International Journal Software Engineering and Computer Science (IJSECS)
5 (2), 2025, 484-497
Published Online August 2025 in IJSECS (http://www.journal.lembagakita.org/index.php/ijsecs)
P-ISSN: 2776-4869, E-ISSN: 2776-3242. DOI: https://doi.org/10.35870/ijsecs.v5i2.3855.

RESEARCH ARTICLE Open Access

Development of a Prototype for a Product Recommendation System Using Blockchain Technology

Adrian Tri Setiawan *
Informatics Study Program, Faculty of Communication and Informatics Technology, Universitas Nasional, City of South Jakarta, Special Capital Region of Jakarta, Indonesia.
Corresponding Email: adriansetiawan26@gmail.com.

Djarot Hindarto
Informatics Study Program, Faculty of Communication and Informatics Technology, Universitas Nasional, City of South Jakarta, Special Capital Region of Jakarta, Indonesia.
Email: djarot.hindarto@civitas.unas.ac.id.

Received: February 24, 2025; Accepted: June 20, 2025; Published: August 1, 2025.

Abstract: Blockchain technology ensures data security and transparency through decentralization and immutability. Smart contracts facilitate automation and foster trust by reducing dependence on intermediaries. Nevertheless, most existing recommendation systems remain centralized, leaving them susceptible to manipulation and security breaches. Although recommendation algorithms are widely used, their application within blockchain-based systems remains limited. By leveraging the Ethereum blockchain and smart contracts, the proposed system enhances transparency, security, and decision-making reliability. The algorithm ranks products based on price, appearance, quality, size, and availability, with results permanently recorded on the blockchain. Experimental findings indicate that the integration of TOPSIS and PROMETHEE II algorithms improves the recommendation process by systematically evaluating multiple criteria. Each product is assessed according to its proximity to both positive and negative ideal solutions, with the final ranking score calculated as the ratio of the negative distance to the total distance (positive plus negative). For example, Pocari Sweat achieved the highest preference score of 0.9619, indicating it is the top recommendation, while Coca-Cola 390ml scored 0.4182, reflecting a lower ranking. These results demonstrate the algorithms' capacity to distinguish products objectively, supporting accurate and transparent recommendations. The study advances blockchain-based decision support systems by providing secure and transparent recommendation mechanisms. Additionally, the integration of TOPSIS and PROMETHEE II within a blockchain framework demonstrates both feasibility and effectiveness in decentralized environments.

Keywords: Blockchain; Smart Contract; Recommendation System; TOPSIS; PROMETHEE II.

1. Introduction

Blockchain has rapidly emerged as a transformative information technology, finding applications across a range of sectors and daily activities. Designed to address the challenges of the information disruption era, blockchain offers a compelling alternative to traditional, centralized technology architectures. With its core features of decentralization and encryption, blockchain enables data storage without the need for a central authority, making unauthorized changes or breaches considerably more difficult [1]. At the heart of blockchain lies the principle of decentralized information management. Data is stored permanently in records that are distributed peer-to-peer throughout the network, ensuring active collaboration among participants. This approach marks a significant departure from earlier internet-based technologies, which typically relied on centralized data control. As highlighted by Hindarto (2023) and Nugraha (2022), blockchain is increasingly viewed as a technology capable of replacing the prevailing centralized information architectures, thanks to its unique operational model [2][3]. The decentralized nature of blockchain ensures that data cannot be altered or tampered with unless consensus is achieved among all nodes in the network. This feature makes blockchain particularly effective in preventing fraud and guaranteeing data authenticity [4]. By leveraging blockchain, organizations can benefit from enhanced data security, transparency, and automation—factors that collectively help boost operational efficiency. In essence, a blockchain is a growing ledger of data records, each confirmed by participants, or "nodes," within the network [5]. The distributed architecture means that data can only be modified if all nodes agree, which significantly reduces the risk of manipulation and ensures the integrity of the information stored.

Smart contracts represent another significant advancement enabled by blockchain technology. These digital agreements are programmed to execute automatically when predefined conditions are met, eliminating the need for intermediaries and reducing the potential for human error or interference [6]. Smart contracts are now being adopted in various domains, including finance and digital commerce, where they provide legal certainty and streamline transactions by minimizing reliance on conventional systems. As Nick Szabo—the pioneer of smart contracts—suggested, such technology can automate transactions to the extent that manual verification becomes unnecessary. By offering a secure and immutable record of transactions, blockchain has the potential to fundamentally reshape how information is shared among stakeholders [19].

In Indonesia, practical implementations have demonstrated blockchain's ability to enhance transparency, efficiency, and security at every stage of a transaction, including the selection of blockchain-based products integrated with intelligent decision-making systems. Furthermore, smart contracts on blockchain platforms offer additional benefits; transactional data is protected and remains tamper-proof [7]. To support users in selecting the best products based on multiple criteria—such as price, appearance, and quality—multi-criteria decision-making algorithms like TOPSIS and PROMETHEE II can be embedded into smart contracts on the blockchain. This integration allows for detailed, objective calculations and rankings that accurately reflect user preferences [8]. Combining blockchain technology with smart contracts provides a robust foundation for building fair and secure digital transaction systems. Every action in the product selection process can be tracked and verified by all network participants, which helps prevent manipulation and fraud. Against this backdrop, the research presented here aims to develop a blockchain-based product selection system that incorporates both the TOPSIS and PROMETHEE II algorithms. The goal is to further enhance transparency and accuracy in decision-making processes related to product selection [9].

Despite its promise, the adoption of blockchain in recommendation systems faces several hurdles. In Indonesia, discussions on blockchain-based recommendation systems remain limited, and most platforms still depend on centralized databases. Nevertheless, Ethereum was chosen for this study due to its flexible smart contract capabilities, vibrant developer ecosystem, and decentralized design, which collectively ensure transparency and data validity. Ethereum's strengths in security, transparency, and compatibility with various development tools make it a leading choice for implementing blockchain-based recommendation systems. However, widespread adoption is hindered by complex infrastructure requirements, high costs, limited user understanding, and a lack of clear regulations in many sectors—all of which may slow the adoption process [10]. This study seeks to design a blockchain-based product selection system that integrates the TOPSIS and PROMETHEE II algorithms to generate product rankings according to predefined criteria. By leveraging smart contracts, the system aims to deliver transparency and security throughout the product evaluation process, preventing data manipulation and ensuring that transactions are recorded automatically. Ultimately, this research contributes to the advancement of intelligent decision support systems by integrating blockchain technology with multi-criteria decision-making algorithms, resulting in a more reliable and transparent recommendation framework [11].

