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Blockchain in Supply Chain Transparency, Flexibility, and Supplier Trust in a Lean Perspective: A Study of PT. Siam Cement Group Yogyakarta

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ABSTRACT

This study examines to analyze the role of blockchain technology in supporting transparency, flexibility, and supplier trust through Lean Supply Chain techniques at PT Siam Cement Group Yogyakarta. The research employs a qualitative approach, utilizing in-depth narrative interviews and direct observation of the implementation of the RMC NET system. Data were gathered from key informants involved in operational activities and system usage, then analyzed through open coding, categorization, cross-informant comparison, and triangulation. The findings indicate that blockchain enhances information visibility and traceability, cross-functional integration, and decision-making rapidity. These factors foster internal transparency, operational flexibility, and the implementation of a Lean Supply Chain by improving process efficiency, productivity, inventory management, delivery performance, processing time, and quality. However, blockchain has not directly shaped supplier trust, which is instead more significantly influenced by performance track records, consistency, communication, and direct interaction.

Keywords: Blockchain Technology, Supply Chain Transparency, Supply Chain Flexibility, Supplier Trust, Lean Supply Chain.

I. Introduction

Blockchain is a distributed ledger technology that enables transactions and information exchanges to be recorded and verified by authorized parties within a single network. As an accessible, distributed ledger underpinned by cryptographic values, it can assist in storing and recording data (Dutta et al., 2020). The study by Gligor et al. (2022) substantiates the relevance of blockchain adoption, as growing supply chain complexity heightens firms' need for information-exchange mechanisms that all parties involved in procurement, production, distribution, and supplier relations can trust. The technology enables real-time interaction among machines, data, and people, thereby creating an ecosystem that is more efficient, flexible, and responsive to market demands (Vicky et al., 2022).

Supply chains involve numerous parties, such as manufacturers, distributors, logistics providers, and consumers. Prior research has found that many supply chains still struggle to share information accurately and punctually, resulting in inefficiencies, errors, and delays in decision-making (Njuaem, 2022). Stakeholders

increasingly demand information that is transparent, reliable, and tamper-proof regarding financial flows and the ownership of rights, not only for internal decision-making but also for external accountability, governance, and alignment with environmental, social, and governance expectations (Paliwal et al., 2024).

Demands for supply chain flexibility have intensified in step with rapidly shifting market dynamics, demand uncertainty, and external disruptions, ranging from raw material shortages to logistical difficulties; in this regard, flexibility refers to a system's capacity to respond swiftly and effectively to changes in demand and disruptions in order to sustain operational performance (Zhou et al., 2025). This need for flexibility is increasingly critical to achieving corporate objectives, because sustainable performance is determined not merely by a firm's ability to generate profit but also by its capacity to manage resource utilization, process resilience, and environmental and social considerations simultaneously (Shahzad et al., 2024).

Blockchain plays a pivotal role in building trust among supply chain actors. Such trust emerges because all data recorded on the blockchain are transparent and verifiable by every party (Zayed & Hatem, 2026). To foster trust, it is essential to facilitate transparency across the supply chain, enabling individuals and companies to trace the provenance of their products together with all information associated with them (Hellani et al., 2021). A study by Shahzad et al. (2026) reports that blockchain exerts a positive influence on lean, agile, resilient, green, and sustainable supply chains, collectively termed LARGS. This finding suggests that the Lean approach is becoming increasingly pertinent in this context, since Lean focuses on process optimization by eliminating non-value-adding activities, thereby enhancing productivity and cost efficiency (Cho et al., 2025). Studies by Wang & Yang (2022), Chen (2023), and Pattanayak et al. (2024) have examined the associations between blockchain and transparency, trust, flexibility, and Lean Supply Chain; however, a gap remains in that these constructs have been investigated separately rather than integrated simultaneously, particularly at PT Siam Cement Group Readymix Yogyakarta. This gap is all the more salient because the research by Shahzad et al. (2026) demonstrates that technology's influence is not invariably direct, which calls for an understanding of supply chain fluidity capability as the conduit linking technology to firm performance.

The research gap of this study lies in the limited empirical evidence that integrates blockchain, transparency, flexibility, supplier trust, and Lean Supply Chain within the ready-mix industry. PT Siam Cement Group Readymix Yogyakarta has adopted RMC NET as its principal system for supporting the process from ordering through to delivery. This circumstance furnishes an empirical context for understanding how technology is employed in material supply chain processes and how its benefits are perceived by different operational functions. Most blockchain supply chain studies test relationships quantitatively, whereas qualitative inquiries that explore the experiences of internal users in the ready-mix industry remain scarce. Blockchain research has been conducted largely in the automotive, manufacturing, logistics, or general supply chain sectors, whereas the ready-mix industry is characterized by time-sensitive delivery, quality sensitivity, batching, logistics scheduling, and quality inspection.

Although earlier studies indicate that blockchain has the potential to enhance transparency and coordination within supply chains, these benefits do not necessarily yield uniform consequences across every dimension of interorganizational relationships. Information visibility within a firm must be distinguished from the information access available to external suppliers, whereas supplier trust may draw upon collaborative experience, performance consistency, and inter-party communication. This distinction is particularly relevant in the ready-mix industry, which demands the integrated coordination of delivery timing, quality control, production scheduling, and raw material procurement. Accordingly, this study explores how blockchain adoption through the RMC NET system supports transparency and operational flexibility, and how limitations in supplier access and interaction relate to the formation of trust in the context of PT Siam Cement Group Readymix Yogyakarta.

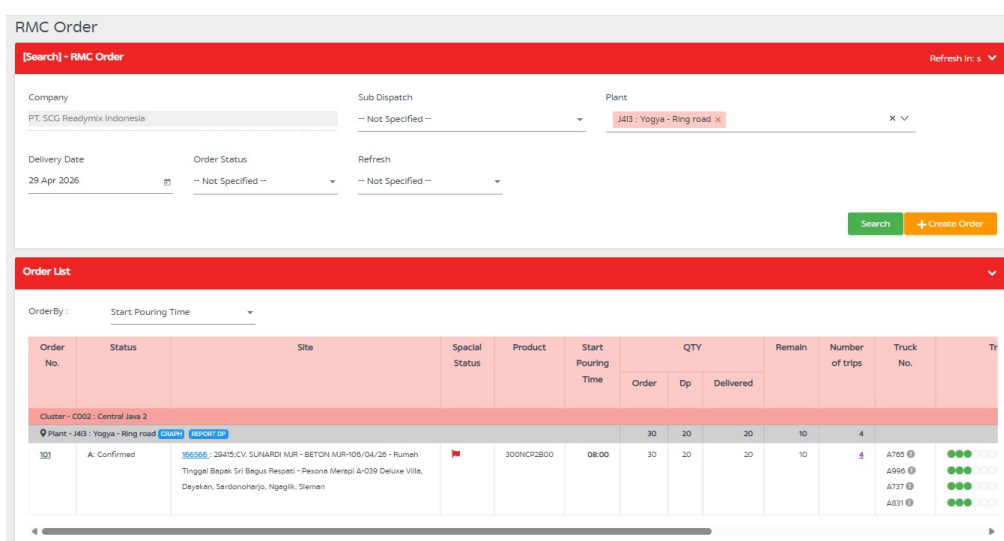
In light of this gap, the study is not intended to test causal relationships statistically; rather, it aims to understand patterns in informants' experiences and perceptions of blockchain adoption. It concentrates on three principal propositions: (1) blockchain adoption supports greater information transparency in supply chain activities; (2) blockchain adoption supports supply chain flexibility through information visibility,

