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건강정보에 대한 블록체인 기술 응용: 블록체인 기술은 글로벌 건강 정보 이슈에 대해 만병 통치약이 될 수 있는가?[1]

Blockchain technology usage on health equity: Is Blockchain technology a panacea for global health equity issues?

자야 수흐바트 (Zaya Sukhbat) 순천향대학교 경영학과[2]
최 재 원 (Jaewon Choi) 순천향대학교 경영학과[3]

ABSTRACT

This paper explores the potential of Blockchain technology in enabling a panacea for health equity. Since Satoshi Nakamoto first described Blockchain technology in 2008 pseudonymous paper, that distributed ledger system is empowered and ranging from finance to law to another sector and beyond. Also impacting healthcare sector and life science. In other words, there are many usage cases being researched in healthcare and Blockchain has shown its considerable special side in recent years. But this paper aims to the distributed ledger that is the special side of Blockchain technology is potentially can panacea for some global health equity issues such as patient data, counterfeit drug and hospital payment management.

Keywords: *Blockchain technology, Healthcare, Distributed ledger, Panacea, Patient data, Hospital payment management, Counterfeit drug*

1. Introduction

The functional principle of the Blockchain technology is also explained using the concept of cryptocurrency, such as about Bitcoin. A purely peer-to peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution(Adam and Matt 2014). But while Bitcoin is the first Blockchain technology-

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2) 제1저자 (zaya@sch.ac.kr)
3) 교신저자 (jaewonchoi@sch.ac.kr)

based coin achieving widespread media attention, the impact of the Blockchain technology extends beyond with some advantages and opportunities to other industries. Health is the foundation of a tranquility life and modern humans have been explored that great advances in technology and healthcare sector. New era millennials want to search applying the Blockchain technology to solve the many problems, which are including efforts to track public healthcare, and manage patient data from an increasing number of information, also pharmaceutical issues. But besides, healthcare industry maybe suffering from lack of effective adoption of horizontal innovations versus vertical innovations. However, fundamental problem in healthcare is called by many different names on the medical or clinical side(Bill 2017). But all of these problems are come to down one core issue and that' s all kind of transactional inefficiency. A study by Mckinsey & Company estimated that more than $300 billion could be recovered per year by using health data creatively and effectively, with two-thirds of that in the form of reductions to U.S national healthcare expenditure-about 8 percent of estimated healthcare spending at 2010 levels(Chaum 1983). A growing number of use cases of this technology has gained widespread traction and is attracting investments like no other emerging technology(Crosby and Pradan 2016). The use of Blockchain technology in healthcare is expected to reinvent the ecosystem in limitless ways to benefit the patient and advancements in treatments, outcomes, security and costs(Buterin 2015). To summarize, the 2 major research questions derived from the above discussion are as follows:

Recommended question 1: If Blockchain technology will soar in the next years, can't we imagine our future without this technology?

Recommended question 2: What kind of issues can be solved through the Blockchain technology?

Recommended question 3: How to effectively solve those issues in health equity?

2. Literature review

2.1 Blockchain technology

David Chaum introduced digital cash as a research topic in 1983, in a setting with central server that is trusted prevent "double-spending" (Karen 2015). To mitigate the privacy risk to individuals from this central trusted party, and to enforce fungibility. In 2009, as we known as Satoshi Nakamoto released that implementation of peer-to-peer trustless electronic cash, based on proof of work. A Blockchain is well-ordered collection of blocks, on which all users must

