

# An Auditing Method for Blockchain-based System Development Projects

Youngjoo Lee<sup>1</sup> and Soo Yong Park<sup>2\*</sup>

<sup>1</sup> Department of Computer Science and Engineering, Sogang University, 35 Baekbeom-ro, Mapo-gu Sogang University, Seoul, South of Korea; yjoo99@hanmail.net

<sup>2</sup> Department of Computer Science and Engineering, Sogang University, 35 Baekbeom-ro, Mapo-gu, Seoul 04107, South of Korea; sypark@sogang.ac.kr

**Abstract:** Since the "fourth industrial revolution" was thrown as a topic at the World Economic Forum, artificial intelligence, blockchain, and big data-related system-building projects have been pouring out in Korea. In particular, as blockchain technologies are applied to various fields such as the financial industry, healthcare, and public sectors, the development of blockchain-based systems is increasing. The use of Hyperledger Fabric in Public institutions and companies is on the rising. When developing the system in public organizations in South Korea, the operator shall be obliged to undergo an information system audit, and the information system audit shall perform the audit according to the inspection criteria. However, there is a limit to perform the information system audit of newly emerging blockchain-based systems using the existing audit items and criteria. Therefore, it is required that standardized audit items and audit techniques for a system based on blockchain. Accordingly, audit items and audit techniques were derived suitable for the system development project using blockchain technologies, and the adequacy of inspection items and inspection techniques was verified from experts. This research will directly help the information system auditor to perform an audit, and it is expected that the operators who develop the blockchain-based system and the organizer that provides services through the blockchain-based system will also contribute to the quality improvement of the system.

**Keywords:** Information System Audit, Software Engineering, Blockchain and Audit Item

## 1. Introduction

Since the National Computerization Agency (currently NIA: National Information Society Agency) in South Korea, was first conducted in 1986 and a private audit corporation began to establish in 1998. The basic clause for information system audit was newly established under Article 15-2 (now Article 57 of the Electronic Government Act and Article 71 of the Enforcement Decree) of the "Framework Act on Informatization Promotion" in 1999, and based on this, the "Information System audit Standards" (established in 1999) were announced.

The term "The Information System Audit" means activities in which a person independent of the audit requester and the auditee comprehensively check matters concerning the construction, operation, etc. of the information system and makes up for problems to improve the efficiency and ensure the safety of the information system as a third party's perspective.[1]

According to government laws, if the project cost is more than 500 million won and it is an information system construction project, it is mandatory to take the information system audit. Also, there are many technical obligations for the system as follows.

- Databases standardization by public organizations
- Web Accessibility
- Web site compatibility, complying with Web standards, and eliminating non-standard technologies
- Security weaknesses that are 20 items in the design phase and 47 security weaknesses
- E-government standard development frameworks shall be considered a priority
- Upload Software cost information in the software repository after the end phase of the project

Information System Auditors should check that the provisions of these laws are applied in conformity with the system. However, the current audit check items framework and the audit check

guide have not been revised since 2013, and there are no check items related to the blockchain in the current Information System Audit Inspection guide V3.0. So the IT auditors are improvising and making them individually. This undermines the credibility of IT audits.

To solve these problems in this paper, we drew audit items using Delphi Technique and finally presented the audit items that passed verification to IT auditors.

Usually, there are four areas of audit in a system development project: project management, application system, database, and system structure, but in this study, the scope of Information System Auditing is limited to the application system and database area, and system development project is limited to HyperLedger Fabric-based system.

The composition of this paper described the necessity of this research in Chapter 1. And Chapter 2 presented the research related to Information System audit, Chapter 3 presented the introduction of HyperLedger Fabric and conformed the audit items by an expert, Chapter 4 presented verification of new audit items on the fabric-based system. Finally, Chapter 5 described the conclusion and future work of this study.

## 2. A Study on the Information System Auditing

### 2.1 Information System Audit Framework [2]

Information Systems Audit is divided into three audit points: Requirement definition phase, design phase, and completion phase. If the project cost is less than 2 billion won or the project period is less than six months, it is possible to omit the requirement definition phase.