process integration, and faster decision-making; and (3) blockchain adoption has not directly fostered supplier trust where supplier involvement in the system remains limited.

II. Literature Review and Hypothesis Development

2.1. Blockchain Technology

Blockchain is a digital technology that employs a distributed ledger system to store and validate transaction information among multiple parties within a network (Wang & Yang, 2022). In supply chains, blockchain is characterized by information transparency, security, traceability, and the capacity to preserve the integrity of transaction records, which enables firms to enhance visibility over activities occurring throughout supply chain operations (Chou et al., 2023). Blockchain characteristics, such as traceability, data integrity, recording transparency, and immutability, can help organizations trace transaction histories and reduce reliance on fragmented record-keeping. These characteristics have the potential to improve information traceability and ease coordination among the units involved in the supply chain (Chou et al., 2023; Madanchian & Taherdoost, 2025). However, such benefits are determined not solely by the presence of the technology but also by how the system is implemented, who holds access, and how information is used in decision-making. A salient limitation of blockchain adoption is that the integrity of records does not necessarily guarantee the veracity of the information first entered into the system. Moreover, disparities in data standards and limited interoperability may impede interorganizational information exchange. Blockchain adoption should therefore be understood as part of a process of technological and organizational integration, rather than as an automatic guarantee of information openness or of effective relationships among supply chain actors (Madanchian & Taherdoost, 2025; Lustenberger & Spychiger, 2025).



The screenshot displays the 'RMC Order' web application. At the top, there's a search bar with the text '[Search] - RMC Order' and a 'Refresh In: s' dropdown. Below this are several filter fields: 'Company' (PT. SCG Readymix Indonesia), 'Sub Dispatch' (Not Specified), 'Plant' (J43 - Yogya - Ring road), 'Delivery Date' (29 Apr 2026), 'Order Status' (Not Specified), and 'Refresh' (Not Specified). A 'Search' button and a '+ Create Order' button are on the right. Below the filters is the 'Order List' section, which includes a table with columns: Order No., Status, Site, Special Status, Product, Start Pouring Time, QTY (Order, Dp, Delivered), Remain, Number of trips, Truck No., and Tr. The table shows one order with details like 'Cluster - C002 - Central Java 2', 'Plant - J43 - Yogya - Ring road', and 'Product - 300NCP2800'. The status is 'A: Confirmed' and the start pouring time is '08:00'.

Figure 1. RMC NET

In this study, Blockchain Technology refers to the technology underlying the RMC NET system used at PT Siam Cement Group Readymix Yogyakarta that can be looked in figure 1. The analysis examines how the system supports recording, tracing, information integration, and operational processes on the basis of informants' experiences. This delimitation matters because a system's internal capacity to manage data does not automatically imply that all external suppliers have access to, or can verify, the same information.

Accordingly, blockchain in this study is conceptualized as a technology with the potential to bolster supply chain capabilities, the benefits of which hinge on the scope of implementation, system integration, and the involvement of the parties concerned.

2.2. Supply Chain Transparency

Supply chain transparency refers to the ability of a party in the supply chain to receive and provide relevant information on activities, transactions, and the flow of operations in an open and traceable manner (Chou et al., 2023). Supply chain transparency has become increasingly important because companies are obliged not only to control internal activities but also to know the condition of their suppliers, production processes, and distribution (Schäfer, 2023). Transparency is important because supply chain activities involve diverse functions and organizations that hold different information. When information on procurement, material availability, production processes, delivery, and quality inspection is not integrated, firms may struggle to monitor processes holistically. Conversely, information that is traceable and shared has the potential to improve coordination, bolster oversight, and reduce information asymmetry among parties with access to the system (Kouhizadeh et al., 2021; Budler et al., 2024).

Blockchain has the potential to support transparency through traceable transaction records and the verification of records available within the network. When activities are recorded consistently, authorized parties can review transaction histories and obtain more structured information. Even so, the resulting transparency remains contingent upon the scope of the data recorded, the quality of the information, and users' access rights. Consequently, enhanced transparency within one organization does not necessarily mean that the same transparency has materialized in relationships with external suppliers (Chou et al., 2023; Cui et al., 2024). The distinction between internal and external transparency is pertinent to this study. Internal transparency concerns the ability of a firm's units to obtain and use the information available within the company's system. External transparency, by contrast, presupposes mechanisms for sharing information with parties outside the firm. If suppliers lack direct access to the system, the information available to employees cannot necessarily be independently verified by those suppliers. Logistics information integration is one of the capabilities that can underpin supply chain optimization through enhanced visibility, operational efficiency, and responsiveness. Nevertheless, the effectiveness of such integration is determined not only by the availability of technology but also by data quality, organizational readiness, and collaboration among supply chain actors (Nurani & Rajab, 2026). In the context of this study, this perspective is employed to understand how the RMC NET system supports internal information transparency and the extent to which its benefits reach external suppliers.

2.3. Supply Chain Flexibility

Supply chain flexibility is the capacity of a supply chain to adjust to changing internal and external conditions without incurring significant disruption to ongoing operational activities (Agrawal et al., 2023). Flexibility comprises various dimensions, including supplier flexibility, procurement flexibility, production flexibility, distribution flexibility, and flexibility in accommodating changes in customer demand (Nascimento et al., 2024). Supplier flexibility pertains to a supplier's ability to adjust volume, timing, and specifications in accordance with existing orders. Production flexibility pertains to a firm's ability to adapt its production capacity and processes when material suitability, demand, or operational conditions change. Distribution flexibility pertains to the ability to modify delivery activities, from the routes employed to the distribution volumes, as directed by the company (Nascimento et al., 2024).