<Table 1> Types of Blockchain technology

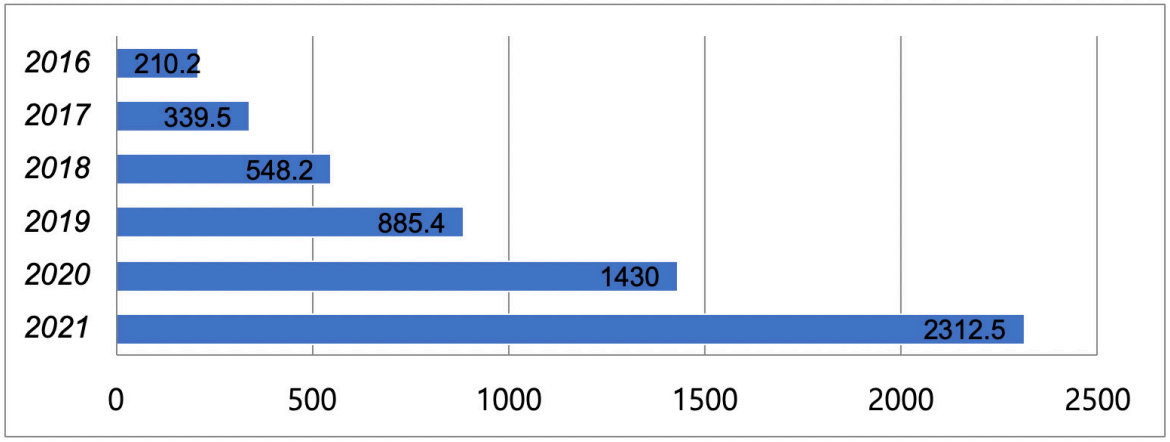
Private	Public	Consortium
The company writes and verifies each transaction. This allows for greater efficient and transactions on a private Blockchain will be based on significantly faster. Example: Bank chain, Multichain, Monax…	In public ledger, everyone can charge, and anyone can participate in reading and other operations in the Block chain technology. Also, public type of Blockchain are open and anyone can review anything at a given information on public Blockchain. Example: Bitcoin, Ethereum, Litecoin …	Consortium type of Blockchain tries to remove the main autonomy, which is getting vested in just one entity by using private Blockchain. Basically, a group of companies or representative individuals are coming together and making decisions for the best beneficent things of through the network. Example: R3, Corda…

come to consensus(Adam and Matt 2014). The blockchain is essentially a distributed database of records, or public ledger of all transactions or digital events that have been executed and shared among participating parties(Drew 2016). Also, three types of(Private, Public, Consortium) Blockchain have own difference.

The combined market capitalization of all typed of crypto-currencies is approximately USD $19 billion(as of February 2017), with the top 15 currencies representing over 97% of the market(Predrik and Milai 2016). And blockchain technology's advantages are become especially interesting, when many different parties need to access the same information(Gartee 2011). And through, previous studies suggested Blockchain technology market are growing fast.

2.2 Smart healthcare data management for patient

The electronic health record is including long time electronic health record of patient, which



<Figure 1> Size of the Blockchain technology market size by million USD

is generated by one or encounters in all type healthcare delivery setting (Health Information Management Systems) (Irving and Holden 2017). Murphy, Walters and Hanken, also specially suggests that it includes “any information relating to past, present or future physical/mental health, or condition of an individual which resides in electronic system used to capture, transmit, receive, store, retrieve and manipulate data for the primary purpose of providing healthcare and health-related services(Kefa 2016). And EHR gives for doctors fast, reliable and secure access to patient medical histories, prescription records and past test results. Generally, Electronic Medical Records (EMRs) or Electronic Health Records (EHRs) contains medical and clinical data related to a given patient and stored by the responsible healthcare provider since 1972(Kevin 2015). Healthcare providers have always led healthcare services. One of the biggest reasons is the highly percentage gap between healthcare providers and patients in the terms of the information. Medical treatment is a direct or indirect service related to the treatment of the patient by the physician as the subject and treatment of the patient with proper medication or treatment according to the symptom(Kim 2010). However, as the accessibility of information has been improved through the development of technologies such as Internet, the dynamics between healthcare professionals and patient is changing rapidly(Kho 2018). On the other side of quantitative growth of patent that companies hold, there are some problems such as the difficulties to determine(Ko 2012). Specially, comprehensive EHRs have helped them reduce medical errors, shorten inpatient stays and produce better clinical outcomes. Electronic health record adoption rate in South Korean hospitals (37.2%) was higher than that in US hospitals in 2010 (15.1%), but this trend was reversed to (58.1% vs 75.2%) in five years later(Kim and Jung 2017).

2.3 Hospital payment management

Eight basic payment methods are applicable across all types of healthcare(Latanya 2002). All kind of hospital payment methods are defined by the <Table 2> more broadly. These types of all methods are more specific than common terms, such as payment problems. They also correspond from the division of financial risk between payer, who is patient and healthcare provider, with each method reflecting a factor within the healthcare spending identity. In healthcare industry, many hospitals are faced operational difficulties and competing impetuously(Kim and Num 2009). Financial risk implicating from being primarily on healthcare providers when hospital payment is type of sper time period to being primarily on payers when payment is per currency of charges.

