Blockchain Governance Framework and Assessment Tools from a Readiness Perspective

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Abstract—**Blockchain has been used in various sectors and use cases, but inadequate blockchain governance can cause failure in blockchain adoption. Previous research on blockchain governance has not been carried out with multiple perspectives and has not yet reached the point of developing governance assessment tools. This research aims to identify the factors that comprise blockchain governance, as well as identifying functional requirements of blockchain governance assessment tools. The methodology used in this research is literature review using PRISMA, thematic analysis, expert validation with fuzzy Delphi method. This research resulted in 25 factors and enhanced the STOPE framework by adding a collaboration dimension to develop a blockchain governance framework and 5 functional requirements for blockchain governance assessment tools. The 25 factors consist of 3 factors in strategy, 3 factors in technology, 4 factors in organization, 1 factor in the people, 4 factors in the environment, and 10 factors in the collaboration. This research identifies the factors that comprise blockchain governance and the functional requirements of blockchain governance assessment tools and provides a readiness-based blockchain governance initial framework, and functional requirements of blockchain governance assessment tools. This research also provides guidance for researchers, regulators, and practitioners in blockchain governance implementation and assessment.**

Keywords—Blockchain governance; blockchain governance framework; blockchain readiness; fuzzy Delphi method; governance assessment tools; STOPE framework

I. Introduction

Blockchain is an emerging technology that allows digital transactions without the role of intermediaries [1]. Blockchains that adopt the distributed ledger principle are, in certain cases, used because of their security or cryptographic features [2],[3] and privacy support [4]. However, there is quite a lot of research regarding the use of blockchain for cryptocurrency [5], conceptualizes blockchain as a trusted infrastructure to enhance community participation and strengthen local economies through cryptocurrencies [6], and analyzes the psychological factors influencing individuals' intention to hold or own Bitcoin [7].

Now the use of blockchain is increasingly widespread in various sectors and use cases. This use takes into account various blockchain characteristics, not only hashing or cryptography, but also immutability, decentralization, and transparency [8]. Blockchain is used in various use cases or sectors [13], such as non-fungible tokens (NFT) [9], access to Artificial Intelligence (AI) models [10], supply chain management [11], asset management [12], trading and privacy [13].

However, the current increase in the use of blockchain has not been matched by comprehensive research on its governance aspects [14],[15],[16],[17],[18]. Poor or inadequate governance in blockchain adoption or utilization is a factor that can cause blockchain adoption or utilization to fail [14]. Research on blockchain governance has been widely carried out using various perspectives. Research conducted by Tan, Mahula, & Crompvoets [14] proposes a blockchain governance conceptual framework in the context of the public sector, where blockchain governance should be understood as a socio-technical system rather than merely a technological implementation. Research by Laatikainen, Li, & Abrahamsson [15] conceptualize blockchain governance from a system perspective, in which blockchain is considered a dynamic and interconnected system, requiring holistic rather than partial analysis. Research by Beck, Müller-Bloch, & King [16] develops a foundational framework for governance in the blockchain economy and identifies two forms of governance, namely on-chain governance and off-chain governance. Research by Liu et al. [17] focuses on formulating principles of blockchain governance. Meanwhile, research by Koning & van der Linden [18] compares decentralized governance with corporate governance. However, the studies are still limited to the concept of governance, and the resulting framework is not equipped with properties for implementing governance based on the framework that has been researched [14],[15],[16],[17],[18]. Apart from that the framework built does not emphasize the readiness aspect or feasibility analysis stage [14],[15],[16],[17],[18], which is an important stage in developing a blockchain-based system [19].

Research on blockchain governance framework has been also carried out using various perspectives. Research conducted by Tan et al. [14] proposes a blockchain framework from the public management perspective. Research by Laatikainen et al. [15] develops blockchain governance model from a system-based perspective, which can serve as a reference framework for developing a blockchain system governance framework. Research by Beck et al. [16] develops blockchain governance from a corporate governance perspective. These studies have produced frameworks from different perspectives, but are less comprehensive, and have not been equipped with assessment properties or assessment tools for implementing governance following with the proposed framework [14],[15],[16].

The blockchain governance framework has been the focus of several studies, using various perspectives or theories. Research by Pereira et al. [20] develops blockchain governance from the perspective of platform governance. Meanwhile, research by Laatikainen et al. [15] develops blockchain governance with a focus on an Information Technology governance perspective. Research by Beck et al. [16] develops blockchain governance from the perspective of Information Technology governance and corporate governance. Some studies view blockchain governance from other perspectives, such as game theory [45] and public management [14].

Based on the conditions described above, this research proposes an initial readiness-based multi-perspective and collaborative blockchain governance framework, which is equipped with the functional requirements of its assessment tools. This research aims to provide an initial blockchain governance framework and functional requirements for assessment tools. This research aims to provide guidance in readiness-based, multi-perspective, and collaborative blockchain governance so that it can prevent failure in blockchain adoption in various sectors or use cases. The research questions to be answered in this research are (1) What factors comprise blockchain governance framework? (2) What are the functional requirements of blockchain governance assessment tools?

This research contributes to developing a readiness-based, collaborative, and multi-perspective blockchain governance initial framework, equipped with the functional requirements of assessment tools, based on the initial framework developed. This research also enhances the STOPE framework [21],[22] with a collaboration dimension based on the characteristics [8] of blockchain technology which requires collaboration in its implementation.

This paper is organized as follows. Section II elaborates related work; Section III explains the research methodology; Section IV presents the research results and discussion; Section V closes the research with the conclusion and limitation of the study.

II. Related Work

A. Blockchain Governance Framework

The blockchain governance framework has been the focus of several studies, using various perspectives or theories. Research by Pereira et al. [20] develops blockchain governance from the perspective of platform governance. Meanwhile, research by Laatikainen et al. [15] develops blockchain governance with a focus on an Information Technology governance perspective. Research by Beck et al. [16] develops blockchain governance from the perspective of Information Technology governance and corporate governance. Some studies view blockchain governance from other perspectives, such as game theory [23] and public management [14]. A summary of literature review that represents these perspectives, key factors, strengths, limitations, and research gaps can be seen in Table I.