2. Related Work

The development of blockchain-based product selection systems has attracted significant scholarly attention in recent years, particularly as organizations seek more secure, transparent, and efficient ways to manage digital transactions and decision processes. Blockchain technology itself is recognized for its decentralized architecture, which eliminates the need for a central authority and distributes data storage across a peer-to-peer network. This structure has proven effective in enhancing data security and integrity, as every transaction is recorded in a chain of cryptographically linked blocks that are validated by multiple network participants [12]. Researchers such as Fardian et al. (2025) and Hindarto (2023) have highlighted how blockchain's immutable ledger not only fosters trust among stakeholders but also reduces the risk of fraud and unauthorized data manipulation, making it an attractive foundation for critical applications in fields such as education, supply chain management, and digital commerce [1][2].

A closely related innovation is the smart contract, which automates the execution of agreements once predefined conditions are met. As described by Surbakti (2023), smart contracts operate on blockchain platforms and are executed without human intervention or reliance on third-party intermediaries [13]. This automation streamlines complex processes, reduces operational costs, and ensures that contractual obligations are fulfilled with transparency and consistency. The adoption of smart contracts has been further facilitated by development tools such as Truffle, which supports the compilation, deployment, and testing of contracts in simulated environments before they are launched on public blockchains [15]. Ganache, in particular, enables developers to create local Ethereum networks for rapid prototyping and debugging, thereby accelerating the iterative development cycle [16].

The programming of smart contracts is most commonly conducted using Solidity, a language specifically designed for the Ethereum ecosystem. Solidity's support for object-oriented programming and its alignment with the latest Ethereum standards have made it the de facto choice for blockchain developers [14]. These technological advancements have opened new avenues for integrating blockchain with decision-support algorithms, thereby extending the utility of distributed ledgers beyond simple financial transactions.

In the context of decision-making, multi-criteria decision-making (MCDM) algorithms such as TOPSIS and PROMETHEE II have been widely adopted to handle complex selection problems involving multiple, often conflicting, criteria. TOPSIS, as outlined by Rahmah & Timur (2024), enables the ranking of alternatives based on their proximity to an ideal solution, offering a clear and systematic approach for users to identify the most suitable option among many [18]. PROMETHEE II, meanwhile, is praised for its efficiency and ease of use, providing a straightforward ranking mechanism that is especially beneficial in environments where transparency and objectivity are paramount [20]. The integration of these algorithms into blockchain-based systems has been explored by several researchers, who have demonstrated that combining MCDM techniques with smart contracts can produce robust, tamper-resistant decision-support platforms [8].

Front-end development for these systems is often achieved using React, a JavaScript library renowned for its ability to build dynamic and responsive user interfaces [17]. The use of React ensures that users can interact seamlessly with blockchain-based platforms, accessing complex functionalities through intuitive and accessible interfaces. This alignment of advanced backend technologies with modern front-end frameworks is crucial for driving user adoption and maximizing the practical impact of blockchain innovations.

Despite these advancements, the literature also notes several challenges associated with the widespread adoption of blockchain and smart contract technologies. Issues such as scalability, regulatory uncertainty, and limited public understanding remain significant obstacles, particularly in developing contexts like Indonesia [10]. Nevertheless, ongoing research and development efforts continue to address these barriers, with a growing number of studies demonstrating the feasibility and advantages of blockchain-enabled decision-support systems [11]. The convergence of blockchain technology, smart contracts, and multi-criteria decision-making algorithms represents a promising direction for the development of secure, transparent, and efficient product selection systems. By leveraging the strengths of each component, researchers and practitioners are paving the way for next-generation digital platforms that can deliver enhanced trust, automation, and user empowerment in a variety of domains.

3. Research Method

Manual Calculation of the Topsis Algorithm Implementation The author will conduct a manual calculation test using the TOPSIS and PROMETHEE II algorithm by obtaining three data samples prior to performing the calculation.

Table 1. Data Product

No	Product	Price	Appearance	Taste	Size	Availability
1	Nipis Madu	3000	4	4	3	3
2	Coca-Cola	5000	3	4	4	4
3	Teh Pucuk	4000	3	3	3	5

Note: Price is a cost criterion, while appearance, taste, size, and availability are benefit criteria.

3.1 Manual calculation of Topsis Algorithm

1) Determining normalized decision matrix

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x\frac{2}{ij}}}$$

Then, make a normalized decision matrix based on existing data on the product, to make a normalized decision matrix with the price criteria as follows:

$$r_{11}=\frac{3000}{\sqrt{(3000^2)+(5000^2)+(4000^2)}}=\frac{3000}{50,000,000}=0.00006$$

$$r_{21}=\frac{5000}{\sqrt{(3000^2)+(5000^2)+(4000^2)}}=\frac{3600}{50,000,000}=0.000072$$

$$r_{31}=\frac{4000}{\sqrt{(3000^2)+(5000^2)+(4000^2)}}=\frac{3000}{50,000,000}=0.00006$$

For the calculation of the normalized matrix with the appearance criteria as follows:

$$r_{12}=\frac{4}{\sqrt{(4^2)+(3^2)+(3^2)}}=\frac{4}{34}=0.117$$

$$r_{22}=\frac{3}{\sqrt{(3^2)+(4^2)+(3^2)}}=\frac{3}{34}=0.088$$

$$r_{32}=\frac{3}{\sqrt{(3^2)+(4^2)+(3^2)}}=\frac{3}{34}=0.088$$

For the calculation of the normalized matrix with taste criteria as follows:

$$r_{13}=\frac{4}{\sqrt{(4^2)+(4^2)+(3^2)}}=\frac{4}{41}=0.097$$

$$r_{23}=\frac{4}{\sqrt{(4^2)+(4^2)+(3^2)}}=\frac{4}{41}=0.097$$

$$r_{33}=\frac{4}{\sqrt{(4^2)+(4^2)+(3^2)}}=\frac{3}{41}=0.073$$

For the calculation of a normalized matrix with capacity/size criteria as follows:

$$r_{14}=\frac{3}{\sqrt{(3^2)+(4^2)+(3^2)}}=\frac{3}{34}=0.088$$

$$r_{24}=\frac{4}{\sqrt{(3^2)+(4^2)+(3^2)}}=\frac{4}{34}=0.117$$

$$r_{34}=\frac{3}{\sqrt{(3^2)+(4^2)+(3^2)}}=\frac{3}{34}=0.088$$

For the calculation of the normalized matrix with the product convenience criteria obtained as follows:

$$r_{15}=\frac{3}{\sqrt{(3^2)+(4^2)+(5^2)}}=\frac{3}{50}=0.06$$

$$r_{25}=\frac{4}{\sqrt{(3^2)+(4^2)+(5^2)}}=\frac{4}{50}=0.08$$

$$r_{35}=\frac{5}{\sqrt{(3^2)+(4^2)+(5^2)}}=\frac{5}{50}=0.1$$

Normalized matrix result

$$r = \begin{bmatrix} 0.00006 & 0.117 & 0.097 & 0,088 & 0,06 \\ 0.000072 & 0.088 & 0.097 & 0,117 & 0,08 \\ 0.00006 & 0.088 & 0.073 & 0,088 & 0,1 \end{bmatrix}$$

