Journal of Economics, Finance and Management (JEFM)
ISSN: 2958-7360
Vol. 3, No. 3, June 2024

Designing Audit System of Gold-backed Stablecoin with Model-Based Systems Engineering

Aldi Damora Siregar
Department of Industrial Engineering, Faculty of Engineering
Universitas Indonesia, Depok, Indonesia

Novandra Rhezza Pratama
Department of Industrial Engineering, Faculty of Engineering
Universitas Indonesia, Depok, Indonesia

Abstract: In the face of complicated system design, Model-Based Systems Engineering (MBSE) is recommended to solve the challenges of traditional Document-Based System Engineering (DBSE). To apply MBSE, three pillars are required: modeling language, methodology, and modeling tools. This paper presents an MBSE-based Audit System for Gold-backed Stablecoin conceptual design, namely the G-01 SCA project. Through the stages of requirements analysis, functional analysis, and design synthesis, the design and modeling are finished using the Capella Application under the supervision of the customized Harmony-SE methodology. An instance of the G-01 SCA changing parameter scenario generated during its implementation is also provided. Finally, MBSE is fitted to complex systems, and appropriate modeling tools and methodology should be selected for implementing MBSE. It is believed that MBSE can increase management and communication efficiency, according to the MBSE design practice stated in this work and by the result of an evaluation survey conducted for the internal team of the G-01 SCA project.

Keywords: Modelling, Systems engineering, Gold-backed stablecoin

Digital Object Identifier (DOI): https://doi.org/10.5281/zenodo.11694259

1. Introduction

The financial system technology is currently developing rapidly. The emergence of distributed ledger technology (DLT) has driven the development of money and payment technology (Let, 2023). One form of implementation of DLT technology in the financial system is stablecoins. Stablecoins are cryptocurrencies with a value tied to fiat currency or other assets. Stablecoins incorporate powerful monetary instruments into the digital environment, making them a hybrid form of central and decentralized financial systems (Grobys, 2021). In the last decade, gold-based stablecoins have developed significantly. Physical assets encrypted with the help of Blockchain technology have been used by millions of users worldwide (Binance News, 2024). As a result of this surge, companies providing physical asset storage services (custodians) need to look for ways to become new players in the value chain in this market. Custodian companies that are slow to adapt will struggle with digital asset storage management (Grobys, 2021).

Custodian companies require the adaptation of development processes and new equipment, and the activities of investors who are internet explorers (not physical people) must be accommodated in the digital asset business world. Several things must be considered in DLT-based finance: smart contracts, tokens, digital identity, and wallets. Smart contracts are assets of blockchain infrastructure. Investors who already have digital identities have verification on the blockchain network, which is checked by smart contracts. The token can then be put into a wallet that matches the investor's identity. Stablecoins also require audit features to maintain the trust of customers who use these products (Grobys, 2021). Therefore, it is necessary to develop an audit system for gold-based stablecoins. Developing an audit system for gold-based stablecoins that connects custodian companies, token issuers, and customers is complex, and changes occur quickly. Therefore, new methods are needed to conduct development effectively and efficiently, including model-based systems engineering (Holt, 2023).

A current project for developing an audit system for gold-backed stablecoins is G-01 SCA in one of the gold custodian companies in Indonesia. This project aims to allow the customer to check whether the stablecoin token is valid by having its physical form of gold at the custodian company. The existing process in the developing process uses the way of work DBSE (Document-Based Systems Engineering). By using this type of work, validating and changing parameters in 17 technical documents took more than five work days. As implementing new technology like blockchain is a rapidly changing environment, a new way of working is needed to make the development process efficient and effective. MBSE (Model-Based Systems Engineering) was tested to be implemented as a new working method in the G-01 SCA project to replace the DBSE methodology.

2. Literature review

2.1 Model-Based Systems Engineering

Systems engineering became known in the 20th century from Bell Laboratories in the United States. At that time, systems engineering was applied during the Second World War. Academically, the concept of systems engineering was taught at MIT in 1950. As systems became increasingly complex, new approaches were needed to develop systems, so in 1990, an organization called the National Council on Systems Engineering (NCOSE) was born in the United States. Then, the organization changed its name to the International Council on Systems Engineering (INCOSE) in 1995.