Phased auditing is conducted in the order of preliminary investigation, auditing in the site, and checking corrective action. After each procedure is completed, a document of the audit plan, an audit report, and a corrective action confirmation report should be prepared and submitted as a result.

On-site auditing consists of 6 procedures such as initiation of audit; initiation meeting; IS Auditing; preparation and review of reports; termination meeting; report confirmation and notification.[3]

In principle, the auditing method shall be determined by referring to the "business type/ timing of audit" of the "Information System audit Inspection Framework V3.0".

The results of audit include 2 types of auditing performance report and corrective action confirmation report. The results of audit performance report are prepared in this audit, corrective action is taken for the improvement direction in this audit, and the results are prepared in the audit corrective action confirmation report. The picture below is an audit checking framework.

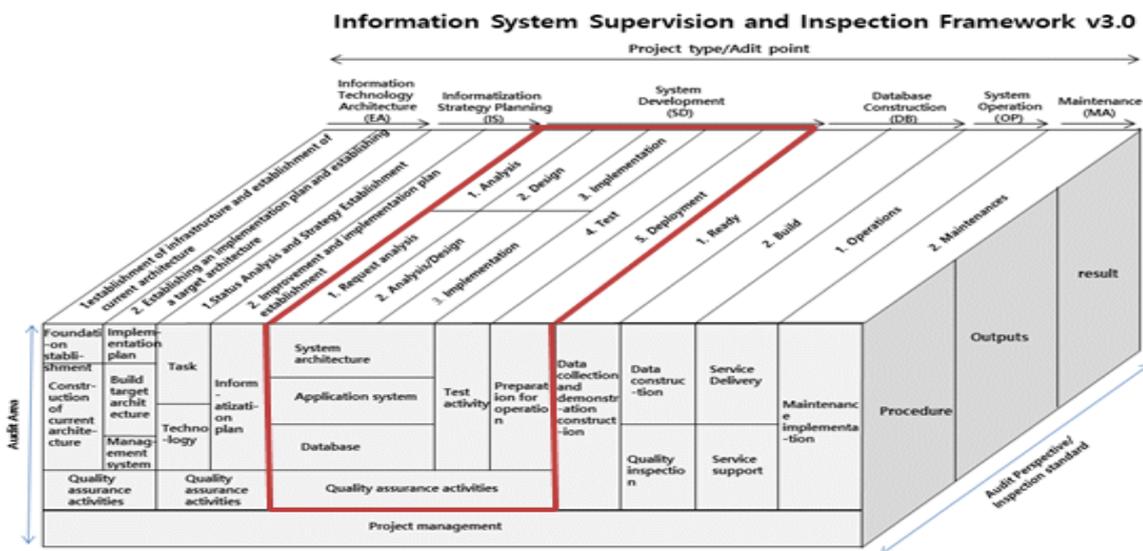


Figure 1. Audit Framework 3.0 (Adapted from [3])

## 2.2 A Study on the Information System Auditing

The subjects of research on Information System audit are data modeling, auditing automation, database security, data quality, and extracting audit checking items for specific systems. However, there is no research on inspection items for systems that are used in blockchain technology.

A study on data modeling suggests structured monitoring criteria based on data models. There is a study related to SQL tuning[4] and data quality diagnosis[5] using the monitoring automation tool. In this paper, the database structure was analyzed using automation tools and the effect of logic/physical data consistency and data structure on performance was investigated, and the research on performance improvement measures was conducted. In the study related to database security auditing [6], the database security auditing framework was presented, and there was a paper that analyzed DB error type and domain integrity to improve data quality and proposed a DB quality certification system[7]. The research related to the inspection item presentation is on the question and answer (SQL) inspection item presentation[8] to ensure timely data quality. Some studies analyze the importance of inspection items and the present selection and intensive auditing[9]. Some studies have presented improved review items for improving the quality of information system construction projects, focusing on Information System audit projects and risk generation project data conducted over 4 years.

Although there is no research on Information System audit on the blockchain-based system development project that is intended to be presented in this paper, research on the blockchain-based system development project is related to architecture design, development methodology, and smart contract vulnerability. More specifically, there is a study that is applied to blockchain development using UML of existing development methodologies[11], a study that suggests agile software engineering methods[12] to develop blockchain applications, and an alternative to the vulnerability of smart contracts[13]. Although it has not been a study related to Information System audit, it has included a study related to Information System audit because it is a study on software development.