2) Determining the Weighted Decision Matrix

$$y_{ij} = r_{ij}\ x\ w_j$$

For the Weighted Decision Matrix with price criteria as follows

$$y_{11} = 0.00006\ x\ 3000 = 0.18$$
$$y_{21} = 0.000072\ x\ 5000 = 0.36$$
$$y_{31} = 0.00006\ x\ 4000 = 0.24$$

For the Weighted Decision Matrix with the following appearance:

$$y_{12} = 0{,}117\ x\ 4 = 0.468$$
$$y_{22} = 0{,}088\ \ x\ 3 = 0.351$$
$$y_{32} = 0{,}088\ x\ 3 = 0.351$$

For the Weighted Decision Matrix with flavor criteria as follows:

$$y_{13} = 0{,}097\ x\ 4 = 0.388$$
$$y_{23} = 0{,}097\ x\ 4 = 0.388$$
$$y_{33} = 0{,}073\ x\ 3 = 0.219$$

For the Weighted Decision Matrix with capacity/size:

$$y_{14} = 0{,}088 \text{ x } 3 = 0.351$$
$$y_{24} = 0{,}117\ x\ 4 = 0{,}468$$
$$y_{34} = 0{,}088\ x\ 3 = 0.351$$

For the Weighted Decision Matrix with capacity/size:

$$y_{15} = 0{,}06\ x\ 3 = 0.18$$
$$y_{25} = 0{,}08\ x\ 4 = 0.32$$
$$y_{35} = 0{,}1\ x\ 5 = 0.5$$

3) Determine the value of positive ideal solution (A+) and negative ideal solution (A-)

$$A+ = (y1^{+}+, y2^{+}, \dots, yj^{+}$$
$$A^{-}\ (\ y1^{-},\ y2^{-}, \dots, yj^{-})$$

With

$$yj^{+} = \begin{cases} \max i\ y_{ij}\ if\ j = benefit \\ \min i\ y_{ij}, if\ j = benefit \end{cases}$$
$$yj^{-} = \begin{cases} \min i\ y_{ij}\ if\ j = keuntungan \\ \quad \max i\ y_{ij}, if\ j = cost \end{cases}$$

Table 2. Ideal Solution

Yi	Solusi ideal	Max	Min
Y1	0.18; 0.468; 0.388;0.351;0.18	0.18	0.36
Y2	0.36; 0.351; 0.388;0.468;0.32	0.468	0.351
Y3	0.24; 0.351; 0.219;0.351;0.5	0.388	0.219
		0.468	0.351
		0.5	0.18

4) Determining the Distance Between Alternative Values from the Ideal Solution Matrix

$$D_1^{+} = \sqrt{\begin{matrix} ((0.18-0.18)^2) + ((0{,}468-0{,}468)^2) \\ +((0{,}388-0{,}388)^2) + \ ((0{,}468-0{,}351)^2 \\ +\ ((0.5 -\ 0.18)^2 \end{matrix}}$$

$$D_1^{+} = \sqrt{0.116} = \ 0.34$$

$$D_2^{+} = \sqrt{\begin{matrix} ((0.18-0.36)^2) + ((0{,}468-0.351)^2) \\ +((0{,}388-0.388)^2) + ((0{,}468-0{,}468)^2) \\ +((0{,}5-0.32)^2) \end{matrix}}$$

$$D_2^+ = \sqrt{0.078} = 0.279$$

$$D_3^+ = \sqrt{\begin{matrix}((0.18 - 0.24)^2) + ((0,468 - 0.351)^2) \\ +((0,388 - 0.219)^2) + ((0,351 - 0.219)^2) \\ +((0,5 - 0.5)^2\end{matrix}}$$

$$D_3^+ = \sqrt{0.063} = 0.251$$

$$D_1^- = \sqrt{\begin{matrix}((0.36 - 0.18)^2) + ((0,351 - 0,468)^2) \\ +((0,219 - 0,388)^2) + ((0,351 - 0,351)^2 \\ ((0.18 - 0.18)^2)\end{matrix}}$$

$$D_1^- = \sqrt{0.074} = 0.273$$

$$D_2^- = \sqrt{\begin{matrix}((0.36 - 0.36)^2) + ((0,351 - 0.351)^2) \\ +((0,219 - 0.388)^2) + ((0,351 - 0,468)^2) \\ +((0,18 - 0.32)^2)\end{matrix}}$$

$$D_2^- = \sqrt{0.06185} = 0.2487$$

$$D_3^- = \sqrt{\begin{matrix}((0.36 - 0.24)^2) + ((0,351 - 0.351)^2) \\ +((0,219 - 0.219)^2) + ((0,351 - 0.219)^2) \\ +((0,18 - 0.5)^2\end{matrix}}$$

$$D_3^- = \sqrt{0.134} = 0.366$$

5) Finding Preference Results

$$v_i = \frac{di^-}{di^- + di^+}$$

Product1

$$v_i = \frac{di^-}{di^- + di^+} = \frac{0.273}{0.273 + 0.34} = 0.4454$$

Product2

$$v_i = \frac{di^-}{di^- + di^+} = \frac{0.2487}{0.2487 + 0.279} = 0.4713$$

Product3

$$v_i = \frac{di^-}{di^- + di^+} = \frac{0.366}{0.366 + 0.251} = 0.5932$$

Based on the above calculations, the highest preference, namely a score of 0.5932, is the top tea product while the lowest is honey lime with a score of 0.4454 With this, the top tea product is considered the most recommended based on the calculation of the topsis algorithm.

3.2 Promethee II Calculation

Using the same data, P1-P3 is product, A1-A5 is weight criteria

$$H(d)\begin{cases}0 \text{ } if \text{ } d = 0 \\ 0 \text{ } if \text{ } d \leq 0 \\ 1 \text{ } if \text{ } d \geq 1\end{cases}$$

Table 2. Preference Values

	A1	A2	A3	A4	A5
P1-P2	-2000	1	0	-1	-1
P1-P3	-1000	1	1	0	-2
P2-P1	2000	-1	0	1	1
P2-P3	1000	0	1	1	-1
P3-P1	1000	-1	-1	0	2
P3-P2	-1000	0	-1	-1	1

Positive differences are assigned a value of 1, and negative differences are assigned 0. The results are then divided by the number of criteria (5).