Systems engineering is a form of realization of a system that runs successfully. Systems engineering is applied to the system's entire life cycle and is not limited to only certain life cycle stages. System engineering aims to prevent system failure. Three factors can cause system failure or what is usually called the Three Evils of Systems Engineering: complexity, communication, and understanding. These three system failure factors are related to each other, where if complexity cannot be identified, communication errors and lack of understanding will occur. Communication errors can cause complexity and lack of understanding. Lack of understanding will increase complexity and communication problems.

One of the most important aspects of a systems engineering project is ensuring that system requirements are met. To fulfill these needs, validation must be carried out. The mechanism used to carry out validation is to create several scenarios for each case. Scenarios can be operational or performance. Operational scenarios show that the actions taken will produce specific outputs. Performance scenarios change system parameters to meet specific outputs (Holt, 2023).

2.2 ISO 19011: 2018 Management System Audit Guidelines

Based on information in the ISO 19011: 2018 document concerning Management System Audit Guidelines, individuals who manage audit programs must select and determine methods to effectively and efficiently conduct audits, depending on the audit objectives, scope, and criteria. Audits can be performed on-site, remotely, or in combination. If two or more audit organizations conduct joint audits of the same auditee, each managing the various audit programs must agree on audit methods and consider the implications for audit resources and planning.

Audit planning must be flexible enough to allow for changes that may become important as audit activities progress. Audit planning should address or refer to the following: audit objectives, scope, audit criteria and any documented reference information, location and time of the audit, methods to be used, roles and responsibilities of audit members, and allocation of available resources (ISO, 2018).

3. Data and Methodology

In general system design, four MBSE (Model-Based Systems Engineering) methods can be used: MBSE Grid, Dori Object-Process Methodology, IBM Harmony Systems Engineering, and INCOSE Object Systems Engineering (Mazeika, 2019). Information regarding each of the four methods can be seen in Table 1.

Table 1: MBSE Method for General System

Information	**Methods**			
	MBSE Grid	**Dori Object-Process Methodology**	**IBM Harmony Systems Engineering**	**INCOSE Object Systems Engineering**
Abbreviation	MBSE Grid	OPM	Harmony-SE	OOSEM
Year	2016	2002	2005	2008
Component	Requirements, behavior, structure, parametric	Functional, structure, behavior	Requirement, functional, architecture	Need, requirement, functional, logical/physical architecture, evaluation, verification and validation

Table 1 details the four MBSE methods applied to the general system. MBSE Grid is the most recent method that emerged in 2016. It comprises four components: requirements, behavior, structure, and parametrics. Meanwhile, OPM (Dori Object-Process Methodology) is the earliest MBSE method that appeared in 2002, and it consists of three components: function, structure, and behavior. OOSEM (Object System Engineering) has six components: needs, requirements, functions, logical/physical architecture, evaluation, verification, and validation. From these four methods, one method will be selected that best suits the design of the G-01 SCA system, as can be seen in Table 2.

Table 2: Selection of the MBSE Method for the G-01 SCA System Design Use Case

Needs	Methodology			
	MBSE Grid	**OPM**	**Harmony-SE**	**OOSEM**
Can be applied at Capella Software	-	-	✓	✓
Focus on model elements and relationships between models	-	✓	✓	-
Able to customize parameter changes	✓	✓	✓	✓

Three needs were identified in designing the G-01 SCA system: it must be able to be applied to the Capella Application, focus on model elements and relationships between models, and customize parameter changes. In Table 2, the Harmony-SE type MBSE method was chosen for this research because it meets all the G-01 SCA system use-case design needs. Therefore, this research will implement Harmony-SE by defining the diagrams and information required for each process using Capella software.

The system engineering model for the G-01 SCA use case was created using Capella software. This research used the Harmony-SE method, which consists of three main activities: analyzing requirements, analyzing system functionality, and creating designs. Each activity has its output, which can be seen in Figure 1.

