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TOEHBCHAIN: A Framework for Blockchain-Based Food Distribution Transparency

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ABSTRACT

This study develops and validates TOEHBCHAIN, a readiness-driven blockchain adoption framework designed to enhance transparency, efficiency, and accountability in Indonesia's *Makan Bergizi Gratis* (MBG) program. Using a mixed-methods design, data were collected from 323 student beneficiaries, 23 schools, and qualitative interviews with government officials, vendors, and administrators. The Technology–Organisation–Environment–Human (TOEH) framework guided readiness assessment, while blockchain architecture was structured into four layers: Application, Smart Contract, Data, and Integration. Triangulation through expert validation and Focus Group Discussions strengthened reliability. Results show high organisational and environmental readiness but moderate technological understanding and limited human competence. Qualitative findings emphasise the need for automated reporting, real-time tracking, and inclusive interfaces. The TOEHBCHAIN framework integrates TOEH dimensions with blockchain features such as RBAC security, lightweight PWA design, and interoperability with government databases. Validation confirmed its feasibility, contextual relevance, and replicability. TOEHBCHAIN effectively aligns stakeholder readiness with blockchain functionalities to address digital transparency gaps in food distribution, offering an adaptable model for broader public welfare applications.

Article information:

Keywords: Blockchain Adoption, TOEH Framework, Public Food Distribution, Digital Transparency, Stakeholder Readiness, RBAC, PWA, Indonesia, MBG Program

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1. INTRODUCTION

The MBG program (Makan Bergizi Gratis) is a national initiative that provides free, nutritious meals to students, particularly in underserved areas. The program aims to reduce stunting and improve educational outcomes. The Indonesian school system includes multiple levels from SMP (junior high school) to SMA/SMK (senior high/vocational school), which are the primary beneficiaries of MBG. Meanwhile, Dapodik (Data Pokok Pendidikan) is the national education database system, which records student data and school profiles. Integrating MBG with Dapodik ensures accuracy and accountability in food distribution.

Indonesia still faces serious challenges in fulfilling the nutritional needs of school children. The prevalence of stunting has reached 21.6% (SSGI, 2022) [1], [2], and is one of the inhibiting factors in achieving the SDGs, especially SDG 2 (Zero Hunger), SDG 3 (Good Health and Wellbeing), and SDG 4 (Quality Education) [3]. To solve this problem, the government implemented the Makan Bergizi Gratis (MBG) Program [4], [5] as part of the national nutrition intervention strategy. However, the program still faces significant transparency and accountability challenges due to manual reporting, inconsistent monitoring, varying levels of digital capacity among local implementers and student beneficiaries, and several incidents of food poisoning were reported [6], [7].

The results of the questionnaire from 323 respondents who received the MBG program, consisting of students from various schools with different levels of education, showed that the majority of them stated that they were satisfied with the existence of this program. However, different results were obtained from interviews with the Education Office, Health Office,

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food vendors, and schools. Criticism was obtained regarding distribution tracking, reporting effectiveness, and the need for a more modern monitoring system because the MBG distribution and reporting process has not been based on a transparent digital platform.

The research questions guiding this study are: (1) What is the readiness level of different stakeholders (students, schools, government, vendors) to adopt blockchain-based MBG distribution systems? (2) How can readiness factors be translated into concrete blockchain architectural design? (3) Why is blockchain more suitable than centralised systems in ensuring transparency and accountability in food welfare programs?

Blockchain technology is present as an innovative solution that offers advantages over conventional database systems [8], [9] because it has the following characteristics: an immutable ledger where data cannot be changed, a decentralised consensus that allows for independence from one party, and real-time auditability that allows every transaction to be traced. In order to adopt blockchain technology that is appropriate to the recipient's conditions, the Technology-Organisation-Environment-Human (TOEH) innovation adoption framework is used. [10], [11], [12], [13], which is a development of the Technology-Organisation-Environment (TOE) framework. The TOEH framework discusses the readiness of grassroots stakeholders with limited digital literacy, such as school children and frontline school personnel, who interact directly with the system daily. Current studies of blockchain technology adoption often stop at identifying factors that influence adoption intentions, without translating these factors into blockchain architecture. This study addresses this gap by developing a new framework called the TOEHBCHAIN framework, which is a readiness-based blockchain technology adoption framework that explicitly includes user groups with low literacy levels, so that the implementation of blockchain technology can be more practical, safe, and truly support public food welfare programs.

