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Managerial and Organizational Implications Arising from the Implementation of Blockchain Technology in Supply Chains: An AS-IS and To-Be Analysis

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Abstract: **Purpose:** The main objective of this research is to highlight the managerial and organizational implications for businesses resulting from the implementation of blockchain logic and technologies. The functionalities of blockchain technologies are compared with the traditional approach to supply chain management to emphasize the impact they can have on managing intra-supply chain relationships and the organizational structure of companies involved in supply channels. **Design/methodology/approach:** To conduct this study, a conceptual study was carried out, starting from an analysis of the main characteristics of blockchain technologies, to build an AS-IS scenario compared with the TO-BE scenario resulting from the implementation of these technologies within supply chains. To conduct this study, conceptual categories of the viable system approach and process management perspective were utilized. The conceptual analysis was performed using a matrix representation, which correlates material, informational, and financial flows with the dimensions of traceability, transparency, and efficiency, before and after the implementation of blockchains in managing supply chain transactions. **Findings:** The study highlighted how the principles underlying blockchain can lead to overcoming the traditional indispensable search for trust among supply chain operators. Therefore, through these results, it is possible to hypothesize an improvement in the resilience conditions of companies operating in block-supply chains. **Originality/value:** This study contributes to investigating the relationship between blockchain and operational consonance among operators in managing interorganizational processes to improve conditions of efficiency, traceability, and transparency, which are functional in the resilience of companies involved in the supply chain compared to the changing dynamics of the context. **Research implications:** Trustless logic in the implementation of blockchain technologies leads to the configuration of a new concept of trust, connected to the entire supply chain system, as a result of the improvement in the security, visibility, and efficiency conditions of transactions. The increased visibility and transparency developed in block-supply chains prompt all actors involved in the supply chains to rethink information management, given the reduction in informational asymmetries and, thus, the optimization of transaction costs.



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1. Introduction: Interorganizational Processes

The digital transition and data management in supply chains represent some of the most significant challenges in recent years. The optimization of supply chain management (SCM) has gained increasing importance in the process of creating business value, as indicated by Brinch (2018) and Chen et al. (2015). The debate among researchers on integrating supply chains through technology has emphasized the importance of promoting trust and partnerships among the various actors involved, as highlighted by Kshetri (2018).

In this context, blockchain technology (BT) has attracted considerable attention due to its potential impact on interorganizational process management and the structures of the

companies involved, as highlighted by [Das \(2020\)](#). The application of BT is seen as a specific and efficient solution to improve supplier relationship management ([Dubey et al. 2020](#)). Studies have shown that integrating BT into business processes brings various benefits, including disintermediation, process automation, a reduction in transaction costs, and information security ([Cozzolino et al. 2023](#)).

Among these benefits, traceability emerges as a key element for the application of BT in supply chain management ([Chang et al. 2022](#)). BT, being a distributed ledger technology, allows multiple nodes to read and modify information, as explained by [Ali et al. \(2021\)](#). Furthermore, trust plays a crucial role in the value-creation process within supply chains ([Wu et al. 2023](#)). The use of BT offers opportunities to transform trust dynamics within supply chains, enabling the exchange of value between the supply chain and the blockchain itself ([Kiwala et al. 2023](#)). By eliminating the need for intermediaries, BT creates trust between parties inherently ([Hackius and Petersen 2017](#)). Moreover, BT serves as a cost-effective tool to address collaboration and trust issues in supply chains, while also minimizing the negative impacts of information asymmetry across its echelons ([Longo et al. 2019](#)).

This transformation is facilitated by smart contracts (SC), which are business logics executed on a blockchain, ensuring secure and transparent transactions among supply chain actors ([Dolgui et al. 2020](#)). Through SC, the verification and control of contractual agreements are decentralized to all nodes in the network, improving consensus and transparency ([Yalcin et al. 2020](#)). From a control standpoint, the implementation of blockchain technology will serve to streamline and enhance the transparency of information collection processes, consequently reducing overall audit delivery times ([Venkatesh et al. 2020](#)).

Despite numerous BT applications and projects in supply chain management, there is a gap in the analysis of the impact on the current operational state and future of processes affected by BT implementation ([Batwa and Norrman 2020](#); [Dietrich et al. 2021](#)). However, studies have highlighted significant benefits in terms of traceability, security, and fraud prevention ([Saberi et al. 2019](#); [Karunamurthy et al. 2023](#)).

To address this gap, we propose a simulation of an AS-IS-TO-BE scenario and demonstrate the empirical effects of BT application in supply chain management ([Moosavi et al. 2021](#)), with particular attention to operational consonance, trust perspective, and emerging resilience.

The main research gap emerging from the analysis of the topics addressed in this study is related to evaluating the impact of blockchain technologies on interorganizational process management in the supply chain, particularly their contribution to overcoming the traditional perspective of the “trust” concept, which has seen companies engaged in creating one-to-one collaborative relationships in recent years.

Therefore, there is a need to investigate the relationship between blockchains and operational consonance among operators in managing interorganizational processes to improve conditions of efficiency, traceability, and transparency, which are functional in the resilience of companies involved in the supply chain against the changing dynamics of the context. Another research gap is closely related to evaluating the implications on the make-or-buy trade-off and the concept of transaction costs.

Due to the identified research gaps, this study aims to address the following research questions:

RQ 1. Do blockchain technologies facilitate the development of conditions for increasing structural consonance within supply chains?

RQ 2. Does the underlying logic of blockchain contribute to a paradigm shift in the concept of “trust” among operators involved in supply chains?

The hypothesis underlying this work is the actual capacity of blockchain technology and logic to contribute to the enhancement of operational consonance among different operators involved in supply chains as a prerequisite for increasing visibility in the supply chain and the knowledge available to operators TO BE resilient against the evolving dynamics of the context.