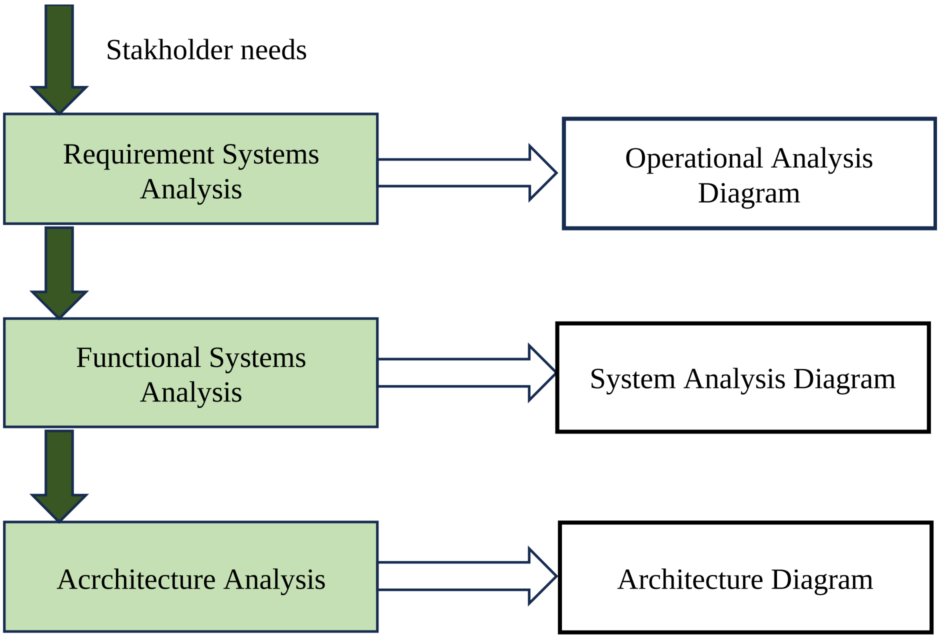


Figure 1: Work Steps for Designing the G-01 SCA System using the Harmony-SE Methodology

Figure 1 shows the work steps taken in designing the G-01 SCA system model using the Harmony-SE methodology. The first activity is to collect stakeholder requirements and then conduct requirements analysis. The output from this stage is a system requirements model. Next, a functional analysis of the system is carried out, which consists of two outputs: an activity diagram and a sequence diagram. The final activity is design creation, consisting of two activities: architectural analysis and design. The output of the architectural design is an internal block diagram.

An evaluation will be carried out to determine its effectiveness in designing the G-01 SCA system, which uses the MBSE (Model-Based Systems Engineering) method. The evaluation is carried out by surveying seven team members involved in the system development. The list of questions in the questionnaire can be seen in Table 3.

Table 3: List of Questions on the Evaluation Questionnaire for Using the MBSE Method

Topic	Index	Questions	Reference
Understanding	Q1	Model-based working methods enhanced my understanding of project requirements.	(Gregory, 2020)
	Q2	A model-based approach improves the clarity and accuracy of project documentation.	(Gregory, 2020)
Collaboration	Q3	I find it easier to collaborate with team members using a model-based approach.	(Gregory, 2020)
	Q4	Model-based methods improve communication between different project stakeholders.	(Gregory, 2020)
Accuracy	Q5	I find it easier to track changes and revisions with model-based methods.	(Gregory, 2020)
Productivity	Q6	The model-based approach increases my productivity and efficiency in completing tasks.	(Kolossvary, 2023)
	Q7	Model-based methods improved my ability to meet project deadlines and milestones.	(Kolossvary, 2023)
Recommendation	Q8	Overall, I prefer model-based working methods over previous document-based methods.	(Kolossvary, 2023)
	Q9	I would recommend applying a model-based approach to other engineering teams or projects.	(Kolossvary, 2023)

Each question will be assessed on a Likert Scale (1-5), where a value of one indicates strongly disagree, and a value of five indicates strongly agree. The level of satisfaction of team members involved in the G-01 SCA Project was measured using the Weighted Average Method via Equation 1.1.

$$Weighted\ Average\ (WA) = \frac{Sum\ of\ weighted\ terms}{Total\ number\ of\ questionnaire} \quad (1.1)$$

Determining the intervals of categories is done using Equation 1.2.

$$interval\ (i) = \frac{Range\ (r)}{Total\ class} \qquad (3.2)$$

$$r = highest\ scale - lowest\ scale$$

Based on Equation 3.2, the interval on each scale is 0.8. Therefore, the scale of each satisfaction category can be seen in Table 4.