2. METHODS

The method used is Research and Development (R&D) using a mixed-method approach [14], [15], [16], namely involving quantitative data (surveys) and qualitative data (in-depth interviews) with research stages as seen in Table 1, and using a list of questions that refer to the TOEH framework as seen in Table 2.

Table 1: *The Research Stages.*

No	Stages	Activities
1	Preliminary research	Interviews to identify research field issues with some sources from: 1. Education Office, 2. Health Office, 3. Schools, 4. Food Vendors (SPPG).
2	Quantitative Data Collection	Questionnaires were distributed to MBG recipients using the TOEH+ framework, consisting of: 1. 323 MBG program recipients, consisting of students in grades VII, VIII, IX, X, XI, and XII from several schools located in Batang Regency, Pekalongan City, Pekalongan Regency, and Pemalang Regency, 2. 23 MBG program recipient schools located in Batang Regency, Pekalongan City, Pekalongan Regency, and Pemalang Regency, ranging from junior high school (SMP) to senior high school (SMA/SMK) levels, both private and public schools.
3	Data analysis	1. Validity and reliability testing of survey data (SPSS), 2. Thematic analysis of interview data.
4	Design Planning	Combining the TOEH framework (having four dimensions, namely: Technology Dimension, Organisational Dimension, Environmental Dimension, and Human Dimension) with Blockchain technology (having four layers, namely: Smart Contract, Data Layer, Application Layer, Integration Layer)
5	Results Validation	To strengthen the research results, validation was carried out using the triangulation method [17], [18] to obtain valid data, namely: 1. Conducting Focus Group Discussions (FGDs) involving MBG program stakeholders, 2. Conducting interviews with experts in the field of blockchain technology implementation, 3. Strengthening the results with existing research findings.

Table 2: *The List of Questions in the Questionnaire.*

Aspect	Code	Question	
		Student	**School**
Technology (TE)	TE1	I have adequate digital devices to access a technology-based system.	The school has adequate equipment to support the implementation of the MBG program distribution and monitoring system.
	TE2	I am aware of the MBG program distribution system.	The school understands the MBG program distribution and monitoring system.
	TE3	Applying technology can help improve the efficiency of the MBG program distribution system.	The school believes that implementing technology can improve the efficiency of the MBG program distribution and monitoring system.
Organisation (OR)	OR1	Our school supports the MBG program distribution system	The school supports the implementation of the MBG program distribution and monitoring system.
	OR2	Our school already has the staff responsible for implementing the MBG program.	The school has appointed the staff responsible for implementing the distribution and monitoring of the MBG program.
	OR3	Our school already has procedures to regulate the MBG program distribution system.	The school already has SOPs to regulate the distribution system and monitoring of the MBG program. program.
Environment (EN)	EN1	Our environment supports the implementation of technology for the MBG program distribution system.	The school environment supports the implementation of technology for the MBG program distribution and monitoring system.
Environment (EN)	EN2	The local government supports the implementation of technology for the MBG program distribution system.	The local government policies support the application of technology to the MBG program distribution and monitoring system.
	EN3	Our school has the infrastructure (internet network, electricity) to support the implementation of technology in the MBG program distribution system.	The school has infrastructure (internet network, electricity) that supports the application of technology in the distribution system and monitoring of the MBG program.
Human (HU)	HU1	I have basic competencies in using technology-based systems.	Schools have staff with basic competencies who can use the MBG program distribution and monitoring system.
	HU2	I am willing to learn to improve my skills in using technology-based systems.	The school is willing to hold training for all teachers and staff to improve their skills in utilising the technology-based MBG program distribution and monitoring system.
	HU3	I was involved as the beneficiary of the MBG program.	The school is actively involved in implementing the MBG program.
	HU4	I am ready to adapt if a technology-based MBG program distribution system is implemented.	Schools are ready to adapt if a technology-based MBG program distribution and monitoring system is implemented.