Table 3. Converted Preference Values

A1	A2	A3	A4	A5	Result
0	1	0	0	0	0.2
0	1	1	0	0	0.4
1	0	0	1	1	0.6
1	0	1	1	0	0.6
1	0	0	0	1	0.4
0	0	0	0	1	0.2

Table 4. Multicriteria Preference Table

Alternative	P1	P2	P3
P1	-	0.2	0.4
P2	0.6	-	0.6
P3	0.4	0.2	-

The results will then be coreferenced first and then divided by the criteria, all values with positive results will be given a value of 1 while negative values will be given a value of 0. The coreference results are then divided by the number of criteria, because there are 5 criteria, it will be divided by 5.

Leaving flow

P1

$$\Phi^{+}(a) = \frac{1}{3-1} \text{ x } (0{,}2 + 0{,}4)$$
$$= 0{,}5\ x\ 0{,}6 = 0.3$$

P2

$$\Phi^{+}(a) = \frac{1}{3-1} \text{ x } (0.6 + 0.6)$$

$$= 0{,}5\ x\ 1.2 = 0.6$$

P3

$$\Phi^{+}(a) = \frac{1}{3-1} \text{ x } (0{,}4 + 0{,}2)$$
$$= 0{,}5\ x\ 0{,}6 = 0{,}3$$

Entering Flow

P1

$$\Phi^{-}(a) = \frac{1}{3-1} \text{ x } (0{,}6 + 0{,}4)$$

$$= 0{,}5\ x\ 1 = 0{,}5$$

P2

$$\Phi^{-}(a) = \frac{1}{3-1} \text{ x } (0{,}2 + 0{,}2)$$

$$= 0{,}5\ x\ 0{,}4 = 0{,}2$$

P3

$$\Phi^{-}(a) = \frac{1}{3-1} \text{ x } (0{,}4 + 0{,}6)$$

$$= 0{,}5 \, x \, 1.0 = 0.5$$

Net Flow

P1

$$\Phi(a) = (0{,}3 - 0{,}5) = -0.2$$

P2

$$\Phi(a) = (0{,}4 - 0{,}2) = 0.4$$

P3

$$\Phi(a) = (0{,}3 - 0{,}5) = -0.2$$

Based on Net flow for product selection using PROMETHEE II based on the test sample, product number 2 has the highest net flow of 1, therefore the first product gets product recommendations based on calculations. The flow of this research is as follows:

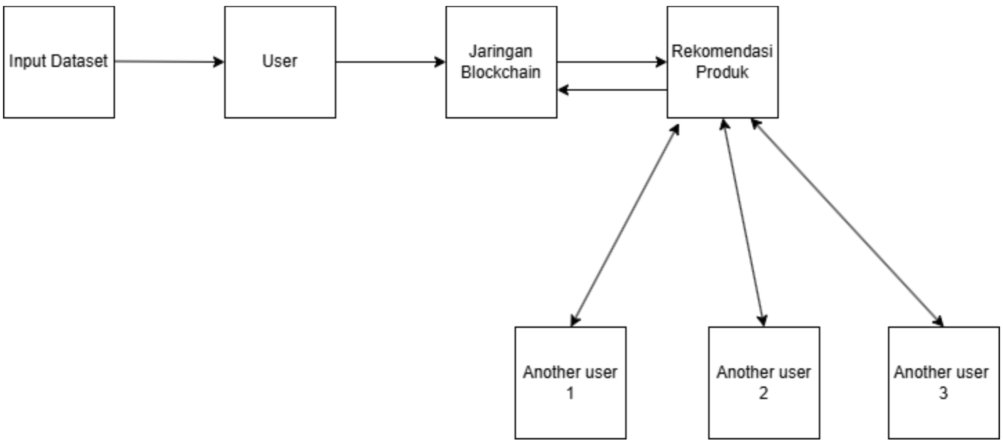

Figure 1. Research flow

1) Dataset Input
   This research begins with the compilation of a dataset containing product information, particularly product prices from various supermarkets, and the collection of questionnaire responses via Google Forms. To ensure the accuracy and relevance of the data, the dataset is compiled based on five main evaluation criteria: price, appearance, quality, size, and availability. These criteria are selected because they represent essential factors in consumer decision-making and are assessed using a Likert scale in the questionnaire. Price is treated as a cost criterion (lower is better), while appearance, quality, size, and availability are considered benefit criteria (higher is better). The collected data is entered through a validated web interface, then normalized and weighted before being processed using the TOPSIS and PROMETHEE II methods to generate accurate product rankings. This approach ensures that the system's recommendations are transparent, data-driven, and aligned with user preferences, while leveraging blockchain technology for secure and immutable storage.
2) User
   The user is the primary actor who interacts directly with the system through the web interface. Users can input datasets such as product information (price, appearance, taste, size, and ease of acquisition) and receive product recommendation results based on the entered criteria. Additionally, users can view the recommendation process generated by the combination of the TOPSIS and PROMETHEE II algorithms. The data entered by the user is stored on the blockchain network to ensure security and transparency.
3) Blockchain Network
   In this research design, the blockchain network serves as the key infrastructure to ensure the security, transparency, and integrity of the data used in the product recommendation system. The blockchain network's roles and functions in this research include:
   a) Secure Data Storage
   b) Transparency and Auditability
   c) Data Sharing
   d) Interaction with Smart Contracts
   e) Data Security

5) Product Recommendation
A crucial aspect of the proposed system is the product recommendation process, which is achieved by integrating the TOPSIS and PROMETHEE II algorithms to generate suggestions based on established standards. The dataset, which includes features such as price, appearance, taste, and other related variables, is entered via the web interface. These features are processed and normalized before being used in the calculations. The TOPSIS algorithm provides an initial ranking based on the distance from the ideal solution, while the PROMETHEE II algorithm performs further evaluation by calculating the net flow, which indicates the overall preference of each product compared to others. The final result is a ranking of products based on the predefined criteria. The recommendation results are stored on the blockchain network to ensure transparency and integrity. This storage increases user trust in the system's output by ensuring that the recommendation data cannot be edited or tampered with by external parties. Users can view the recommended product list along with details about their features, such as price, appearance, and taste, through a user-friendly interface. This strategy, supported by the data security provided by blockchain technology, enables users to make smarter decisions based on accurate and transparent multi-criteria evaluation results.
6) Other Users
Other users refer to individuals who can also access the recommendation system. They connect to the blockchain using their devices (laptops, tablets, or mobile phones) to view recommendation results or participate in the product evaluation process. Other users do not have direct access to edit data but can view information that has been transparently stored on the blockchain network. This ensures that all users obtain the same information without manipulation, thanks to the data integrity guaranteed by blockchain technology.