Table 4: Satisfaction Category

Category	Scale
Very Dissatisfied	1,00 - 1,80
Dissatisfied	1,81 - 2,61
Neutral	2,62 - 3,42
Satisfied	3,43 - 4,23
Very Satisfied	4,24 - 5,00

4. Result and Discussion

The MBSE (Model-Based Systems Engineering) design for the G-01 SCA was carried out using the Harmony-SE method, which started with an analysis of stakeholder requirements. The output from this stage is an operational analysis diagram. Next, a functional analysis of the system is carried out with output in the form of a system analysis diagram. The final activity is design creation, consisting of two activities: architectural analysis and design. The output of architectural design is an architectural diagram. G-01 SCA is a project to develop an audit system for the gold-based stablecoin business, carried out at a physical gold custodian company as collateral for the value of the stablecoin circulated in the wallet by the issuer.

G-01 SCA is a project to develop an audit system for the gold-based stablecoin business. This business is carried out at a physical gold custodian company as collateral for the stablecoin's value, which circulates in the issuer's wallet. In this case, three main stakeholders must be considered: customers, custodian companies, and stablecoin token issuers. The system requirements were obtained through interviews using the Delphi Method with stakeholders at the custodian company, as seen in Table 5.

Table 5: Analysis of Needs of Stakeholders

Stakeholder	Role	System Requirement
Custodian Company	System Analyst	The system must be able to safely store the gold-back stablecoins, using best security practices such as offline storage (cold storage) and implementing strong encryption technology.
	Business Analyst	The system must integrate directly with the blockchain that supports the stablecoin, enabling

		precise and authentic transaction recording and real-time tracking of assets.
	Infrastructure Analyst	The system is able to identify, assess and manage risks associated with the storage and processing of crypto assets, with the system having strict security and monitoring features.
	Product Manager	- The system must comply with all relevant regulations, including KYC (Know Your Customer) and AML (Anti-Money Laundering), with the ability to provide accurate and comprehensive compliance reports. - Integrated reporting features and the ability to access historical data are required to facilitate internal and external audits and accurate financial reporting.
Customer	Customer	- Access to the physical gold checking link for your stablecoin token can be accessed from the front page of the stablecoin page. - There is no time limit for checking the existence of physical gold from the stablecoin tokens owned. - Receive e-Statement files on customer emails. E-Statement is issued by the Custodian Company regarding the existence of physical gold stored at the Custodian Company every month. - There is a report on the amount of physical gold from stablecoin tokens for every physical gold sales or purchase transaction carried out by the Issuer which is displayed on the stablecoin page.
Token Issuer	System Analyst	The system must be able to securely manage private keys, ensuring that only authorized parties have access to stored crypto assets.
	Infrastructure Analyst	The need for a system that can be easily maintained, including software updates and regular maintenance, with technical support available if needed.
	Product Manager	The system must enable validation and confirmation of transactions quickly and efficiently, ensuring that asset transfers are carried out accurately and securely.

A requirements model diagram, shown in Figure 2, can be created based on the needs of the stakeholders listed in Table 5.