3. RESULTS

3.1 The Questionnaire Results

1. Student Respondents (n=323)

From the technology aspect, although most students feel they have adequate equipment (TE1: 80.5%), their understanding of distribution systems (TE2: 64.1%) and the benefits of technology (TE3: 67.5%) is still classified as moderate. From the organisational aspect, school institutional support is very high (OR1 and OR2 > 85%), but readiness in the form of SOPs still needs to be improved (OR3: 57.3%). The environmental aspect shows strong external support (above 70%), including from local government and school infrastructure. However, in the Human aspect, there was a contrast. Although most students are willing to learn and adapt (>90%), only 36.2% feel they have basic technology competence, indicating a need for initial training. All variables were declared valid and reliable with Cronbach's Alpha > 0.6.

Table 3: *The Results of Student Respondent Questionnaires.*

Aspect (TOEH)	**The Percentage of Agree, Strongly Agree**	**Validity and Reliability**
Technology (TE)	- TE1: 80,5% - TE2: 64,1% - TE3: 67,5%	- The significant TE1, TE2, and TE3 values are 0.00 < 0.05, which are considered valid. - The Cronbach's Alpha value for the TE variable is 0.69 > 0.6, so it is considered reliable.
Organisation (OR)	- OR1: 85,1% - OR2: 87,7% - OR3: 57,3%	- The significant values of OR1, OR2, and OR3 are 0.00 < 0.05, so they are considered valid. - The Cronbach's Alpha value for the OR variable is 0.726 > 0.6, so it is considered reliable.
Environment (EN)	- EN1: : 72,8% - EN2: 81,1% - EN3: 83,9%	- The significant values of EN1, EN2, and EN3 is 0.00 < 0.05, which is considered valid. - The Cronbach's Alpha value for the EN variable is 0.739 > 0.6, so it is considered reliable.
Human (HU)	- HU1: 36,2% - HU2: 66,3% - HU3: 92,3% - HU4: 97,2%	- The significant HU1, HU2, HU3, and HU4 values are 0.00 < 0.05, so they are considered valid. - The Cronbach's Alpha value for the HU variable is 0.600 > 0.6, so it is considered reliable.

2. School Respondents (n=23)

In the Technology aspect, the level of agreement in the questionnaire options is 56.5%–65.2%, which shows that schools are starting to understand and accept the application of technology. The organisational aspect received a fantastic response: all schools supported the MBG distribution system (OR1: 100%), and almost all had staff and implementation procedures for MBG. In the Environment aspect, support from infrastructure and policies is very high (> 95%). Meanwhile, in the Human aspect, the majority of schools feel that they already have competent staff (HU1: 73.9%) and are ready to adapt and conduct training (> 87%). All items in each variable show high validity and reliability.

Table 4: *The School Respondent Questionnaire Results.*

Aspect (TOEH)	**The Percentage of Agree, Strongly Agree**	**Validity and Reliability**
Technology (TE)	- TE1: 65,2% - TE2: 60,8% - TE3: 56,5%	- TE1, TE2, and TE3 are declared valid because the Sign value is 0.000 < 0.05 - The Cronbach's Alpha value for the TE variable is 0.715 > 0.6, so it is considered reliable.
Organisation (OR)	- OR1: 100% - OR2: 85,7% - OR3: 87%	- The significant value of QR1, QR2, and QR3 is 0.000 < 0.05, so it is stated as valid. - The Cronbach's Alpha value for the RQ variable is 0.823 > 0.6, so it is declared reliable.

