Blockchain: A revolutionary idea whose time has come?

Andrew Forster* and Nicholas Ferriman**

Abstract

Bitcoin has breached the threshold of global public consciousness. What is less understood is the technology that underpins it: blockchain. This paper will explain how blockchain technology works and its potential to overcome key global problems. The paper will also look at the implications of blockchain technology for finance, education, and supply chain management. Blockchain is a bottom-up digital revolution that is going to have a far-reaching impact on the way we live, on the way we teach, and on the way we do business.

Key words: blockchain, fintech, distributed ledger technology, cyber attack

* Humanities and Languages Division, Mahidol University International College
** Humanities and Languages Division, Mahidol University International College

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บทคัดย่อ

บิตคอยน์ได้ก้าวผ่านความรู้สึกของคนทั่วโลกไปเรียบร้อยแล้ว แต่สิ่งที่คนยังไม่ค่อยเข้าใจก็คือเทคโนโลยีที่สนับสนุนอยู่ ซึ่งก็คือบล็อคเซน นั่นเอง งานตีพิมพ์นี้อธิบายถึงวิธีการทำงานของเทคโนโลยีบล็อคเซน และศักยภาพของเทคโนโลยีดังกล่าวในการแก้ไขปัญหาที่สำคัญๆ ทั่วโลก นอกจากนี้งานตีพิมพ์ยังเจาะลึกถึงนัยสำคัญของเทคโนโลยีบล็อคเซน ต่อการบริหารจัดการด้านการเงิน การศึกษา และห่วงโซ่อุปทาน บล็อกเซน ถือเป็นการวิวัฒนาการดิจิตอลจากกล่างขึ้นบนซึ่งกำลังจะมีผลกระทบ อย่างมากกับวิถีชีวิต วิธีการสอน และวิธีทำธุรกิจของเรา

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* Humanities and Languages Division, Mahidol University International College

** Humanities and Languages Division, Mahidol University International College

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1. Introduction

The financial collapse of 2008, triggered by the demise of Lehman Brothers, the fourth largest investment bank in the US, undermined many people's faith in the global financial system. The consequent unwillingness of governments to prosecute bankers for the crimes they had committed spurred some in the 'tech' world to look for a solution to empower the citizen. What was needed was a system that did not rely on banks or central authorities. The result was Bitcoin.

It was no coincidence that the first Bitcoin transaction was implemented on 09 January 2009, shortly after the UK finance minister, Alistair Darling, announced his second bailout to revive the fortunes of the UK banking industry at great cost to the UK taxpayer (Elliott & Duncan, 2009). Satoshi Nakamoto, an individual (or individuals) whose identity remains unknown, devised the first decentralized

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*   Humanities and Languages Division, Mahidol University International College
** Humanities and Languages Division, Mahidol University International College

ledger–the blockchain–and was subsequently behind the release of the first Bitcoin. The aim of the system was to allow peer-to-peer online payments that bypassed traditional financial institutions (Nakamoto, 2008). The result has been a revolution in digital technology that is not only changing the face of the finance industry but is also affecting nearly every other field of commerce and business.

Thailand has positioned itself well as an early adopter of blockchain technology. The Thai Fintech Association was established by Korn Chatikavanij, a former Finance Minister, to move the country out of the middle-income trap as part of Thailand 4.0. Public consciousness was further raised when Vitalik Buterin, the co-founder of Ethereum and one of the pioneers in blockchain technology, was invited to speak to the Bank of Thailand in August 2017.

Action has followed. The Bangkok Bank has funded blockchain-based startups in the financial field, and Omisego, a digital payment solution looking to leverage blockchain, was awarded Thailand's 2017 "Digital Startup of the Year" (Palin, 2017). To service the needs of a US$45 billion market in Letters of Guarantee (LG), Kasikorn Bank, introduced the world's first blockchain-based LG service in July of 2017 (Kasikorn Bank, 2017). Blockchain has arrived.