2. Theoretical Background

2.1. Blockchain and Supply Chain Management

Blockchain technology has been widely adopted in the financial sector, but it is increasingly finding applications in other industrial sectors as well (Jabbari and Kaminsky 2018). This adoption has led to significant changes in supply chains and markets (Esmailian et al. 2020). The integration of blockchain into business processes offers numerous benefits, including disintermediation, process automation, a reduction in transaction costs, and increased information security (Cordova et al. 2021), as well as increased trust, visibility, transparency, and speed (Huang et al. 2023), which positively impact all processes across the entire supply chain, from upstream to downstream (Di Francesco et al. 2023). Process automation is made possible by the automatic operation of blockchain technology, eliminating the need for manual intervention by users (Jackson et al. 2023). This allows all parties to access the same information simultaneously, potentially reducing connection or data transfer issues (Anupama Kumar and Anusha 2023). In fact, blockchain replaces manual activities with automatic interactions, making processes faster and more efficient (Francisco and Swanson 2018). Transaction verification occurs directly by chain participants, reducing the need for intermediaries (Apte and Petrovsky 2016). This leads to a reduction in transaction costs and times (Fahimnia et al. 2015; Abdelgalil et al. 2021). Blockchain-enabled supply chain management (SCM) helps to eliminate bottlenecks, avoid uncertainties, and improve decision-making, resulting in enhanced firm performance and robustness capabilities (Aslam et al. 2023). Implementing blockchain can significantly transform the management of intra- and interorganizational processes, making them more efficient and transparent (Pournader et al. 2020), and it has the potential to substantially enhance existing supply chain processes and may lead to entirely new organizational structures in the future (Blossey et al. 2019). Furthermore, blockchain promotes a different perspective of trust among operators involved in supply chains (Christidis and Devetsikiotis 2016) and offers innovative potential for all industries (Risso et al. 2023). Business organizations should be aware of the value-creation potential and competitive advantage offered by process automation and blockchain adoption (Yontar 2023).

2.2. Viable System Approach

The impact of blockchain technologies on relationship management processes within supply chains can also be analyzed using the viable system approach (VSA) (Golinelli 2005). This derives from Beer's definition of a viable system: "The viable system is a system that survives, remains united and integral; it is homeostatically balanced both internally and externally and also has mechanisms and opportunities to grow and learn, to develop and adapt, and thus to become increasingly effective in its environment" (Beer et al. 1973). This interdisciplinary approach allows for the examination of organizations within their reference context, identifying two main areas: that of strategic decisions, guided by the governing body (Gatti et al. 2007), and that of operational decisions and daily activities, defined as the operational structure (Barile and Calabrese 2011a, 2011b). In the context of this approach, the concept of structure, also understood as a genotypic dimension, encompasses various semantic qualifications that are widely used. For example, consider the concept of the human body or a nation; both imply the presence of interconnected components (Barile and Calabrese 2009; Barile and Saviano 2011).

The concept of structure is subject to various interpretations, depending on specific contextual conditions, sometimes making a representation based on connections more appropriate, other times on relationships, and still other times on interactions and processes (Barile and Nigro 1998).

On the other hand, the dimension of the process (phenotypic) is examined through the concept of a system (Esposito De Falco 2006, 2008).

At the system level, the physical boundaries of individual firms involved in supply chains become irrelevant, and the connections between them in managing various supply chain exchanges transform into relationships. These relationships, when activated through

the operation of processes, generate interactions between the involved systems. Structural consonance is the condition of harmony among the components of structure (resources and processes), which enables relationships and facilitates the emergence of systems and interactions among them (Barile et al. 2016).

2.3. Process Management

To achieve planned performance, management must define an effective strategy, primarily using internal resources and combining them appropriately to gain the desired competitive advantage (Grant 2022). It is therefore important for every company to identify specific internal resources and combine them correctly to develop capabilities and competencies crucial for maintaining a competitive advantage over time (Calabrese et al. 2024).

To do this, the company must organize resources (such as personnel, technologies, and structures) into processes, leveraging a broader vision than that limited to within the company's boundaries. This means also combining resources and structures into interorganizational processes—as in the case of supply chains—to generate conditions for enhancing the potential of a competitive advantage.

Processes facilitate relationships between resources, allowing the development of specific capabilities and competencies (Biffi and Pecchiari 1998).

Therefore, we can say that processes are fundamental for creating the instrumental conditions for value generation, as they are linked to resource allocation and, consequently, the development of the capabilities and competencies necessary to achieve and maintain a company's competitive advantage (Jeston and Nelis 2006).

In this analysis, the focus is on the interorganizational processes of the supply chain, hypothesizing the impact of blockchain technologies on them through a comparison analysis between the AS-IS and TO-BE scenarios to highlight the implications on the dimensions of efficiency, traceability, and transparency (Barile and Nigro 1998).

3. Methodological Note

In light of the identified research questions, this study aimed to hypothesize the implications arising from the implementation of blockchain in the management of interorganizational supply chain relationships.

This study aims TO BE a “conceptual” contribution, where the logical reasoning started from a narrative analysis of the literature, which was deliberately non-systematic so as to follow a path not limited to specific contributions already present in the literature, thus allowing ample freedom for analysis¹.

Based on the knowledge of the main characteristics of blockchain logic and technologies, ex ante (AS-IS) and ex post (TO-BE) scenarios were constructed considering the impact on physical, informational, and financial flows of potential implementation within supply chain relationships.

The conceptual work was conducted using a matrix schematization, which crosses material (and service execution) flows, informational flows, and financial flows with the dimensions of traceability, transparency, and efficiency, before (AS IS) and after (TO BE) the implementation of blockchain and smart contracts in the regulation of supply chain transactions.

Furthermore, the macro-process of interorganizational supply chain relationships was reconstructed, building a TO-BE hypothesis to represent the potential improvement in the emerging flow following the implementation of interorganizational blockchains.

4. The Framework

Before delving into the details of the main flows affected by blockchain technology, it is useful to clarify what is meant by security, transparency, and exchanges by stating from now on that security is closely related to blockchain's ability to ensure transparency and the traceability of exchanges.

Transparency is linked to the functioning of the technology itself, which guarantees visibility in the entire system within which exchanges occur in an environment where there is no central node through which all transactions pass but rather a peer-to-peer openness and decentralization of exchange approval. Each exchange is certified by a passage in the blockchain network of nodes, either established or adhered to by operators, and each subsequent modification of that passage is made transparent to the entire blockchain system.