As summarized in Table I, existing blockchain governance remain fragmented, with each approach focusing on specific dimensions such as technology, incentives, or organizational control [14],[15],[16],[20],[23]. No prior studies have developed a fully integrated framework that simultaneously and systematically address strategic, technological, organizational, people, and environmental aspects [14],[15],[16],[20],[23]. This fragmentation indicates a significant research gap in the development of a comprehensive governance model capable of capturing the complexity of blockchain ecosystems. Therefore, this study proposes an enhanced STOPE-based framework to bridge this critical gap by providing a holistic and structured approach to blockchain governance.

TABLE I. Summarize of Literature Review on Blockchain Governance Framework

Perspective	Key Focus	Strengths	Limitations	Gap
Platform governance [20]	Coordination mechanisms	Explaining ecosystem coordination and roles	Coverage of factors.	Limited coverage of organizational and environmental factors.
IT governance [15],[16]	Alignment between IT structures and blockchain systems.	Relationship with organizational IT governance practices	Decentralization dynamics and external environment	Does not address multi-dimensional governance complexity
Corporate governance [16]	Accountability, control, and decision rights	Integrates managerial and control aspects	Technological adaptability and stakeholder dynamics	Partial integration; lacks environmental & people dimensions
Game theory [23]	Incentives (game theory)	Insights into specific governance aspects (incentives)	Fragmented	Not integrated governance aspects
Public management [14]	Regulation and public policy	Insights into specific governance aspects (regulation)	Highly domain-specific.	Not integrated governance aspects

B. Stope Framework and Collaboration

STOPE integrates the dimensions of strategy, technology, organization, people, and environment. The STOPE framework is a framework that is commonly used to measure readiness, for example, user readiness in implementing certain services or technologies [22]. The STOPE framework in the governance area can also be used as a view in assessments, such as in research to measure IT governance [21]. Using grades for factors evaluation will measure the readiness level for each factor. Table II describes the evaluation grade that can be used in readiness assessment [21],[22]. Evaluation of factors in STOPE is carried out individually and collectively [21],[22].

TABLE II. Evaluation Grades for Factors Evaluation

Scale	Evaluation Grade [21],[22]
1	Poor/low
2	Below average
3	Average
4	Above average
5	Good/high

In this research, the STOPE perspective is used by adding the collaboration dimension [8] to group factors identified by thematic analysis [24]. The addition of this dimension is related to the characteristics of blockchain which can be viewed not only from an Information Technology perspective but also from socio-technical aspects which include collaboration aspects [8]. A description of each dimension used in this research, in the context of its influence on blockchain governance, can be seen in Table III.

TABLE III. DEFINITION OF STOPE AND COLLABORATION DIMENSION

Dimension	Description and Representative Literature
Strategy	How the strategy aspect affects blockchain governance [25],[26],[27]
Technology	How the technology aspect affects blockchain governance [25],[27],[28]
Organization	How the organization aspect affects blockchain governance [25],[26],[27],[28]
People	How the people or personal aspect affects blockchain governance [29],[30]
Environment	How the environment aspect affects blockchain governance [25],[26],[28],[31]
Collaboration	How the collaboration aspect affects blockchain governance [25],[26],[27],[28],[30],[32]

The governance theory perspective [16],[18],[32] emphasizes that effective governance in multi-stakeholder environments relies on interaction processes, including joint decision-making, collective problem-solving, and consensus-building mechanisms. These processes cannot be fully represented within the existing STOPE [21],[22] dimensions, as they extend beyond individual domains and more accurately reflect the relational nature of governance through collaboration. Grouping collaboration-related factors within domains such as “people” or “organization” risks reducing collaboration to a localized attribute, thereby overlooking its systemic significance.

In the context of blockchain governance, the importance of collaboration is further reinforced by the absence or minimal presence of centralized control and the existence of trustless interactions. Mechanisms within blockchain systems, such as consensus protocols, decentralized decision-making, and community-based governance, inherently depend on collaborative processes [16],[18],[32]. Collaboration is therefore not merely a supporting factor, but a fundamental governance mechanism underpinning the functioning of the entire ecosystem [16],[18],[32].

Modeling collaboration as an enhancing dimension in this study explicitly captures the cross-cutting and integrative nature of stakeholder interactions, coordination processes, and interdependencies across STOPE [21],[22] dimensions. Enhancing the STOPE framework [21],[22] by introducing the collaboration dimension enables a more comprehensive and structurally coherent representation of blockchain governance, thereby enhancing the analytical depth and practical relevance of the proposed framework, particularly in evaluating multi-stakeholder governance systems.

C. Fuzzy Delphi Method

The Fuzzy Delphi method is a refinement of the Delphi method combined with fuzzy [33],[34]. The Fuzzy Delphi method reduces the possibility of ambiguity by consensus and reduces data retrieval time when compared to the Delphi method [33],[34]. The Fuzzy Delphi method can be used for forecasting, validation, and evaluation [33],[34].

D. Governance Assessment Tools

Governance assessment tools are usually used for environmental governance e.g. flood risk maps [35] and infrastructure [40], water governance [36], protected area [37],[38],[41], waste reduction [39], water, energy, and food [42]. One of the widely adopted instruments is the Governance Assessment Tool (GAT), which evaluates governance quality based on four key parameters: extent, coherence, flexibility, and intensity [40],[41],[42],[43]. Meanwhile, the components assessed, as can be seen in Table IV, include responsibilities and resources, actors and networks, strategies and instruments, levels and scales, problem perspectives and goal ambitions [35],[36],[37],[38],[39],[40],[41],[42]. This component can be considered in governance assessments in other areas or sectors.

TABLE IV. COMPONENT OF GOVERNANCE ASSESSMENT TOOLS

Component	Representative Literature
Responsibilities and resources	[35],[36],[37],[38],[39],[40],[41],[42]
Actors and networks	
Strategies and instruments	
Levels and scales	
Problem perspectives and goal ambitions	

III. METHODOLOGY

This section will discuss the materials and methods used in this research. This research employed mixed methods. This research has used the following methods: literature review, component and functional requirements analysis, thematic analysis [24], expert review with fuzzy Delphi questionnaire, and fuzzy Delphi analysis [33],[34].