Aspect (TOEH)	The Percentage of Agree, Strongly Agree	Validity and Reliability
Environment (EN)	- EN11: 95,6% - EN2: 100% - EN3: 95,5%	- EN1, EN2, and EN3 are stated as valid because the sign value is $0.000 < 0.05$ - The Cronbach's Alpha value for the EN variable is $0.869 > 0.6$, so it is considered reliable.
Human (HU)	- HU1: 73,9% - HU2: 91,3% - HU3: 95,7% - HU4: 87%	- HU1, HU2, HU3, HU4 are stated as valid because the sign value is $0.000 < 0.05$ - The Cronbach's Alpha value for the EN variable is $0.821 > 0.6$, so it is considered reliable.

3.2 The Interview Results

Table 5: *The Interview Results.*

Aspect (TOEH)	Problem Identification	Needs Identification
Technology (TE)	- Reporting and monitoring do not have an integrated system yet; they are still using direct communication with the WhatsApp application. - The distribution of MBG to schools is sometimes late - It was found that the MBG received by the students was in a stale condition.	- Build the automatic reporting features, - Set a distribution time limit (so that the food does not go stale), - The system has an MBG tracking feature (distribution process and student response to the condition of the MBG that they received)
	- All stakeholders have SOPs to support the implementation of the MBG program distribution and monitoring system. - All of the stakeholders support the existence of a technology-based MBG program distribution and monitoring system, - Student data has not yet been integrated with Dapodik - data.	The system has role-based access control (RBAC) for security and to restrict access to the system.
Environment (EN)	The infrastructure conditions of stakeholders vary in specifications; some have low specifications, and some have high specifications.	- Lightweight and resource-saving web technology, - The system has an offline mode feature.
Human (HU)	The capabilities of the staff appointed by the stakeholders in utilising technology-based systems are not the same.	- The Simple and responsive system dashboard design, - There is a wizard (step-by-step) for beginners, - Use the simple language in system displays, - Complete the system with video tutorials & FAQ, - Training is held for staff who use the system.

From a technological perspective, the current distribution system is not digitised yet and still relies on WhatsApp; there have been complaints about spoiled food and delays in the distribution. Therefore, an integrated system with automatic reporting, distribution tracking, and service deadlines is needed. In terms of organisation, all stakeholders already have SOPs and support digital transformation, but student data integration with Dapodik is not available yet. The Environment aspect highlights the differences in infrastructure between schools; therefore, the system must be lightweight, resource-efficient, and support offline mode. Finally, from the Human per-

spective, the disparity in technological capabilities among staff indicates the need for an easy-to-use system, accompanied by training, wizards, and visual aids.

3.3 The Readiness Level for Adoption of the MBG Distribution and Monitoring System

Based on the data in tables 3, 4, and 5, it shows the readiness of stakeholders to adopt the MBG Distribution and Monitoring System based on Blockchain Technology, as summarised in table 6 below:

Table 6: *The Stakeholder Readiness Summary.*

TOEH Components	The Readiness Aspects (Based on Data)	The Blockchain Implementation
Technology (TE)	Students and schools have devices, but not all of them understand the MBG system (TE2 & TE3 low)	Immutable Ledger & Smart Contract
Organisation (OR)	Institutional support is high, but SOPs and data integration are incomplete (OR3 & Dapodik)	Role-Based Access Control (RBAC)
Environment (EN)	Infrastructure support is relatively high, but there is variation in quality.	Offline Mode, Lightweight System
Human (HU)	Low initial competency, but high willingness to learn and adapt (HU1 low, HU4 high)	Inclusive and educative UI/UX

4. DISCUSSION

4.1 Four-Layer-Based Architecture

Table 7: *Blockchain Architecture.*

Layer	Main Components	Function
Smart Contract Layer	- Distribution and reporting rules - Validate distribution deadline	Ensures the transparency and automation of distribution logic and time-based report audits.
Data Layer	- Immutable Ledger (Blockchain) - Local Cache (PWA)	Store all distribution and reporting transaction data securely and unalterably.
Application Layer	- Web-based UI dashboard - Wizard onboarding - Simple language - Lightweight System	An inclusive, lightweight, and easy-to-understand user interface for students, schools, and agencies.
Integration Layer	- API to Dapodik - WhatsApp Gateway - Automatic notification	Connecting the system with external databases and popular communication systems (WhatsApp).