This paper will describe the problems of data security and access that blockchain can resolve, how blockchain (the solution) itself works, and two aspects of financial technology (fintech) that

will have a top-down impact on the world of banking: Bitcoin as a global reserve currency; banking the world's unbanked. It will end by considering two other fields

where blockchain applications are already in use, namely education and supply chain management.

2. Data security: fraud and cyber threats

Bitcoin was a response to unethical banking practices, but it may be the solution to other problems too, particularly in the realm of digital security. For example, the hacking of information systems has reached epidemic proportions, and it appears that no online system is safe. In 2011, 117 million emails and passwords were stolen from LinkedIn, Sony, and Dropbox (Hackett, 2016). In 2013, it was Tumblr and Yahoo, and in 2015 Verizon and Weebly.

Much of the data lost in these hacks, and others like River City, were long lists of email addresses for spam email distribution. The hacking of sensitive personal data at JP Morgan Chase Bank, the Philippines Election Commission, and the UK's National Health Service were much more serious. The hack of the Democrat Party's server in 2016 may even have influenced a US presidential election (Calabresi, 2016).

Commerce and business are key targets for cyber attack. A survey commissioned by the UK Government into the cost of hacking found that 81% of large organisations and 61% of small businesses in the UK suffered a security breach in 2014. Though

the figures were down on 2013, the financial impact had doubled ("Cost of business cyber-security", 2014). In response, in New York, banking regulators have toughened up the scrutiny procedures to counter increasingly sophisticated cyber attacks (Chon & Scannell, 2014).

So serious is the threat to the well-being of the national economy, the UK's premier intelligence gathering establishment, Government Communications Headquarters (GCHQ), the descendant of Bletchley Park and the Enigma code-breakers, has linked up with other national security agencies to provide cyber protection for key sectors of the economy. These sectors include power grids, telecommunication networks, infrastructure systems, and government (Fleming, 2017). The WannaCry ransomware attack of May 2017, which affected the UK's National Health Service, Spain's Telefonica, and Germany's national railway, Deutsche Bahn, was an example of what is expected to come.

There is an even bigger and potentially more catastrophic threat, cyber terrorism. In a 2016 report, the Royal United Services Institute considered the cyber threats to the storage and use of nuclear weapons. The report highlighted the concern that these systems could be spoofed into reporting a non-existent nuclear attack, with the appalling consequences that this could trigger (Futter, 2016).

Keeping personal and commercial information "in the cloud" or on centralized databases are no longer the fail-safe options they once were. The increased costs of defending against cyber attacks

is the new norm. There is a therefore a need for more secure alternatives which decentralise storage and decentralise risk. Blockchain is such an alternative.

3. Access

Security is not the only problem. There is also the issue of access to banking facilities, and this access is particularly under threat in the developing world.

Unfortunately, in what is known as "de-risking" or "de-banking", many big banks are abandoning the poorest countries of the world. Christine Lagarde, the Managing Director of the IMF, has acknowledged that the pull-back from the developing world by the major banks is due in part to the capital requirements imposed on the banks by the 2008 financial crisis. However, she has voiced concerns that these poorest countries, through no fault of their own, are now at greater risk of marginalisation within the world banking system than ever before (Lawder & Spicer, 2016).

The banking situation is already bleak for many in the Global South. A World Bank report estimates that there are nearly 2.5 billion people worldwide who do not have a formal bank account (The World Bank Development Research Group, 2014). Most of these people are in the developing world, and without a bank account, or access to financial services, escaping poverty is a Herculean task. Lagarde also acknowledged that these same countries are heavily dependent on remittances sent from their citizens working overseas (Lawder &

Spicer, 2016). If there is no banking system, then there will be systemic economic and financial failure. If there is systemic failure, hundreds of millions of families will be cut off from funds sent from overseas by their loved ones. This is a man-made disaster waiting to happen.