4. Result and Discussion

4.1 Results

Before proceeding to product selection, it is necessary to build and migrate the established smart contract. In this study, the contract used is called "ProductSelection," developed using Solidity version 0.8.18 and Truffle version 5.11.5.

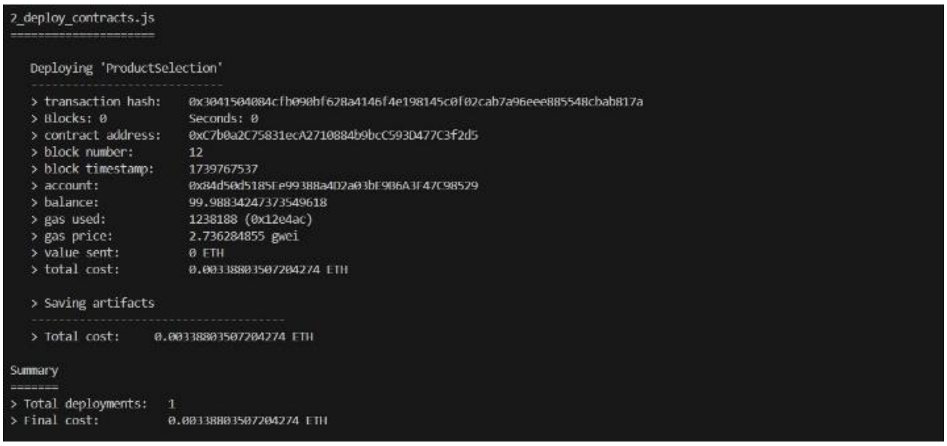

Figure 2. Contract

After designing and deploying the smart contract to the blockchain network, the subsequent step involves running the product selection web application. This application functions as the primary interface through which users interact with the blockchain-based recommendation system. Upon launching the application, users are required to log in to ensure the security and personalization of their interactions. Only authenticated users are permitted to access the core features of the system, including the addition and management of product data. Once logged in, users are redirected to the menu page (Figure 3), which serves as the central navigation hub. From this menu, users can select the "Go to Apps" option to proceed to the product selection interface (Figure 4). Within this section, users are provided with input forms to enter comprehensive product information, including the product name and various attributes such as price, appearance, taste, size, and availability. This structured data collection is essential for the accurate operation of the recommendation algorithms. The application leverages the integrated TOPSIS and PROMETHEE II algorithms to process the collected data, enabling multi-criteria decision-making and generating ranked product recommendations.

These rankings are then securely stored on the Ethereum blockchain via smart contracts, ensuring both transparency and immutability of the recommendation results.

