reports, Suspect Guns, Traced Guns, Out of Business Records, and Theft Guns.

Additional data needed that is not covered by these databases is more complicated. If it was decided that Internet browsing data could be included, a contract could potentially be reached with the aforementioned companies so that they share this data.. The mental health and substance abuse records that are able to be released by HIPAA provisions are

also contained in these repositories. The “No-Fly” list is another valuable existing database that could be used to help.

Solution Development

To develop the described solution into a successful system that can fully take advantage of the technology’s capabilities, extensive collaboration with various agencies of the federal government is necessary. The main aspects in developing this project are collecting the relevant data and eliciting the necessary requirements.

If this solution is agreed upon, the first step to development is to understand and define the scope of the system. The system is intended to revolutionize the gun tracing and gun background check processes. In order to assemble the necessary requirements, it is pivotal to work closely with each of the aforementioned organizations and stakeholders. Consolidating and digitizing the gun tracking and background check processes will be a challenge, but will result in fewer mistakes and increased safety for all.

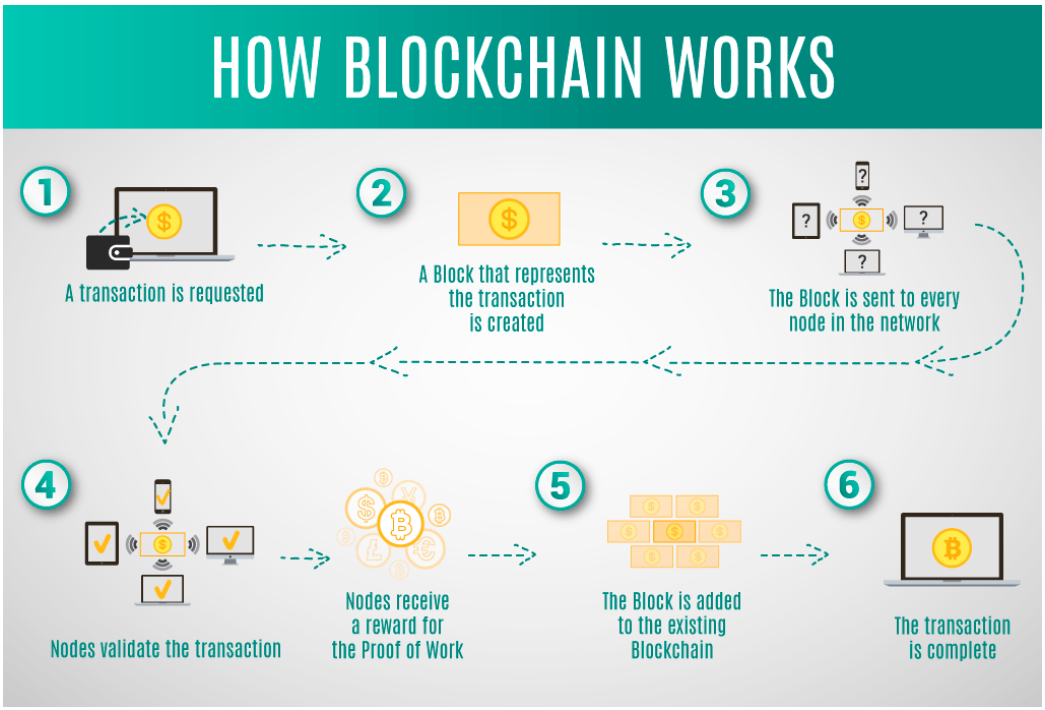
It is no surprise that both the current gun tracking system and the background check process are unreliable and not comprehensive given the manual and uncollaborative work taking place between the various agencies involved in America’s gun system, such as the NICS, FBI, and ATF.The development of this solution will entail collecting the data that will go into the electronic gun safes and then eliciting requirements for how to integrate itr into a comprehensive system.

Information Technical Architecture

Perfecting the architecture of this system is essential to ensuring the effectiveness and efficiency of the Blockchain network. The architecture must support the offerings of

the solution that are described throughout the proposal and must be crafted to ensure elite performance.

The architecture of the proposed Blockchain database will be a decentralized, privately distributed ledger arranged into a peer to peer network. Individuals will be able to see and access the contents of their own gun safes. Only authorized users from the various government and law enforcement agencies that monitor gun transactions and gun tracking will be able to access comprehensive data from the ledger of transactions, which is time-stamped and incorruptible, providing a full and accurate record of when a gun trades hands. The Blockchain structure allows for these agencies to check the history of any transaction at any time (Lastovetska, 2018). The following image from the same source demonstrates how a Bitcoin transaction is completed in Blockchain, which can be easily adapted for gun transactions:



The information stored in each block will contain data about the receiver, sender, and the gun. The sender and receiver are identified by their hash. A hash is a sort of "digital fingerprint" that is generated with the help of a cryptographic hash algorithm (Lastovetska, 2018). For any instance in which a block is created, a hash is automatically attached. Any changes made in a block will also affect the change of a hash (Lastovetska, 2018). Any attempt at corruption causes all blocks in the database to carry false information, rendering the system invalid. This is the reason Blockchain is said to be incorruptible. The architecture of the Blockchain gun system will take into account all required functionality and user roles. The open-source solution Ethereum will be used to build the Blockchain architecture. The Blockchain network and code rules of transactions will be constructed in accordance with the requirements gathered from the various agencies that will use the system.