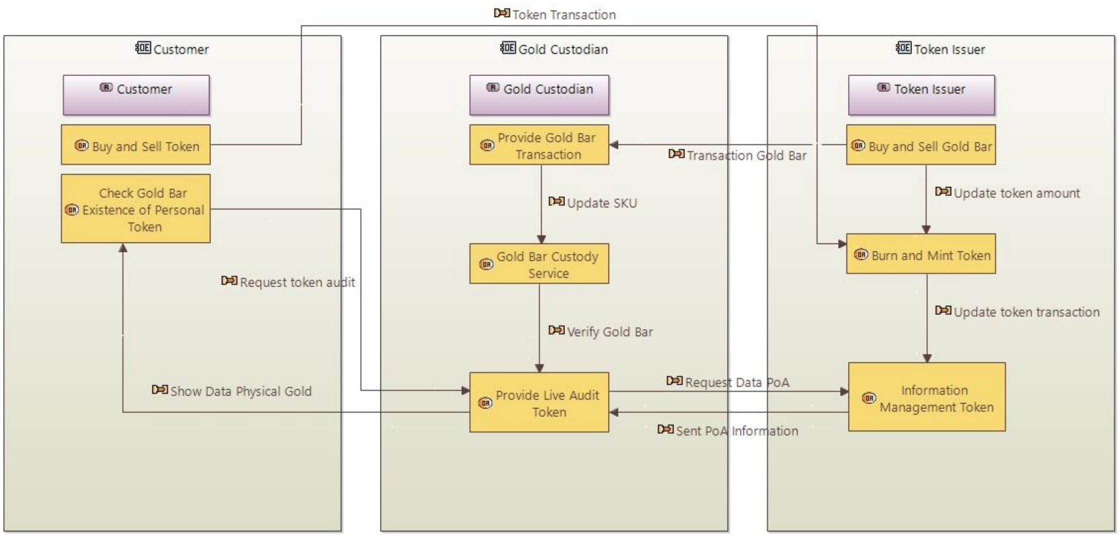


Figure 2: G-01 SCA Operational Analysis Diagram

In Figure 2, the custodian company's operational capability is to provide live audits of stablecoin tokens. The audit information is sent to the issuer, who provides the ID address of the customer who requested the audit. Each stakeholder's operational capabilities are analyzed in system functional analysis, as shown in Figure 3.

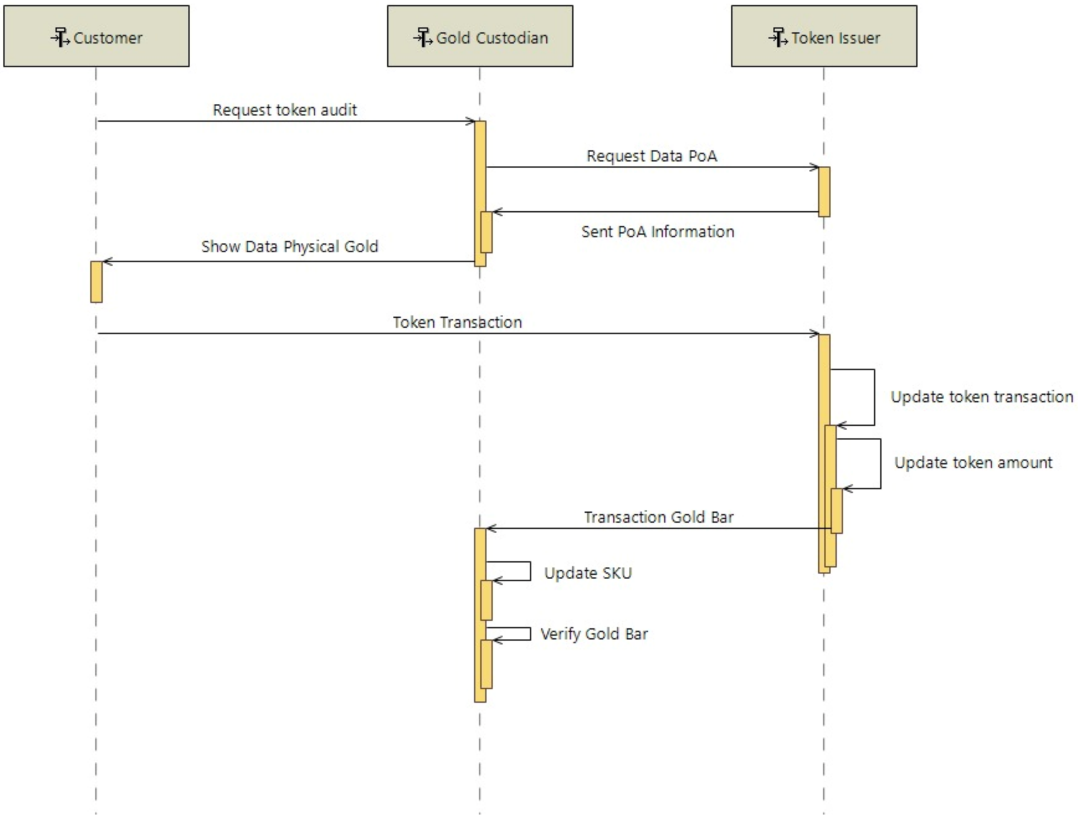


Figure 3: G-01 SCA System Functional Analysis Diagram

Figure 3 shows the sequence of activities required to audit the stablecoin tokens. The sequence will start with the customer making an audit request via the stablecoin page, then validating the customer, and then checking the customer ID address obtained through information by the issuer. The checking results will be displayed on the stablecoin page to provide information on the physical gold value of the tokens owned.

At the design stage, the architectural components required in the G-01 SCA project were analyzed. Table 6 contains information regarding the properties used in the model to design a gold-based stablecoin audit system.