## 3. Extracting Audit Items on Blockchain-Based System

### 3.1 Hyperledger Fabric [14]

Fabric is a modular, scalable open-source system for deploying and operating one of the hyper ledger projects hosted by the Linux Foundation and licensed blockchains. Fabric mainly develops in GO language, and communication between clients, peers, and odors uses the gRPC framework. The below figure presents a component of the fabric.

Major features include Permission architecture, Highly modular; flexible data privacy with 'channels' and 'collections'; Support for Go, Java and Javascript development languages for smart contract implementation; governance and version management of smart contracts, queryable data (key-based queries and JSON queries).

The Membership Service Provider (MSP) maintains the identity of all nodes (client, peer, OSN) in the system and issues node credentials used for authentication and authorization. The ordering service manages multiple channels such as transaction order setting and channel reconfiguration. The peer gossip protocol is responsible for checking each other's status between peers and exchanging distributed ledger between peers. Chain codes are used to record or read data in distributed ledger and are developed and used in conjunction with distributed applications (DApps) tailored to business models. There are application chain codes and system chain codes and currently, Go, Java, and Node is supported. Also, there is a private data collection function to ensure privacy among members of the same channel, and sensitive data such as personal information can be stored in SideDB instead of the world state for management and deletion.

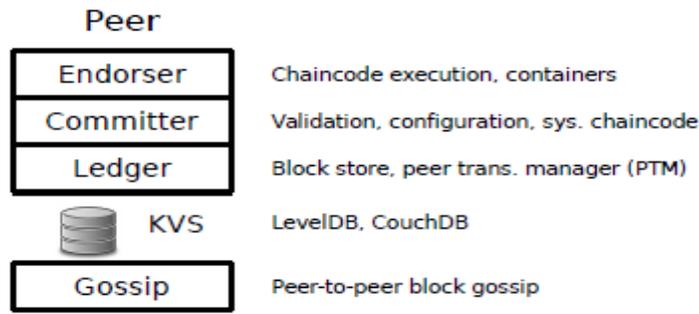


Figure 2. Components of a Fabric Peer.(Adapted from[14])

3.2 Extracting Audit Item using Delphi Technique

3.2.1 Delphi Technique Overview

The Delphi technique is a way of obtaining a collective view from individuals about issues where there is no or little definite evidence and where opinion is important. The process can engender group ownership and enable cohesion among individuals with diverse views. It is an iterative questionnaire exercise with controlled feedback to a group of anonymous panelists. [15]

3.2.2 Audit Item Extracting Procedure by Tailoring Delphi Process

The Delphi process has been comprehensively reviewed elsewhere (Adler & Ziglio, 1996; Skulmoski, Hartman, & Krahn ). The number of Participants is five and the figure below is the Delphi procedure used in this paper (Figure 3).