Due to the architecture's complexity and the number of law enforcement and government organizations that will be a part of the network, it is important for the project team to use an agile development approach. Building an architecture on this scale is a large undertaking, but is not groundbreaking. The process for developing the architecture is quite similar to the processes used to built Bitcoin's architecture. The requirements will be more advanced since gun transactions require more precaution than monetary transactions. Safety is the key distinguisher between the architecture of the proposed solution and the architecture of Bitcoin. Additional steps and precautions will be included in the code that defines the rules of transaction to make sure all of the relevant data is taken into account for gun sales within this architecture.

Technical Implementation

Navigating the complexities and intricacies in implementing a Blockchain technology solution on this scale is of the utmost importance in ensuring gun safety. No matter how effective Blockchain capabilities can be, the effort cannot succeed if the information that goes into the ledger is not reliable and accurate. The solution would work similarly to current cryptocurrency utilizations of Blockchain technology.

All current or soon-to-be gun owners will receive an "electronic gun safe," which would be similar to a bitcoin wallet (Heston, 2017). The wallet can be tied to all types of data, including retina scans and fingerprints, but this is outside the scope of the proposed solution. The electronic safe would include the individual's history of illegal activity, parole status, domestic violence history, military history, immigration status, drug history, and mental health issues (Heston, 2017). Depending on privacy barriers, this safe could also contain data from the individual's Internet browsing history. Companies such as Amazon, Google, and FaceBook currently collect and utilize their customers' browsing history to target advertisements towards interested demographics and individuals. The sources of the data that will reside in the "electronic gun safe" will be explained further in the "Data Sources" section of this proposal.

Every time a gun is manufactured, sold, or bought, the transaction from one individual's gun safe to the gun safe of the other individual would be recorded on the Blockchain. This recording is time-stamped and unchangeable. Before the transaction is possible, both the seller and a licensed gun vendor are required to approve the sale and sign the transfer. Additionally, before the transfer, the receiver of the gun must pass a background check. Ethereum smart contracts can be used for this. If the buyer passes the

background check, the transfer goes through. However, if the buyer fails the background check, the transfer is barred and a note of this is recorded in the buyer's electronic gun safe.

With all of this information, and potentially even more such as no-fly lists, consolidated into the gun safe, the effectiveness of background checks will be greatly improved. Browsing history collection is challenging due to being a highly political topic, but could be important if it becomes a possibility. People who have gun obsession or violent tendencies apparent in their internet history could trigger a more thorough investigation to take place before a purchase can be approved. The gun safes provide an easier way to track aggregate gun tallies in our country and also individual gun ownership tallies. The Las Vegas shooter bought 33 guns in 12 months. Blockchain technology would have made it easier to "flag" the excessive nature of these transactions before the violence could occur (Heston, 2019).

The most difficult aspect of the implementation will be consolidating the information from the various data sources into the Blockchain system and the electronic gun safes. The Blockchain implementation itself should be relatively straightforward since the technology is so prevalently used and well developed in other areas. The implementation would be similar in scope to implementing the Bitcoin network, with a few inherent differences stemming from accessibility of the ledger.

Use Cases

The following use cases provide a foundational explanation of what the background check and gun tracking processes under a Blockchain system would entail. This includes

the flaws of the current systems and the ways in which a Blockchain system can plug these performance gaps.

1. *Background Checks*

In 2017, it was reported that the FBI's background check system was missing millions of instances of criminal convictions, mental illness, and other non-qualifiers that would have individuals barred from purchasing a weapon (Mire, 2019). The main issue with the current system is reliance upon third party organizations to submit this information to the federal agencies that enter the relevant data into the background check database. Hospitals, treatment providers, local law enforcement, and other agencies are required to send in this information, but they often neglect to do so or it is often lost somewhere along the way.

The Blockchain system proposed is able to automate the process by which these third party organizations submit the pertinent information. Blockchain's capability of "secure, interoperable access and automated, algorithmic updating based on a confluence of data sources" will allow third party organizations to abandon manual submissions of pertinent data to the federal agencies (Mire, 2019). Instead, the information will be automatically transferred whenever it would be relevant in a background check, eliminating manual errors and human forgetfulness.

2. *Gun Tracking*

Lawful gun owners commit less than one in five gun crimes in America, and of 893 guns from crime scenes in 2008, eight of ten perpetrators were not legal gun owners (Mire, 2019). This is why it is absolutely vital that America is able to successfully track its weapons. Because of Blockchain's decentralized nature, the system can install custom made

decentralized applications that can easily track inventory and distribution of weapons (Kariuki, 2018). Additionally the Blockchain ledger automatically updates with transactions that are confirmed with multisig validation. This means that both the seller and receiver must sign in order for a transaction to be accepted and be recorded on the ledger.