A. Literature Review

The systematic literature review in this research was carried out in two stages, and both were carried out using the PRISMA method [44]. The steps for a systematic literature review in this research using the PRISMA method [44] include searching the database with defined criteria, determining inclusion criteria, study selection, and data synthesis. The first stage of the systematic literature review was carried out to identify previous research regarding governance assessment tools in general. The second stage of the systematic literature review was carried out to identify factors that influence blockchain governance. Apart from that, a literature review was also carried out to look for indicators of factors that influence blockchain governance.

1) Search strategy: In the first stage of the systematic literature review, the search was carried out on the Scopus database for journal articles published in all years. The terms or keywords used in the search are “blockchain governance”. The results of the systematic literature review in the first stage are influencing factors of blockchain governance.

The first stage of the systematic literature review was conducted using the Scopus database due to its extensive multidisciplinary coverage and rigorous indexing of peer-reviewed scholarly publications. Scopus is widely recognized as one of the largest curated abstract and citation databases, encompassing high-quality journals in information systems, computer science, governance, blockchain, and related socio-technical domains that are central to this study. Although other databases such as Web of Science, IEEE Xplore, and ACM Digital Library also contain relevant publications, Scopus was selected as the primary data source in the initial stage of the systematic literature review (SLR) due to its broad coverage and significant overlap with these databases, thereby ensuring adequate representation of high-quality literature. This approach is consistent with systematic review studies that rely on a single comprehensive database to maintain consistency and reduce duplication.

The search in the second stage of the systematic literature review was conducted across eight databases—Scopus, ScienceDirect, ACM Digital Library, Emerald Insight, ProQuest, IEEE Xplore, SpringerLink, Sage Journals, and Taylor & Francis—targeting journal articles published between 2019 and 2023. The terms or keywords used in the search are "governance assessment" AND "tool". The results of the systematic literature review in the second stage used in this research are the components and functionality requirements of governance assessment tools.

2) Eligibility criteria: In the first stage of the systematic literature review, the author established three inclusion criteria where the literature must be available in full text and written in English (IC4), must report research findings published in reputable journals (IC5), and must focus on and discuss governance assessment tools or blockchain governance assessment tools (IC6). In the second stage of the systematic literature review, the author applied three inclusion criteria, requiring that the literature be available in full text and written in English (IC1), report research findings published in reputable journals (IC2), and focus on the topic of blockchain governance (IC3). There is a total of six inclusion criteria (IC) in the two stages of the systematic literature review.

3) Study selection: Study selection is carried out at both the first and second stages of the systematic literature review. Study selection in this research includes the following steps: searching based on a keyword or search string in each online database, checking and removing duplicate records, selecting the title and abstract of identified articles according to the eligibility criteria, and including the articles that meet the inclusion criteria for full-text review. The study selection process is the same between the first stage and the second stage of systematic literature review in this research.

4) Data items and synthesis: Data collection was carried out manually using a spreadsheet. The information extracted in the first stage of the systematic literature review consists of design and development methods, elements (of readiness) measure, type of governance measure, assessment concept, and main features or main functionality. The information extracted in the second stage of the systematic literature review consists of influencing factors of blockchain governance. Authors then synthesize the data based on the STOPE framework [21],[22].

B. Functional Requirement Identification and Validation

Functional requirements identification [19] was carried out in this research to identify the functionality of the assessment tools based on the results of the first stage of the systematic literature review. Apart from being based on the research results, functional analysis also considers existing tools used in governance assessment practices [43]. After that, the results of the functional requirements identification are then reviewed by experts to ensure functional suitability (completeness, correctness, appropriateness) [45] of the functional requirements of the assessment tools.

C. Thematic Analysis

Thematic analysis [24] was carried out in this research to identify factors that influence blockchain governance based on the results of the literature review in the second stage. The stages in the thematic analysis are familiarization with data, initial code generation, theme search, review of themes, naming, and defining themes. The grouping of the initial stages of thematic analysis in this document is carried out based on the STOPE framework [21],[22],[24].

D. Expert Review with Fuzzy Delphi Method

Expert reviews are carried out on functional analysis, factors, and indicators. The criteria for selecting experts are having experience in the field of governance or policy formulation for at least five years and having a basic understanding of blockchain and information system development. An expert review of factors influencing blockchain governance was carried out based on the Fuzzy Delphi Method [33],[34].

Questionnaires whose readability has been validated are then distributed to experts. Semi-structured interviews were conducted to validate data from questionnaires filled in by experts. The results are used in Fuzzy Delphi Method analysis [33],[34].

A total of five experts participated in the Fuzzy Delphi process. Despite the relatively small panel size, the experts were purposively selected based on their domain expertise and professional experience in blockchain and governance. Their organizational backgrounds include both government and non-government sectors, as summarized in Table V.

Although the panel consisted of five experts, prior studies have demonstrated that fuzzy Delphi method can yield reliable results with small but carefully selected expert groups, particularly in specialized domains where expertise is more critical than sample size [33],[34]. The experts were selected based on the following criteria: 1) relevant expertise in blockchain governance, 2) professional experience, and 3) demonstrated contributions, such as publications, projects, or leadership roles in related fields. This selection process ensured that all participating experts possessed sufficient domain knowledge to provide informed and credible judgments.

TABLE V. EXPERTS' PROFILES

Expert ID	Organization	Position	Experience
Expert 1	Government	IT Policy Analyst	>15 years
Expert 2	Non-government	IT Governance Specialist	>10 years
Expert 3	Government	IT Policy Analyst	>15 years
Expert 4	Non-government	Vice President of Technology	>5 years
Expert 5	Non-government	IT Governance Specialist	>25 years

In this research, the fuzzy Delphi method was used because this method can accommodate various opinions and uncertainties [33],[34]. The fuzzy Delphi method is suitable for research where the availability of appropriate information does not exist, or the information is difficult to obtain [33],[34]. This method can be used for forecasting and filtering [33],[34].