Even for those individuals within the formal banking system, there are problems. The correspondent-banking system, which facilitates the transfer of remittances from one country to another, has proven to be vulnerable. The primary international payment system is SWIFT, but a recent theft of US$81 million from the Bangladesh Bank via SWIFT has highlighted weak links in the chain of a system that is meant to be secure (Leetaru, 2016). Could blockchain be the solution? Yes.

4. How does blockchain work?

There are four key features of blockchain technology: the open ledger; the distributed ledger; nodes; miners.

The 'open ledger' is at the heart of the system. In it, everyone can see when A sends $5 to B, and when B sends $8 to C, and so on. Everyone can also see how much digital money there is in each person's account and if a transaction is valid. For example, they will be able to see that A cannot make a payment of $20 to C as they only have $15 left in their account. The transaction will fail and will not be recorded on the open ledger.

Further to this, the 'open ledger' is decentralized via peer-to-peer distribution of the ledger. This 'distributed ledger' is a full copy

of the open ledger and is distributed by blockchain to tens of thousands of individuals across the network. These individuals, operating as 'nodes', are volunteers who use their own computing space to store a complete copy of the distributed ledger. In effect, these individuals perform a public service as a node gains no income from any of the transactions that take place. Whenever a transaction does take place, it appears simultaneously on each and every distributed ledger at all nodes across the network. To enhance security still further, every single transaction comes with a time-stamped digital receipt to prove its validity.

There is one last hurdle to overcome and that is 'synchroni-sation'. All copies of the ledger must be synchronized, which means that everyone sees the same copy of the ledger, and not one that is out-of-date. This is where "miners" come in. Their duty is to maintain the synchronization of the system, and they do so by being the sole custodians of transactions. Only they can validate a transaction, and only they can record transactions in the ledgers. How does this work? If individual E wants to send $5 to individual F, E indicates his desire to the network that he wants to send the money. This intention does not become a transaction until it is spotted by a miner who steps in and carries out the trade. It is the miner who moves the $5 from E's account to F's, no-one else. The first miner to step in and assist is rewarded with a small fee by E. In effect, miners are competing against each other to grab an intention, validate it, and put it into the ledger. When a miner has completed a number of transactions they

place them into a "block" and broadcast this block to the rest of network where the transactions are further validated. After validation, the transactions then join the chain on the distributed ledger. For this service, miners are again rewarded with a fee.

As a postscript, many miners are also involved in the mining of Bitcoins. A miner uses their computing power to solve an algorithm, the answer to which then becomes a Bitcoin. A Bitcoin is very simply the digital expression of this answer. So far, there are some 16 million Bitcoins in circulation and the limit to the number of solutions has been arbitrarily set at 21 million. There will be no more issues of Bitcoin beyond this number.

5. Is Blockchain secure?

Hacks of Bitcoin have only ever occurred at the individual user level when someone has been careless with the password for their wallet. [A wallet is where someone stores their Bitcoins. It could be at an exchange, on their phone, on their computer, or taken out of the system and put on paper]. This is no different than hacking somebody's email or cracking their password. To date there have been no successful attempts to open by brute force a SHA-256 encrypted private key upon which Bitcoin wallets rely for integrity.

At the systems level, blockchain is very secure. Unlike proprietary programs of software giants such as Microsoft and Adobe, which are closely guarded secrets, the code for Bitcoin is "open source" and free. This means that literally anyone in the world

can view the code and scour it for irregularities. Thousands of programmers have done and are doing just this daily. There are no hidden files, no Trojans, and no 'backdoors' anywhere in the current code. Like Linux, blockchain draws its resilience from the public-spirited actions of others. It is an area of the global commons policed by citizens, not by companies and not by governments.

Is it possible to "hack" the blockchain? Theoretically and technically, yes it is. In practice, it is not. Why not? In blockchain technology, to make a fraudulent entry on the ledgers, a malicious entity would need to overcome not one but thousands of networked computers which are constantly monitoring and validating transactions. This would mean hacking the public cryptography underpinning the system, and hacking the private keys of each user, all at the same time. As the Harvard Business Review writes, "Each single ledger entry among billions would need to be found and then individually "cracked" at great expense in time and computing, making the database as a whole very safe" (Mainelli, 2017).