SWOT Analysis

The following SWOT (Strengths, Weaknesses, Opportunities, and Threats) Analysis provides a comprehensive picture of the positive capabilities of the proposed solution and the holes in the current gun system that need to be addressed. Additionally, the SWOT Analysis demonstrates what can still be improved in the solution's offerings and the factors that put the success of the solution at risk.

Strengths	Weaknesses
➢ Immutable records on the blockchain will provide the needed accuracy, and increase difficulty of hacking or modifying gun ownership records. ➢ A system such as this provides the government and law enforcement with a clearer picture of the gun population and their owners. This improves public safety for both civilians and law enforcement. It also allows for more effective preparation when entering the field for law enforcement agents. ➢ Smart Contract capability allows	➢ Certain aspects of the solution are only as good as the information and data gathered. Data gathering and consolidation of the data is critical. ➢ Data gathering for the gun safes and background checks involves many different data sources, which complicates the project. ➢ Many organizations would have access to the system. While this enables more effective usage by each organization, it complicates requirements gathering. ➢ The solution requires a

the affected processes to become more automated and less prone to manual error. Organizations such as the NTC and the NICS become less overburdened and can focus on other relevant work.	tremendous amount of raw computing power, which may not be good for the environment and could be considered unethical by many and opposed by political lobbyists in the field of energy consumption.
Opportunities	**Threats**
➢ Millions of guns in our country are currently not tracked. ➢ An estimated 3,000 potentially harmful people manage to pass a background check per year while purchasing guns. Many of these individuals go on to use these weapons for violent reasons. ➢ Organizations such as the NICS and the NTC are backlogged and overworked. An automated Smart Contracts system will reduce the time it takes to trace guns and conduct background checks, while also improving their effectiveness and accuracy.	➢ While the solution is politically neutral, there potentially will be opposition from those who perceive the solution as limiting gun access. ➢ Arizona lawmakers passed a bill banning the use of Blockchain or any other decentralized technology to track firearms. Others may follow. ➢ Competition. The Blocksafe foundation has started down a similar path and the FAABS has also begun working on a similar solution to the one proposed here. As Blockchain becomes more intertwined in society, competition will continue to grow. ➢ The potential exists for the solution to be expensive.

Impact

Stakeholder Impact

The largest stakeholder in any American matter regarding firearms will always be the National Rifle Association (NRA). The NRA has received much backlash from gun control activists due to the NRA's commitment to an uncompromising support for gun laws remaining unchanged. Even after tragedies in this country involving guns, the NRA has prioritized ensuring the constitutional rights of their constituents, provided in the 2nd Amendment, are not infringed upon. The mission of the NRA is to protect and defend the Constitution of the United States regarding the 2nd Amendment, to focus on promoting public safety through training in the safe and efficient handling of small arms, and to emphasize hunter safety and shooting sport promotion (Chilson, 2014). The NRA will be positively impacted by this project because despite the fact that no gun laws will change, there will be less gun violence.

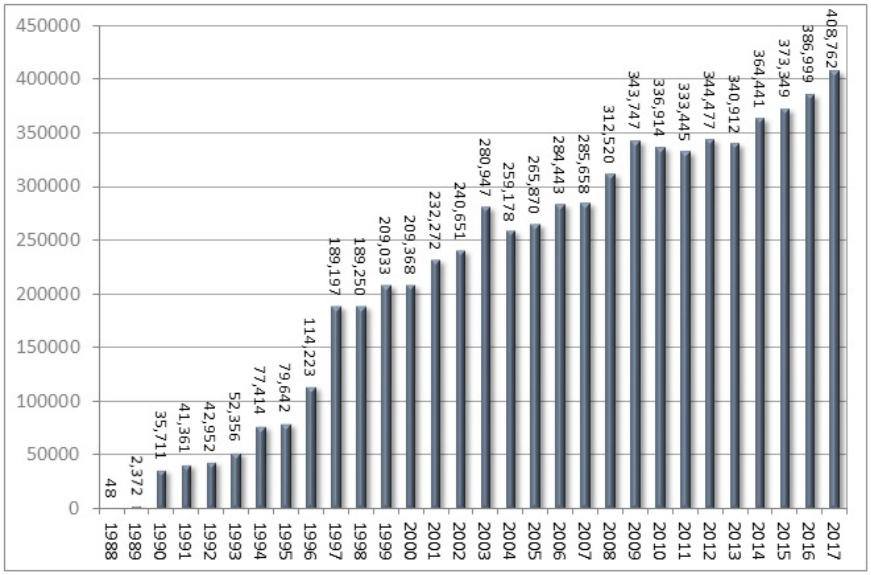
Additional stakeholders include law enforcement agencies, intelligence agencies, gun control advocacy groups, gun lobbyists, gun owners, gun vendors, and gun manufacturers. The proposed project will change the way guns are tracked, bought, and sold so essentially anyone who is involved in firearms of any kind has a stake in this matter. All of these groups want the same things. They want their constitutional rights to be respected, but in a way that people are still safe. This solution will provide that because it is a politically neutral way of making the gun process safer in our country. Many of these broad stakeholder groups will be described more specifically in the "Beneficiaries" section later in the paper.