Closely related to transparency is the traceability that blockchain technology guarantees. The ability to fix steps in the system—thanks to their certification—allows for an open view of the steps that each transaction takes along the physical, informational, and financial flows connected to it, resulting in optimizing exchanges in terms of execution speed and financial realization.

From our perspective, the transparency and traceability induced by blockchain technology contribute to increasing the level of security within which exchanges occur, facilitating the emergence of a conducive environment for the optimal management of relationships among the involved operators, who are induced to trust the system and thus open up to cooperation. The structural alignment of internal and interface processes is facilitated by the functional characteristics of blockchain technology, which, through this, can be considered a facilitating factor of structural consonance among the involved operators.

It is evident that an objective to pursue in the implementation of a blockchain—or in joining an existing one—must be the improvement in operational efficiency, which is linked to the ability to achieve an optimal level of transaction performance, with the simultaneous reduction in resources employed and the associated level of risk.

Material flows are connected to the transfer along the supply chain of the goods exchanged, such as raw materials useful for their transformation into semi-finished or finished products, products purchased for resale, products purchased by end buyers, complementary materials for production, or the execution of services. Within this category of flows, the execution of services is undoubtedly included and is characterized by simultaneous consumption at the time they are delivered.

These flows often require the involvement of third parties for their realization; think of the value added by logistics operators in managing transportation and stocks.

Material flows are closely linked to informational flows, often as a consequence of an informational input that activates them, such as a supply order, for example. But informational flows are also connected to documentary flows that follow material exchange or service delivery; in this case, reference is made to fiscal documents (delivery notes, invoices) that accompany the execution of the supply. Today, more and more frequently, within supply chains, exchanges of information concerning certain aspects are developed, such as, for example, market information, the profiling of buyers and end consumers, market forecasts and scenarios, etc., with a view to informational sharing aimed at increasing the overall value of the supply chain.

The exchanges that take place within a supply chain generate financial flows that, if connected to top-down supplies, develop in the opposite direction to material flows and are linked to the payment of supplies and the provision of services. Financial flows are also closely linked to informational flows, particularly documentary flows, as the payment for supplies usually depends on the receipt and approval of documents proving the exchanges, such as sales invoices.

Below is presented an AS-IS and TO-BE analysis connected to the intersection between the three dimensions of transparency, traceability, and efficiency and the material, informational, and financial flows considered, in order to highlight how the introduction of blockchain technologies can impact the dimensions themselves and consequently affect the three flows considered (Tables 1 and 2).

Table 1. Flow dimensions analysis matrix (AS IS).

	Material Flow	Information Flow	Financial Flow
Transparency	Limited view of (a) the supply chain, to the phases in which individual operators intervene; (b) product availability along the supply chain; (c) exchanges along all the steps that occur in the supply chain.	Sharing of information limited to individual transactions (order management and exchanged fiscal documents). Nearly absent additional information on the needs of the supply chain and the markets served (information asymmetries also on exchange conditions).	Limited view of (a) exclusive assessment of the reliability of the other party involved in the exchange; (b) opportunities for working capital mobilization and the operating financial actors.
Traceability	The traceability of goods along the supply chain is limited to individual transactions and the specific counterparts involved in the exchange. There may be ex post information on documentation or labels, but specific certainty is not certified.	The information flows are traced only within the specific exchange relationship: order sent–order received; delivery note sent–delivery note received; invoice sent–invoice received. The traceability of goods’ movements is limited to documentation and labels, visible only ex post, meaning upon receipt. Information and documentary flows are also subject to mandatory analog conservation to comply with legal regulations.	The traceability of financial flows is an aspect that concerns each individual transaction within a contractual relationship between two parties, and it materializes only when the debtor makes the payment and sends a specific (accounting) communication to the creditor.
Efficiency	Material flows are affected by the limited sharing of information flows, as they are tied to the constraints of document issuance, particularly to the reconciliation between them for the activation of material flows. Consider the non-automatic verification of order conditions to prepare the goods for shipment, the need to reconcile orders with confirmations to prepare the goods for shipment, and the physical receipt of the delivery note (DDT) to confirm and accept the goods. This implies the use of specific resources to carry out the material flow.	Partial view of the supply chain, the involved operators, and the trading conditions (information asymmetries and opportunistic behaviors, which need to be reduced). Operators must allocate more resources to mitigate the effects of these limitations, leading to increased transaction costs. The efficiency of the exchange is also affected by the resources needed for the analog conservation of document flows, in accordance with legal requirements.	Operational limitations associated with the constraints of the traditional flow: invoice issuance–order and DDT reconciliation–payment; elongation of times and potential opportunistic behaviors of debtors. Limited view of counterparts and their reliability, resulting in the need for greater resources to achieve an adequate level of knowledge and reliability in managing exchanges. Human and financial resources must also be employed to seek alternative forms of working capital mobilization, which generally increases transaction costs.

Table 2. Flow dimensions analysis matrix (TO BE).

