An overview of Blockchain applications and its impact to Vietnam context

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ABSTRACT— *Explosion of information and communication technologies providing worldwide connection through the Internet as well as the unstoppable development of technology is transforming how development is done locally and globally. Blockchain technology aims to build applications based on decentralized architecture, in which has received extensive attention currently. A decentralized peer-to-peer system is applied to record pseudonymous transactions in trustless environment. It is believed that blockchain has a significant role for the rapid growth of application domains such as public services, Internet of Things, supply chain management. We provided a short introduction of blockchain technology. Finally, we also discussed the impacts and challenges when applying this promising technology in Vietnam context.*

Keyword — Blockchain technology; Decentralized system; Decentralized application

I. Introduction

Blockchain is essentially a data structure (also called ledger) that all confirmed transactions are stored together into units called blocks. These blocks are connected to one another like a chain, hence the name Blockchain. This chain gradually increases when new transactions have been added to the ledger. To prevent data changing, a mechanism of asymmetric cryptography and decentralized consensus has been applied. Main properties of blockchain technology including immutability, anonymity, fault-tolerance and traceability allow transaction being validated in a decentralized approach, without any central intermediary.

Blockchain technology not only is used in financial services [1,2], but also potentially is one of important technologies for the next Internet generation, such as public services, Internet of Things (IoTs), energy management and supply chain services [3,4,5,6].

In a centralized network, decisions are observed or made under one authorized identity. It could be a single person or a group. Since the power is concentrated, it makes performance up to standards and latest protocols. A single authority is also good at that it can observe and adjust network activities. It also means that the functions in the systems are agonistic with respect to physical and geological locations. The units are usually spread around a country or over the world [7].

Most blockchain systems are public system. Because of this, they need to make use of cryptographic algorithms to protect transactions between two users. Since it is decentralized and peer-to-peer, there is no need for a intercessor or central authority. All transactions are executed purely on a peer-to-peer basis. Each node in the system can take role as the intercessor when transaction verification is needed. This is the standard for many blockchain or public pledger models. A desired advantage that blockchain has over traditional service is that it offers complete anonymity in transactions. It is extremely hard to trace the parties committed in a transaction.

In particular, this paper presents a short blockchain introduction including definition, main components and key characteristics. Besides, this paper shows a numerous of blockchain applications. Research challenges and future directions when applying to Vietnam context are also discussed.

The remaining of the paper is structured as follows. Section 2 discusses definition of blockchain technology. Section 3 discusses on applications domain. Section 4 summarizes the barriers when applying to Vietnam context. And finally, some conclusions are indicated in Section 5.

II. Short introduction to Blockchain Technology

A. Technical concept

From a technical view, a blockchain technology is used to build a immutable, secure, shared digital ledger that records the history of asset transactions between nodes in a public or private peer-to-peer network. When a transaction is executed all the nodes within the network have to reach a consensus and consistency on the correct state of a shared ledger. The main idea with the blockchain technology is that the decentralized transaction ledger functionality of blockchain can be used to register, confirm and transfer all kinds of contracts and properties without any intermediary needed [10].

In most blockchain designs, the cryptographic algorithm, namely secure hash algorithm (SHA), is used to generate a 'fingerprint' of a bock, so that the blocks can be identified uniquely. When data of block is changed, the

fingerprint of block is also changed. The next block will store the hash (fingerprint) of a previous block, in which all blocks will interconnect and form to the chain immutable over time.

B. Component of Blockchain Technology

Fundamental of a blockchain system consists of four components as share ledger, cryptography, peer-to-peer network and consensus mechanism. The details are presented as below.

1. Share Ledger

A share ledger is also called distributed ledger, which is a data structure where all the nodes within a system can store and access information related to a given set of assets and their holders in this shared ledger. In particular, the shared ledger is a linked list data structure, with each block containing a hash of the previous block shown in Figure 1.
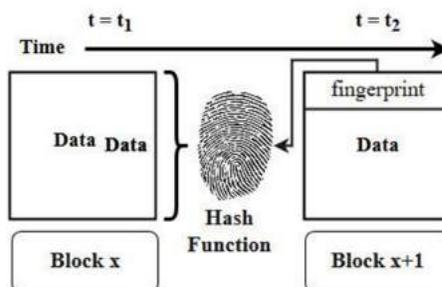

Figure 1 – Shared Ledger

2. Cryptography

The technology is needed to ensure security in transactions. With cryptography, transmission of messages can be protected better. Integrity is strengthened with the usage of cryptography that the message is likely to not be changed during the transaction. Another advantage of using cryptography is to ensure the message is transferred to the correct person [12].