<Table 2> Methods of hospital payment[1]

Unit of payment	Common Term	Examples (Common Classification Systems)	Comment
1. Time period	Budget and salary	Salaried physicians and government hospitals	Typically, but not necessarily per year
2. Beneficiary	Capitation	Managed care organizations (ACG, CDPS, CMS-HCC, CRG, and DxCG)	More commonly used to pay health plans than to pay individual providers
3. Recipient	Contact capitation	Physician specialist services	Not common; an example is a cardiologist accepting financial risk for treatment of cardiac patients
4. Episode	Case rates, payment per stay, and bundled payments	Hospital inpatient (DRG), Physician surgeries (RBRVS), home healthcare (HHRG), and multiple providers (ECR, ETG, MEG, and PFE)	Defined here as related clinical services across multiple days
5. Per day	Per diem and per visit	Nursing facilities (RUG), hospital outpatient (EAPG) and ambulatory surgical centers (APC)	An outpatient visit may be defined as all services on 1 day
6. Per service	Fee-for-service	Physician services (RBRVS), hospital outpatient (APC), dentists, medical equipment and supplies, and drugs	Separate payments are often made for multiple services per day
7. Currency of cost	Cost reimbursement	Critical access hospitals, government-owned providers, and nursing facilities	Payers typically pay a percentage of cost as allowed by the payer
8. Currency of charges	Percentage of charges	Any provider type	Based on charges as billed by the provider

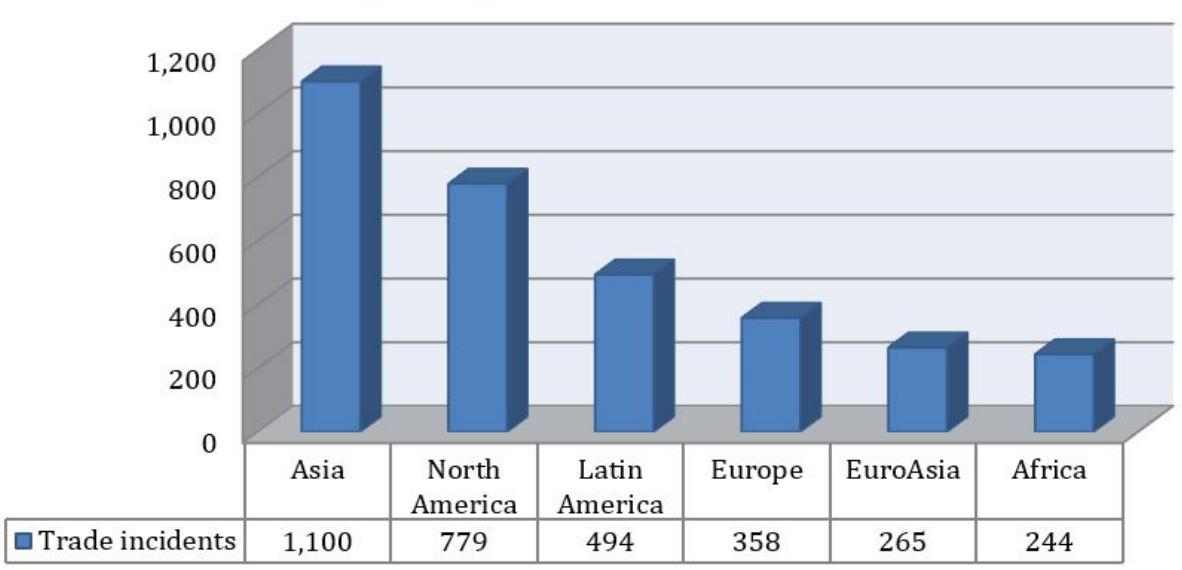
[1] ACG= adjusted clinical group; APC= ambulatory payment classification; CDPS= chronic illness and disability payment system; CMS-HCC=Centers for Medicare & Medicaid Services-hierarchical condition category; CRG= clinical risk group; DRG= diagnosis related group, EAPG= enhanced ambulatory patient group; PFE= patient focused episode, RBRVS= resource based relative value scale, RUG= resource utilization group

Method 4 (per episode) marks the line between epidemiologic and treatment risk. The 8 methods are typically combined to balance risk and thus balance incentive between payers and providers.