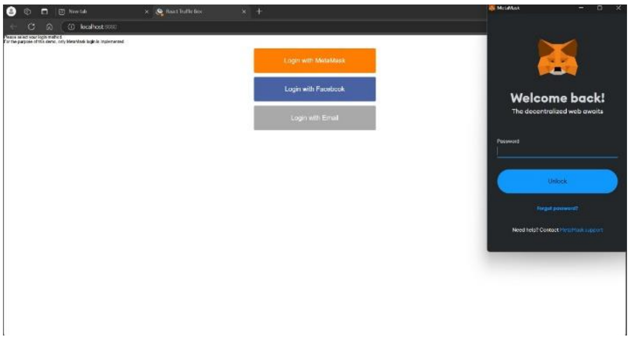

Figure 3. Login Page

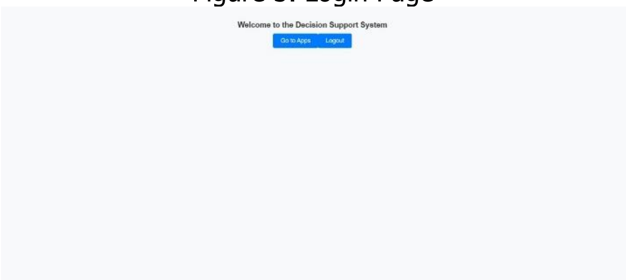

Figure 4. Menu Page

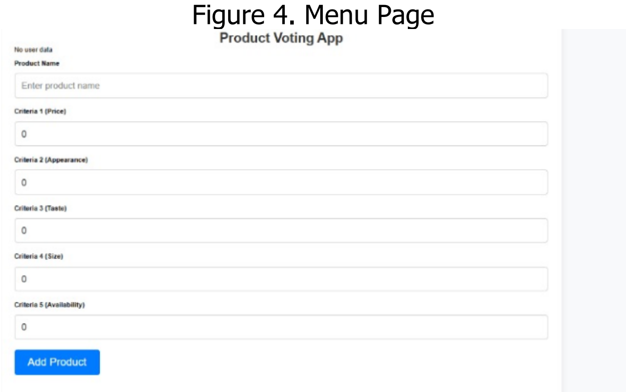

Figure 5. Input Data

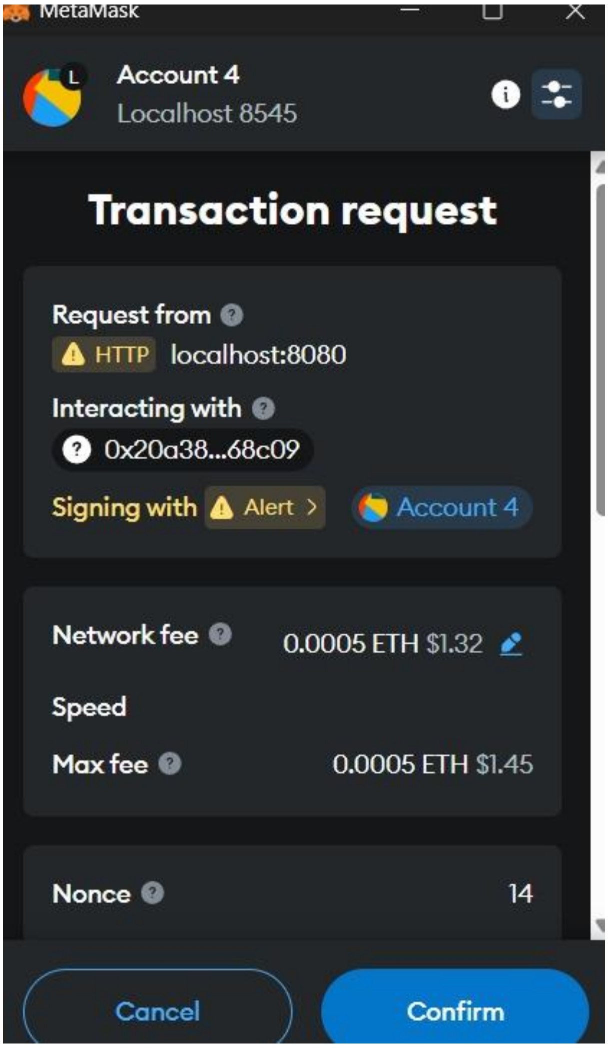

Figure 6. Confirmation

Before the entered data is committed to the blockchain, the system prompts users with a transaction confirmation via Metamask (Figure 5). This additional verification step not only enhances security but also ensures that users are informed of the transaction details prior to final submission. The web application is developed using React.js and Web3.js, providing a seamless and responsive user experience. The software is capable of fetching stored recommendations from the blockchain, displaying results dynamically, and offering supplementary features such as filtering or adjusting product preferences according to user needs. In this research, React.js version 18.2.0 is utilized to ensure compatibility and performance. Overall, the integration of blockchain technology with advanced recommendation algorithms and a modern web interface creates a robust and user-friendly system for secure and transparent product selection.

This step ensures that all inputted information is securely verified and authorized prior to being stored in the blockchain system. The input dataset is stored on the blockchain, ensuring data integrity, transparency, and security. Each product entry, including its features such as price, appearance, and taste, is recorded in a decentralized manner via smart contracts. This prevents unauthorized modifications and ensures that all users access the same validated information. Once stored, the system processes the dataset using the TOPSIS and PROMETHEE II algorithms to generate a ranked list of recommended products. The calculated rankings are then updated on the blockchain and made accessible to users through the web application. Users can interact with the system via the React.js and Web3.js-powered interface, retrieving recommendations and filtering results according to their preferences. The adoption of blockchain technology ensures that all recommendations remain tamper-proof, increasing trust and reliability in the product selection process. In this study, Ganche GUI version 2.7.1 is used.

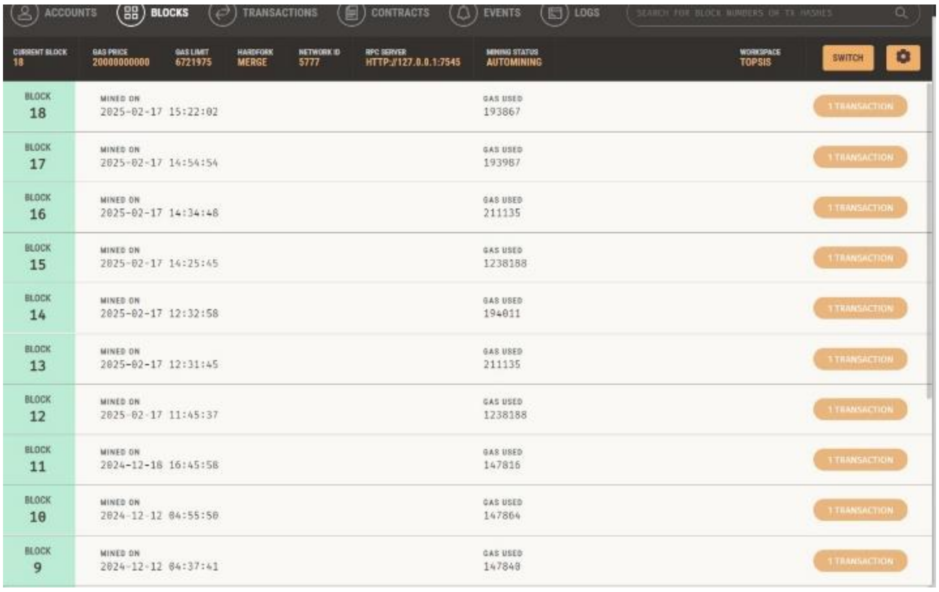

Figure 7. Blockchain

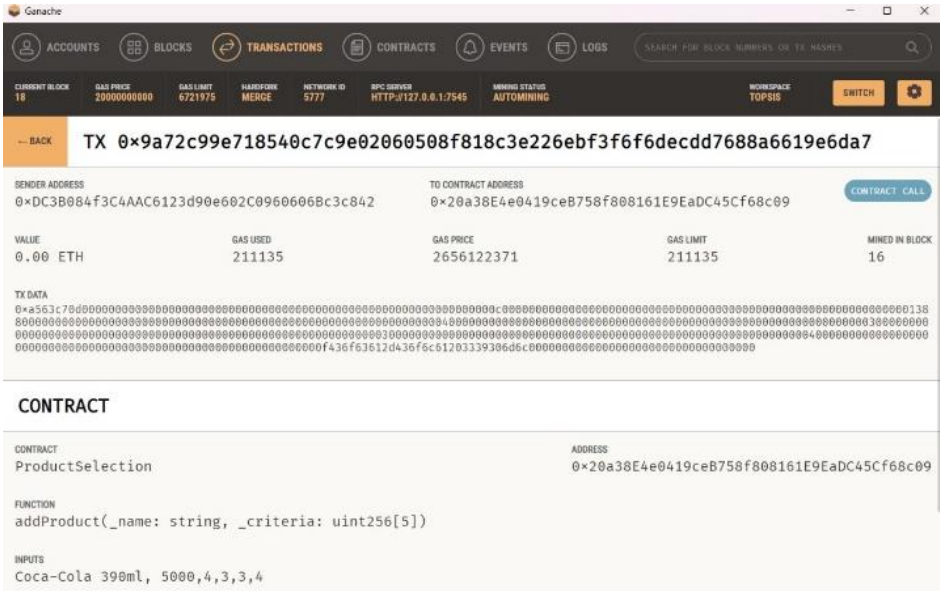

Figure 8. Transaction Event

When the user selects the "Rank Product" button, the system starts the process of calculating product rankings based on the input dataset. Product data stored on the blockchain is fetched and processed using the selected algorithm, either TOPSIS or PROMETHEE II, depending on the user's choice. If TOPSIS is selected, the system calculates the preference value of each product by comparing the distance between the positive and negative ideal solutions based on predefined criteria such as price, appearance, and taste. The final result is a list of products organized by their relative closeness to the ideal solution. If PROMETHEE II is selected, the system calculates the net flow value, which determines the degree of preference of one product over other alternatives. This method evaluates the dominance relationship between each pair of options to generate the final ranking. Once the calculation is complete, the ranking results are displayed on the web interface as a catalog of products sorted from most recommended to least recommended. The system also stores these calculation results on the blockchain through smart contracts, ensuring that the data remains secure, transparent, and immutable.