There are three fundamental techniques of cryptography are listed below:

- Public and Private key: the main idea of this is providing a pair of keys: public and private [13]. The private key is kept by the owner, who will use it to generate encrypted messages. Only people who have the corresponding public key can decrypt such messages. If someone opens the encrypted messages without the public key, it will only show ciphertext and this text is unreadable.

- Secure Hash Function: is a one-way function that maps an input of some size to an output of fixed size. It is very easy to hash an input given the function and it's extremely hard to find the original input given the hash value. Additionally, it's very difficult for two similar inputs to have the same hash output (collision). One example of cryptographic hashing is SHA256.

- Digital signature: a pair of private and public keys are called the signature of a user. All digital transactions can be signed using the private key (signing). The transactions can be accessed by the use of public key. Public keys should be visible to everyone in the network. With the public key, all peers can verify if a hashed transaction was from the correct owner (signature verification). In blockchain, the usual digital signature algorithm is elliptic curve digital signature algorithm (ECDSA) [14].

3. Network

A peer-to-peer connection is implemented based on link [15]. In a peer-to-peer system, all users connect through the same protocol. The main different between this system and the traditional client-server one is that all users have the same role. Each peer can be a server and a client as the same time. In the classic model, one can only take the role of either a server or a client [15]. The development of decentralized control allows all users in the network to be equal in role.

4. Consensus mechanism

Consensus is an agreement of all nodes in the blockchain, in which enables decentralized operation and multiple processes cooperate with each other. When a transaction has been created, it needs to be broadcasted and validated. Because of different network state from each node view, the divergence may be existed.

Therefore, mechanism to mitigate branches should be proposed. As a result, achieving a consensus is an essential challenge. Two consensus mechanisms are most commonly used to establish consensus:

- POW (Proof of work) [16]: In blockchain technology, the proof-of-work is a consensus mechanism used with the concept called miners. The mining is done to verify each block before its transaction information is stored.

- *POS* (Proof of stake) [17]: To simplify the mining process, the proof-of-stake concept is used where a lot of tokens (crypto-currency) need to be verified. Under POW, a huge group of decentralized peers actively verify the transactions through finding the solution of the difficulty problem. On the other hand, POS principle needs the users to prove their ownerships of their stake. In this scenario, the verification based on their current stake is done by users (in percent). If someone has 20% stake of the total assets, he or she must take responsibility of 20% of the mining activity. This helps reducing the complexity of the verification process, which in turn saves more energy (electronic) and operating costs.

C. *Key characteristics*

Blockchain technology has following properties.

- *Decentralization:* In a blockchain network, all transactions can be done through a peer-to-peer (P2P) manner. This is a complete opposite to the traditional counterpart where all transactions are validated by a centralized system. With the use of blockchain and P2P, sever costs can be reduced and there won't be bottle neck at central servers.

- *Immutability:* All transactions in the network are stored in blocks. These blocks contain a hash of the previous block and they are distributed to all nodes in the network. Therefore, it's virtually impossible for data in these blocks to be modified and falsified. Recorded transactions cannot be deleted or reversed. Transactions can't be tampered in a ledger because the same records are stored on several nodes and constrained by hash function that guarantees to integrity of data.

- *Anonymity*: While interacting in decentralized system, no one can identify users through their key. This guarantees a certain amount of anonymity in the system, although complete anonymity is impossible due to intrinsic constraints.

- *Traceability:* User can trace back to the first transaction in the blockchain since all validated transactions have a timestamp and they couldn't be modified. This allows better transparency than traditional systems.