In Republic of Korea, the diagnosis-related groups (DRG) based payment system was introduced in stages after the beginning of demonstration project at National Health Insurance Service Il-san Hospital in 2009 and finally, entire hospitals in Korea were required to implement a DRG based payment system for seven groups of specific operations/diseases including appendectomy from July 2013 onwards(Margaret 2014).

2.4 Fake/ Counterfeit medicine

Counterfeit medicine is which fake medicine, it may be contaminated or contain the wrong or



<Figure 2> Trade incidents by involving fake pharmaceuticals in 2015

no active ingredient(Mathias 2016). As shown in <Figure 2>, the issue of fake/ counterfeit drug, medicine is an urgent and increasingly acute worldwide issue(Matyika and Michael 2011).

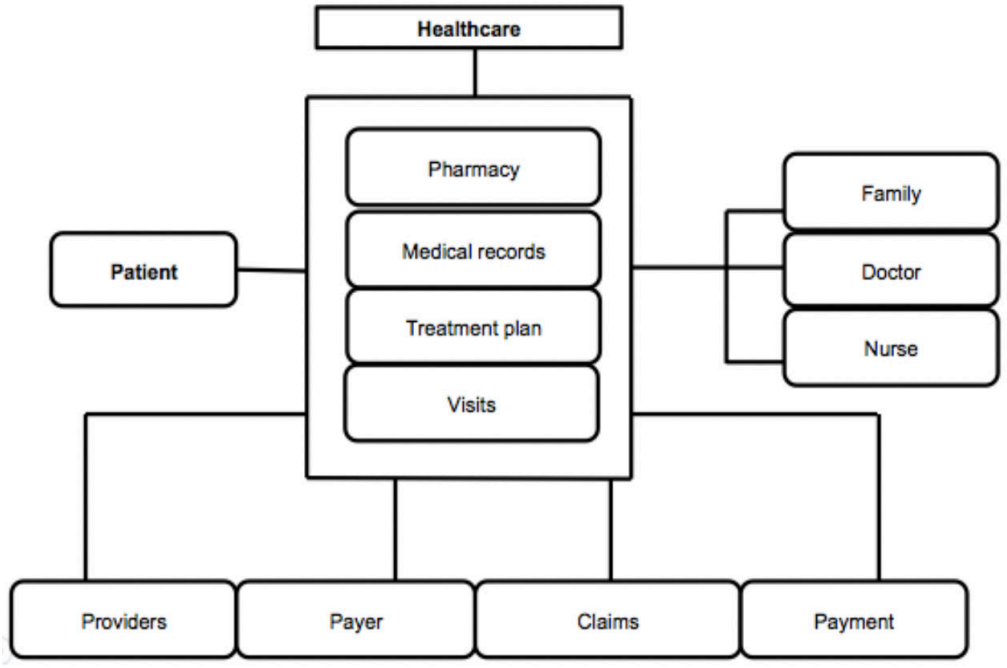
According to the recent World Health Organization (WHO) report, up to 30% of all drugs in circulation are fake, leading up to a million deaths annually, including 450,000 preventable deaths from such as malaria alone(Nakamoto 2008). Some kind of deaths can be attributed directly from the chemical ingredients, such as toxic ingredients (which as rat poison, floor wax, industrial chemicals and like) used to produce fake/ counterfeit drugs. Because of that problem, global fake/ counterfeit drug detection devices market was valued at $904.5 million in 2016 and is expected reach $1368.5 million by 2021 at CAGR of 8.5%(Raghu 2017).

3. Research Framework

In this paper's all studies are based for above research model contents and aimed to determine the solutions for healthcare issues as shown in <Figure 3>.