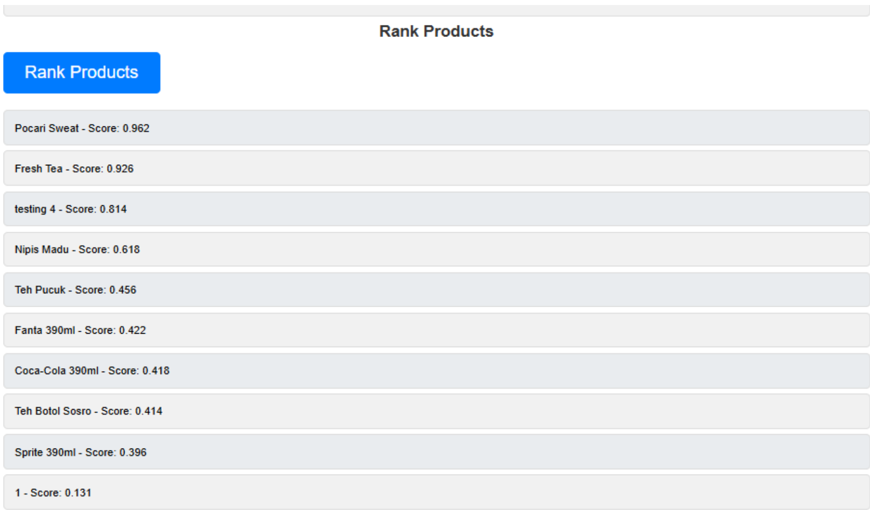

Figure 9. Rank Product

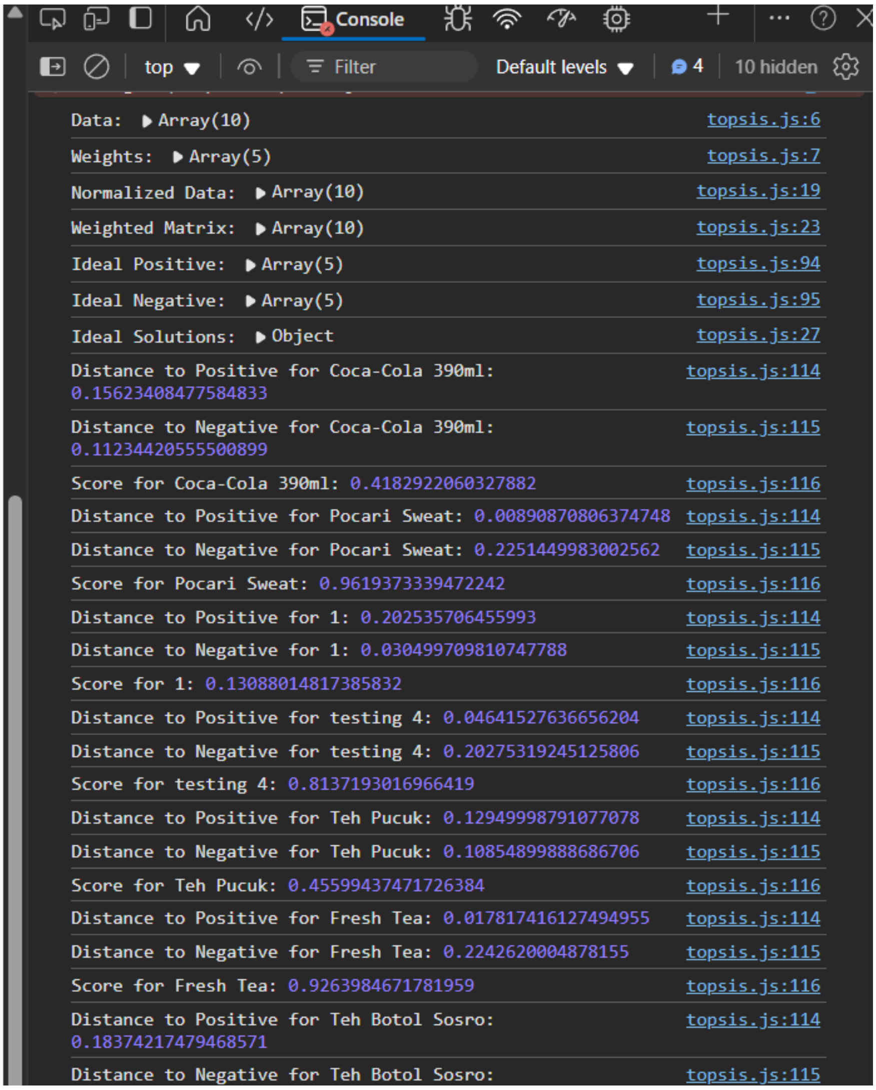

Figure 10. Topsis

The following figure presents the calculation results of the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method applied in the recommendation system. Each product in the dataset is evaluated based on its distance to the positive and negative ideal solutions. The "Distance to Positive" value indicates how close a product is to the best solution, while the "Distance to Negative" value shows how far the product is from the worst solution. The final score of each product is computed using the ratio of the negative distance to the total distance (positive + negative), resulting in a value between 0 and 1. The product with the highest score receives the highest preference in the recommendation system. For example, based on the experimental results, the Pocari Sweat product has a score of 0.9619, indicating a high degree of preference compared to other products according to the specified criteria. If, in another scenario, Pocari Sweat has lower criteria values, its ranking will automatically decrease based on the entered criteria.

4.2 Discussion

This study's results highlight the significant benefits of integrating multi-criteria decision-making algorithms—specifically TOPSIS and PROMETHEE II—with blockchain technology in the context of product recommendation systems. By leveraging blockchain, all data and ranking outcomes are stored in a decentralized and tamper-resistant ledger, ensuring that the information users receive is both valid and trustworthy. This approach addresses longstanding concerns about data manipulation and transparency in digital recommendation platforms, as supported by recent research on blockchain's role in securing information systems [1][13][19]. The use of smart contracts plays a central role in automating critical processes, from data entry and evaluation to the recording of final rankings. These contracts operate independently of third-party oversight, which not only streamlines operations but also enhances user trust. The ability to audit and verify every transaction on the blockchain network fosters an environment of openness and accountability, as emphasized in studies on smart contract adoption across various sectors [6][8][12][14]. From a user experience perspective, the adoption of modern web technologies like React.js and Web3.js has made the system intuitive and accessible. Users can easily enter product details, view recommendations, and adjust their preferences, all through a seamless interface. This aligns with the growing trend of integrating user-friendly web frameworks with blockchain backends to bridge the gap between advanced technology and everyday usability [17][18]. The findings of this research reinforce the value of combining robust decision-making methodologies with blockchain infrastructure. Not only does this union improve the quality and reliability of recommendations, but it also empowers users with greater control over their data and the decision-making process. Users can trust that the recommendations they receive are impartial, transparent, and secure—qualities that are increasingly demanded in today's digital landscape [4][5][15][20].