Fast, accurate, and trustworthy information is a prerequisite for flexibility because decisions on procurement changes, scheduling, distribution, and the fulfillment of customer requirements depend on the quality of the data visibility available. Empirical research has found that the transparency and information security afforded by Blockchain Technology are positively associated with supply chain flexibility, both directly and through the formation of trust within the supply chain network (Wang & Yang, 2022). In the ready-mix concrete industry, operational flexibility must be understood in terms of the interplay among material availability, production scheduling, delivery readiness, and customer requirements. Information that becomes available more quickly can assist management in making decisions, yet the effectiveness of the response is

still shaped by actual conditions in the field and by coordination with external parties. Supply chain digitalization can support process efficiency, cost-information accuracy, service responsiveness, and product availability. Nevertheless, the use of digital systems also faces challenges in the form of integration complexity and information security risks (Sarjono et al., 2025). The contribution of technology to supply chain flexibility should therefore be understood through the manner in which it is used to support coordination, information provision, and operational decision-making.

2.4. Supplier Trust

Supplier trust is a firm's confidence that a supplier is dependable, discharges its obligations, and honors its commitments within a business relationship. This trust relates to perceptions of honesty, reliability, competence, performance consistency, and a partner's willingness to sustain the cooperative relationship (Wang & Yang, 2022; Garcia-Torres et al., 2024). In supply chain activities, trust carries operational consequences because firms rely on suppliers to deliver raw materials in accordance with agreed specifications, quantities, and timelines. Quality discrepancies, delivery delays, or inconsistent information can heighten uncertainty and prompt firms to conduct additional scrutiny of suppliers. Conversely, a consistent performance record and effective communication can help build confidence.

Blockchain Technology can help reinforce the trust defined above through transparency, security, traceability, and the ability of the relevant parties to verify transactions on the basis of jointly agreed records (Paliwal et al., 2020). However, the ability to record and trace information is not tantamount to a guarantee that the initial information is always accurate, that suppliers fulfill their commitments, or that the business relationship already enjoys a high level of trust (Kouhizadeh et al., 2021; Pattanayak et al., 2024). For this reason, the relationship between blockchain and supplier trust warrants more critical scrutiny. Technological transparency can furnish an informational basis for evaluating partners, but trust also develops through collaborative experience, consistent order fulfillment, communication, and direct interaction. The influence of technology may be limited when suppliers do not participate directly in the system or when firms must still verify the quality and condition of materials through other operational procedures. In this study, supplier trust is understood as a relational dimension that cannot be equated with information transparency. The analysis focuses on how informants assess supplier reliability, trust in vendor information, consistency in meeting obligations, and the role of the blockchain system in that relationship. This separation enables the study to elucidate whether the availability of information through the system is genuinely translated into trust or merely aids recording and oversight.

2.5. Lean Supply Chain

Lean supply chain management is an approach to managing supply chains that is oriented toward creating customer value by reducing non-value-adding activities in the operational flow, so that supply chain operations become efficient (Vieira et al., 2023). A Lean Supply Chain is a network of interconnected organizations through which products, services, information, and funds flow from upstream to downstream. Lean supply chain management aims to reduce waste and enhance value through improved process flow, product quality control, and the reduction of activities deemed inefficient or non-value-adding (Tortorella et al., 2017). The core principles of lean encompass identifying value, mapping the value stream, creating flow, and pursuing continuous improvement, all aimed at eliminating non-value-adding activities (Vieira et al., 2023). The development of the Lean Supply Chain concept is linked to the sustainability of corporate operations because waste reduction can help firms curtail resource consumption arising from those operations (Kosasih et al., 2023). The utilization of digital systems in the supply chain can support process efficiency, cost accuracy, and operational responsiveness (Sarjono et al., 2025). In this study, these benefits are reflected in informants' experiences of ease of information access and cross-functional coordination. Nonetheless, such findings are better understood as an indication of technological support for more efficient

operational practices, rather than as quantitative evidence that blockchain adoption directly lowers costs or reduces waste.

2.6. Proposition Development

2.6.1. The Influence of Blockchain Technology on Supply Chain Transparency

Prior studies indicate that blockchain can support traceability and information sharing, while transparency outcomes also depend on system design, data coverage, and stakeholder access (Chou et al., 2023; Budler et al., 2024; Cui et al., 2024). This leaves an important issue for the present case: whether the information recorded through RMC NET is sufficiently complete, timely, and accessible to the functions that need it, and whether this visibility extends beyond internal employees to external suppliers. This relationship warrants investigation because ready-mixed concrete operations require coordination among procurement, inventory, quality control, production, and delivery. When these functions rely on incomplete or delayed information, managers may struggle to establish the status of materials and transactions. Conversely, a digital system may improve internal visibility without giving suppliers access to the same information. Examining this distinction can help identify where information gaps remain and whether management needs to improve data governance, access rights, or communication practices. The intended implication is a context-specific assessment of the actual contribution and limits of RMC NET, rather than an assumption that blockchain automatically creates end-to-end transparency.

2.6.2. The Influence of Blockchain Technology on Supply Chain Flexibility

Supply chain flexibility depends on the ability to respond to changes in demand, material availability, production requirements, and delivery conditions. Research on blockchain and supply chain capabilities provides a basis for examining whether better information visibility supports more timely coordination and operational decisions (Wang & Yang, 2022; Potnis et al., 2023; Nascimento et al., 2024). However, the relationship should not be presumed to be direct: information may help managers recognise a disruption, but it cannot itself create additional raw materials, expand production capacity, or remove transportation constraints. The research is therefore needed to understand the practical pathway between information visibility and operational response at PT Siam Cement Group Readymix Yogyakarta. By exploring how employees use RMC NET when adjusting schedules, coordinating functions, or responding to disruptions, the study can distinguish information-related barriers from constraints that require procurement planning, production adjustments, delivery coordination, or closer supplier collaboration. This distinction has managerial value because it can prevent the company from treating technology as a complete solution to problems that are partly physical or inter-organisational. The expected contribution is an explanation of when digital information supports flexibility and when additional operational capabilities are still required.

2.6.3. The Influence of Blockchain Technology on Supplier Trust

Conceptually, blockchain has the potential to support supplier trust by providing traceable transaction records and information that can be inspected by parties with access. Such information can help firms evaluate transactions and mitigate some of the uncertainty arising from informational disparities among parties (Wang & Yang, 2022; Pattanayak et al., 2024).

However, supplier trust cannot be equated with technological transparency. Trust is also associated with quality consistency, delivery punctuality, commitment fulfillment, communication, and collaborative experience. Furthermore, blockchain's ability to record transactions does not in itself guarantee the correctness of the original data or ensure that suppliers will fulfill their obligations (Kouhizadeh et al., 2021; Garcia-Torres et al., 2024).