Smart contracts will arrange distribution and reporting logic, including deadlines. The dashboard UI should be intuitive, Indonesian-language, and equipped with wizards, video tutorials, and automated reporting. For connection limitations, a Progressive Web App (PWA)-based system will store data locally and synchronise when online. The Role-Based Access mechanism will separate access rights based on stakeholders (schools, vendors, agencies, students). Finally, Integration connects the system to Dapodik and WhatsApp Gateway for efficiency and user familiarity.

4.2 The Design of Role-Based Access Control (RBAC)

The MBG program distribution and monitoring system implements RBAC to manage system user access rights to make it more efficient, secure, and structured, as shown in Table 8.

Table 8: *Role-Based Access Control.*

Role Stakeholder	The Primary Access Rights
Student	Input the food receipts (good/stale), access notifications, and distribution history.
School	Input student data, confirm acceptance, and access the distribution dashboard and reports.
Food Vendor	Input distribution schedule & status, real-time updates via dashboard.
Education Office	Distribution tracking, report analysis, vendor & school monitoring.
Health Office	Food quality monitoring, monitoring of stale food cases, and reporting audits.

4.3 The System Design Based on TOEH

Table 9 shows that the blockchain system design has been adjusted to the needs of each aspect of TOEH, as seen in Table 9.

Table 9: *The System Design Based on the TOEH Framework.*

TOEH Aspects	Design Implications of Blockchain Technology
Technology	Lightweight web-based system (PWA), automatic reporting, and real-time tracking features.
Organisation	SOPs are integrated and stored in the system, dashboard for management, and role-based access (RBAC).
Environment	Offline mode support, efficient network and device Integration, and compatibility with government systems.
Human	Simple UI, guide wizard, tutorial and training materials, communicative Indonesian text.

4.4 The Readiness Level for Adoption of the MBG Distribution and Monitoring System

Figure 1 illustrates the TOEH dimensions and the 4-layer blockchain integration into a holistic framework called TOEHBCHAIN. Each blockchain layer (Application, Smart Contract, Integration, and Data Layer) is adjusted to the Technology, Organisation, Environment, and Human aspects to achieve adaptive, safe, efficient, and inclusive implementation results, as explained in Table 10.

Table 10: *The Advantages of the TOEHBCHAIN Framework.*

Aspect	TOEH Framework	Blockchain	Synergy
Adaptability	Assessing user readiness	Modular system design	The system is made according to the user capacity
Security	Roles & access per stakeholder	Immutable ledger	Rules-based data validation and transparency
Efficiency	SOP and infrastructure mapped	Smart contract automation	Reduction of duplication & process delays
Inclusivity	User capability analysis	Wizard-based UI/UX	Low digital literacy support

Compared with previous studies, this research extends TOE-based blockchain adoption frameworks by explicitly including the Human readiness dimension. Unlike Chittipaka et al. (2023), which focused on supply chains, TOEHBCHAIN integrates low-literacy user needs with technical design choices such as RBAC and PWA. Furthermore, while Clohessy et al. (2019) highlighted organisational readiness as crucial, our framework operationalises this readiness into system architecture. In technical terms, TOEHBCHAIN specifies blockchain components beyond the conceptual level: the network is designed as a consortium blockchain with permissioned nodes, leveraging Practical Byzantine Fault Tolerance (PBFT) consensus for efficiency. Security is reinforced through RBAC, on-chain storage of distribution logs, and off-chain storage of large media files for efficiency. A proof-of-concept Progressive Web App (PWA) has been developed, demonstrating offline data caching, WhatsApp-based notifications, and student feedback submission.