The Fuzzy Delphi Method is an expert consensus-based method with the important concept being the Triangular Fuzzy Number or TFN (n1, n2, n3) [33],[34]. Each TFN (n1, n2, n3) from the expert responses was averaged and produced values m1, m2, and m3 [33],[34]. Acceptable item requirements are a threshold (d) of 0.2 or less, an expert agreement of 75% or greater, and a defuzzification value of 0.5 or more [33],[34]. The conversion of Likert scores into fuzzy numbers and linguistic variables [33],[34] can be seen in Table VI. Table VI shows the Likert scale used is a 7-point Likert scale [33],[34].

TABLE VI. CONVERSION BETWEEN SEVEN-POINT LIKERT SCALE AND FUZZY NUMBER

Likert Scale	Linguistic Variable	Fuzzy Number		
		n1	*n2*	*n3*
1	Extremely Strongly Disagree	0.0	0.0	0.1
2	Strongly Disagree	0.0	0.1	0.3
3	Disagree	0.1	0.3	0.5
4	Unsure	0.3	0.5	0.7
5	Agree	0.5	0.7	0.9
6	Strongly Agree	0.7	0.9	1.0
7	Extremely Strongly Agree	0.9	1.0	1.0

The process of calculating d (threshold) is carried out using the following formula:

$$d(\underline{m}, \underline{n}) = \sqrt{\frac{1}{3}(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2} \quad (1)$$

Meanwhile, the defuzzification value calculation is carried out using the following formula:

$$A = \frac{1}{3} * (m1 + m2 + m3) \quad (2)$$

If the d value is 0.2 or less, and the A value is 0.5 or more, the item or factor is retained.

E. Framework and Assessment Tools Development and Validation

Based on the results of factor validation using the Fuzzy Delphi Method [33],[34], the results of identification and validation of indicators, analysis, and validation of functional requirements from assessment tools, then an initial blockchain governance framework and assessment tools were created. Next, expert validation is carried out on the proposed blockchain governance framework, to ensure the perceive ease of use, usefulness, extent, coherence and flexibility [35],[36],[37],[38],[39],[40],[41],[42],[46].

This study does not adopt the STOPE framework as a measurement model or rating scale; rather, it is employed as a structural framework to organize governance dimensions. The assessment is conducted using ISO/IEC-based criteria, thereby ensuring a standardized and rigorous evaluation. This integration enables a comprehensive alignment between multidimensional governance aspects and established evaluation standards.

IV. RESULTS AND DISCUSSION

This section will discuss the results of this research and its discussion. The findings and their implications are also discussed in this section. The limitations of this research are highlighted and recommendations for future research are given in this section.

A. Influencing Factors of Blockchain Governance

The first step in identifying factors that influence blockchain governance is to carry out a systematic literature review using the PRISMA method [44], on the Scopus database for journals published all year. The stages in the selection of previous studies consist of identification, screening, and inclusion [44]. Following the removal of duplicates and the screening of titles, abstracts, and keywords, the remaining articles were further selected according to the inclusion criteria, i.e. must be available in full text and written in English (IC4), must report research findings published in reputable journals (IC5), and must focus on and discuss governance assessment tools or blockchain governance assessment tools (IC6). Details of the article selection process can be seen in Fig. 1.

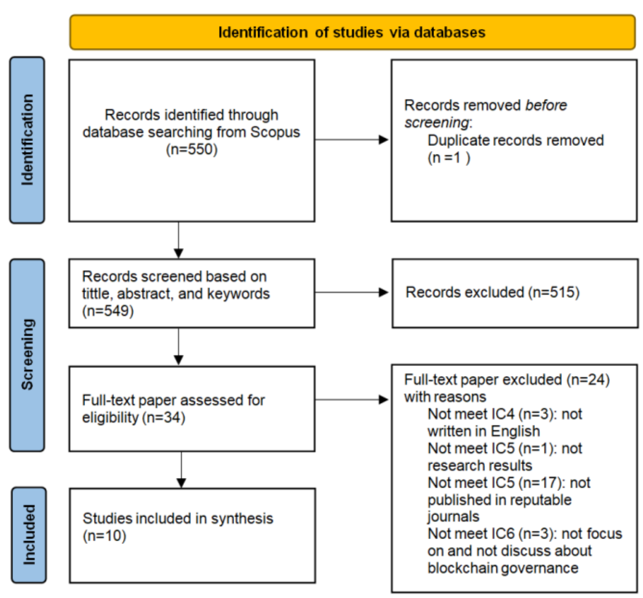

Fig. 1. Flow diagram for search results on the first stage of systematic literature review.

Fig.1 describes the search and filtering process for article selection. A total of 550 articles were obtained by entering the keyword "blockchain governance" in the Scopus database. After eliminating duplicates and filtering based on title, abstract, and keywords, 34 articles were obtained which were filtered based on eligibility criteria. Screening by eligibility criteria resulted in 10 articles being included for synthesis. Synthesis results from the 10 articles and analysis with thematic analysis [46] can be seen in Table VII for the strategy dimension, Table VIII for the technology dimension, Table IX for the organization dimension, Table X for the people dimension, Table XI for the environment dimension, and Table XII for the collaboration dimension.

Table VII describes the influencing factors in the strategy dimension. Five factors were identified within the strategy dimension, including incentives, centralized risk, flexibility of governance, allocation, and the enaction of decision rights [25],[26],[27],[50]. These five strategy factors can influence blockchain governance [25],[26],[27],[50].

TABLE VII. INFLUENCING FACTOR OF STRATEGY DIMENSION

Factor	Code	Representative Literature
Motivational factors (incentive)	S1	[25]
Nature of how decision rights are allocated and enacted	S2	[26]
Centralization risk	S3	[27]
Flexibility of governance	S4	[27],[50]
Misalignment of incentives	S5	[27]

Table VIII presents the influencing factors in the technology dimension. Within the technology dimension, three factors were identified, including formation and contextual elements of the blockchain, such as background information (e.g., licensing), resolve of conflict between competing version of ledger, and inter-proposal dependencies [25],[26],[28],[50]. These three technological factors have the potential to impact blockchain governance [25],[26],[28],[50].