Beneficiaries

The main beneficiaries of this solution will be Law Enforcement agencies and the general public.

1. *Law Enforcement:*

Law Enforcement processes regarding the tracing of weapons is currently a complete debacle. The National Tracing Center (NTC), part of the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) is currently the only gun tracing facility in the entire country (Bureau of Alcohol, Tobacco, Firearms and Explosives, 2018). They receive so many trace requests each year that the organization is continuously backlogged. The chart below from the ATF website demonstrates the steady increase in conducted traces by the NTC each year.



According to the chart, the NTC is now requested to do over 40,000 gun traces each year and with the current system, each trace can take multiple days or even weeks. The NTC has never updated their system to be able to deal with such an increase in volume of traces. In a 2016 GQ Magazine interview, Charlie Houser, an ATF agent who works at the

NTC headquarters, provided a picture of just how overworked the NTC has become. He discusses how at any given time there are between 5,000 and 15,000 boxes of trace requests backlogged at headquarters (Laskas, 2018).

He then describes how he and his fifty or so fellow employees at the NTC not only have to deal with the abundance of trace requests, but they also have to manually sort and store two million new firearm records every month (Laskas, 2018). These paper records have no standard format so it takes even more time to get them sorted accurately. The process is not only manual, but unorganized. The proposed Blockchain solution would be warmly received by the people working at the NTC, an organization that is long overdue for electronic automation of these processes.

In addition to the NTC, many other law enforcement agencies would benefit. The fact remains that many FBI and other law enforcement agents are going into the field without an accurate understanding of what guns are out there. An accurate gun ledger, which Blockchain can provide, would provide agents increased safety by letting them know what firearms they may come up against in any given situation.

2. *The General Public:*

It is self-explanatory how better equipping law enforcement to do their jobs benefits the general public. The better of an understanding that law enforcement has on who possesses which guns guns, the more effectively they can protect the general public by keeping through crime prevention. The Blockchain system will also help streamline the Background Check process currently in place when buying weapons by consolidating the necessary information of multiple data sources into one place.

According to the Washington Post, the FBI database for gun buyers is "missing millions of records of criminal convictions, mental illness diagnoses, and other flags that would keep guns out of potentially dangerous hands" (Barrett, 2017). When background checks are more accurate, individuals who are risks of committing gun violence will not be able to obtain weapons. This happens far too often because the background check system currently has poor record keeping. Many mental health diagnoses and criminal records from various data sources have not been recorded or sent in for whatever reason. Keeping guns out of the hands of those who are not suitable to possess them will greatly benefit the general public in America, especially considering many of the mass shootings in this country have been by people who should not legally be able to have bought a gun (Buchanan, 2015).

Financial Assessment

While decreased gun violence and improved gun safety are the goals of this solution, there will surely be economic benefits. Most of these benefits stem from the fact that each and every instance of gun violence causes a ripple effect of economic burden. This is difficult to accurately estimate, but studies have taken place attempting to quantify the economic ramifications of gun violence so these will be used as a starting point in these estimated calculations.

The costs of gun violence were estimated in 2012 to be $229 billion, which is $88 billion more than the US Federal Government budgeted for education that year, costing every man, woman, and child in the US over $700 per person (Follman, 2018). Direct costs account for $8.6 billion, including long-term prison costs for people who commit assault

and homicide using guns, which at $5.2 billion a year is the largest direct expense (Follman, 2018). The average cost to taxpayers for a single gun homicide in America is $400,000 and we pay for about 32 of them every single day (Follman, 2018). Indirect costs amount to at least $221 billion (Follman, 2018).

Every single act of gun violence, regardless of outcome or intention, comes with an abundance of costs. When deaths from guns occur, property values go down in affected areas. Law enforcement response to gun violence is costly. Additionally, there is all of the residual healthcare that follows any act of violence. These are just three of the numerous costs that are the product of acts of gun violence. Every single act of gun violence that is prevented will save significant money and help our economy. Every gun homicide the solution prevents will save about $400,000. Safety is the primary concern, but whatever this project ends up costing will be worth it.

The costs associated with implementing the solution are large, but necessary for public safety. It is impossible to estimate total cost until after the requirements are fully defined, which is likely a multi-million dollar effort by itself. Once requirements have been finalized, major cost categories include:

- Development. The average Blockchain developer billing rate is about $90 per hour, but this project will likely need the highest quality developers who charge around $140-$160 per hour.
- Stakeholder engagement. Hired teams will be needed to work with the various partners, customers, data sources, and other groups that will be needed to bring this solution to fruition.

- Implementation and training. Blockchain implementation is relatively straightforward and has been done many times in various fields.
- Management oversight. The Federal organization that accepts this proposal will be responsible for overseeing implementation and ongoing operations.
- Maintenance. Maintenance is always necessary, but for a Blockchain solution should be minimal.