As testament to blockchain's efficacy as a secure system, key personnel within the international banking system recognize that the technology looks a game changer. Mark Carney, the Governor of the Bank of England, has given his stamp of approval (Carney, 2016), as has Ben Bernanke at the US Federal Reserve in 2013, and the Bank of Canada more recently (Chapman, Garratt, Hendry, McCormack, & McMahon, 2017).

6. Fintech

6.1 Bitcoin as a Global Reserve currency

The 2008 financial crisis almost broke the international monetary system. Nearly a decade later, quantitative easing, negative interest rates, and threats of hyperinflation are symptomatic of a continuing malaise. One of the causes of the crisis was the dual role of the US dollar. It was both a global reserve currency and a domestic one. The tensions this creates–the so-called Triffin Dilemma–has led to calls from a number of institutions, including the Bank of China, for a truly unique global currency.

In response, the IMF has proposed the Special Drawing Rights (SDRs) as a potential global currency. The SDR would be based on a basket of national currencies, such as the US dollar, the Chinese Yuan, and the Euro, with perhaps some precious metals in the mix as well. The IMF could also issue its own cryptocurrency. Certainly, Mark Carney has intimated that the Bank of England could issue its own digital currency, the 'Britcoin', and the US Federal Reserve might issue the 'Fedcoin', so there is no reason why the IMF could not do so either. Christine Lagarde has created the High Level Advisory Group on Fintech at the IMF to explore this and other fintech issues.

However, others are more skeptical. Vitalik Buterin, the co-founder of Ethereum, does not believe that national currencies based on blockchain will ever reach fruition, and even if they do, it will be many years before they are launched (Roberts, 2017).

The reason why may lie with the explanation of US mathematician John Nash. In his paper on "ideal money", he concludes that, through political evolution, it is not inconceivable that one day the ordinary citizen may make choices about where to store his money that effectively sidelines the banks (Nash, 2002). That day may not be far off, but in the meantime, such is the low-esteem in which the banking system is held, it is difficult to see how they can accumulate the good will to compete effectively with Bitcoin in the cryptocurrency stakes.

In fact, by default, Bitcoin could conceivably become the global reserve currency. Its price volatility effectively rules it out for now, as does the limited number of users and small market capitalisation. However, as Bitcoin continues to grow, then it will become a serious contender. Trust is hard-wired into blockchain, whereas this is no longer the case with the traditional banking system.

6.2 Blockchain for the unbanked

The developing world may not have access to banks but they do have access to online platforms via their phones. Mobile phone penetration is almost 100% in many parts of the world. In Senegal for example, mobile phone ownership was 57 per 100 people in 2009. However, household penetration was 30 points higher with 87 homes out of a 100 having access to a mobile phone, a higher proportion of homes than in either the US or Canada (Minges, 2012).

This compares with less than one land line per 100 homes in many developing nations. Mobile wallets, whereby users make

payments via their phones, appear to be a cost-effective and practical solution for many. Yet the complexities of setting up the digital platforms have limited the scope of the roll-out. Blockchain provides a simpler alternative. In a revolutionary partnership, The Gates Foundation has joined with Ripple and other digital entities to create a new open-source software system based on blockchain. The software development will be funded by the Gates Foundation, and the goal is to create an interoperable payments platform that will provide the World's poor with access to financial tools (Johnson, 2017). In short they will be able to use their mobile devices as their bank.

7. Applications

7.1 Education technology

Blockchain technology offers numerous potential benefits for the education sector. In an increasingly globalized world of education, academic transcripts, diplomas, and various other certificates need to be readily available and readily verifiable. This can be done easily from anywhere in the world almost instantly using blockchain.