III. Domain applications

According to the Vietnam's Ministry of Technology and Communications [18], the orientation of applying the information and communication technologies to all fields and effective exploitation of information and knowledge in all sectors in the period 2015-2020 have significant role for economic growth. Vietnam determined to take advantage of the opportunities from the industrial revolution to enhance productivity and profitability. With the advent of blockchain technology, it has changed the way to handle daily interactivity through decentralized technology, in which it distributes storage to user. As the result, the system becomes more transparent and perhaps more democratic. Therefore, most governments in many countries are investing heavily in research and development to enhance their services. Blockchain is not a solution to all problems and it does not even revolutionize every aspect of our lives, but they can have a significant impact in various areas.
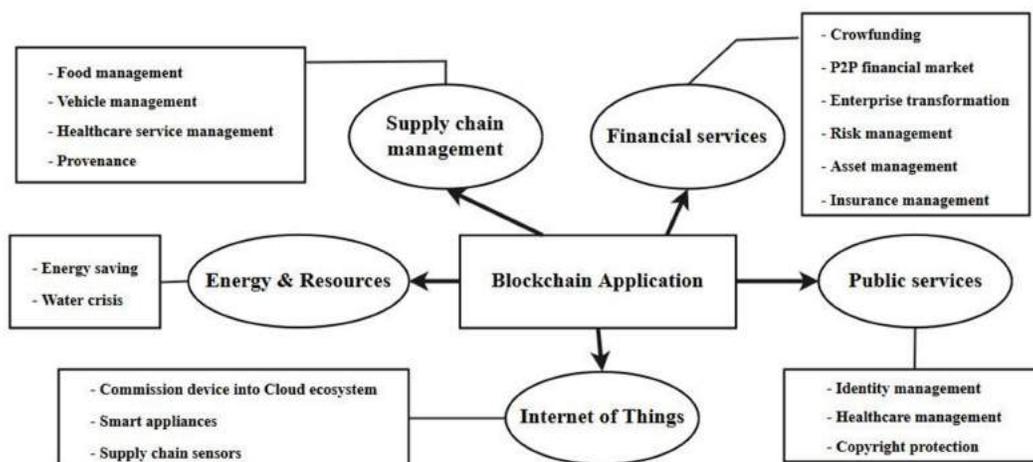

Figure 2 – Representative domain applications of blockchain

A. Financial services

The Bitcoin blockchain [16] has brought an impact on traditional financial and payment services. The overview of blockchain and its impact on traditional financial services such as remittance, digital assets is provided by Peters and Panayui [1]. In addition, Trautman [19] indicated the great opportunities for financial services. Besides, the suitability of blockchain can be considered as the backbone about infrastructure of financial sector due to the vulnerability to bugs.

However, other ones mentioned that it will improve financial sector without replacing them. In particular, Morini [20] showed that many practical business situations using FinTech to improve financial market. Noyes mentioned the combining of fully decentralized mechanisms to support peer-to-peer financial system [21]. Moreover, the theoretical model of fully decentralized trading systems with blockchain features is captured by Malinova and Part [22]. Microsoft Azure and IBM focused on blockchain technology which is offered as a services [23].

Blockchain has revolutionized startups organizations, especially around 3000 start-up companies in Viet Nam. Crowdfunding based on blockchain technology and its features can be the next step of the evolution by supporting interesting projects coming to fruition. For example, Decentralized Autonomous Organizations (DAO) [24] project allows startups to connect directly with potential consumers in order to find the funding. The DAO acted as a trusted third party to keep the investment, supporting to prevent scam for the potential investors. It is meaning that if the funding succeeds, the investors will get whatever was promised to them from part of investment strategy. If funding fails, their money will be sent back. The issue with these crowdfunding companies acted as the centralized party with charging high fees for seeking funding and also influencing the projects. Therefore, blockchain based crowdfunding plays as significant role as a game changer due to its decentralized feature, which the funding can raise from many tiny amounts of money which come from a huge number of people via the Internet.

B. Internet of Things

Internet of things (IoTs), one of the most potential information and communication technologies to keep pace challenges of an ever-changing global economy. The current popularity of IoT has become common in the daily life of people not only in the world but also in Vietnam. The goal of IoTs is to aim for integrating the things into the Internet and proposes the different services to users [25,26]. The typical applications of IoT consists logistic management with RFID, smart homes [27], e-health [28], smart grids [29] and Maritime Industry [30].

Currently, the IoT sector can be potentially improved by using blockchain technology. In [31], Christidis and Devetsikiotis focussed on the study of integration between IoTs and blockchain technology. They proposed to use smart contract, the concept is proposed in [32], which reside on the blockchain and enable to execute in a prescribed manner. In fact, smart contract plays as vital role of blockchain 2.0. Furthermore, the new e-business model based on IoTs is proposed by [33], which realize the transaction related to smart contract on blockchain. Recently, there are several companies like Antshare, Taiyiun and Bubi in China that are concentrating on digitalizing assets on decentralized network.

Another important concern with IoTs industry is privacy preservation. In particular, the privacy-perserving method is proposed by [34] for commissioning IoT devices into a cloud ecosystem. According to [34], the new architecture is designed to support devices, which used to show its origin without authentication from the third-party and enable anonymous registration. Besides, IBM is building the IoTs project based on blockchain technology in collaboration with Samsung, dubbed Autonomous Decentralized Peer to Peer Telemetry (ADEPT), which the system applied blockchain to build a decentralized Internet of Things. IBM and Samsung want to build the appliances in the home with autonomously maintaining themselves as well as identifying the operational problems and retrieving software updates themselves.