Previous research by Pattanayak et al. (2024) found that blockchain is associated with trust and relational capabilities in supply chain relationships, such that the technology can bolster the quality of interfirm relationships (Pattanayak et al., 2024). In addition, the study by Wang & Yang (2022) found that blockchain is expected to enhance supplier trust by improving the transparency, security, and verifiability of existing supply chain information (Wang & Yang, 2022). Accordingly, the relationship between blockchain and supplier trust needs to be explored openly. This study examines whether information from the system is actually used to build confidence in suppliers or merely assists internal recording and oversight. Limited supplier access to the system is also an important condition for understanding why internal transparency is not necessarily translated into relational trust. Therefore, based on this relationship, the proposition proposed in this study is as follows:

- P1: Blockchain technology supports increased transparency in supply chain activities.
- P2: Blockchain technology fosters greater supply chain flexibility by enhancing information visibility, process integration, and the speed of decision-making.
- P3: The implementation of blockchain facilitates the development of supplier trust through transparency and the verifiability of information; however, its contribution depends on the suppliers' access to information and the quality of inter-organizational relationships.

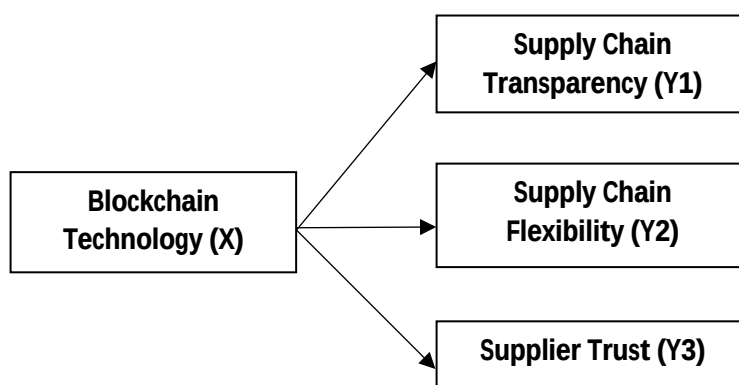


Figure 2. Conceptual Framework

III. Research Method

3.1. Research Type and Design

This study adopts a qualitative approach with the aim of gaining an in-depth understanding of a condition, phenomenon, or problem occurring in the field from the perspectives and direct experiences of the parties involved. The approach is implemented in a narrative manner to explore the experiences of each user of Blockchain Technology in the company's operational activities (Buu & Engelhardt, 2026). The research focus encompasses Blockchain Technology adoption, supply chain transparency, supply chain flexibility, supplier trust, and Lean Supply Chain practices. These five foci serve as a framework for exploring how technology is utilized in operational activities, how information is used in decision-making processes, and how informants assess the benefits and limitations of its adoption. The research propositions function as a guide for exploration during data collection and analysis, not as hypotheses to be tested through statistical testing. Primary data were collected through in-depth interviews and direct observation. Interviews were conducted with five informants who hold managerial responsibilities in different functions of the company's supply chain. The interviews were used to obtain detailed accounts of informants' experiences in using the system,

accessing information, coordinating, adjusting operational activities, and interacting with suppliers (Bekele & Ago, 2022).

The interview guide was developed on the basis of the research focus and of indicators synthesized from the literature on Blockchain Technology, supply chain transparency, supply chain flexibility, supplier trust, and Lean Supply Chain. The questions were designed to elicit informants' concrete experiences, examples of system use, perceived benefits, obstacles encountered, and circumstances in which the system has been unable to meet operational needs. Accordingly, the interviews were intended not only to obtain responses that support the propositions but also to identify experiences or findings that diverge from the study's initial expectations. The interviews were conducted from 21 April 2026 to 30 April 2026, each lasting approximately 10 to 20 minutes. They were recorded using a mobile device and subsequently transcribed for analysis. Direct observation was carried out by attending to the use of the RMC NET system and the operational activities relevant to the research focus. The observed aspects included information flow, the recording process, inter-unit coordination, and the use of information in procurement, production, and logistics activities.

3.2. Sampling Technique and Sample Size

This study employs non-probability sampling, a sampling technique that does not afford every element of the population an equal chance of being selected as part of the sample. More specifically, the technique used is purposive sampling, whereby informants are selected deliberately on the basis of particular criteria and considerations rather than at random (Zrineh et al., 2026). The informant selection criteria comprised: (1) holding a managerial position in a function related to supply chain activities; (2) having direct experience or adequate knowledge of the use of the RMC NET system and the operational processes under study; (3) understanding information flows, coordination, or decision-making within their working function; and (4) being willing to provide information based on their professional experience. The research manuscript states that the informants have worked at the company for at least three years. This experience criterion was used to support the selection of informants who understand the company's operational context. The final sample consisted of five parties selected according to the research objectives, informant relevance, depth of information, and the attainment of information sufficiency (Bekele & Ago, 2022). All informants from the company hold senior executive positions and have been involved in the implementation of blockchain at the company's facilities for at least three years (Yadlapalli et al., 2022). The five informants are the area manager, the batching plant operations manager, the logistics manager, the production manager, and the purchasing manager.

The five informants were selected on the premise that each position offers a distinct perspective on system adoption and supply chain activities. The Area Manager provides perspectives on general management and decision-making; the Batching Plant Operations Manager supplies information on the use of the system in batching plant operational processes; the Logistics Manager explains aspects of ordering and delivery; the Production Manager provides information on the execution and control of production processes; and the Purchasing Manager explains the procurement process and supplier relations.

3.3. Variable Measurement and Indicators

The instrument used in this study comprises 36 indicator items, distributed across the variables as follows: 8 indicators for Blockchain Technology (BC), 8 for Supply Chain Transparency (TRS), 6 for Supply Chain Flexibility (FRS), 7 for Supplier Trust (KP), and 7 for Lean Supply Chain (LSC). All items were used to formulate the interview questions and were adapted to the context of PT Siam Cement Group Readymix Yogyakarta. The details of the indicators are presented in Table 1.

3.4. Analysis Method

The data were analyzed using thematic analysis, drawing on the stages of qualitative data analysis comprising data condensation, data display, and conclusion drawing and verification (Miles et al., 2013). The analysis was conducted systematically to identify patterns in informants' experiences, similarities and differences across perspectives, and the conditions that explain Blockchain Technology adoption in supply chain activities.

First, transcription and data organization. The interview data were transcribed and then checked against informants' statements. Observation notes and supporting documents that were actually obtained were organized by source and by their relevance to the research focus. The collected data were then prepared for the coding process. Second, open coding. The researcher read the transcripts thoroughly and assigned codes to segments containing relevant information. Initial codes were formed on the basis of the meaning of informants' statements, such as ease of tracing information, delays in data updates, inter-unit coordination, schedule adjustments, supplier consistency, and the reduction of manual work. Coding was directed not only at pre-established indicators but also allowed new codes to emerge from informants' experiences that were not represented in the initial framework.