	Material Flow	Information Flow	Financial Flow
Transparency	Shared view of the supply chain due to the decentralized certification of operations among the nodes of the blockchain network. Material exchanges traced and visible to all nodes of the network. Transparency regarding product availability increases in relation to the technology's ability to track the movements of goods. The use of IoT technology allows the monitoring of various stages of merchandise along the supply chain.	Thanks to the automatisms of the shared smart contracts among the involved parties, the constraints related to the need to reduce informational asymmetries among the actors of the supply chain in managing exchanges are minimized. Information transparency is also linked to the immutability of the document passages between the different nodes of the blockchain: all data, information, documents tracked in the blockchain are immutable. This generates certainty in exchanges and widespread transparency.	Thanks to the full and shared traceability of financial flows among the actors involved in the blockchain, it is possible to ensure broader financial transparency within the supply chain. In particular, every actor in the chain is able to know the financial transactions within the chain and have certainty about when they occur. Furthermore, it is possible to have a comprehensive view of all the financial actors participating in the blockchain and, therefore, also of the different solutions that can be pursued for the mobilization of working capital.
Traceability	The certification of each step of goods between the nodes of the blockchain network allows the tracking of exchanges within the supply chain and, particularly, ensuring the immutability of these steps, to the benefit of greater certainty of traceability, no longer tied to a unilateral attestation by individual operators post facto in documents and labels. Therefore, all involved operators can have visibility into the traceability of goods.	Information and documents are tracked along the supply chain through blockchain certification of each step. Therefore, traceability is shared in peer-to-peer logic. Document flows are also directed towards digital preservation: the hash of the documents is crystallized on the blockchain, but the native digital document can undergo a legal digital preservation procedure in order to obtain legal validity over time. Thanks to greater traceability of goods and information passages, the involved actors can better plan the receipt of goods and the financial management of the exchange.	Financial flows are tracked and certified on the blockchain, and as a result, their traceability is no longer limited to the parties involved in the transaction. This implies full and shared financial traceability, leading to an increase in financial transparency within the supply chain.
Efficiency	The operation of material flows is optimized thanks to the functioning of smart contracts. Material flows can benefit from the functionalities of smart contracts and the certification of the hash of all documents or information issued for the management of material flows. This includes the automatic verification of order conditions against shared smart contracts to prepare goods for dispatch, the ability to reconcile orders with confirmations directly on the blockchain nodes to proceed with preparing the goods and linking the certified delivery note (DDT) on the blockchain to confirm and accept the goods. All of this implies a saving of specific resources to advance the material flow. The use of IoT technologies linked to blockchains allows the monitoring of the passage of goods along the supply chain with optimal resource utilization, generating cost savings and improving subsequent outcomes.	The automations associated with the functioning of smart contracts allow for a reduction in the use of resources for mitigating informational asymmetries, particularly those related to opportunistic behaviors. The impact on process efficiency is also linked to the functionalities of blockchains integrated with document management technologies, enabling the automatic reconciliation of documents (orders, order confirmations, delivery notes, invoices, payment receipts) along the supply chain. Furthermore, improving process efficiency can be achieved through the use of technology for digital document preservation compliant with regulations. This not only ensures legally valid preservation but also optimizes the resources used for preserving documentation related to exchanges within the supply chain.	The operational limitations associated with the constraints of the traditional flow—invoice issuance, reconciliation with orders and delivery notes, and payment—can be overcome through the use of smart contracts combined with blockchain-based document management technologies. These technologies enable a reduction in the timing of transaction payments through the automation of cause-and-effect processes and document reconciliation functionalities for documents certified on the blockchain. As a result, the opportunistic behaviors of debtors can also be limited, and this solution enables the optimization of working capital. The increased financial transparency, coupled with broader traceability of financial flows, allows the involved parties to have a broader view of the other parties involved and their reliability.

Through a workflow representation of the material, informational, and financial flows, we outline the following:

Firstly, an AS-IS reconstruction of the process related to procurement orders within a generic supply chain (Figure 1), then, a TO-BE reengineering of the same due to the implications arising from the use of blockchain technologies (Figure 2).

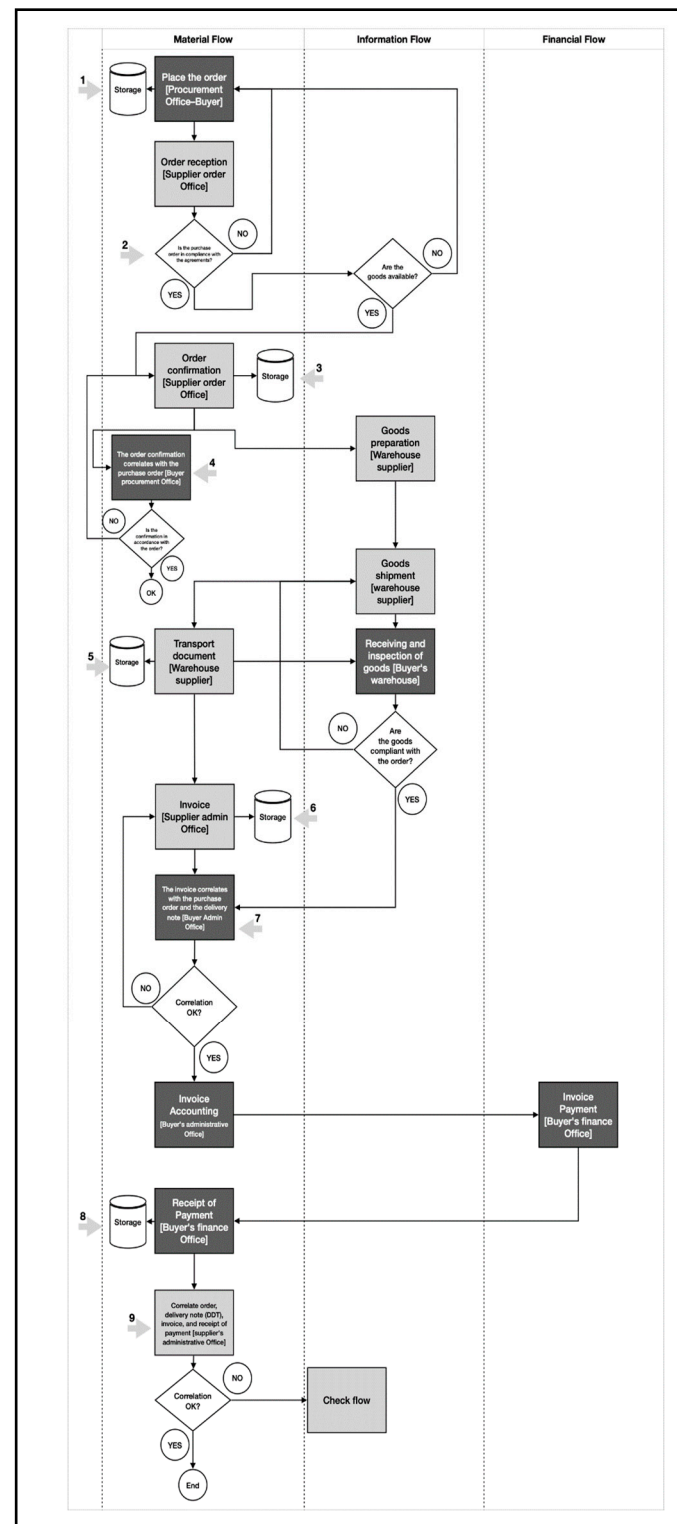


Figure 1. AS-IS process of the material, informational, and financial flows related to the procurement order management process within a supply chain. Source: our elaboration.