C. Public services

Vietnam is investing strongly for the establishment, construction and development of digital platform with e-citizens, e-government, e-business. In addition to the applications in financial and business services, the blockchain can be widely applied in public sectors, especially e-government. One of blockchain applications in public sector is real-estate registration, which consisted of physical status and related rights can be registered and announced on blockchain system. Any changes made on the real-estate as the transfer or the establishment of a mortgage that can be stored on blockchain system in order to enhance the efficiency of public sectors. Other public services such as marriage registration and copyright management [35] can be implemented by applying blockchain.

Blockchain systems can also be used to manage identity such as birth certificate, wedding certificate or e-Residency in [36]. One of typical blockchain application in public sector is digital identity system that have been applied in Estonia. The government of Estonia built its digital identity system, dubbed e-Estonia, which used to manage the information of Estonian citizens via the Estonia ID and mobile ID. Basically, the Estonia ID card is cryptographically secure digital identity card that implemented by blockchain infrastructure, which enables an Estonian to access financial services, public services as e-voting, healthcare as well as providing digital signatures and travel within the EU without passport.

D. *Energy and Resources*

In order to meet the energy demand for economic and social development in the coming years, Vietnam needs to have appropriate solutions to the market economy regime in the context of our increasingly deep integration into the world economy. The energy market, like all other commodity markets, is based on the principle of supply and demand. In the context of mitigation and adaptation to climate change, the implementation of green growth strategy is the main strategic task set for the period 2011-2020. There has been increasing recognition of the role of blockchain in green energy as its significant contribution to the global economy in terms of energy, income and employment. Gogerty and Zitoli [37] have proposed the Solarcoin to enhance the usage of renewable energies in order to reward solar energy producers. The Solarcoin network applied Proof-of-Stake Time (POST) rather than the traditional consensus Proof-of-Work (POW) that wasted much energy to reach consensus.

Furthermore, the water crisis can be solved by using blockchain technology. In fact, the diseases could be caused by unsafe water and lack of sanitation, which led to the large number of people be killed annually. Statistically, the increasing number of people are living without clean drinking water in the world, approximately 1 billion people. It is occurring all over the world, especially in undeveloped countries. Clean water projects are established since 2006 to solve the water crisis and integrated with blockchain technology in 2015. The nonprofit organization TCWCI [38] designed and developed the Clean Water Coin for saving lives through mining in this blockchain network.

E. *Supply chain management*

Global supply chain is no longer unfamiliar to Vietnamese enterprises. Since moving to a market economy and international integration 30 years ago Vietnam has established trade relations with more than 180 countries and attracted investment capital in more than 100 countries. The definition of Supply chain can consist of the chain of various points involved in producing and delivering goods, from the procurement stage to the end customer. Therefore, it is significantly difficult to trace events in the entire chain. Moreover, due to the lack of transparency in the supply chain, buyers and customers cannot be sure in the true value of the products or services. Furthermore, there are several factors related to the supply chain, which cannot be tracked, such as environmental incidents [39]. It has become harder to investigate the accountability of illegal events associated with the supply chain. Because of these challenges, the world has faced following problems of counterfeiting, forced labor and poor conditions in factories. The application based on blockchain that have the potential to improve supply chains by providing infrastructure for registering, certifying and tracking goods being transferred between stakeholder parties, who are connected via a supply chain but do not necessarily trust each other. All goods will be uniquely identified as 'tokens' and can be transferred via the blockchain system, which each transaction verified and time-stamped in an encrypted but transparent process. This gives the stakeholder access whether they are suppliers, vendors, transporters or even buyers. The terms of each transaction remain irrevocable and immutable, which empower to consumers or to authorized auditors for inspection.

In October 2016, Walmart [40] launched the program with the goal to improve the way food is tracked, transported and sold to consumers across China. Blockchain technology is harnessed to generate transparency and efficiency in supply chain record-keeping. The first food item to be tracked by using this technique is pork. The Information of this supply chain is consisted farm origination details, batch numbers, factory and processing data, expiration dates, storage temperatures and shipping detail, which are digitally linked to the physical food items as it moves from source to destination. The captured information during each transaction is validated by businesses within the network such as farms, transport companies, packaging companies, warehouses and stores, which forming a consensus. The record of each transaction, called 'Block', is validated and it is automatically added to a 'chain' of transactions, becoming a permanent record of the entire process. Each pork item distributed at store, which is verified as authentic and its digital record could potentially prove food safety issues picked up between farm and store. The digital record can also support Walmart retailers better manage their products in individual stores.