TABLE VIII. INFLUENCING FACTOR OF TECHNOLOGY DIMENSION

Factor	Code	Representative Literature
Formation and context	T1	[25]
Conflicts resolving	T2	[28],[50]
Inter-proposal dependencies	T3	[26]

TABLE IX. INFLUENCING FACTOR OF ORGANIZATION DIMENSION

Factor	Code	Representative Literature
Roles, responsibility, accountability	O1	[25]
Security of DAO	O2	[28]
Problem at hand	O3	[26]
Corporate governance	O4	[25][28]

Table IX describes the influencing factors in the organization dimension. Four factors were identified within the organizational dimension, including roles, responsibilities, and accountability [25], security of DAO [28], and the specific problem at hand [26], such as demand management, data management, system architecture design and development, as well as corporate governance [25][27]. These four organization factors can influence blockchain governance [25],[26],[27],[28].

Table X describes the influencing factors in the people dimension. Two factors were identified within the people dimension, comprising dilemmas of sharing knowledge and sharing information resources, and vulnerability of the combination of private interests [29],[30]. These two people factors can influence blockchain governance [29],[30].

TABLE X. INFLUENCING FACTOR OF PEOPLE DIMENSION

Factor	Code	Representative Literature
Social dilemmas (sharing knowledge and information resources)	P1	[30]
Vulnerability of the combination of private interests	P2	[29]

Table XI describes the influencing factors in the environment dimension. Four factors were identified within the environmental dimension, including legal aspect, organizational theories, public or private sector role, and the nature of information exchanged [25],[26],[28],[31]. These four environmental factors can influence blockchain governance [25],[26],[28],[31].

TABLE XI. INFLUENCING FACTOR OF ENVIRONMENT DIMENSION

Factor	Code	Representative Literature
The nature of the information exchanged	E1	[28]
Legal compliance	E2	[31]
Organizational theories	E3	[26]
Role of public or private sector	E4	[25]

Table XII describes the influencing factors in the collaboration dimension. Eleven factors were identified within the collaboration dimension, including membership or way participation, membership management for available roles, and decision-making processes [25]. These eleven collaboration factors can influence blockchain governance [25],[28],[30],[32],[47],[50].

TABLE XII. INFLUENCING FACTOR OF COLLABORATION DIMENSION

Factor	Code	Representative Literature
Membership	C1	[25]
Communication	C2	[25],[50]
Decision making	C3	[25]
Coordination mechanism within a group of users	C4	[28]
Decision problem	C5	[26]
Consensus of stakeholders	C6	[27]
Respons in problem cases	C7	[27]
Exercise of voting rights	C8	[47]
Community governance	C9	[30]
Private property	C10	[30]
Democrate form of governance	C11	[32]

The factors that have been generated from the systematic literature review and thematic analysis are then analyzed based on the Fuzzy Delphi Method [33],[34]. The factor is retained if the threshold d = 0.2 or less, and the defuzzification value A = 0.5 or greater than that, and the expert's agreement is 75% or greater than that [33],[34]. The analysis results based on the Fuzzy Delphi Method [33],[34] can be seen in Table XIII for the strategy dimension, Table XIV for the technology dimension, Table XV for the organization dimension, Table XVI for the people dimension, Table XVII for the environment dimension, and Table XVIII for the collaboration dimension. In total, there were 29 factors proposed. Two factors of which were accepted although they did not meet the threshold criteria (d), due to the expert agreement exceeding 75%. Two factors of which were rejected because the threshold value (d) is greater than 0.2 and the percentage of expert agreement is less than 75%. A total of 27 factors were accepted.

Table XIII describes the calculation results using the fuzzy Delphi method for factors in the strategy dimension. There are five factors proposed in the strategy dimension. Two of these factors, specifically S3 (centralization risk) and S5 (misalignment of incentives), were retained despite their threshold values (d) exceeding 0.2, as expert consensus surpassed 75%.

As described in Table XIII, the accepted factors on strategy dimension in this research are in line with previous research conducted by Pelt et al. [25], Ziolkowski et al. [26], and Dursun et al. [27]. However, in contrast with research conducted by Dursun et al. [27], the centralization risk factor and misalignment of incentives in this research are rejected based on expert consensus in the fuzzy Delphi method. This rejection may be influenced by the work experience and organizational background of the expert involved in filling out the questionnaire in this research and may be due to the scope of the research conducted by Dursun et al. [27] is limited to on-chain governance, so there is a difference in risk.

TABLE XIII. RESULTS ON THE STRATEGY DIMENSION

Factor Code	Threshold value (d)	Percentage of Expert Agreement	Fuzzy Score (A)	Expert Consensus
S1	0.073	100%	0.927	Accept
S2	0.073	100%	0.927	Accept
S3	0.312	80%	0.760	Reject
S4	0.118	100%	0.873	Accept
S5	0.235	80%	0.673	Reject

TABLE XIV. RESULTS ON THE TECHNOLOGY DIMENSION

Factor Code	Threshold value (d)	Percentage of Expert Agreement	Fuzzy Score (A)	Expert Consensus
T1	0.168	100%	0.840	Accept
T2	0.168	100%	0.840	Accept
T3	0.188	100%	0.807	Accept

Table XIV describes the calculation results using the fuzzy Delphi method for factors in the technology dimension. There are three factors proposed in the technology dimension. These three factors are accepted based on expert consensus, with a threshold value (d) of less than 0.2 and a fuzzy score (A) of greater than 0.8. The accepted factors on the technology dimension in this research are in line with previous research conducted by Pelt et al. [25], Dursun et al. [27], and Maggiolino et al. [28].

Table XV describes the results of calculations using the fuzzy Delphi method for factors in the organizational dimension. There are four factors proposed in the organizational dimension. These four factors are accepted based on expert consensus, with a threshold value (d) of less than 0.2 and a fuzzy score (A) of greater than 0.8, where the minimum value of fuzzy score (A) for an item or factor to be accepted is 0.5. The accepted factors on organization dimension in this research are in line with previous research conducted by Pelt et al. [25], Ziolkowski et al. [26], Dursun et al. [27], and Maggiolino et al. [28].