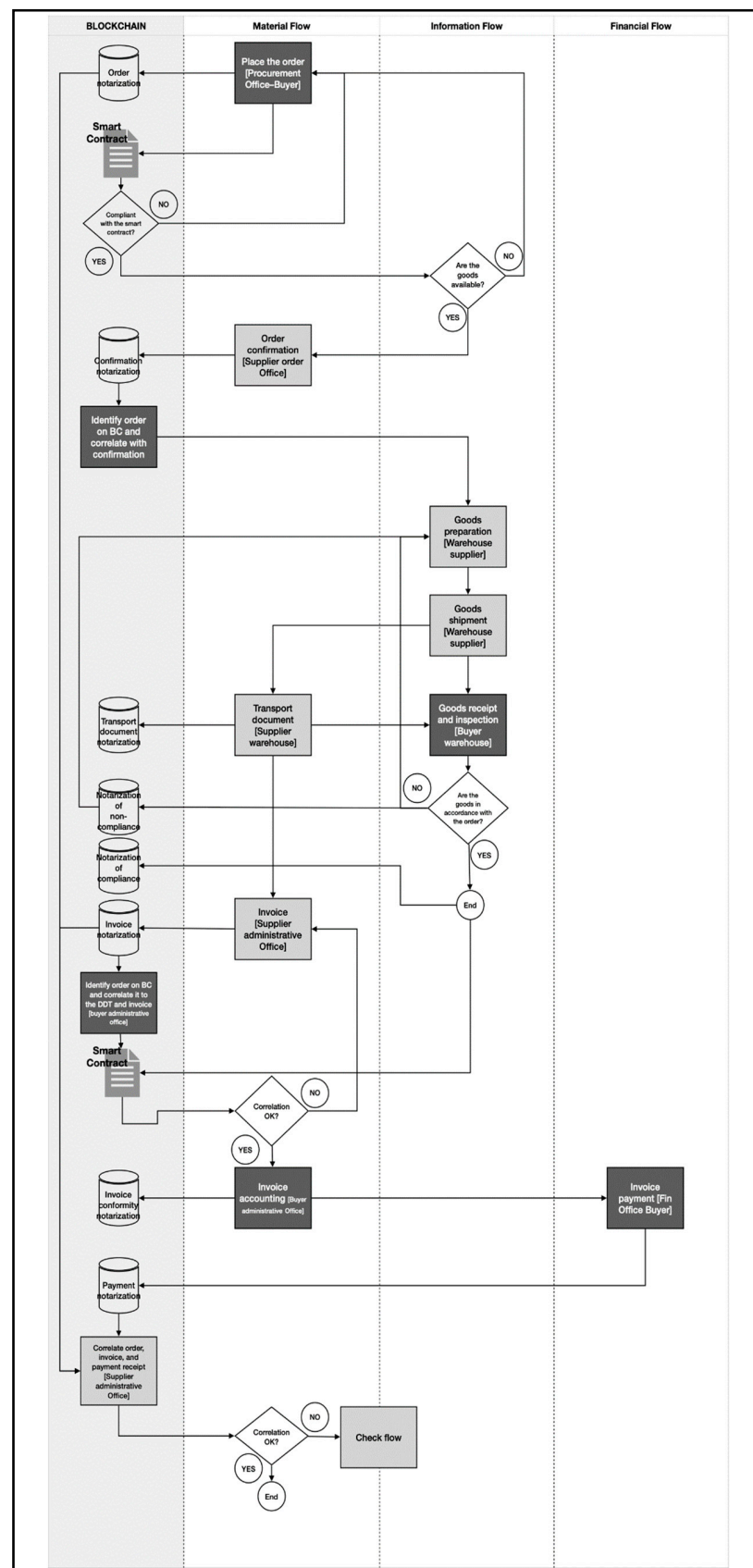


Figure 2. TO-BE process of the material, informational, and financial flows related to the procurement order management process within a supply chain, with the use of blockchain technologies. Source: our elaboration.

The hypothesized re-engineering highlights the organizational implications and their impact on the dimensions of transparency, traceability, and efficiency considered so far in our analysis. Specifically, the following implications can be observed, depending on the dimension considered:

1. *Transparency Dimension*

In the AS-IS flows, all of the steps where the involved organizations must store documents and information in an analog manner were highlighted, specifically those coded with numbers 1, 3, 5, 6, and 8. This results in the following:

- Increased organizational complexity due to continuous analog storage of documents or digital storage of dematerialized documents;
- Lack of adequate transparency of document and informational flows, as the documents are stored by individual organizations involved, and thus are not visible within the processes managing the supply chain relationships.

The hypothesized re-engineering with the integration of digital technologies and blockchain allows for the notarization of native digital documents and information, with the triple effect of the following:

- Ensuring the temporal certification, certainty, reliability, and immutability of the same;
- Increasing the level of document flow sharing within the processes managing the supply chain relationships;
- Reducing organizational complexity associated with document and information production and their subsequent preservation².

2. *Traceability Dimension*

The notarization of documents and information produced in the management of supply relationships increases visibility in the supply chain, particularly the traceability of the material flow of goods correlated with the document and financial flow. Specifically, notarization affects the following steps:

- Order confirmation -> order being prepared at the supplier;
- Delivery note (DDT) -> order dispatched by the supplier;
- Non-conformity/conformity -> order received by the buyer;
- Invoice conformity -> delivery approved by the buyer;
- Payment -> order paid by the buyer and approved by the supplier.

Most active blockchain projects in supply chains involve tracking products and raw materials for their certification, thus increasing visibility in the supply chain.

With the integration of IoT technologies, it is also possible to visualize the flow that products and raw materials follow along the supply chain, even during transit, allowing for the scheduling of subsequent activities, such as goods' receipt.