3.1 Study 1: Smart data management with Blockchain technology for patients

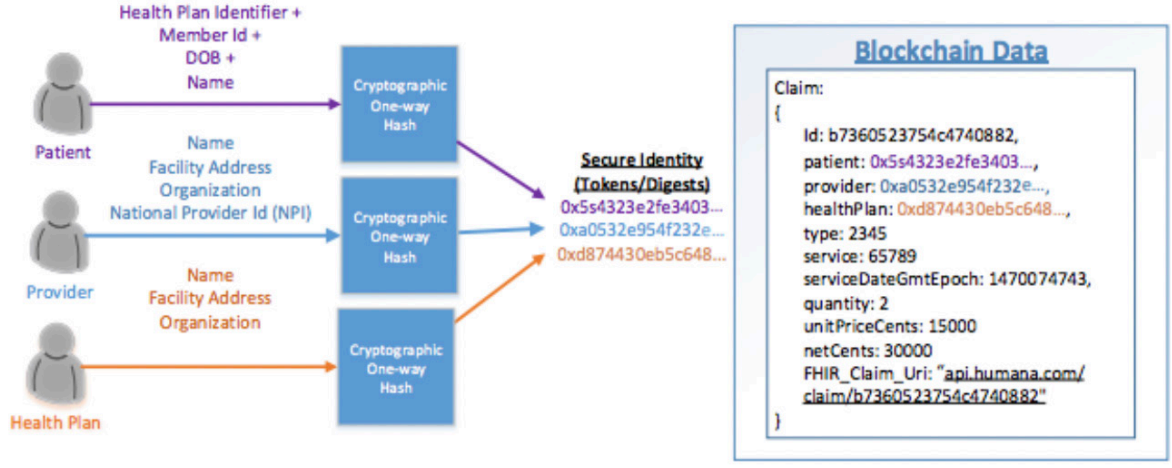
Blockchain technology is ensures information on the chain is verified by requiring users to provide a signature and time-stamp with a private key to access the data. If we would use Blockchain technology in EHR, Blockchain will enable to



<Figure 3> Research Framework

different healthcare providers such as doctors, hospitals, laboratories, pharmacists and insurers to request permission to access in their medical records. Data can only be accesses by the patient's private key; even if the database is hacked, the patient's data will be unreadable like <Figure 4>.

A decentralized database, which is decentralized ledger system is consistently held up to date, gets many advantages to the healthcare and information technology industry. For example, Los-Angeles based startup Gem has unveiled its first partner on the effort, Philips, which will assist

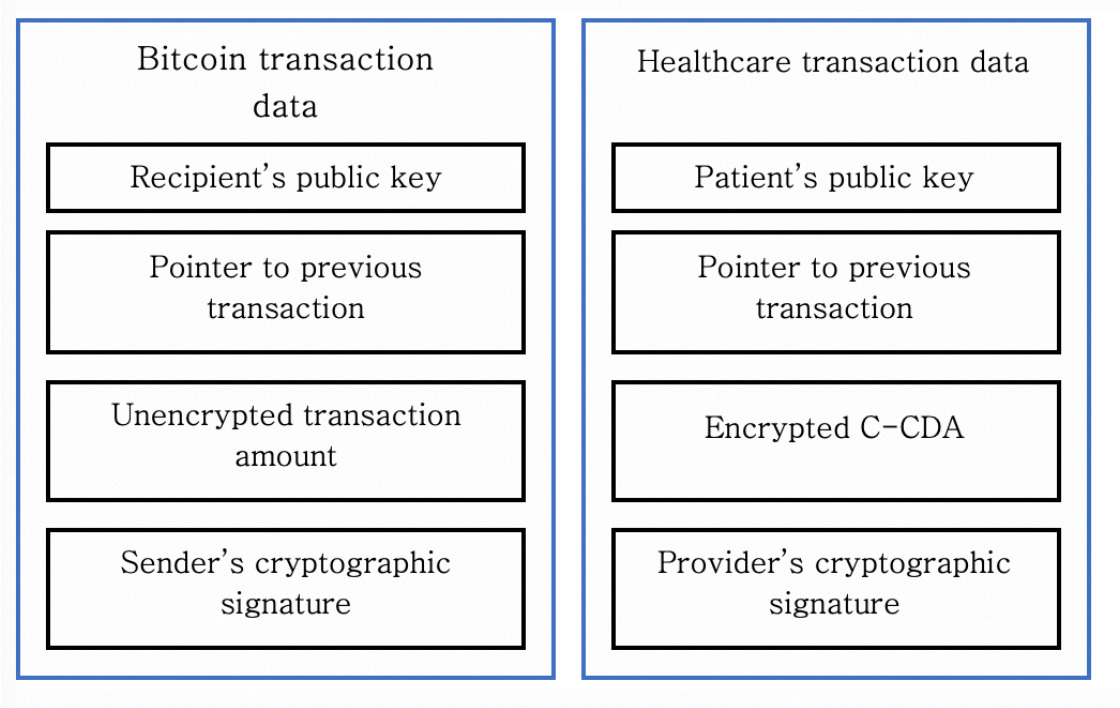


<Figure 4> One-way cryptographic hash for patient data

Gem as it seeks to build out a private Ethereum Blockchain for use in the development of enterprise healthcare application and developed the first Blockchain product for health claims management, which is being demonstrated at Consensus at 2017.