Third, category grouping and axial coding. Codes with similar meanings were grouped into broader categories. At this stage, the researcher examined the relationships among the conditions informants experienced, system use, operational actions, and the reported consequences. For instance, statements about the availability of information could be grouped under the category of information visibility, whereas statements about schedule adjustments could be grouped under the category of operational flexibility. Inter-category relationships were determined from the content of the data, not merely because those relationships were anticipated in the propositions. Fourth, selective coding and theme formation. The established categories were then compared to identify the principal themes that address the research focus. The researcher examined how these themes relate to Blockchain Technology, supply chain transparency, supply chain flexibility, supplier trust, and Lean Supply Chain. At this stage, the researcher also checked for information that contradicts the dominant pattern or delineates the limits of the benefits of system adoption. Fifth, cross-informant comparison and data display. Each informant's findings were compared according to their function and responsibilities. The results of the comparison are presented in the form of thematic exposition, category tables, and relevant interview excerpts. Differences in perspective were not discarded but were used to understand how experiences of system use can differ across managerial functions.

Sixth, verification and interpretation of findings. The themes that emerged were reviewed against the transcripts, observation notes, and supporting documents where available. The findings were then compared with the literature and the research propositions to explain their consistency, their divergences, and the conditions that constrain the benefits of the technology. The propositions are not declared statistically proven; rather, they are discussed on the basis of the strengths and limitations of the qualitative evidence found.

3.5. Data Trustworthiness

3.5.1. Credibility

Credibility was established by examining the congruence among interview results, observation notes, and the interpretations formed during analysis. The transcripts were re-read to ensure that the codes and themes reflect the substance of informants' statements. Cross-informant comparison was used to identify recurring patterns while also uncovering divergent views. To strengthen credibility, documentary evidence and supplementary materials were collected systematically when access was available and their relevance to the research questions had been established. These materials included relevant operational documents and records associated with order processing, raw-material procurement, production, delivery, and quality

control, as well as accessible RMC NET records or system-generated information that could clarify the sequence and status of operational activities. For each item, the researcher recorded its type or title, source, date of collection, relevant period, and the research issue it could help verify. Materials were screened for relevance and consistency, and confidential or identifying information was excluded from reporting where necessary. The documentary and system-based evidence was then compared with interview transcripts and field-observation notes to check whether the sources converged, complemented one another, or revealed discrepancies. Any inconsistency was retained as an analytical issue and examined in context rather than automatically resolved in favour of one source. Only documents and system records actually accessed during fieldwork should be treated as collected data; materials that were unavailable or inaccessible were not used as empirical evidence.

3.5.2. Source Triangulation

Source triangulation was conducted by comparing information obtained from informants with different job backgrounds and responsibilities. The five informants hold different vantage points on the adoption of RMC NET, so the information they provided can be used to test the consistency of a finding. The Area Manager offered perspectives on system adoption at the level of general management and decision-making. The Batching Plant Operation Manager provided information on production processes and system use in batching plant operational activities. The Logistics Manager explained aspects of ordering, delivery, and product tracking. The Production Manager provided information on process and quality control, while the Purchasing Manager contributed perspectives on supplier relations and raw material procurement.

3.5.3. Confirmability

Confirmability is a criterion of data trustworthiness in qualitative research that seeks to ensure that research findings are grounded in empirical data rather than merely in the researcher's views, assumptions, or subjective bias. In the context of this study, confirmability was pursued to demonstrate that conclusions regarding Blockchain Technology adoption, transparency, flexibility, supplier trust, and Lean Supply Chain can be traced back to the raw data collected in the field. Confirmability in this study is also operationalized by restricting interpretation so that it does not exceed the available empirical evidence. The researcher explicitly states that this study was not designed to test causal relationships statistically but to understand patterns in informants' experiences and perceptions of blockchain adoption. For this reason, the term hypothesis was replaced with proposition, and the research narrative avoids claims of hypothesis acceptance or rejection.

Table 1. Informant Demographics

Name	Gender	Age	Education	Position	Length of Service
Informant 1	Male	45 years	Bachelor's degree (S1)	Area Manager	10 years
Informant 2	Male	43 years	Bachelor's degree (S1)	Batching Plant Operations Manager	8 years
Informant 3	Male	45 years	Bachelor's degree (S1)	Logistics Manager	10 years
Informant 4	Male	30 years	Vocational diploma (D3)	Production Manager	3 years
Informant 5	Male	40 years	Bachelor's degree (S1)	Purchasing Manager	10 years

IV. Results and Discussion

4.1. Analysis Result

4.1.1. Blockchain Technology (BC)

The analysis of the Blockchain Technology variable generated two related themes: “blockchain as an established internal recording backbone” and “a closed-loop system with limited external integration.” Across the five interviews, informants described RMC NET as supporting the recording and retrieval of order approvals, operational parameters, raw-material information, and quality documentation. One informant explained that changes or approvals to parameters were recorded and could be accounted for, while another noted that quality documentation had become more organized, accessible, and difficult to manipulate.

These accounts indicate an operational consequence in the form of more structured internal records and easier access to recorded information. They do not, by themselves, demonstrate that all recorded information is accurate at the point of entry, that errors have been eliminated, or that the system has improved company-wide performance. The interviews also identified boundaries to system coverage: suppliers do not directly enter data into the system, and some field-level decisions, such as delivery-route choices, remain outside RMC NET. Accordingly, the result is best described as the use of a blockchain-enabled or blockchain-associated digital system to support internal documentation, with incomplete integration of external and field activities. The data available for this study do not independently establish the technical architecture of every RMC NET function; the wording here therefore reflects how the system and its use were described by informants.