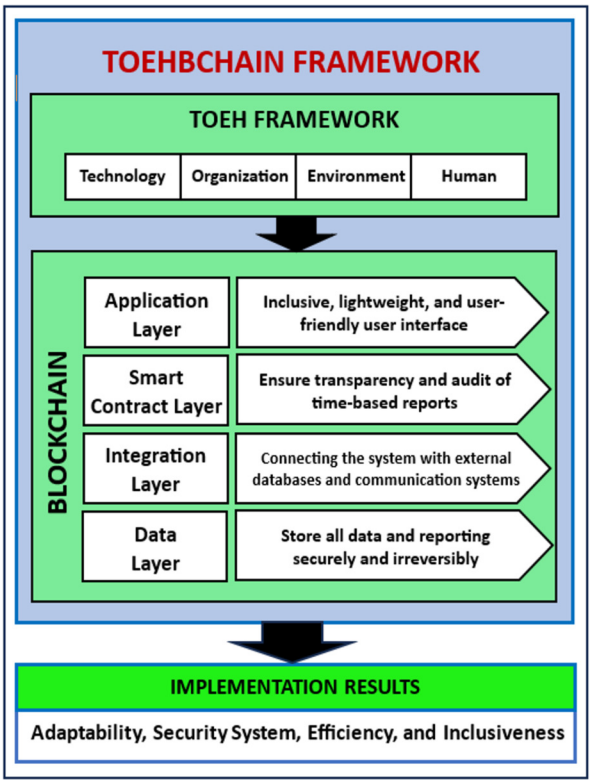

Fig.1: *TOEHBCHAIN Framework.*

Table 10 shows the synergy between the TOEH framework and blockchain technology through adaptability capabilities that consider user readiness and modular systems, a good level of security with RBAC and an immutable ledger, good efficiency due to SOPs and smart contracts, and a high level of inclusivity due to user education.

4.5 The TOEHBCHAIN Framework Validation

The validation results found that, according to MBG stakeholders, the TOEHBCHAIN framework is appropriate for technical and non-technical needs. According to blockchain practitioners, it also states that the TOEHBCHAIN framework is technically and applicably strong. The two statements above are also reinforced by previous research results, which support increased effectiveness when using a hybrid approach between the innovation adoption framework

and blockchain technology. Details of the validation results are in Table 11.

Table 11: *The Validation of the TOEHBCHAIN Framework.*

Validator	Validation Results
MBG Program Stakeholders	The TOEHBCHAIN framework has been designed to be comprehensive and relevant to stakeholder needs. The following are the results of discussions with stakeholders that match the results in each dimension: 1. The suitability of the needs in the technology dimension is good because this framework already provides automatic reporting, smart contracts, and a real-time tracking system that directly addresses the needs of digital distribution, validation, and auditing. 2. Suitability with the needs in the organisational dimension is good, because the RBAC design and Integration of government systems (Dapodik) show that this framework was built to meet organisational needs. 3. The suitability to the needs in the environmental dimension is good, because using lightweight technology (PWA) and offline mode support is very suitable for conditions where digital infrastructure is not evenly distributed. 4. The suitability to the needs in the human dimension is high, because it applies an educational approach and inclusive design to answer the challenge of low digital literacy.
Blockchain Practitioner	The TOEHBCHAIN framework is highly relevant and meets the needs of MBG program stakeholders both technically and organizationally, with its strengths lying in: 1. Integration of reporting and distribution logic in smart contracts, 2. Inclusive UI/UX for users with low digital literacy, 3. Offline mode capability and a lightweight system, 4. Flexible RBAC for various stakeholder roles.
Literature	The research results state that combining the innovation adoption framework with blockchain technology increases the success rate of blockchain technology implementation. 1. Blockchain adoption frameworks facilitate the successful implementation of blockchain technology [19]. 2. A blockchain technology adoption framework can significantly improve company performance, increasing stakeholder transparency, trust, and security [20]. 3. Top management support, organisational readiness, and buy-in play a significant role in successfully adopting blockchain technology [21]. 4. Recipient suitability evaluation is crucial for successfully adapting blockchain technology [22].