5. Conclusion

Based on the research conducted, blockchain technology enhances security and transparency in product recommendation systems. Its decentralized and immutable nature ensures data integrity, increasing user trust. The integration of TOPSIS and PROMETHEE II algorithms improves recommendation accuracy by evaluating multiple criteria such as price, appearance, and taste. This hybrid approach optimizes decision-making compared to conventional methods. Smart contracts further enhance efficiency by automating transactions and eliminating third-party intervention, reducing data manipulation risks. Experimental results confirm the system's effectiveness in a local blockchain environment using Ganache, Truffle, and React.js, enabling secure storage and retrieval of recommendations. However, challenges remain in deploying the system on a public blockchain, particularly regarding computational costs and transaction fees. Future research should explore blockchain scalability solutions and integrate alternative MCDM algorithms to improve recommendation accuracy and personalization.

References

[1] Rohman, V. F. N., & Rahmadika, M. (2025). Analisis Implementasi Teknologi Blockchain pada Sistem Informasi untuk Meningkatkan Keamanan Data Mahasiswa. *Jurnal Teknik Mesin, Industri, Elektro dan Informatika*, *4*(2), 22-31.

[2] Hindarto, D. (2023). Enterprise architecture development to strengthen sustainability in the supply chain. *Jurnal JTIK (Jurnal Teknologi Informasi dan Komunikasi), 7*(4), 714–723. https://doi.org/10.35870/jtik.v7i4.1834

[3] Nugraha, A. C. (2020). Penerapan Teknologi Blockchain dalam Lingkungan Pendidikan: Studi Kasus Jurusan Teknik Komputer dan Informatika POLBAN. *Produktif: Jurnal Ilmiah Pendidikan Teknologi Informasi*, *4*(1), 302-307. https://doi.org/10.35568/produktif.v4i1.386

[4] Iswahyudi, I., Hindarto, D., & Indrajit, R. E. (2023). Digital transformation in university: Enterprise architecture and blockchain technology. *Sinkron, 8*(4), 2501–2512. https://doi.org/10.33395/sinkron.v8i4.12977

[5] Sari, A. N., & Gelar, T. (2024). Blockchain: Teknologi Dan Implementasinya. *Jurnal Mnemonic*, *7*(1), 63-70. https://doi.org/10.36040/mnemonic.v7i1.6961

[6] Wibowo, S. A., Dzulhijjah, D. A., Jufani, M. N., Krisnanda, A. R., & Irbad, A. (2022). Penerapan smart contract dalam sistem blockchain pada pengakuan sistem kredit semester kampus merdeka. *Prosiding SENIATI*, *6*(3), 535-543. https://doi.org/10.36040/seniati.v6i3.5095.

[7] Fajarianto, E. R., Zulfikar, P., & Mulyadi, E. (2022). Tinjauan Yuridis Penggunaan Blockchain-Smart Contract Dalam Transaksi Non-Fungible Token (Nft) Pada Pt. Saga Riung Investama. *Jurnal Pemandhu*, *3*(2), 84-97.

[8] Hermawan, A., Karlim, D. P. S., Junaedi, J., & Daniawan, B. (2023). Pemanfaatan smart contract dalam transformasi supply chain melalui teknologi blockchain. *Jurnal Edukasi dan Penelitian Informatika (JEPIN), 9*(3), 471. https://doi.org/10.26418/jp.v9i3.69328

[9] Kadly, E. I., Rosadi, S. D., & Gultom, E. (2021). Keabsahan Blockchain-Smart Contract Dalam Transaksi Elektronik: Indonesia, Amerika Dan Singapura. *Jurnal Sains Sosio Humaniora*, *5*(1), 199-212.

[10] Zamzam, I., Mahdi, S. A., & Ansar, R. (2023). Government Budget Policy Related To Lockdown Covid19: A Political Pressure Study. *Jurnal Ilmiah Akuntansi Peradaban, VII*, *1*, 1-24.

[11] Hindarto, D., Hariadi, M., & Rachmadi, R. F. (2025). A Blockchain-based Landslide Mitigation Recommendation System for Decision-Making. *Engineering, Technology & Applied Science Research*, *15*(1), 20452-20460. https://doi.org/10.48084/etasr.9806

[12] Parmitasari, I. (2022). Eksistensi smart contract menurut hukum kontrak di Indonesia. *Prosiding Seminar Nasional Hasil Penelitian dan Pengabdian Masyarakat*, 93–101.

[13] Surbakti, M. (2023). Revolusi Teknologi Blockchain: Dampaknya pada Keamanan dan Integritas Data. *literacy notes*, *1*(1), 1–9.

[14] Restu Aji, S., & Trisari Harsanti Putri, W. (2023). Implementasi teknologi blockchain dalam aplikasi e-voting berbasis mobile. *Digital Zone: Jurnal Teknologi Informasi dan Komunikasi, 14*(2), 219–231. https://doi.org/10.31849/digitalzone.v14i2.16682

[15] Hassan, H., Hassan, R., & Gbashi, E. (2023). E-voting system based on Ethereum blockchain technology using ganache and remix environments. *Engineering and Technology Journal*, *41*(4), 562-577.

[16] Raipure, M. A. *Product Authentication System Using Blockchain* (Doctoral dissertation, Sant Gadge Baba Amravati University).

[17] Koirala, S. (2022). Building a Frontend User Interface of a Crypto Website by Utilizing React. https://urn.fi/URN:NBN:fi:amk-2022082419621.

[18] Rahmah, D. L., & Timur, K. J. (2024). Sistem pendukung keputusan pemilihan perumahan, 333–338.

[19] Hindarto, D., Alim, S., & Hendrata, F. (2024). Uncovering Blockchain's Potential for Supply Chain Transparency: Qualitative Study on the Fashion Industry. *Sinkron: jurnal dan penelitian teknik informatika*, *8*(2), 1107-1115. https://doi.org/10.33395/sinkron.v8i2.13590

[20] Alwendi, A., & Mandopa, A. S. (2023). Research Grant Decision Support System Based on The PROMETHEE II Method. *Journal Of Digital Learning And Distance Education*, *1*(10), 318-324. https://doi.org/10.56778/jdlde.v1i10.95.