Table 6: Properties of the Gold-Based Stablecoin Audit System Model

Information	Property	Description
Gold storage approval data	Custodial Contract ID	An identity number that identifies the contract of the physical gold storage agreement of the stablecoin token
	Custodial Terms	Information about the agreement that must be fulfilled by the custodian company as well as the customer and token issuer company
	Custodial Information	Date information related to the agreement agreed to by the user
Gold data	Serial Number	The identity number of the physical gold that is printed and contained on the gold is from the company that provides the physical gold
	Weight	The weight of gold contained in physical gold
	Purity	Purity of physical gold
	Custodial location	Location of physical gold storage
Token stablecoin data	Token ID	ID number information from token minting results carried out by the token issuer
	Token Supply	Information on remaining tokens available on the market
	Tokenization Ratio	Information on the comparative value between tokens and available physical gold
	Owner Address	Ethereum address information of the user
	Redemption Status	Token status
Audit data	Audit Trail	Token audit historical information
	Audit Reports	Audit report information
	Audit Certification	Evidence of audit validation carried out from the custodian company

Based on the information in Table 6, an analysis of the infrastructure needed to fulfill the data needed in the audit system is carried out. Table 7 contains information regarding the tools required for the gold-based stablecoin audit system (Project G-01 SCA).

Table 7: System Component Properties in the Audit System Gold-Based Stablecoins

Platform	Component	Description
Gold custodian	React JS	Responsive and interactive user interface (UI) developer
	Restful API (Representational State Transfer Application Programming Interface)	Interaction platform of custodian companies with blockchain supporting Proof of Asset.
	CI/CD (Continuous Integration/Continuous Deployment) Pipelines	Automate the development process, including testing, merging code, and executing delivery steps.
Token issuer	Solidity	Programming language for developing smart contracts on blockchain platforms.
	Encryptor	Encrypt sensitive user data, such as private keys or identity information
	NoSQL	Easily horizontally scalable data storage.

Based on the tools components described in Table 7, an architectural design model for the system is created, connecting the custodian company to the issuer's blockchain. The design of the G-01 SCA project architecture can be seen in Figure 4.

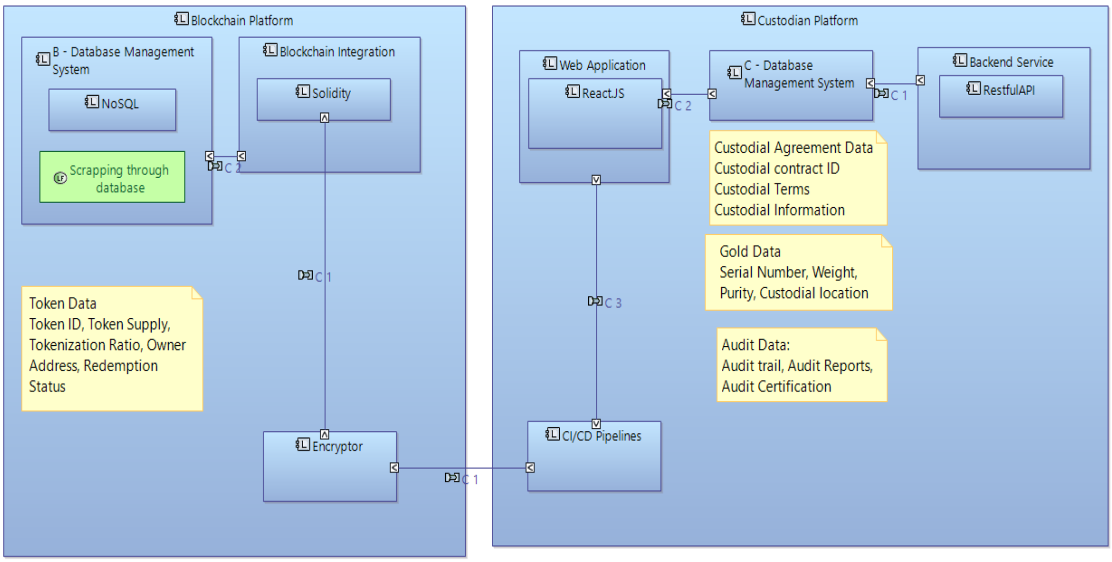
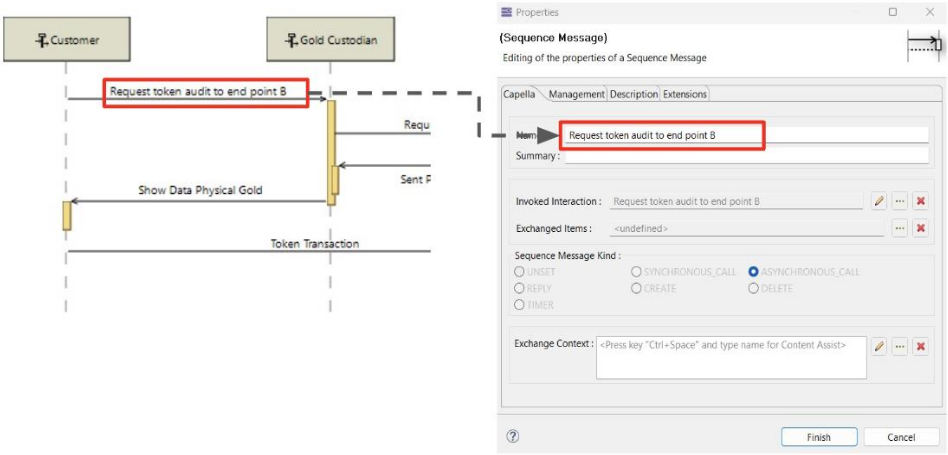