The results of this study align with and expand on the results of previous research on the adoption of blockchain technology, such as:

1. Technological readiness, management support, and expected performance are the main determinants of blockchain adoption in the SME sector. However, the TOEHBCHAIN framework expands on this by including the human readiness dimension, which has not been widely explored in previous studies. [19].
2. Applying the TOE framework for supply chains in developing countries supports the success rate of blockchain implementation. However, the TOEHBCHAIN framework builds further by adding a Human dimension and developing a technical approach based on the needs of each stakeholder, more specifically through the RBAC approach and educative UI design [20].
3. The importance of top management support and organisational readiness for blockchain adoption, but it does not propose a technical framework or system architecture, and the TOEHBCHAIN framework bridges this gap by presenting a concrete and integrated four-layer system design [21].

Recipient suitability evaluation is a crucial stage in blockchain adoption, and this study operationalises this idea through surveys and in-depth interviews with stakeholders from various levels (students, schools, government, vendors), making it an intense context-based study [22].

4.6 The Limitations of the TOEHBCHAIN Framework

Although the TOEHBCHAIN framework has demonstrated high effectiveness in the context of the Makan Bergizi Gratis (MBG) Program, several limitations appear when the framework is applied outside the domain of public food distribution:

1. Social and Regulatory Context Dependency: MBG has a similar reporting and stakeholder structure. This framework may be less flexible when applied to contexts with complex organisational structures or multiple independent stake-

holders (e.g., private logistics sector, cross-border agriculture).
2. The Minimum Digital Readiness Assumption: TOEHBCHAIN is designed for environments with minimum technology readiness (relying on PWA, offline mode, etc.). In sectors or countries with high infrastructure, this approach can be too conservative and not optimise the full potential of blockchain technology.

5. CONCLUSIONS

While centralised systems may be simpler and cheaper, they are prone to data manipulation and limited accountability issues. Through immutability and distributed consensus, blockchain ensures that all transactions are transparent and auditable. This feature is particularly critical in food distribution, where accountability lapses can directly affect public health. Therefore, blockchain provides added value beyond efficiency by embedding trust and resilience into the system.

The TOEHBCHAIN framework developed in this study successfully answered the distribution and reporting challenges of the Makan Bergizi Gratis (MBG) Program. The Integration between stakeholder readiness (TOEH) and blockchain technology capabilities (4-layer) has resulted in a system that:
1. Transparent: through smart contracts and an immutable ledger.
2. Adaptive and Inclusive: through a light and educational UI.
3. Efficient: through automation of reporting and distribution processes.
4. Secure: with RBAC implementation that is appropriate to stakeholder roles.

The questionnaire and interview results indicate that all stakeholders have strong motivation and support, despite digital literacy and infrastructure challenges. The TOEHBCHAIN framework not only answers current needs but can also be replicated for other public distribution systems that require transparency and multi-stakeholder participation.

Future research should explore the scalability and adaptability of the TOEHBCHAIN framework in other public service contexts, such as subsidy distribution, healthcare logistics, or disaster relief management. Given that this study is bounded within the Indonesian MBG program, further validation is needed in different socio-economic and regulatory environments to test the framework's robustness and generalizability. Researchers may also investigate integrating emerging technologies, such as AI or IoT, to complement blockchain in real-time quality control and predictive analytics. Additionally, longitudinal studies assessing the long-term impacts of blockchain adoption on transparency, accountability, and stakeholder engagement in public distribution systems are highly recommended

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AUTHOR CONTRIBUTIONS

Conceptualisation, Eko Budi Susanto and Paminto Agung Christianto; methodology, Eko Budi Susanto and Paminto Agung Christianto; software, Bambang Ismanto; validation, Eko Budi Susanto, Paminto Agung Christianto and Bambang Ismanto; formal analysis, Eko Budi Susanto, Paminto Agung Christianto and Riski Sulistyaningsih; investigation, Eko Budi Susanto and Paminto Agung Christianto; data curation, Bambang Ismanto and Riski Sulistyaningsih; writing—original draft preparation, Paminto Agung Christianto; writing—review and editing, Eko Budi Susanto, Paminto Agung Christianto and Riski Sulistyaningsih; visualisation, Eko Budi Susanto and Bambang Ismanto; supervision, Paminto Agung Christianto; funding acquisition, Eko Budi Susanto. All authors have read and agreed to the published version of the manuscript.

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