It is also possible that this proposal could be built on top of the established bitcoin blockchain through the use of "colored coins" that bind metadata to specific transactions and "this metadata can contain information on assets such as guns, and additional data describing the gun data" (Heston, 2017). If the "colored coins" approach is able to be used to develop the Blockchain gun system on top of an existing Blockchain system, such as Bitcoin, the costs associated with the solution would likely significantly decrease.

Key Performance Indicators (KPIs) and Financial Impact

1. *KPIs*

The following Key Performance Indicators will be tracked once implementation of the solution is complete so that there are metrics to judge how well the solution is performing and the impact it is having. It is expected that all of these KPIs will improve 2-5% after a single year. Following that, the KPIs will continue to improve as the system becomes more fleshed out with collected information.

- Gun deaths per year
- Gun crimes per year

- Failed background checks per year
- Gun crimes committed by products of failed background checks
- Gun crimes committed by untracked guns

2. *Impact Based on Assumptions*

Assumptions:

- As previously noted, the cost of gun violence was estimated to be about $229 billion per year.
- In 2015, there were 33,636 deaths total from firearms, 13,286 of which were gun homicides.

Impact Calculations:

- If the system results in 2-5% less cases of gun violence in its first year as estimated, then first year savings will be $4.58-$11.45 billion.

  Calculations:

  Assume 2% Decrease in Gun Violence: $229 billion * .02 =

  $4.58 billion saved in year 1.

  Assume 5% Decrease in Gun Violence: $229 billion * .05 =

  $11.45 billion saved in year 1.

- If the system results in 2-5% less gun homicides in its first year as estimated, then there will be between 266 and 665 less homicides in year 1.

  Calculations:

  Assume 2% Decrease in Gun Homicides: 13,286 * .02 =

  266 less homicides in year 1.

Assume 5% Decrease in Gun Homicides: 13,286 * .05 =

665 less homicides in year 1.

- If the system results in 2-5% less total gun deaths in its first year as estimated, there will be between 673 and 1,682 less total gun deaths.

  Calculations:

  Assume 2% Decrease in Total Gun Deaths: 33,636 * .02 =

  673 less total gun deaths in year 1.

  Assume 5% Decrease in Total Gun Deaths: 33,636 * .02 =

  1,682 less total gun deaths in year 1.

The proposed solution has the potential to save our country billions of dollars every year, but more importantly it can save thousands of lives every year. These first year estimates are nothing in comparison to the lives and dollars that can be saved when the system becomes more effective in years to come after the data has become more complete and the process of the system is more refined.

Risks and Other Considerations

Risk Assessment

A project of this magnitude comes with risks. While developing the Blockchain platform itself would be relatively straightforward, the consolidation of all of the data needed is a sizeable and complex undertaking. For the gun safe to be as effective as it can be, the information in it needs to be extensive and accurate. For this to be the case, the gun

safe has to be filled with information from multiple different data sources--some of which might be tricky to gather if the respective organizations are not willing to comply.

Additionally, it may be hard to get all of the nation's gun owners, vendors, and manufacturers to embrace the new system. This system would also likely be contested by various legislators. Arizona lawmakers passed a bill banning the use of any decentralized technologies for tracing firearms and Missouri has a bill in the works as well. This project would be for federal adoption of the system, but state legislators contesting could still pose issues. The last major barrier would be the cost of a project of this magnitude. The costs will be significant. The last paragraph of the previous section "Financial Assessment" offers a potential solution that could drastically cut the cost of this solution if it is able to be executed.

Risk Mitigation

The risks identified in the risk assessment preceding this section will be critical to accurately diagnose and mitigate. In order to do so, each risk was weighed according to severity in two categories: potential impact and probability. Impact refers to the negative effect the risk has on the project given the risk comes to fruition. Probability assesses how likely the risk is of coming to fruition. For each risk, a value of low, medium, or high was diagnosed for each category. The following chart lists the results, as well as providing the mitigation strategy for combating each of these risks.

Risk ID	Risk	Impact	Probability	Mitigation
R1	Lack of cooperation and/or access from organizations that have the needed data.	High	Medium	Stay ahead of this and participate in constant communication with federal government to get their push for the organizations causing problems.
R2	Legislators pushing against implementation.	Low	High	Develop a strategy for implementation disregarding states that ban Blockchain for gun purposes.
R3	Blockchain is rapidly evolving. System could be outdated too quickly.	Medium	Low	Agile project approach with a team staying ahead of the curve regarding all emerging solutions.
R4	Cost to implement is too high.	High	Low	Keep costs as low as possible and accentuate economic and safety benefits.

Legal Implications

One of the most important benefits of the proposed solution is that no gun laws have to change. The vision for this project is that many lives can be saved from the updating/integrating of existing data, technology and processes. No gun law reformation is needed to have substantial impact in improving safety, making the solution as politically neutral as possible. This will make the solution desirable to people from all political affiliations and demographics.

State legislators are important legal stakeholders that will need to be continuously considered and tracked. Arizona is the first state to pass legislation banning the use of Blockchain or any other decentralized technology to track firearms for privacy concerns. Many think Missouri is soon to follow. While a few states taking such measures should not affect the proposed solution, if it becomes a trend that states are opposing the use of

Blockchain for gun control then the project could be in trouble and may need to target a different market space. Broad communication, education and awareness are vital to assure citizens that PI will be safeguarded but that the "common good" must prevail to ensure public safety.