Figure 4: Internal Block Diagram of G-01 SCA

Figure 4 shows the architectural diagram of the G-01 SCA project. The diagram matches the system block (Figure 2) and activity diagram (Figure 3). This uniformity indicates that the system details and functionality meet all the stakeholder needs.

One of the benefits of implementing MBSE is flexibility in changing parameters. Changing a parameter in one part immediately automatically changes the related parameter in another model. In the previous model, scenarios were compared, namely, changing the system's functional parameters. The parameter change scenario can be seen in Figure 5.

System Analysis Diagram



Operational Analysis Diagram

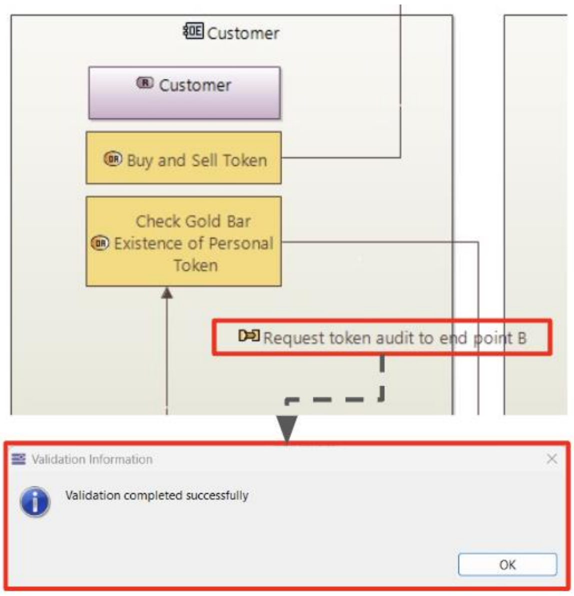


Figure 5: Parameter Change Scenario

Figure 5 shows the parameter change scenario in the system analysis diagram. The request token parameters at endpoint A are changed to endpoint B, where changing these parameters also directly changes the parameters in the operational analysis diagram.

The use of MBSE in the G-01 SCA Project was evaluated by surveying the seven team members involved. Questions have been designed in Table 3. The final results of the survey are in Table 8.

Table 8: Results of Evaluation Survey on the Use of MBSE in the G-01 SCA Project

Topic	Index	Score
Understanding	Q1, Q2	4,64
Collaboration and Communication	Q3, Q4	4,57
Accuracy	Q5	4,71
Productivity	Q6, Q7	4,71
Recommendation	Q8, Q9	4,85

Based on the satisfaction scale value categories in Table 4, Very Satisfied starts from a scale of 3.24, while the survey results on the G-01 SCA Project team in Table 8 show that the overall score is above 4.24. This shows that MBSE has a positive influence on team members in the development of an audit system on gold-based stablecoins. The highest scores are on topics related to recommendations, and the lowest are related to collaboration and communication.