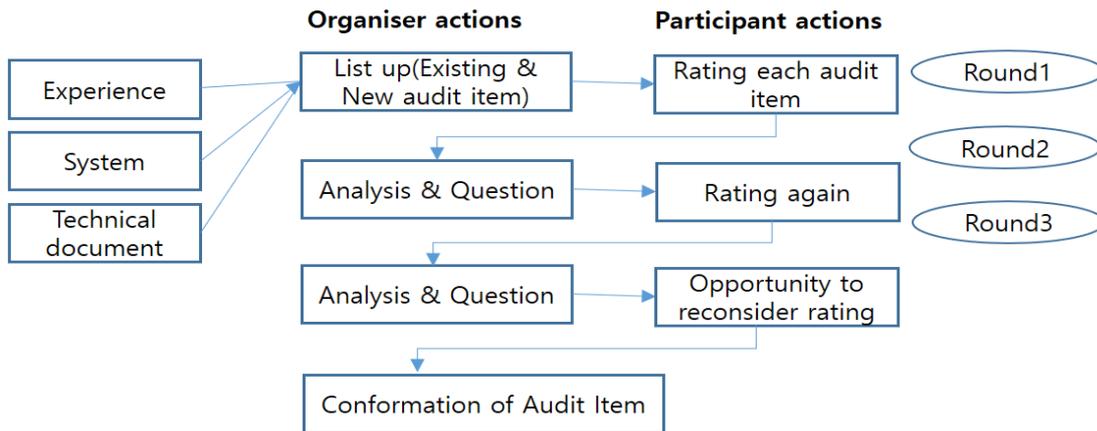


Figure 3.Delphi Technique for Audit item on a Blockchain system

3.2.3 Result of Three-Round Delphi Technique

As a result of using the three-round Delphi Technique, New Audit Items are related to Data standardization, Secure coding, Data integrity, Anchoring, Encryption key values, Personal Information Protection, WORLD STATE, Smart contract(Chaincode).

## 4. Verification of New Audit Items for Fabric-Based System

### 4.1 Survey Respondents

The improved audit items in this study were verified by a survey. A survey was conducted on IT auditor with experience in auditing of private blockchain-based system construction inspection items were collected.

The survey asked 15 people to do the survey, 15 people answered the result of it.

All 15 people have answered, "some existing audit check items can use without customizing, but the new item also has to be added in auditing blockchain-based system". So this paper concluded that research is necessary.

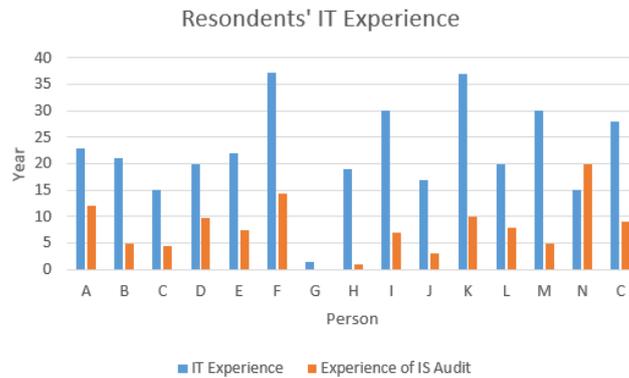


Figure 4. IT & AUDIT Experience of Respondents

### 4.2 Analysis Process on Survey Response

The following procedure determined the inspection items for 15 respondents.

- If the Crombach' alpha coefficient is 0.7 or higher, add an inspection item, and if it is less than 0.7, delete or re-examine the inspection item (Crombach'alpha coefficient on application = 0.982885, Crombach'alpha coefficient on DB =0.9746599)
- Delete contradictory answers
- The audit items with nonconformities (2 points) and very nonconformities (1 point) of 70% or more shall be deleted

### 4.3 Result of Survey

All audit items derived from expert opinion as shown in Table 1 should be valid as a survey shall be valid. Survey about Whether audit point/time, audit area, audit items are accuracy and completeness. Audit Items that more than one-third of respondents rated below two points were excluded.

Table 1. Result of Survey

Phase	A number of Audit Item on Appl.			A number of Audit Item on DB			New Audit Item		
	F/W	Delphi Panel	Audit Group	F/W	Delphi Panel	Audit Group	F/W	Delphi Panel	Audit Group
Req Definition	5	5	3	3	2	1	0	8	8
Design	15	7	13	10	7	7			
Implementation	6	5	6	4	3	2			

Phase	A number of Audit Item on Appl.			A number of Audit Item on DB			New Audit Item		
	F/W	Delphi Panel	Audit Group	F/W	Delphi Panel	Audit Group	F/W	Delphi Panel	Audit Group
Total	21	17	21	17	12	10	0	8	8

As shown above, the results on new audit items are meaningful because the survey and opinion gathering by a group of experts are mostly auditors who have knowledge of fabric and have more than 10 years of IT experience, including IT audit. However, there is a large deviation between the Delphi Group and Audit Group for existing items. Therefore, a study of the two groups' differences over existing items is needed.

## 5. Conclusion and Future Studies

When conducting an information system audit, it is natural to audit the information system with an objective and agreed audit items, but the reality is not. In this study, audit items for blockchain-based systems were derived using the Delphi method. To verify the results, current information system supervisors were verified through a survey.