Many of the other legal ramifications of a Blockchain system for gun purchasing/ownership/disposal monitoring involve conflict resolution. With Smart Contracts, there is almost zero input requirement from users. Smart Contracts are a great benefit of Blockchain capability because they provide increased security, a streamlined process with the middleman cut out, and decreased costs (Price, 2019). They also result in unprecedented legal predicaments. Who is responsible when there is conflict and who can claims be made against in these instances? In developing this solution, it will be important to consult with a legal team that works to sort out these inherent holes involving conflict resolution.

Another legal factor that will need to be considered involves the eventual possibility of moving away from the proposed Blockchain solution many years in the future. If it is ever decided that a new service would work better many years from now, there could be the risk of not holding a copy of the data on the ledger and in the gun safes (Price, 2019). The legal team would need to craft provisions and processes to be put into place that ensure the smooth transition of all information and records to the vendor implementing the new solution. It is important to remember that this is an issue of public safety and the common good so there needs to be a balance between information protection and information sharing.

The Blockchain system proposed will create the opportunity for new regulations should they be desired. In Thomas Heston's whitepaper on the matter, he has this to say:

> *"Finally, putting background check information, gun transfer information, and gun owner information onto a blockchain system, there would be a much greater ability to determine the overall gun ownership in the US. A gun regulatory board could then be setup to help determine and balance the legal rights to gun ownership with the public health concerns of excessive gun availability. This gun regulatory board could thus operate very loosely like a central bank, limiting the importation or manufacture of new guns when the overall number of guns in society exceeded a certain level" (Heston, 2017).*

A gun regulatory board, such as the one described by Heston, may never come to fruition, but the fact remains that when a comprehensive Blockchain gun system exists and the estimated amount and location of guns in America is far more accurate, precautions of this nature become possible. The Blockchain system has many more potential legal ramifications such as this because many new laws--possibly ones that are more easily passable--become plausible when America has accurate numbers and effective enforcement systems regarding the country's guns.

Ethical Implications

1. *The Good:*

The positive ethical implications of this solution have been and will be discussed throughout the duration of this paper. The positive ethical implications of this solution are as follows:

- Improved gun tracing - and in cases prevention of gun purchasing/ownership - lead to a safer society for the general population and law enforcement.
- An improved background check process leads to a safer society for general population and law enforcement.
- The Blockchain network being unhackable protects citizens from having their gun data and background check information stolen and abused.
- The solution's politically neutral nature will lead to a more productive and less hostile discussion on guns and what needs to be done about gun violence in our country moving forwards.
- The solution provides the country current information and total visibility for a better understanding of what guns are possessed by who, which allows for the opportunity of more informed decisions by legislators and law enforcement. The vast majority of US gun owners are law abiding and their rights can be protected with this system, while various subsets of the population who should not purchase or possess firearms can be the focus of law enforcement.

These are the major positive ethical implications of this solution, most of which involve improved safety, privacy, and decision making due to increased knowledge. These points, as well as smaller positive ethical implications, are fleshed out in greater detail throughout the paper.

2. *The Bad:*

There are two main ethical concerns associated with the proposed Blockchain gun system: the impact such a system would have on the environment and the potential for cybercrime if the system is not regulated correctly.

One of the main driving factors of what makes Blockchain technology successful is its raw computing powers (Price, 2019). Blockchain is reliant on encryption and the solving

of complex mathematical puzzles. Because of this, the amount of computing power to run Blockchain networks is very large. According to Morgan Stanley, the Bitcoin blockchain alone will use as much power in 2018 as the entire nation of Argentina (Rapier, 2018). Additionally, Bitcoin's current estimated yearly electricity usage is 1.5 percent of America's annual consumption (Price, 2019). It is also estimated that the Bitcoin Blockchain is now responsible for 0.6 percent of the world's entire electricity usage (Price, 2019).

The Blockchain gun solution in this paper proposes a system that would run similarly to Bitcoin so the impact such a system would have on our environment is similar in size and debatably unethical. However, an argument can be made that energy consumption of this magnitude is worth it for the resulting public safety improvements the system can provide. There will surely be individuals who argue for both stances. Because of this, it will be important for Blockchain developers in the near future to work on solutions that have the same capabilities with more efficient energy consumption. This is already a major innovation that Blockchain experts are hoping to improve.

The other main ethical concern of this solution is the potential for the system to be hacked or abused. While Blockchain provides a decentralized and incorruptible system that makes threats such as hacking essentially impossible, there are other cybercrime risks that need to be considered. For instance, cryptocurrencies that use Blockchain technology have become the most prevalent payment option for people committing illegal acts. Two of Blockchain's greatest strengths are its safe and anonymous aspects, but the potential exists for these aspects to be abused with guns in similar ways as they are abused in currency.