It is possible to track the movement of goods even during shipping without implementing blockchain technology (BT) solutions, but the following concerns are raised:

1. The tracking depends on specific inputs provided by the logistics operator and is not protected by a secure, verifiable, and permanent system like BT;
2. Therefore, a notarization of the transfer is missing, which would guarantee the immutability of the transfer and related information;
3. Even with the implementation of IoT applications (such as sensors that detect material flow movements) that can capture the tracking of goods' movements and provide visibility to the involved operators (supplier and buyer), they do not guarantee the following:
 - The notarization of the transfer (immutability);
 - Automation toward connected activities, such as document issuance or the activation of operations (such as payments). These automations, however, could be guaranteed by the BT functions typical of smart contracts.

3. Efficiency Dimension

In the AS-IS flows, the phases in which activities of verification, control, and correlation of documents are performed for the supply process along the supply chain are identified. These activities are connected to verifying compliance between orders and the terms of supply agreements, correlating order documents and tax documents related to their processing, and correlating these with the payment made by the buyer.

The implementation of blockchain technologies can increase the level of efficiency within supply chains in the following phases of material, informational, and financial flows:

1. Verification activities, as outlined in point 2 of the current process, involve checking the conditions stated in the order against the supply agreements. The subsequent activation of the informational flow (with order confirmation) and the material flow (order preparation) depend on this verification. The proposed re-engineering involves the use of blockchain technologies for automating this step, using smart contracts to ensure that the involved parties verify the supply conditions. This optimizes resources by freeing up human resources from manual verification tasks, eliminates the risk of errors that may occur during verification, and streamlines the execution times of supply-related flows.
2. Further implications are related to financial transaction management for settling exchanges within the supply chain. As highlighted in a study conducted by E. Hoffman et al. (2018), a significant aspect of assessing the impact of blockchain technologies on the supply chain is the reduction in transaction processing times due to the automation of invoice payments under certain conditions, thanks to smart contracts. Among these conditions are certainly the delivery of the purchased goods and the validation of the associated documents. The sharing of orders, transport documents, and invoices on the blockchain facilitates quick and seamless validation, as all involved parties are interconnected on the blockchain and have access to shared documents.
3. Document correlation activities involve the following:
 - For the buyer: correlating the order with the supplier's order confirmation (point 4 of the current process) to identify any discrepancies and communicate necessary changes to the supplier before shipment.
 - For the buyer: correlating order/delivery note/invoice (point 7 of the current process) to match the document flow with the order and verify any billing discrepancies.
 - For the supplier: correlating order/invoice/payment (point 9 of the current process) to match the payment to the issued invoice and close the flow.

The proposed re-engineering transfers the correlation tasks to the blockchain environment, where digitalization technologies are used to automatically identify and correlate documents and information, providing the involved parties with the outcome of the correlation. This results in operational efficiency gains, including time savings, reduced reliance on human resources for matching and document verification tasks, and minimized risks associated with document matching errors.

5. Discussion

Focalizing the research on supply chains meant directing the analysis towards the dynamics influencing the structural alignment conditions of supply relationships. The study hypothesized the implications of implementing blockchain technologies in exchange relationships, particularly on the structure of processes managing the exchange of goods, informational flows, and financial flows.

The narrative literature analysis highlighted some research gaps TO BE addressed, confirming the opportunity to verify the implications of blockchain on the structural alignment of supply chain processes, the subject of RQ 1 of this study.

The analysis conducted by reconstructing the current flows in supply chain relationships and the subsequent re-engineering with the implementation of blockchain highlights

an increase in the structural alignment conditions of exchange processes among supply chain operators, specifically linked to the improvement in transparency, traceability, and operational efficiency conditions.

Analyzing the specific functionalities of blockchain technologies in supply chain management, it emerges that they are potentially capable of creating a trustless context (Yavaprabhas et al. 2023; Tiwari et al. 2023), where the concept of “trust” takes on different connotations that cannot be placed in the classic dichotomy describing contexts characterized by purely opportunistic exchanges and contexts where operators—all or some—seek shared co-makingship solutions to reduce the risks of opportunistic behavior and informational asymmetries.

In reality, from our point of view, even the concept of trustlessness cannot adequately describe the specificity of the supply chain contexts in which blockchains operate.

Therefore, we have highlighted a paradigm shift in the concept of “trust”, closely linked to the impact that blockchain technologies can have on increasing supply chain visibility, informational sharing, flow fluidity, and speed of execution.

Blockchain technology, with its functional characteristics, would allow involved operators to manage their exchanges without needing to establish prior trust relationships, i.e., without the need to assess the reliability of counterparts to prevent desired effects.

From our point of view, the concept of trustless needs TO BE framed in a broader framework; blockchain technology creates an environment where there is greater transparency, sharing, and security, leading the involved actors to place greater trust in the overall context in which exchanges occur. It is no longer about trusting this or that operator, but rather trusting the general context in which exchanges take place, exchanges regulated on the blockchain and notarized on it.

Consider a hypothetical scenario wherein a multinational electronics conglomerate procures components for its products from diverse suppliers scattered across the global marketplace. Traditionally, the company relies on interpersonal trust mechanisms with each supplier to guarantee the caliber or punctuality of deliveries. Nevertheless, this conventional *modus operandi* is susceptible to vulnerabilities, including counterfeit parts, logistical delays, and opaqueness in transactional processes. By integrating blockchain into its supply chain architecture, the company transitions towards a trustless environment wherein transactions are meticulously recorded and immutable. Each stage of the procurement journey, extending from component fabrication to final product assembly, is meticulously documented on the blockchain ledger, furnishing stakeholders with real-time insights into the circulation of goods. This newfound transparency obviates the imperative for reliance on interpersonal trust dynamics with individual suppliers, as the integrity of transactions is unequivocally safeguarded by the blockchain network’s cryptographic protocols.

Therefore, we will have a situation where “greater transparency and security of the exchange context” induces “greater diffuse trust in the exchange context”. Therefore, even the parties involved, although no longer feeling the need to establish trust relationships with individual actors they encounter, place trust in the system within which they establish and manage exchanges.