TABLE XV. RESULTS ON THE ORGANIZATION DIMENSION

Factor Code	Threshold value (d)	Percentage of Expert Agreement	Fuzzy Score (A)	Expert Consensus
O1	0.132	100%	0.893	Accept
O2	0.188	100%	0.860	Accept
O3	0.132	100%	0.893	Accept
O4	0.132	100%	0.893	Accept

Table XVI describes the results of calculations using the fuzzy Delphi method for factors in the people dimension. There are two factors proposed in the people dimension. One factor, P1 (dilemmas of sharing knowledge and sharing information resources), was rejected because its threshold value (d) exceeded 0.2 and the level of expert agreement was below 75%. This rejection may be influenced by the organizational background and organizational culture of each expert, which may cause differences in views regarding aspects of sharing knowledge and sharing information resources as mentioned in research conducted by Murtazashvili et al. [30]. Factor P2 is accepted and aligns with research conducted by Reijers et al. [29].

The lack of consensus on P1 indicates that social dilemmas in the context of knowledge sharing and information resources are not perceived as a dominant factor in blockchain governance by the expert panel. In contrast, P2 (vulnerability of the combination of private interests) was identified as the factor with the highest level of agreement, highlighting the vulnerability arising from the interaction of diverse private interests within decentralized systems. This finding reflects a fundamental characteristic of blockchain ecosystems, where independent actors with heterogeneous objectives operate without a centralized authority, thereby increasing the potential for interest conflicts and opportunistic behavior.

From a theoretical perspective, these results can be understood through socio-technical perspectives [14] and collaborative governance theory [16],[51],[52], which emphasize that the primary challenges in decentralized systems are not limited to technical coordination, but also include the management of competing interests. Within this framework, P2 (vulnerability of the combination of private interests) represents critical dynamics such as agency problems, collective action challenges, and incentive misalignments, which are often key sources of vulnerability in community-based governance systems. Therefore, although only one factor was retained, P2 (vulnerability of the combination of private interests) still reflects a broad and fundamental construct in explaining the human dimension of blockchain governance.

TABLE XVI. RESULTS ON THE PEOPLE DIMENSION

Factor Code	Threshold value (d)	Percentage of Expert Agreement	Fuzzy Score (A)	Expert Consensus
P1	0.255	40%	0.573	Reject
P2	0.168	100%	0.840	Accept

Table XVII describes the calculation results using the fuzzy Delphi method for factors in the environmental dimension. There are four factors proposed in the environmental dimension. These four factors are accepted based on expert consensus, with a threshold value (d) of less than 0.2 and a fuzzy score (A) of greater than 0.8. The four factors in the environmental dimension that were accepted in this study are in line with previous research conducted by Pelt et al. [25], Ziolkowski et al. [26], Maggiolino et al. [28], and De Filippi et al. [31].

TABLE XVII. RESULTS ON THE ENVIRONMENT DIMENSION

Factor Code	Threshold value (d)	Percentage of Expert Agreement	Fuzzy Score (A)	Expert Consensus
E1	0.168	100%	0.840	Accept
E2	0.168	100%	0.840	Accept
E3	0.168	80%	0.840	Accept
E4	0.168	100%	0.840	Accept

Table XVIII describes the calculation results using the fuzzy Delphi method for factors in the collaboration dimension. There are eleven factors proposed in the collaboration dimension. One factor, C11 (a democratic form of governance), was rejected its threshold value (d) exceeded 0.2 and the level of expert agreement was below 75%. The democratic form of governance reject factor may be due to the case in the research conducted by Thompson [10] taking a case study of digital currency, where the use of digital currency has not been regulated and has not been formally implemented in the organization or environment of origin of the experts. The ten factors proposed in this collaboration dimension were accepted based on expert consensus using the fuzzy Delphi method analysis, and this is in line with research that has been conducted previously by Pelt et al. [25], Ziolkowski et al. [26], Dursun et al. [27], and Maggiolino et al. [28], Venugopalan et al. [47], and Murtazashvili et al. [30].

TABLE XVIII. RESULTS ON THE COLLABORATION DIMENSION

Factor Code	Threshold value (d)	Percentage of Expert Agreement	Fuzzy Score (A)	Expert Consensus
C1	0.188	100%	0.807	Accept
C2	0.188	100%	0.807	Accept
C3	0.168	100%	0.840	Accept
C4	0.168	100%	0.840	Accept
C5	0.132	100%	0.893	Accept
C6	0.145	100%	0.820	Accept
C7	0.132	100%	0.893	Accept
C8	0.188	100%	0.807	Accept
C9	0.155	100%	0.787	Accept
C10	0.132	100%	0.893	Accept
C11	0.362	40%	0.567	Reject

B. Readiness-Based Blocckhain Governance Framework

Based on the results of a systematic literature review, thematic analysis, and fuzzy Delphi method analysis, an initial readiness-based blockchain governance framework was built. This proposed framework was built from a readiness perspective, with enhanced STOPE framework. The initial framework comprises six domains derived from the STOPE framework perspective [21],[22] and blockchain characteristics [8], including the strategy, technology, organization, people, environment, and collaboration domains. The proposed readiness-based blockchain governance framework can be seen in Fig. 2 below.

Fig. 2. Proposed readiness-based blockchain governance framework.

Fig. 2 describes the initial readiness-based blockchain governance framework resulting from a systematic literature review using the PRISMA method [44], thematic analysis [8],[21],[22],[24], and analysis using the fuzzy Delphi method [33],[34], and expert validation. The developed framework encompasses six dimensions: strategy, technology, organization, people, environment, and collaboration. In each framework, factors are the result of expert consensus based on the fuzzy Delphi method [33],[34]. In the strategy dimension, there are 3 factors, in the technology dimension there are 3 factors, in the organization dimension there are 4 factors, in the people dimension there is 1 factor, and in the environment dimension there are 10 factors.

For each factor in each dimension, indicators are identified for assessing blockchain governance readiness. In this research, the factors whose indicators have been identified are DAO security (O2). The selection of factors is based on expert recommendations from interview results. Identification of indicators for the security of DAO factor (O2) was carried out using a literature review. Indicators for the O2 security of the DAO factor, which have been identified from ISO/IEC 27002:2022 [48] and have been validated by experts, are policies for information security, information security roles and responsibilities, segregation of duties, management responsibilities, and information security in project management.