Both of these ethical concerns are of the utmost importance. In today's landscape, people are often not fond of solutions that can hurt our environment through high energy

consumption. Many would argue that an overdraining of our environment's resources is unethical. Additionally, this solution prioritizes decreasing gun violence, but it is critical that while doing so, other cybercrime does not become a greater risk. Both of these ethical concerns will need to be mitigated in the best possible way. The strategies for doing so are not entirely straightforward yet. The plan is to have Blockchain developers continue to research ways in which Blockchain capability can stay the same with less energy consumption necessary and to negate its potential use for cybercrime.

Competitive Analysis/Alternative Solutions

The main alternative to the proposed solution is to keep America's gun system the same. Most agree that this should not be an option because gun violence is continuing to get worse and worse in our country. Many would argue that we should focus instead on reforming gun laws. As mentioned previously in this paper, however, focusing on the reformation of gun laws has done nothing to stop gun violence. Gun law reformation debates have only further divided our nation politically. Another option would be to use a solution that is not enabled by Blockchain technology to develop a new system, but this would likely fail due to the new system being too similar to the current system, which is not working. Even though implementing Blockchain as the solution entails the most investment and change, it is the option that can actually help to make a difference in making America more gun safe.

The main competition for this solution are from other organizations that have begun trying to tackle gun tracking using Blockchain as well. Guniary is a company powered by

BlockSafe with the mission to create the "World's First Blockchain Gun Diary" (*Guniary*, 2018). Their website describes their offerings in this way:

> *"Harness the power of anonymous blockchain technology to privately store and track all of your firearm's information including: license management, gun and ammo inventory, destination management, private GEO fencing & more!" (Guniary,* 2019*).*

While not currently a direct competitor, an organization utilizing Blockchain to track guns will always be on the radar. If they continue to develop stronger solutions and expand their offerings they could eventually provide a challenge in the market space. Blocksafe also powers other partners with its proprietary Blockchain network such as TriggerSmart, Distributed Reality, and Gunshot Spot. While none of these BlockSafe partner organizations directly conflict with our solution, Blocksafe is currently using its proprietary Blockchain network to revolutionize many gun issues in our country.

The nonprofit organization FAABS (Firearm Accountability Auditability Blockchain Solution) seeks to "educate the world on how Blockchain can be used to solve the gun control conflict with a Win-Win solution" (FAABS, 2019). Not only are they currently writing books to describe how this is possible, but they are also "enabling the technology to make it happen" (FAABS, 2019). Their code is written and is currently being tested. What the FAABS is offering is incredibly similar to the proposed solution of this paper, which is why the organization is regarded as the most critical competition. They have yet to release many specifics regarding their offerings but it will be important to track FAABS closely.

Limitations

There are limitations to the proposed solution that need to be kept in mind throughout the process. While Blockchain itself provides a platform that can execute gun tracking efficiently and effectively, there is the human aspect to consider. If people are not willing to follow the protocol of the system then problems will most certainly arise. Like any technology, the system will only be effective if people buy into it and use it correctly.

Additionally, the individual gun safes and the background checks will only be as effective as the data that goes into it. While Blockchain will help immensely going forward with keeping track of this information, the system that has been in place in our country has created many holes that Blockchain is not able to fix immediately. Over the years, our country has lost track of numerous guns and has lost a significant amount of data that should be included in the background checks of people buying guns. The proposed solution can do nothing about information that has been previously lost. It can begin to set new standards and oy help improve enforcement and the information documenting moving forward in the future.

Conclusion

Connecting the dots between a technology proven effective in another application and a seemingly unsolvable problem often provides an innovative breakthrough solution. The critical success factor is leadership resolve to implement the technology and enforce its use nationwide. One of the biggest problems confronting the United States is gun violence stemming from incomplete information about individuals seeking to purchase firearms. And one of the most successful new technologies in cyber currency is Blockchain. Adapting

Blockchain to improve information availability for background checks may offer such a breakthrough solution.

Background checks for gun purchases fail mainly due to missing or latent information. Because of this, people not suitable to possess firearms are committing violent crimes. Current gun tracking processes are out of date and the organizations involved are overburdened. The political debate over gun laws is a stalemate with no solution in sight. Blockchain technology has the potential to dramatically improve the availability and timeliness of background check information while preserving information security and minimizing perceived impacts to American rights to own firearms.

Implementing Blockchain is a large, complex, and expensive solution, but compromises on public safety are not acceptable. Even with the expected large investment, over time the solution will have great economic benefits as well. And the solution does not compromise law abiding Americans' 2nd Amendment rights to own firearms. Blockchain offers the potential to minimize political inertia in the interest of public safety.