Over the past few years, we have witnessed a progressive increase in the need to establish collaboration relationships between the parties involved. We still hear about a collaborative approach between the parties involved, which then identifies itself as a cooperative approach when collaboration develops between competing actors, who intend to increase their selfish return by trying to increase the overall value TO BE poured into the reference markets.

But, then, can all of this be overcome with the implementation of blockchains?

The transparency and traceability of exchanges that blockchain technology is designed to generate lead the involved actors to perceive a higher level of security within which to manage exchange relationships. This makes it possible to overcome the need to seek trust in the counterparts of relationships, as the functional characteristics of the technology

guarantee a cause-and-effect relationship independent of the characteristics of the parties involved and the particular relationships that might otherwise develop (Figure 3).

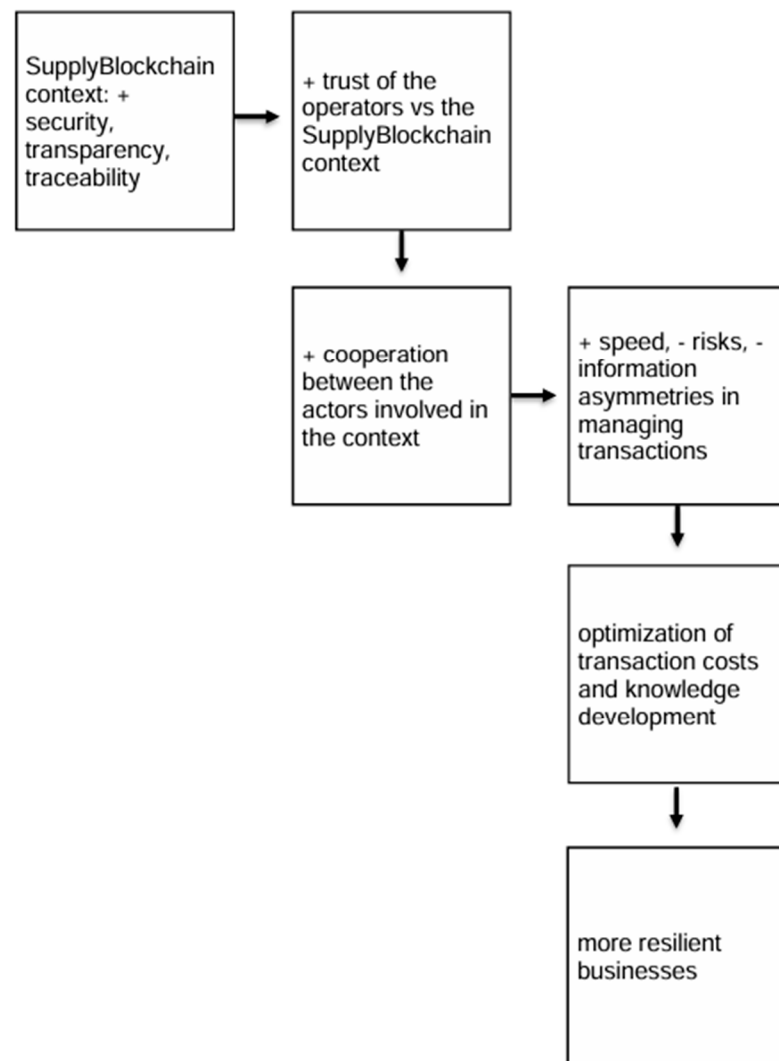


Figure 3. A different interpretation of the trustless concept connected to blockchain technology. Source: our elaboration.

These conditions both enhance the structural alignment conditions among the various operators in the supply chains and can create an exchange context characterized by higher levels of security, reliability of exchanges, transparency, and data sharing, reducing cases of opportunism and information retention.

It is believed, therefore, that such a context, as configured, creates the conditions for the emergence of “trust” among the operators involved in the context itself—with blockchain technology playing the role of a technical–functional guarantor—and, therefore, overcoming the tension of the parties involved towards the search for one-to-one or few-to-few co-makership solutions to try to reduce the risks of opportunistic behaviors in exchange relationships.

Therefore, we believe that the present research has brought to light a different paradigm of “trust”, thus addressing RQ 2 of this study and laying the groundwork for a future line of research on the specific characterization of the new paradigm of “trust” resulting from blockchain implementations within supply chain contexts.

The re-engineering of flows related to exchange relationships, with the implementation of blockchain technologies, is based on the decentralization of flows of data and digitally

native documents, which are certified (notarized) on distributed ledgers and made available to all stages of the supply chain linked to the blockchain. While not delving into the specifics of the legally compliant digital preservation of document flows, it can certainly be stated that blockchain technologies make it possible to make the data or digitally certified document on the blockchain reliable, certain, and unchangeable, thus making the informational flow that develops in the management of material and financial flow secure and shared.

The evidence emerging from the impact that blockchain technologies can have on informational transparency and traceability of transactions—both of goods or services and informational units—also represents a solid result to which to connect the consequences of blockchains on transaction costs in exchange relationships.

From the analysis of the impact of blockchain technologies on supply chain operational flows, as outlined in the results section, their contribution to optimizing the management of informational flows within exchange contexts is evident through the following:

- Data and digital document sharing on the blockchain, implying the following:
- The reliability and immutability of the data, thus ensuring greater security and certainty of the data.
- The increased informational transparency and traceability of the steps that data and documents undergo along the exchange process.
- Broader and faster access to data and documents.
- A broader visibility of the operators involved in supply chains.

The consequent improvement in information asset management can be linked to a potential reduction in informational asymmetries among operators within the supply chain context and, therefore, also to a scaling-down of transaction costs related to both the search and selection of relevant informational units and the anticipation of precautionary measures for informational security and prevention of opportunistic behaviors of the involved parties.

The context thus configured leads to speculation about a reconfiguration of make-or-buy decisions, traditionally associated with the need to optimize the trade-off between transaction costs and the risks typically associated with exchange relationships, as well as the costs and organizational impact typically associated with the internalization of one or more phases of the supply chain.