Sharing healthcare data is one essential step to make healthcare system smarter and improve the quality of healthcare service. Blockchain is demonstrated in the financial field that trusted and auditable computing is possible to using a decentralized network of peers accompanied by a public ledger(Steward 2005). Blockchain was originally conceived as an infrastructural component of the crypto currency, Bitcoin. The transactions on Bitcoin's Blockchain represent financial transactions. In a healthcare context, transaction would consist of documentation of specific episodes of healthcare services provided. Healthcare providers, payers and patients would contribute encrypted data, which would reference a patient ID, to a public Blockchain. This could include clinical data is stored in EHR systems today: claims history and gaps in care from payers; and family history and device readings from patients(Stephan and Jeffrey 2017).

Clinical Document Architecture (CDA) is a popular, flexible markup standard developed by Health Level 7 International (HL7) that defines the structure of certain medical records, such as



<Figure 5> Difference between transaction data

discharge summaries and progress notes, to better exchange this information between providers and patients. These documents can include text, images and other types of multimedia- all integral parts of electronic health records(WHO 2016).

3.2 Study 2: Hospital payment management

Global Blockchain in healthcare market to reach $5.61 billion by 2025, reports BIS research. Blockchain technology has evolved more in to aid in financial transactions. Because all kind of online payments have gained huge transaction size from card-based payment method; credit and debit cards become dominant.

Blockchain supports all these kind of payment changes by creating increased speed of transaction processing, which is in real time processing. Special advantage of Blockchain technology, that distributed ledger support the payment system for digital currency to operate in decentralized mode, by eliminating the need of intermediaries to centralized processing.

Traditional healthcare fee-for-service payment

<Table 3> Payment methods commonly used by provider type [2)]

Provider Type	Basic Payment Method by Table 1							
	Time period	Beneficiary	Recipient	Episode	Per day	Per service	Currency of cost	Currency of Charges
Managed care organization		*	+					
Hospital Inpatient	+			*	+		+	+
Hospital outpatient	+				+	*	+	+
Ambulatory surgical center					*			+
Physician	+	+	+	+		*		+
Dentist						*		+
Therapy (outpatient)						*		+
Clinical ambulatory						*		+
Ambulance						*		+
Drugs (pharmacy)						*		+
Nursing facility					*		+	+
Home health care				*		+		+
Hospice					*			+
HCBS						+		+
ICF/ DD					+		+	+

2) * Predominant method used; + Other methods commonly used; HBCS= home and community-based services; ICF/ DD= intermediate care facilities for the development disabled

systems are overly complex and expensive from an administrative perspective. On average, payment administration accounts for about 14 percent of healthcare spending(WHO 2016). Blockchain applications can reduce waste. Beyond fee-for-service, Blockchain as a technical architecture can enable value-based payments to take off and thrive, some experts studied. Claims adjudication and billing management is ripe for a Blockchain-based system that can provide realistic solutions for minimizing medical billing-related fraud; this is a highly relevant use-case given the amount of fraudulent activities around improper medical billing and reimbursements across payer industry.

3.3 Study 3: Using Blockchain technology to fight for fake/counterfeit drugs

The research for development and production of drugs in pharmaceutical industry are a further field of application for Blockchain technology. And this technology can also be used to monitor the production processes for drugs. But, pharmaceutical type of products is sensitive production process and associated with final liability products. And Bloomberg, Intel, IBM, Accenture, IEEE, Farma Trust, The LinkLab are involved the projects especially focuses on the issues of fake/counterfeit drug. One of the biggest and most important uses for distributed ledger in future will be supply chain management for pharmaceutical. So Blockchain technology can also be used in monitor the medicine/drug production processes. If integrate that project' s model and create steps about monitoring the processes of medicine/drugs through the usage of Blockchain and other technology or operations, it would be like from the verification of individual package of medicine/drug to tracking a pharmaceutical product supply process through the supply chain and real-time tracking. In developing countries, retailers must wait months for payment for delivered medicine/drugs.