Table 2. Open Coding Result for Blockchain Technology Data

Key Informant Quotations	Category (Axial Coding)	Theme (Selective Coding)
<i>“every change or approval of parameters is properly recorded and can be held accountable”</i>	Validated and accountable record-keeping	Blockchain as a mainstay of mature internal record-keeping
<i>“our quality documentation is tidier, easy to access, and difficult to manipulate”</i>	Document integrity and security	Blockchain as a mainstay of mature internal record-keeping
<i>“suppliers do not enter data into the blockchain; internal staff will enter the data”</i>	External data not yet integrated	The system is closed-loop: strong internally, does not reach external parties
<i>“route determination does not use blockchain but depends on the driver”</i>	Field decisions outside the system	The system is closed-loop: strong internally, does not reach external parties

4.1.2. Supply Chain Transparency

The analysis of supply chain transparency produced two themes: “increased internal visibility” and “asymmetric transparency.” Informants described information on material status, production, and delivery as being available through a shared internal system. They also reported that relevant information could be accessed more quickly and that different functions could coordinate using the same data rather than repeatedly waiting for separate reports. The observed operational consequence is improved internal information visibility and availability for coordination. However, the interviews also show that this transparency does not extend equally to external supply-chain partners. Informants stated that suppliers do not have access to the company’s system because access is restricted for internal use and privacy. Therefore, the findings support a bounded conclusion: RMC NET is perceived to improve visibility among internal functions, while transparency between the company and suppliers remains limited. The interviews do not establish that end-to-end transparency across the entire supply chain has been achieved, nor do they measure downstream effects on delivery performance, cost, or customer outcomes.

Table 3. Open Coding Result For Supply Chain Transparency Data

Key Informant Quotations	Category (Axial Coding)	Theme (Selective Coding)
<i>"we now have much better visibility, from the position of materials at the supplier and production status to delivery... within one system"</i>	End-to-end visibility	Internal transparency has increased markedly
<i>"the information needed for decision-making is now more readily prepared and available faster... we do not have to wait for reports so often"</i>	Information readiness and speed	Internal transparency has increased markedly
<i>"all parties now access the same data, so coordination has become smoother"</i>	Cross-functional data parity	Internal transparency has increased markedly
<i>"with suppliers, I think not, because suppliers do not have access to our blockchain"</i>	Closed external access	Transparency is asymmetric: strong inwardly, weak outwardly
<i>"as for externally... it is strictly internal, which is why it is very private"</i>	Private/permissioned system	Transparency is asymmetric: strong inwardly, weak outwardly

4.1.3. Supply Chain Flexibility

In contrast to the two preceding variables, the coding of FRS yielded only a single theme, which emerged consistently and uniformly across all informants, with no counter-theme found among any of the five: "Blockchain creates adaptive capability (dynamic capability)." All informants, across positions and functions, consistently associated blockchain adoption with cross-functional integration, accelerated decision-making, and cost and time savings that ultimately enhance operational adaptability. The absence of a counter-theme, together with the uniformity of language among informants ("one team," "faster," "more flexible"), is a strong indicator that this theme is genuinely well established and not merely a normative response from informants.

These findings suggest that information availability and cross-functional coordination are perceived to support operational responses. They should not be interpreted as evidence that the company's overall flexibility increased by a measurable amount. The interviews do not provide independently verified before-and-after data on response time, production volume, delivery reliability, inventory levels, or total operating costs. Moreover, not every operational decision is managed through RMC NET; informants indicated that some field decisions, including route selection, remain outside the system. The defensible finding is therefore that the system may facilitate coordination and decision readiness, while the extent to which it changes broader flexibility or resilience performance remains unmeasured.

Table 4. Open Coding Result for Supply Chain Flexibility Data

Key Informant Quotations	Category (Axial Coding)	Theme (Selective Coding)
<i>"transformed our supply chain from what previously felt fragmented into something more like a single team"</i>	Cross-functional integration	Blockchain creates adaptive capability (dynamic capability)
<i>"has a positive impact on overall cost, time, and quality performance"</i>	Operational performance improvement	Blockchain creates adaptive capability (dynamic capability)
<i>"management has better control... when demand changes or disruptions occur, we can make decisions faster and more accurately"</i>	Control and response speed	Blockchain creates adaptive capability (dynamic capability)

Key Informant Quotations	Category (Axial Coding)	Theme (Selective Coding)
<i>"a lot of costs can be reduced... so we are more flexible"</i>	Efficiency underpinning adaptability	Blockchain creates adaptive capability (dynamic capability)

4.1.4. Supplier Trust

The coding pattern for the KP variable points in the opposite direction to the preceding three variables. Two mutually reinforcing (rather than contradictory) themes emerged consistently across all five informants: "Trust is still formed relationally and socially" and "Blockchain is necessary but not sufficient for trust." Not a single quotation from any of the five informants, across any position, supports the notion that blockchain directly builds trust in suppliers. This uniformity of rejection (marked by the words "not," "not really," "not yet," and "not significant" throughout the transcripts) in itself constitutes a theme that emerged consistently across all informants, albeit in a negative direction relative to the initial proposition.

Table 5. Open Coding Result for Supplier Trust Data

Key Informant Quotations	Category (Axial Coding)	Theme (Selective Coding)
<i>"our trust in partners is determined more by their performance track record, not merely by the presence of Blockchain Technology"</i>	Trust derived from track record, not technology	Trust is still formed relationally and socially
<i>"trust is built more on consistent quality and delivery punctuality, not just on technology"</i>	Trust derived from performance consistency	Trust is still formed relationally and socially
<i>"blockchain only helps with recording; it does not guarantee the truth of the data's contents"</i>	Recording ≠ verification of truth	Blockchain is necessary but not sufficient for trust
<i>"information from vendors still has to be verified by us through sampling and laboratory testing"</i>	Verification remains manual	Blockchain is necessary but not sufficient for trust
<i>"a deep understanding of how partners work is gained more from direct interaction, field visits, and discussion"</i>	Understanding derived from direct interaction	Trust is still formed relationally and socially

4.2. Discussion

4.2.1. P1: Blockchain Technology Has a Positive Influence on Supply Chain Transparency

The findings for P1 are broadly consistent with previous studies that associate blockchain-enabled supply chains with improved information visibility, traceability, and the ability to follow transactions across operational stages. Chou et al. (2023) discuss a blockchain framework for supply-chain transparency in dynamic partnerships, while Faisal et al. (2024) conceptualize transparency through connected dimensions that include information visibility and traceability. Cui et al. (2024) further show that the design of a blockchain system matters for how transparency is produced. In the present case, informants described RMC NET as supporting access to operational information across internal functions, including material status, production, delivery, and quality documentation. This convergence suggests that the transparency benefit identified in prior research is also visible in the day-to-day operations of a ready-mix concrete company. The dominant theme "Internal transparency has increased markedly" emerged consistently across all five informants in every position (Area, Batching Plant, Logistics, Production, and Purchasing), marked by three categories: end-to-end

visibility, information readiness and speed, and cross-functional data parity. The informant from the production department described the increased visibility over the entire flow from materials to delivery that can be looked in figure 3.

“we now have much better visibility, from the position of materials at the supplier and production status to delivery... within one system” (Production Department Informant, interview, 2026).

A similar point was made by the informant from the operations department regarding the speed at which information becomes available for decision-making:

“The information needed for decision-making is now more readily prepared and available faster... we do not have to wait for reports so often” (Area/Batching Plant Department Informant, interview, 2026).