5. Conclusion

The design of the gold-based stablecoin audit system (Project G-01 SCA) was carried out using the MBSE (Model-Based System Engineering) approach with the Harmony-SE method carried out in the Capella Application, which consists of Operational Analysis Diagrams, System Analysis Diagrams, and Architectural Diagrams. The complexity of system design in companies that deal in physical assets and blockchain-based companies can be reduced with MBSE. Based on the survey results, system design using the MBSE approach provides satisfaction in understanding, collaboration and communication, accuracy, and productivity. MBSE is also recommended when implementing system design. Further analysis needs to be carried out regarding the readiness of organizations or companies to adapt system design methods to MBSE (Model-Based System Engineering), including identifying the infrastructure and human resources needed and change management efforts in implementing MBSE comprehensively.

REFERENCES

1. Arkeman, Y. (2023). Blockchain Teori dan Aplikasinya untuk Bisnis. Argoindustri, & Pemerintahan. Bogor: Brain IPB University.
2. Binance News. (2024, April 14). Retrieved from Binance Page: https://www.binance.com/en/square/post/2024-04-14-stablecoin-market-value-reaches-156-34-billion-shows-0-96-growth-over-the-week-6756098352369
3. Blockchain. (2019). 2019 State of Stablecoins. SSRN.
4. Bains, P. (2022). Regulating the Crypto Ecosystem The Case of Stablecoins and Arrangements. Washington: International Monetary Fund.
5. Dennis, A. (2012). System Analysis and Design. New Jersey: Wiley.
6. Fahim, S. (2023). Blockchain: A Comparative Study Study of Consensus Algorithms PoW, PoS, PoA, PoV. I. J. Mathematical Sciences and Computing, pp. 46–57.
7. Gough, K. M. (2018). Employing Model-Based Systems Engineering (MBSE) on a NASA Aeronautic Research Project: A Case Study. Aerospace Research Central.
8. Gregory, J. (2020). The long and winding road: MBSE adoption for functional avionics of spacecraft. The Journal of Systems and Software, pp. 1–8.

9. Grobys, K. (2021). On the stability of stablecoins. Journal of Empirical Finance, pp. 207–223.
10. Heibrok, H. (2024). Open-source MBSE workflow for automated spacecraft thermal analyses from a system model IAC-22, D1,4B,2,x70017. Acta Astrinautica, 253-260.
11. Holt, J. (2023). Systems Engineering Demystified. Birmingham: Packt Publishing Ltd.
12. ISO. (2018). ISO 19011 Guidelines for Auditing Management System. Switzerland.
13. Kolossvary, T. (2023). Systems engineering in automotive product development: A guide to initiate organizational transformation. Journal of Open Innovation: Technology, Market, and Complexity.
14. Kusnadi, A. (2023). Designing Halal Product Traceability System using UML and Integration of Blockchain with ERP. Jurnal Ilmiah Teknologi Sistem Informasi, vol. , no. 1, 29-41.
15. Let, B. (2023). What drives the popularity of stablecoins? Measuring the frequency dynamics of connectedness between volatile and stable cryptocurrencies. Technological Forecasting & Social Change.
16. London, B. (2014). Model-based requirement generation. IEEE Aerospace Conference. IEEE Xplore.
17. Li, S. (2023). MBSE-Based Turbofan Engine System Simulation Platform Design. Advance in Guidance, Navigation, and Control, pp. 4661–4671.
18. Mousavi, B. A. (2022). Use of Model-Based System Engineering methodology and tools for disruption analysis of supply chains: A case in semiconductor manufacturing. Journal of Industrial Integration.
19. Romero, V. (2021). A user-centric computer-aided verification process in a virtual-reality continuum. Computers in Industry, pp. 1–15.
20. Shamili, P. (2021). Design and Implementation Consideration of POA Network Architecture in the Ethereum Blockchain. Webology, Volume 19.
21. Use of Model-Based System Engineering Methodology and Tools for disruption analysis of supply chains: A Case in semiconductor Manufacturing. (2022). Journal in Industrial Information Integration.
22. Vitolo, F. (2022). Mobile Robots and Cobots Integration: A Preliminary Design of a Mechatronic Interface by Using MBSE Approach. Applied Sciences.
23. Wang, H. (2021). Unified modeling for digital twin of a knowledge-based system design. Robotics and Computer Integrated Manufacturing.
24. Wang, Y.-R. (2022). A model for CBDC audits based on blockchain technology: Learning from DCEP. Research in International Business and Finance.
25. YU, C. (2021). Industrial Design and Development of Software System Architecture Based on Model-Based Systems Engineering and Cloud Computing. Annual Reviews in Control, 401-423.