This potential for blockchain in the education sector is already being realised. Sony Corporation and IBM have begun joint development of a blockchain project for recording and sharing academic data in a transparent and verifiable manner. President of Sony Global Education, Masaaki Isozu, who is behind the collaboration with IBM, states that "blockchain technology has the potential to impact systems in a wide variety of industries, and the educational

sphere is no exception" (Haswell, 2017). The IBM platform will be powered by Hyperledger Fabric 1.0, a blockchain framework, hosted by the Linux Foundation. One function of the system will be to allow prospective employers access to digital transcripts at the discretion of the student.

Massachusetts Institute of Technology (MIT), already one step ahead of the field, has started issuing diplomas to students via its own specially developed blockchain technology called 'Blockcerts'. This allows students and companies to verify diplomas and credentials. The MIT Registrar, Mary Callahan, believes the new system will "empower students to be the curators of their own credentials". The CEO of the software development team of Blockcerts also points out that even if MIT should shut down or go out of business, verification can still take place (Young, 2017). That is the nature of blockchain.

7.2 Supply chain management

As more and more items are moved around the world, at ever-increasing speed and frequency, tracking their movements becomes increasingly complex. Knowing where items are in the supply chain can be vital, and knowing where they originate can be critical. Counterfeiting may seem trivial when it is a t-shirt, but it is of huge significance when it is aircraft spare parts or medication.

A number of multinational companies are already trialing the use of blockchain with their supply chains. For Walmart the concern is food safety. A batch of contaminated food needs its origins to be traced quickly. In a trial partnered with IBM, Walmart shipments were

digitally tracked from farm to store. The time to check their status and history took around two seconds. Prior to the blockchain trial, it took a week (Hackett, 2017).

Aircraft manufacturer Airbus has recognized the value of blockchain for monitoring the components they source for their aircraft, and for confirming the providence of their spare parts to customers. For the Dutch Shipping giant Maersk, the interest in blockchain lies in tracking shipments and reducing friction in customs procedures (Hackett, 2017). For others, the interest will be in reducing the layers of fees typically associated with cross border payments and verification (Hackett, 2017). For yet others, it will be about protecting the human rights of workers across the supply chain.

According to McKinsey (2010), it has become a struggle for supply chain stakeholders to maintain an adequate overview of their networks. Blockchain can reduce that struggle.

8. Discussion

This paper posits that blockchain technology is a game-changer. Its champion to date has been Bitcoin, the cryptocurrency that has been condemned by Jamie Dimon, the head of the investment bank JP Morgan Chase, as "a fraud that will eventually blow up". Others believe that Bitcoin has great potential and should be seen as an asset class in its own right (The Guardian, 2017). Alex Tapshott (2016), a member of the IMF's board on Fintech, goes as far as to say that Bitcoin is going to "eat" the traditional banking sector.

Whatever one's perspective, Bitcoin has proven thus far to be resilient.

The realization is also dawning that Bitcoin was merely the first application of blockchain technology. Transactions across a network do not need to be limited to packets of data representing a digital currency. Instead, they can contain information which represents other items of value. In Fintech, it may be Letters of Guarantee. In Education, it may be verification of degree qualifications. In supply chain management, it may be to track aero engine spare parts to prevent counterfeiting. Many other fields will open up to the technology as they understand the implications.

However, though blockchain has considerable potential, it is at heart a decentralising technology. This means it threatens traditional seats of power, so there will be considerable pushback from those who, like Jamie Dimon, have the most to lose. In the years ahead, we can therefore expect both acceptance and rejection of the technology.

9. Conclusions

This paper believes that blockchain technology is a revolutionary idea whose time has come. Its cryptography and distributed ledgers engender high levels of trust. Its ability to prevent hacking and cyber terrorism offer solace in a time of vulnerability. Its potential to reduce the financial precariousness of hundreds of millions of the world's poor is a powerful reason alone for its global adoption.

The move away from centralised data systems will have an impact beyond the business and commercial worlds. It will have a political impact. Under neoliberalism, globalisation took a wrong turn. Blockchain is the tool to redirect our economies for the benefit of the citizen, not the oligarch.

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