When factory produce a new product, they will create a unique hash and assign it to the product. The product will be registered on the Blockchain using its hash (unique ID). The product will be considered as a digital asset on the Blockchain network, and its hash will be used to track it any time n the network. Any additional information of the product can be stored off-chain or on-chain depends on manufacturer's choice. Off-chain data will be merged with on-chain data by using identifier. Conventionally, in most Blockchain based applications a hash digest of all the off-chain data is generated and linked it to the on-chain data. But the best approach is to store large files (e.g. images) off-chain and text data on-chain. Once the product is registered to the blockchain by the manufacturer, its ownership will be easily

transfer to another participant using a user-friendly mobile app. Wholesaler want to purchase the drugs from the manufacturer, manufacturer will physically transfer the drugs to the wholesaler and a transfer transaction will be registered to the Blockchain simultaneously. Wholesaler will repeat the same process to transfer the drugs to distributer, and distributer will do the same business with pharmacy.

4. Conclusion

This paper aimed to Blockchain technology could panacea for healthcare industry's some issues such as patient data, counterfeit drug detection and also hospital payment management. Future studies may use data effects and difference between development and developing countries special side on technology and healthcare sector. Finally, this study has provided the necessary literature foundation on Blockchain technology usage on healthcare, future studies may develop hypotheses research model that predict actual usage of Blockchain technology.

Widely array of approaches can be implementing Blockchain technology or other Distributed Ledger Technologies(Xiao and Huiju 2016). This study proposes a possible way for using Blockchain technology on facing issues of healthcare industry.

Proposition 1: Blockchain technology is to enable the efficient sharing information with data integrity and protecting privacy.

Proposition 2: Attempting to intentionally manage the culture transformation so as be able to implement an EHR system it would appear resembles an act in futility if the change comes into conflict with a well-entrenched, patient-centered, ethically based healthcare culture.

Proposition 3: The 8 basic payment methods remain applicable, but they are combined in new ways and accountable care organizations and other reforms encourage providers to band together, but consolidation helps providers negotiate higher prices from commercial payers. So, need to find more ways for how to use payment method on provider type with efficiency.

Proposition 4: For the pharmaceutical company and supply chain companies need to quantify the need for more secure technologies such as Blockchain technology to monitor supply chain integrity and for fight counterfeiting.

The potential of Blockchain technology is currently being explored across many country's healthcare sector. And market size of Blockchain technology is fastest growth rate across the global. Thus, this growth can reduce information technology and operational costs in healthcare process and reduce healthcare related issues. Consider that Blockchain technology, like all exponential technologies, is not perfect and need to correctly take advantages of its capabilities. By unlocking the potential for multiple works to solve issues or problems in healthcare, distributed ledger offers hope that the timeline for clinical development. Finally, healthcare sector's system' s each payment methods are own financial risk. Through the distributed ledger, it needs to be created and developed model for suitable with each payment method.

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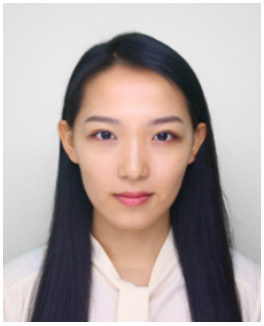
저 자 소 개



자야 수흐바트 (Zaya Sukhbat)

현재 순천향대학교 글로벌경영대학 경영학과 석사 과정 중이다. National University of Mongolia, School of Business에서 경영학 학사로 졸업하였으며, Mongolian Stock Exchange에서 리스크 관리 직원으로 근무하였다. 관심 분야는 Blockchain, Healthcare, Financial technology& Risk Management 등이다.

최 재 원 (Jaewon Choi)

현재 순천향대학교 글로벌경영대학 경영학과 조교수로 재직 중이다. 가톨릭대학교에서 경영학 박사를 취득하였으며, 연세대학교 정보대학원에서 연구교수 및 KAIST경영대학에서 연수연구원으로 근무하였다. International Journal of Electronic Commerce, Journal of Electronic Commerce Research, Technological Forecasting and Social Change, Journal of Global Information Systems, Cyberpsychology Behavior and Social Networking 등의 국제학술지 및 지식경영연구, 전자거래학회지, IT서비스학회지 등의 국내학술지에 다수의 논문을 게재하였다. 주요 관심분야는 Block chain, Web personalization, Digital Marketing, Big Data & Social Network Analysis 등이다.