Meanwhile, the informant from the logistics department affirmed that shared access to data across functions smooths inter-unit coordination:

“All parties now access the same data, so coordination has become smoother” (Logistics Department Informant, interview, 2026).

These findings are consistent with the research of Abobassier et al. (2026), which examines the role of blockchain-based traceability in supporting supply chain transparency. Conceptually, traceable records can help organizations understand the history of information and strengthen process accountability. In the context of this study, such benefits are visible in the orderliness of documentation, the availability of information, and the ease of internal coordination.

“With suppliers, I think not, because suppliers do not have access to our blockchain” (Purchasing Department Informant, interview, 2026)

“As for externally... it is strictly internal, which is why it is very private” (Logistics Department Informant, interview, 2026).

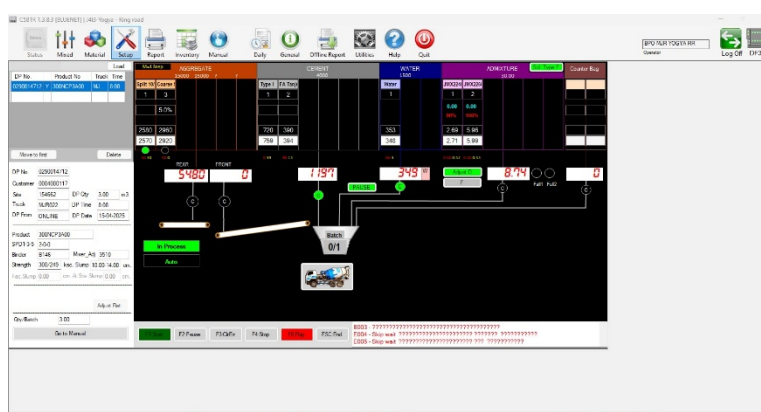


Figure 3. Feasibility of RMC NET

However, the present finding qualifies the broader expectation that blockchain necessarily creates transparency among all supply-chain participants. The RMC NET system is primarily accessible to internal company users, while suppliers do not have equivalent direct access. Therefore, the transparency observed in

this case is stronger within the company than across the full supply network. This boundary is important when read alongside Budler et al. (2024), who review transparency as a concept shaped by its antecedents, technologies, and forms, and Bernards et al. (2024), whose analysis of blockchain and sustainability governance cautions against treating technological transparency as automatically complete or neutral. The current study does not reject the transparency benefits described by previous studies; rather, it shows that these benefits depend on system governance and on which actors are permitted to view or contribute information.

In this section, the Lean method has also supported the company's operational activities: the theme "Internal transparency has increased markedly" likewise provides an indication regarding the process time (LSC6) and delivery performance (LSC5) indicators, because faster availability of information allows decision-making to proceed without bureaucratic obstacles or the wait for manual reports:

"The information needed for decision-making is now more readily prepared and available faster... we do not have to wait for reports so often" (Area/Batching Plant Department Informant, interview, 2026).

Likewise, shared access to data across functions contributes to leaner coordination among units, in keeping with the lean principle of smooth information flow as a prerequisite for efficient material flow:

"All parties now access the same data, so coordination has become smoother" (Logistics Department Informant, interview, 2026).

These findings make it clear that technological transparency and interparty transparency are related but not identical. A system can provide information that is easily traceable for internal users without automatically granting visibility to suppliers. Accordingly, Proposition 1 is supported in the context of internal transparency, subject to limitations in integration and external access. For the management of PT SCG Readymix, these findings indicate that the priority for developing RMC NET lies not merely in adding technological functions but in expanding the integration of relevant information with external parties. The company could consider information-exchange mechanisms with suppliers that still safeguard data security and privacy. In this way, the benefits of transparency do not stop at internal coordination but can be used to improve information synchronization with suppliers. Conclusion for P1: Based on the analysis conducted, the adoption of Blockchain Technology RMC NET supports enhanced information transparency in supply chain activities.

4.2.2. P2: Blockchain Technology Has a Positive Influence on Supply Chain Flexibility

The findings for P2 also align with prior research that links blockchain capabilities with supply-chain flexibility and responsiveness. Potnis et al. (2023) examine the roles of blockchain in supply-chain capability and flexibility, and Wang and Yang (2022) discuss how trusted and timely information can support coordination in supply-chain relationships. In the present study, informants reported that shared operational information and coordination across functions helped staff respond more quickly when order requirements, material availability, or delivery arrangements changed. The finding is consistent with the explanation that digital visibility can improve the information base for operational decisions, thereby making adjustments easier to coordinate.

"Transformed our supply chain from what previously felt fragmented into something more like a single team" (Purchasing Department Informant, interview, 2026).

The informant engaged in cross-functional coordination explained how blockchain changed work patterns in a previously fragmented supply chain. The impact of this integration was subsequently felt at the level of overall operational performance:

“Has a positive impact on overall cost, time, and quality performance” (Production Department Informant, interview, 2026).

At the managerial level, this adaptive capability is evident in the speed and precision of responses to changes in demand and to operational disruptions:

“Management has better control... when demand changes or disruptions occur, we can make decisions faster and more accurately” (Area/Batching Plant Department Informant, interview, 2026).

Meanwhile, the resulting cost efficiency also underpins operational flexibility in the field:

“a lot of costs can be reduced... so we are more flexible” (Logistics Department Informant, interview, 2026)

These four quotations come from different positions, yet they consistently associate blockchain adoption with cross-functional integration, accelerated decision-making, and cost and time savings that ultimately enhance operational adaptability. The absence of a counter-theme, together with the uniformity of language among informants (“one team,” “faster,” “more flexible”), is a strong indicator that this theme is genuinely robust and not merely a normative response from informants. These findings reinforce the literature that positions blockchain as an enabler of supply chain capability and flexibility (Potnis, Lau, & Yip, 2023), and at the same time constitute the finding with the highest level of qualitative confidence in this study, as no contradiction whatsoever was found across sources. At the same time, the findings refine rather than simply repeat this positive relationship. Informants’ accounts suggest that faster access to information can facilitate a response, but it does not remove all operational constraints. Flexibility still depends on the availability of materials, production capacity, transport and delivery conditions, and the ability of relevant parties to act on the information. This interpretation is compatible with the broader concern in Zhou et al. (2025) that blockchain adoption should be considered in relation to the balance between stability and flexibility, rather than assumed to deliver flexibility automatically. Moreover, because suppliers do not directly participate in RMC NET, the flexibility demonstrated by the case is most evident in internal coordination; the study cannot conclude that the system creates equally strong flexibility across the external supplier network. For management, these findings indicate that the strategic value of RMC NET lies not only in its recording function but in its capacity to serve as an operational decision-support tool. Faster information can be used to anticipate changes in material requirements, adjust production and distribution activities, and accelerate coordination when disruptions occur.