**Table 2.** Difference between the Two Groups

New Item				Existing Item			
Delphi G.		Audit G.		Delphi G.		Audit G.	
Avg	Var	Avg	Var	Avg	Var	Avg	Var
4.3	0.5	4.08	0.4	4.0	0.1	3.3	0.1
Mean difference on New Item = 0.22				Mean difference on existing Item = 0.7			
It can be interpreted that the existing item is more abstract than the added item.							

However, all new items had appropriate results (more than 3 points), but there was a greater difference in opinions (more than 3 points) on the existing items.

Therefore, it can be concluded that the maintenance of existing items is necessary. Because the existing audit item is too abstract. Also, future research projects will require research on proven ways to improve existing item problems and derive audit items for new systems in a short time. Because we can't wait for audit items from standard organizations to be provided whenever new technologies are available. The study will help present standards for stable system operations between operators and developers as well as current information system audits.

## Acknowledgments

"This research was supported by the MSIT (Ministry of Science and ICT), Korea, under the ITRC (Information Technology Research Center) support program (IITP-2020-2017-0-01628) supervised by the IITP (Institute for Information & communications Technology Promotion)"

## References

- [1] ELECTRONIC GOVERNMENT ACT [Act No.12592, Other Law Revised], 2014.
- [2] National Information Society Agency," Information System Auditing Guide v2.1", 2013.
- [3] National Information Society Agency," Information System Auditing Manual v3.0", 2008.
- [4] LIU CHEN, "The Design and Implementation of a Rule Based SQL Inspection Tool for Database Audit", a doctoral's degree thesis at Pukyong National University' Graduate School of Department of Computer Engineering, 2016.
- [5] Kim Chang-kwan, "A Case Study on Database Auditing Improvement, Dong-A University Graduate School of Business (Senior Master's), 2005.
- [6] Kim Kwang-yeol, "(The)Framework and Inspection items in Auditing Database Security as the way to ensure data safety", a bachelor's degree thesis at Konkuk University's Graduate School of Information and Communication, 2008.
- [7] Kim Jong-won, "System Audit Improvement through identifying Database Query Audit inspection item", a dissertation on the Graduate School of Information Technology at Incheon National University (Senior Master), 2013.
- [8] Kim Hwal-joong, "Database Quality Improvement through Information Systems Audit," a dissertation of the Graduate School of Information and Telecommunications at Konkuk University, 2011.
- [9] Boo-Hyung Lee, "Relative Importance Analysis of inter-evaluation items in Korean IS Standard Audit Checklist Using Decision making Techniques ", International Journal of Security and Its Applications, NADIA, ISSN: 1738-9976 (Print); 2207-9629 (Online), Vol. 7, No. 5, pp. 365-376, (2013).
- [10] Lee Don-hee, Jung Hong-seop, Lee Ki-young and Han Ki-jun. "A Study on the Quality Improvement Plan through Analysis of Information System Audit Examples", Journal of the Korea Society of Computer and Information, Vol. 17, No. 10, pp. 203-216, (2012).
- [11] M. A. Awad, A Comparison between Agile and Traditional Software Development Methodologies, 2005.
- [12] Michele Marchesi, Lodovica Marchesi,Roberto Tonelli, An Agile Software Engineering Method to Design Blockchain Applications, arXiv:1809.09596, 25 Sept (2018).
- [13] Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereum smart contracts, Universit\_a degli Studi di Cagliari, Cagliari, Italy, International Conference on Principles of Security and Trust, POST: Principles of Security and Trust pp 164-18, (2017)
- [14] Elli Androulaki Artem Barger Vita Bortnikov, IBM, Srinivasan Muralidharan\* State Street Corp.,Chet Murthy\* Binh Nguyen\* State Street Corp.,Manish Sethi Gari Singh Keith Smith Alessandro Sorniotti IBM, Chrysoula Stathakopoulou Marko Vukolić Sharon Weed Cocco Jason Yellick IBMHyperledger Fabric: A Distributed Operating System for Permissioned Blockchains, arxiv:1801.10228v2 [cs.DC], IBM, 17 Apr (2018).
- [15] 10.1576/toag.7.2.120.27071, www.rcog.org.uk/togonline.