C. Functionality of Assessment Tools

Fig. 3 describes the first stage of the systematic literature review process using the PRISMA method [44]. This systematic literature review was carried out to find functional requirements for blockchain governance assessment tools. The search was carried out in ten databases for journal articles published between 2019 and 2023.

Searches were conducted on the databases Scopus, ScienceDirect, ACM, Digital Library, Emerald Insight, ProQuest, IEEE Xplore, SpringerLink, Sage Journals, and Taylor & Francis. At the identification stage, 555 articles were obtained and 10 of them were duplicates so that 545 articles were processed at the screening stage. The screening stage referring to inclusion criteria IC1, IC2, and IC3 resulted in 24 studies included in the synthesis.

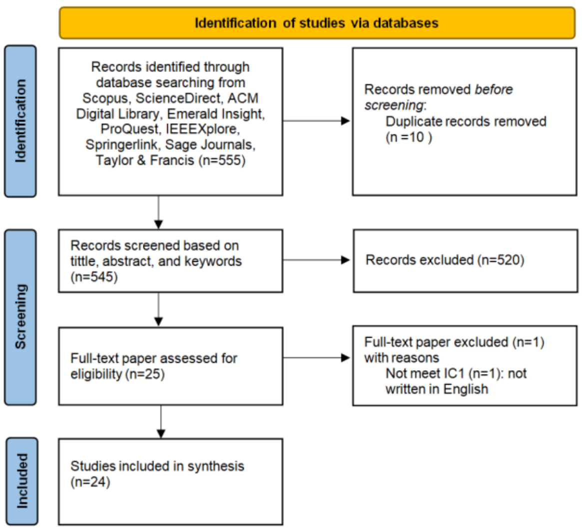

Fig. 3. Flow diagram for search results on the second stage of systematic literature review.

The results of the second-stage systematic literature review revealed a set of functional features, including strategy adaptation, assessment, good practices, community building, and supporting information. The functional results obtained are then combined with the results of the systematic literature review in the second stage and then illustrated in Fig. 4 to make it easier to understand and develop.

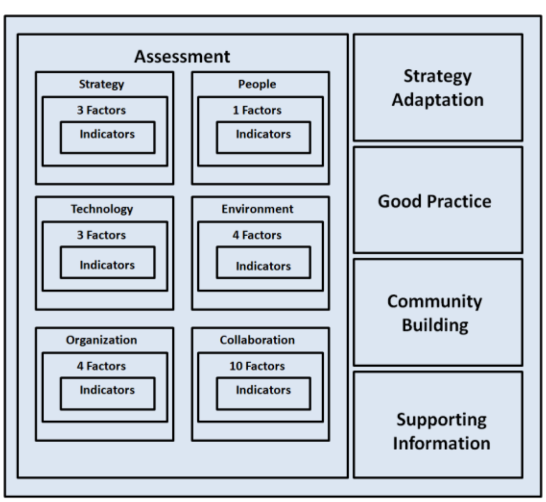

Fig. 4. List of functional requirements of blockchain governance assessment tools.

Fig. 4 presents the set of functional requirements for blockchain governance assessment tools, comprising five key functionalities: assessment, strategy adaptation, good practices, community building, and supporting information. The assessment tools encompass six dimensions: strategy, technology, organization, people, environment, and collaboration. In each dimension, there are factors and indicators for assessment. The "strategy adaptation" functionality is a functionality to inform the strategy adapted in the designed assessment tools. Meanwhile, the "good practice" functionality is functionality to inform about blockchain governance good practice. The "community building" functionality is related to the development of blockchain communities, both technical and non-technical aspects. This list of functional requirements is then subjected to expert validation.

In this study, ISO/IEC 38503:2022 Information technology—Governance of IT—Assessment of the governance of IT [53] was selected as the reference model and rating scale for the assessment instrument based on its relevance in evaluating governance within complex socio-technical systems. Although ISO/IEC 38503:2022 [53] was originally developed for information technology (IT) governance, it provides an assessment approach and structure that can be applied to blockchain environments, which inherently operate as decentralized and multi-stakeholder digital infrastructures. Blockchain governance extends beyond purely technical mechanisms to encompass organizational, behavioral, and environmental aspects, thereby requiring a comprehensive evaluation framework capable of capturing these interdependencies.

ISO/IEC 38503:2022 Information technology—Governance of IT—Assessment of the governance of IT [53] provides a robust assessment structure through its emphasis on governance tasks and practices, evidence of success, and the achievement of beneficial outcomes. This structure enables the operationalization of abstract governance concepts into measurable components, thereby addressing a common limitation in existing blockchain governance studies, which tend to remain conceptual and lack clear evaluative mechanisms. Furthermore, this international standard reflects a global consensus among key stakeholder groups, namely government, industry, academia, and end users, thereby enhancing the credibility and generalizability of the assessment model and rating scale. The adoption of ISO/IEC 38503:2022 Information technology—Governance of IT—Assessment of the governance of IT in this study ensures that the proposed measurement instrument is not only theoretically grounded but also aligned with globally recognized governance practices. This alignment strengthens the methodological rigor of the study and supports the development of a systematic and multi-dimensional assessment of blockchain governance across the STOPE and collaboration domains.

Table XIX presents the measurement instrument for blockchain governance assessment tools. Each factor within the domains of strategy, technology, organization, people, environment (STOPE), and collaboration is assessed based on the ISO/IEC 38503:2022 Information technology—Governance of IT—Assessment of the governance of IT rating scale and maturity model [53]. The assessment is conducted across three key governance aspects, i.e. the implementation of governance tasks and practices as the fundamental aspect of governance, evidence of success, and the achievement of beneficial outcomes [53]. A five-point rating scale is used in the assessment, where 1 indicates unknown, 2 not applied, 3 somewhat applied, 4 largely applied, and 5 fully applied [53]. This five-point rating scale adopted from ISO/IEC 38503:2022 Information technology—Governance of IT—Assessment of the governance of IT [53].