IV. Barriers to adopt Blockchain in Vietnam context

The revolution of information and communication technologies (ICT) providing worldwide connection through internet, blockchain technology has emerged as an efficient channel to handle a vast array of applications or problems, spanning from financial to non-financial applications. Blockchain offers a promising way for enterprises and government to keep pace with challenges of an ever-changing global economy. However, the few available studies on blockchain adoption in developing countries reveal that they lag behind developed countries due to the absence of adequate basic infrastructure and the lack of national ICT strategies from the government. When investigating the factors that restrict adoption of ICT and blockchain technology, which classify barriers of blockchain adoption into four kinds that are organizational barriers (such as hidden or indirect costs, lack of IT infrastructure, and lack of skilled employee), financial barriers (such as market uncertainty, losses in productivity, cost of education and training, investment risk), technical barriers (such as risks associated with authentication and security), and behavioral barriers (such as job-loss fear and reluctance to change). Consequently, the challenges about the strategies of government and technical understanding will be the main obstacle.

They added that blockchain adoption in developing countries, especially Vietnam context, remained a lengthy, time-consuming and complicated process requiring substantial amounts of investment and strategies from government. Besides, the lack of regulatory and legal is the main factors impacting blockchain adoption in Vietnam market. Consequently, Vietnam seems not really to reaping the expected benefits from blockchain.

Especially in Hong Kong, the government announced strategy to create regulatory sandbox that start-up organizations or bank can implement solution and express their ideas before applying for authorization. The sandbox allows the organizations or companies to perform testing of newly technology such as blockchain. With the supporting of sandbox, the organizations can implement their new FinTech products without the need to completely compliance with the usual supervisory requirements of government. In addition, there are many governments such as Singapore, UK and Japan have implemented regulatory sandbox for implementing newly developed technology [41, 42].

The human resources of Vietnam's information technology and communications have reached the level of leading in ASEAN countries in order to meet the demand of quantity and quality for future development of global economy. Thereby, the development of human resources to master knowledge of new technology such as blockchain is a necessity, in which the training of researchers and technicians to meet the demand for high manpower to serve the orientation development. Besides, it is necessary to organize R&D in universities including training and scientific research. It is also necessary to have special policies and incentives to attract talents and encourage domestic and foreign specialists, in which actively participate in the developing and applying this technology in various areas.

V.   Conclusion

In this paper, we present a short introduction of blockchain technology including technical concept, consensus protocols, key properties. The authors discussed various blockchain applications on many fields such as financial and business services, Internet of Things, public services, supply chain management and energy saving sectors. It remains, however a few of research challenges that be required extensive efforts. In overall, the authors believe that rapid development of blockchain will absolutely change the existing industries and create huge opportunities in Vietnam context.

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Tổng quan về các ứng dụng Blockchain và tác động của nó trong bối cảnh Việt Nam

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TÓM TẮT— *Sự bùng nổ của công nghệ thông tin và truyền thông (ICT) cung cấp kết nối toàn cầu thông qua Internet cũng như sự phát triển không ngừng của công nghệ đang làm thay đổi cách phát triển được thực hiện ở địa phương và toàn cầu. Blockchain là một trong những công nghệ cốt lõi của đồng tiền mã hóa (crypto-currency) như Bitcoin hoặc Ethereum, trong đó đã nhận được sự quan tâm sâu rộng hiện nay. Hệ thống phân quyền ngang hàng (P2P) được Blockchain áp dụng để ghi lại các giao dịch ẩn danh trong môi trường ít tin cậy. Người ta tin rằng Blockchain đóng vai trò quan trọng cho sự phát triển nhanh chóng của hệ thống tương tác Internet trong tương lai như dịch vụ công cộng, Internet of Things (IoT), quản lý chuỗi cung ứng chứ không chỉ là thị trường tài chính. Vì vậy, chúng tôi trình bày một tổng quan về các đặc điểm Blockchain. Ngoài ra, chúng tôi cung cấp tổng quan về công nghệ Blockchain và tác động của nó. Bên cạnh đó, chúng tôi đã liệt kê một số lượng lớn các ứng dụng đã áp dụng công nghệ Blockchain. Cuối cùng, chúng tôi thảo luận về những thách thức trong việc áp dụng kỹ thuật đầy hứa hẹn này trong bối cảnh Việt Nam.*