References

Barrett, D., Somashekhar, S., & Horton, A. (2017, November 10). FBI database for gun buyers

missing millions of records. Retrieved April 19, 2019, from https://www.washingtonpost.com/national/fbi-database-for-gun-buyers-missing millions-of-records/2017/11/10/dd87ff8c-c4c4-11e7-aae0-cb18a8c29c65_story.html?utm_term=.5588bf3ee1c

Blockchain: The New Technology of Trust. (2018). Retrieved April 15, 2019, from

https://www.goldmansachs.com/insights/pages/Blockchain/

Buchanan, L., Keller, J., Oppel, R. A., & Victor, D. (2015, October 03). How They Got Their Guns. Retrieved April 19, 2019, from https://www.nytimes.com/interactive/2015/10/03/us/how-mass-shooters-got-their-guns.hml

Bureau of Alcohol, Tobacco, Firearms and Explosives. (2018, May). Retrieved April 19, 2019, from https://www.atf.gov/resource-center/fact-sheet/fact-sheet-national-tracing-center

Buttice, C. (2019, January 04). Is Blockchain the Solution to Gun Control? Retrieved April 15, 2019, front https://www.techopedia.com/is-Blockchain-the-solution-to-gun-control/2/33625

Chilson, M. (2014, October 12). National Association for Gun Rights vs. NRA: How Do They Differ? Retrieved April 19, 2019, from https://www.newsmax.com/fastfeatures/national-association-for-gun-rights-nra-differ/201/10/12/id/600067/

FAABS. (2019). Retrieved April 25, 2019, from https://faabs.org/

Fisher, M., & Keller, J. (2017, November 07). What Explains U.S. Mass Shootings? International Comparisons Suggest an Answer. Retrieved from https://www.nytimes.com/2017/11/07/world/americas/mass-shootings-us-internatonal.html

Follman, M., Lurie, J., Lee, J., & West, J. (2018, November 20). Gun violence costs America

$229 billion a year-more than $700 for every man, woman, and child. Retrieved April 15, 2019, from https://www.motherjones.com/politics/2015/04/true-cost-of-gun-violence-in-america/

Francis, J. (2018, February 23). Could Blockchain Impact Gun Control? Retrieved April 15, 2019, from https://bitcoinist.com/Blockchain-impact-gun-control/

Gun Policy Remains Divisive, But Several Proposals Still Draw Bipartisan Support. (2019, January 23). Retrieved April 15, 2019, from https://www.people-press.org/2018/10/18/gun-policy-remains-divisive-but-seveal-proposals-still-draw-bipartisan-support/

Guniary™ - World's First Blockchain Enable Gun Diary. (2019). Retrieved April 25, 2019, from https://www.guniary.com/

Hertig, A. (2018). How Do Ethereum Smart Contracts Work? Retrieved from https://www.coindesk.com/information/ethereum-smart-contracts-work

Heston, T. (2017, November 13). A Blockchain solution to gun control - PeerJ. Retrieved April 15, 2019, from https://peerj.com/preprints/3407.pdf

Houser, K. (2018, February 26). Here's how Blockchain could be used for gun control. Retrieved April 15, 2019, from https://futurism.com/Blockchain-gun-control

Jacobson, L. (2019, March 19). Could Blockchain have prevented the New Zealand mass Shooting? Retrieved April 15, 2019, from https://modernconsensus.com/technology/christchurch-new-zealand-mosque-shooting-guncontrol-Blockchain/

Johnson, K. (2017, December 05). Exclusive: Feds issue 4,000 orders to seize guns from

people who failed background checks. Retrieved April 15, 2019, from https://www.usatoday.com/story/news/politics/2017/12/04/exclusive-feds-issue-4-000-orders-seize-guns-people-who-failed-background-checks/901017001/

Kariuki, D. (2018, February 24). Blockchain Technology Can Improve Gun Control. Retrieved April 25, 2019, from https://coinpedia.org/news/blockchain-can-improve-gun-control/

Laskas, J. M. (2018, February 15). Want to Know How the Cops Actually Trace a Gun? Retrieved April 19, 2019, from https://www.gq.com/story/inside-federal-bureau-of-way-too-many-guns

Lastovetska, A. (2018). Blockchain Architecture Basics: Components, Structure, Benefits & Creation. Retrieved April 25, 2019, from https://mlsdev.com/blog/156-how-to-build-your-own-blockchain-architecture#What isBlockchainArchitecture?

Mire, S. (2019, March 15). Blockchain In The Firearms Industry: 6 Possible Use Cases. Retrieved April 25, 2019, from https://www.disruptordaily.com/blockchain-use-cases-firearms/

Price, D. (2019, March 08). 5 Blockchain Problems: Security, Privacy, Legal, Regulatory, and Ethical Issues. Retrieved April 23, 2019, from https://blocksdecoded.com/blockchain-issues-security-privacy-legal-regulatory-ethical/

Rapier, G. (2018, January 10). MORGAN STANLEY: Bitcoin could use more energy than Argentina this year | Markets Insider. Retrieved April 23, 2019, from

https://markets.businessinsider.com/currencies/news/bitcoin-mining-could-use-more-energy-than-electric-cars-this-year-morgan-stanley-2018-1-1012823094

Sharma, T. K. (2018, January 11). 5 Critical Components of Blockchain Technology. Retrieved April 15, 2019, from https://www.Blockchain-council.org/Blockchain/5-critical-components-of-Blockchain-technology/

Smart Contracts: 12 Use Cases For Business And Beyond. (2016, December 10). Retrieved April 19, 2019, from https://www.ccn.com/smart-contracts-12-use-cases-for-business-and-beyond