TABLE XIX. MEASUREMENT INSTRUMENT FOR BLOCKCHAIN GOVERNANCE ASSESSMENT TOOLS

Factor	Assessment	Rating				
		1	2	3	4	5
Dimension: Strategy						
Motivational factors (incentive)	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Nature of how decision rights are allocated and enacted	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Flexibility of governance	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Dimension: Technology						
Formation and context	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Conflicts resolving	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Inter-proposal dependencies	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Dimension: Organization						
Roles, responsibility, accountability	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Security of DAO	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Problem at hand	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Corporate governance	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Dimension: People						
	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Dimension: Organization						
The nature of the information exchanged	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Legal compliance	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Organizational theories	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Role of public or private sector	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Dimension: Collaboration						
Membership	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Communication	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Decision making	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Coordination mechanism within a group of users	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Decision problem	Are governance tasks and practices being applied?					
	Is there evidence of success?					

Factor	Assessment	Rating				
		1	2	3	4	5
	Are beneficial outcomes being achieved?					
Consensus of stakeholders	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Respons in problem cases	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Exercise of voting rights	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Community governance	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Private property	Are governance tasks and practices being applied?					
	Is there evidence of success?					
	Are beneficial outcomes being achieved?					
Rating Scale 1 Unknown 2 Not applied 3 Somewhat applied 4 Largely applied 5 Fully applied						

D. Comparison with Prior Work

In comparison with prior studies on blockchain governance [14],[15],[16],[20],[23], this research adopts a more comprehensive set of perspectives, encompassing platform governance, information technology governance, corporate governance, game theory, public management, and collaboration. As depicted in Table XX, research conducted by Pereira et al. [20] perceives blockchain governance from the perspective of platform governance and collaboration, while research conducted by Laatikainen et al. [15] perceives blockchain governance from an IT governance perspective. Table XX also describes the research conducted by Beck et al. [16] perceives blockchain governance from the perspective of Information Technology governance and corporate governance, while research conducted by Lee et al. [23] perceives blockchain from a game theory perspective, and research conducted by Tan et al. [14] perceive blockchain governance from a public management and collaboration perspective. Despite the diversity of perspectives presented in prior studies, they remain largely fragmented and domain-specific, lacking a unified framework that integrates these viewpoints into a comprehensive model of blockchain governance.

Compared with governance frameworks for other innovative and emerging technologies, such as artificial intelligence governance examined by de Almeida et al. [49], this study aligns with the emphasis on incorporating risk considerations in governance development. This research is also in line with research conducted by de Almeida et al. [49] in considering the characteristics of technology to be governed or regulated. When viewed from a regulatory perspective, this research is also in line with research conducted by de Almeida et al. [49] for its usefulness in highlighting regulatory points.

TABLE XX. COMPARISON OF PERSPECTIVE USED IN THE STUDY

Perspective	[20]	[15]	[16]	[23]	[14]	This study
Platform governance	√	x	x	x	x	√
IT governance	x	√	√	x	x	√
Corporate governance	x	x	√	x	x	√
Game theory	x	x	x	√	x	√
Public management	x	x	x	x	√	√
Collaboration	√	x	x	x	√	√

E. Implications

1) Theoretical implications: This research makes four theoretical contributions. First, this research develops a readiness-based, collaboration, and multiperspective blockchain governance framework. To the best of our knowledge, there has been no research that builds blockchain governance based on readiness, collaboration, and multiperspective [14],[15],[16],[20],[23]. Therefore, with this research, we fill the research gap that is important to ensure success in blockchain adoption [14]. Second, we enhanced the stope point of view, which is based on the stope framework [21],[22], based on the results of our literature analysis. This enhancement is done by adding a collaboration dimension [8]. This addition was based on technology characteristics, risk considerations, and previous research [8],[49]. Third, our research results in a list of functional requirements for blockchain governance assessment tools. The list of functional requirements was obtained from the analysis we carried out on previous research of governance assessment [35],[36],[37],[38],[39],[40],[41],[42]. The results of our research can be used as a reference in developing information system development theory in the future, for example, by considering technological characteristics, while also considering risks. Fourth, we provide a future research agenda in the blockchain governance subfield. Future research agendas can use more varied perspectives than existing research. Future research agendas can also use more varied empirical data for stakeholder engagement.

2) Practical implications: This research has two practical implications. First, the blockchain governance initial framework and list of functional requirements can be a reference for practitioners who will adopt blockchain or develop blockchain governance assessment tools. Second, the blockchain governance initial framework which contains factors, can be a reference for regulator in determining the main points of blockchain regulation or policy.

V. Conclusions

This research identifies and discusses factors comprising blockchain governance and functional requirements of blockchain governance assessment tools. This research provides a readiness-based blockchain governance initial framework, built from 25 factors grouped based on the enhanced STOPE framework point of view. This research also provides functional requirements for blockchain governance assessment. This research also provides valuable information that can be a reference for researchers in conducting their research, regulators to highlight the main point of blockchain governance or regulation, and practitioners in blockchain governance framework and assessment in line with governance and risk compliance concept.

A. Limitations of the Study

In this study, the identification of factors that influence blockchain governance through a systematic literature review was limited to English language literature. This study uses only a single database (Scopus) for systematic literature review in identifying factors that influence blockchain governance. This study also does not include readiness level evaluation and maturity level.

B. Future Work

Future research needs to be conducted regarding the readiness and maturity of blockchain governance. Future research should focus on assessing readiness levels and extending this study using broader methodologies and data sources, including the operationalization of indicators for the factors identified. Identification of indicators can be done not only from previous research but can come from international standards or gray literature such as industry reports or news. In future research, more stakeholders can be engaged, with more representative backgrounds and work experience. In addition, to overcome the shortcomings of the fuzzy Delphi method which may have an impact on the quality of the data obtained, it can be carried out in more than one iteration. The findings of this study represent the collective judgment of the selected experts at a specific point in time and may not fully capture the continuously evolving perspectives within the field. Future research is encouraged to involve a larger and more diverse expert panel or to adopt alternative consensus techniques in order to further strengthen the validity of the findings. Further investigation into blockchain governance assessment tools remains necessary. In addition, future studies should address maturity aspects, particularly the identification of relevant indicators and the determination of maturity levels.

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