The Lean-method analysis in this section reveals that the adaptive capability formed through blockchain adoption, as discussed under P2, is also relevant to the inventory management (LSC4) and productivity (LSC3) indicators, since superior managerial control over demand or supply disruptions is, in essence, the lean capability of responding to variability without stockpiling excess inventory:

“Management has better control... when demand changes or disruptions occur, we can make decisions faster and more accurately” (Area/Batching Plant Department Informant, interview, 2026).

“Transformed our supply chain from what previously felt fragmented into something more like a single team” (Purchasing Department Informant, interview, 2026).

The cross-functional integration noted above is a fundamental prerequisite for lean implementation at the supply chain level (not merely at the plant level), because lean practices such as value stream mapping and just-in-time demand visibility and coordination commensurate with what informants described. Faster availability of information can help management respond to changes in demand and disruptions. Likewise, better cross-functional coordination can support adjustments to production and delivery activities. Flexibility thus arises from the use of information in work processes and decision-making, rather than merely from the fact that the technology has been implemented. Conclusion for P2: Based on the analysis conducted, the adoption of Blockchain Technology RMC NET supports supply chain flexibility through enhanced information visibility, process integration, and faster decision-making.

4.2.3. P3: Blockchain Technology Has a Positive Influence on Supplier Trust

In contrast to transparency and flexibility, the findings on supplier trust do not show that blockchain use automatically enhances trust. Informants placed greater emphasis on performance track record, quality consistency, delivery punctuality, and direct interaction in assessing supplier dependability. This finding runs counter to the propositions of Pattanayak et al. (2024) and Wang and Yang (2022), who anticipated a positive relationship between blockchain and trust through enhanced transparency, security, and information verifiability.

This difference should not be interpreted as proof that blockchain cannot support trust. Instead, it indicates that the mechanism identified in prior research may be incomplete or conditional in this setting. First, the suppliers cannot directly access or participate in RMC NET, limiting the system’s ability to create shared visibility and mutual verification. Second, a traceable digital record can make a recorded transaction easier to track, but it does not by itself establish that the underlying material or information is accurate; quality sampling and laboratory testing remain necessary. Third, supplier trust is relational and accumulates through repeated performance and interaction. Madanchian and Taherdoost (2025) discuss blockchain in relation to transparency, traceability, and trust, while the present case highlights that these concepts should not be treated as interchangeable outcomes: traceability may improve without an equivalent immediate increase in relational trust.

Management should not rely on blockchain as the sole instrument for building supplier trust. On the contrary, the findings underscore the need to sustain supplier relationship management through performance evaluations, regular communication, field visits, quality verification, and direct interaction. A more fitting strategy, therefore, is to combine digital trust with relational trust. RMC NET can be used to reinforce transparency and documentation, while supplier trust continues to be built through collaborative experience and performance consistency.

The Lean-method analysis in this section sheds light on the proposition concerning supplier trust: in contrast to transparency and flexibility, the findings on the supplier trust variable (P3) show that improvements in internal efficiency (lean) do not automatically spill over into trust toward external suppliers. Efficiency and process leanness are internal-organizational in nature, whereas trust is relational-interpersonal and is formed through a different pathway:

“Our trust in partners is determined more by their performance track record, not merely by the presence of Blockchain Technology” (Purchasing Department Informant, interview, 2026).

Accordingly, Lean as a mechanism that bridges blockchain and sustainable supply chain performance is relevant only along the informational-procedural pathway (transparency and flexibility) and cannot be

positioned as a pathway that explains the formation of supplier trust. These findings should be read as a contextual explanation, not as evidence that blockchain can never support supplier trust. In the case examined, the technology's benefits for recording and internal transparency were not sufficient to replace the process of building relational trust. The findings on limited supplier access show that internal information integration does not necessarily produce transparency that is evenly distributed across the supply chain network. Nurani and Rajab (2026) identify data quality, technological readiness, organizational alignment, and interorganizational collaboration as factors that influence the effectiveness of information integration. In the context of PT Siam Cement Group Readymix Yogyakarta, this finding indicates that the benefits of RMC NET for external transparency relate not only to recording capability but also to the scope of information access and supplier involvement in the system. Conclusion for P3: Based on the analysis conducted, the adoption of Blockchain Technology RMC NET has not directly fostered supplier trust where supplier involvement in the system remains limited.

V. Conclusions

This study concludes that the adoption of Blockchain Technology RMC NET at PT Siam Cement Group Readymix Yogyakarta supports the development of supply chain transparency, supply chain flexibility, and Lean Supply Chain practices. The findings indicate that blockchain contributes chiefly through enhanced information visibility and traceability, improved information sharing, cross-functional integration, and faster access to information for operational decision-making. These capabilities underpin a more responsive and integrated supply chain.

The findings further indicate that the role of Lean Supply Chain is reflected in the translation of improved information and coordination into operational efficiency. The visibility and integration supported by blockchain facilitate process efficiency, productivity, inventory management, delivery performance, process time, and quality. Lean Supply Chain thus operates as an operational mechanism that explains how technological capability can contribute to sustainable supply chain performance. A pivotal finding of this study concerns supplier trust. Although blockchain supports transparency and traceability, its adoption has not automatically fostered trust between the company and its suppliers. Supplier trust remains closely tied to suppliers' performance track records, consistency, communication, and direct interaction. This finding suggests that technological transparency and relational trust are two distinct dimensions of supply chain relationships. Theoretically, this study shows that the benefits of blockchain should not be understood solely as technological outcomes. Information visibility and traceability can strengthen operational coordination and lean processes, whereas relational outcomes such as supplier trust require additional interpersonal and organizational factors. The study is limited by its qualitative case study design and its reliance on five key informants, so its findings represent the empirical context of PT Siam Cement Group Readymix Yogyakarta and are not intended to demonstrate statistically generalizable relationships. Future research could examine the proposed relationships across multiple firms or supply chain actors with a broader empirical scope.

The company is advised to evaluate opportunities to extend information access to suppliers in line with need and authority, to strengthen cross-functional information integration, and to retain quality verification mechanisms and supplier relationship management. These measures can help the company maximize the benefits of the system without relying on technology as the sole basis of trust. This study is limited because it employs a single-company case study with five key informants, so its results depict the context studied and are not intended to be statistically generalized. Future research could involve companies and suppliers directly and examine further the relationships among blockchain adoption, transparency, flexibility, lean practices, and sustainable performance dimensions.

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