Certainly, opportunistic behaviors related to information asymmetries influence supply chain operators to not share all information with other operators in the chain (e.g., supply chain visibility, information on operators in the chain, etc.) in order to preserve the advantage of using this information for their own benefit and to the detriment of other operators. However, beyond this, the obstacle is also related to technology: blockchain technology allows—compared to ERP, EDI, etc.—the generation of distributed knowledge simply by participating in the blockchain network without going through a single central node. Therefore, it is the technology itself (distributed ledger, hash, smart contracts) that marks the profound transition to a shared context.

The potential of blockchain logic and technologies that have emerged from this research leads us to believe that the aforementioned trade-off can be overcome, given the substantial contribution they can provide to organizations in supply chain management choices and information asset management, net of any other motivations that may suggest converging towards the direction of supply chain integration.

The implementation of blockchain logic and technologies can significantly contribute to the resilience of the companies involved in supply chains. Below are some of the key relationships between blockchain and supply chain resilience:

- The improvement in traceability and transparency conditions, as investigated in this study, is linked to the potential of blockchains to enable the immutable and transparent recording of all transactions along the supply chain. This increases visibility over physical, informational, and financial flows, allowing companies to quickly identify the position and status of items, documents, and payments at any point in the supply

chain. This increased visibility is crucial for responding promptly to unforeseen disruptions, such as quality issues, delays, and external environmental constraints.

- The potential of blockchains regarding the recording and management of critical information concerning suppliers, material quality, and the reliability of customers and other actors in the supply chain enables companies to assess and mitigate risks along the supply chain more effectively. In cases of issues with a supplier or variations in quality levels, companies can react promptly, maintaining greater resilience.
- Blockchains, by supporting the implementation of smart contracts preordained to programmable cause-and-effect relationships within supply chain interactions, are potentially capable of supporting the automation of specific processes within the supply chain, enabling immediate responses to predefined or programmable events. For example, smart contracts could automatically trigger alternative procedures or compensation in case of delivery delays.

In general, the improvement in the resilience conditions of operators within a supply chain resulting from the implementation of blockchain logic is also connected to the following:

- The elimination of or reduction in dependence on intermediaries in transaction and documentation management. This can simplify the supply chain, reducing the risk of disruptions due to issues with intermediaries.

Reduction in risks associated with fraudulent behaviors of other parties interacting with the companies in various capacities and interests. The immutable nature of blockchains prevents data manipulation, ensuring the integrity of information along the supply chain.

The reduction in the complexity of the supply chain is functional to the development of more consistent decision-making processes with contextual conditions. In this way, companies can be resilient to the evolving dynamics of the environments in which they operate.

Blockchains facilitate greater collaboration among the parties involved in the supply chain, thanks to a different paradigm of trust. They can potentially create a more “trusted” environment; this environment is not the result of one-to-one agreements between the involved operators but rather the consequence of disintermediation, transparency, traceability, and efficiency generated by implementing blockchain logic and technologies within supply chain contexts. Trust among supply chain actors is no longer linked to the ability and willingness of individual actors to develop co-makership projects but is instead correlated with the improvement in conditions for managing supply chain relationships, which leads operators to undertake resilient decision-making processes in response to changing contextual conditions.

Considering this hypothesis, establishing one-to-one or many-to-many partnerships solely to cultivate mutual trust may be redundant. Nonetheless, this does not indicate a decreased necessity for partnership endeavors within supply chain operations. Quite the opposite, it would be more advantageous to channel these efforts towards enriching value creation. For example, they could prioritize fostering co-makership to ignite innovation, executing environmental and social sustainability initiatives, fortifying the brand reputation of the involved entities, and ensuring an enhanced customer experience (Cosimato and Troisi 2015).

In general, the improvement in knowledge resulting from the management of supply chains with the support of blockchain logic and technologies (Barile et al. 2019) helps the involved companies to develop a higher degree of resilience to contexts, precisely because of their better ability to adapt their strategies and operations to the changing dynamics of the environments in which they operate (Iandolo et al. 2021).

6. Implications, Conclusions, and Future Research Directions

Why should we consider adopting blockchain in the context of exchange relationships? The hypothesis that we aimed to evaluate with this study refers to the possibility of facilitating, through blockchain, the structural consonance among the actors involved in

relational processes, i.e., the ability to interact efficiently and effectively in managing the flows generated in exchange processes. In other words, blockchain technology is intended as a structural facilitator in managing interactions among different actors in a context and also certifying their steps in a decentralized manner.

In this context, the parties involved place trust in the exchange context developed with the implementation of blockchain and therefore may be induced to foster a higher level of cooperation among them to continuously improve the favorable conditions within which to manage and develop exchange relationships and to increase the speed of transactions and economic–financial cycles resulting from them.

As a result, we can identify a specific advantage in terms of optimizing transaction costs, particularly related to data sharing within the reference context, which determines the following:

- The possibility of relying on a broader and shared information base, including the existence, characteristics, and specificities of the operators present in the context or potentially TO BE involved.
- Automatism, especially smart contracts, enable a more transparent and fluid management of exchange agreements.
- A reduction in informational asymmetries among operators.
- Thus, a reduction in cases of opportunism by the involved operators, thanks to the increased transparency and traceability of exchange steps.

In other words, blockchain technology should be framed, from our point of view, as a facilitator of structural consonance (a favorable condition for the exercise of relationships among the various involved actors and the improvement in the contexts in which exchanges take place) and of the resilience of the companies involved (as the ability to undertake, promptly and timely, decision-making processes coherent with the changing dynamics of reference contexts). Resilience is specifically linked to the production of greater knowledge within supply chains, thanks to the technologies and functionalities of blockchain, which enable companies to undertake informed decision-making processes ([Paniccia 2018](#); [Calabrese 2014](#)).

To identify and measure the impact that blockchain technology can have on supply chains, it is deemed necessary, first of all, to contextualize the relationship between three basic elements: digitalization, process reengineering, and structural consonance.

Blockchain technology is part of the digitalization solutions that companies, public administrations, and any organization can adopt to pursue the goals of streamlining and optimizing operational processes. Its functional characteristics make it a technology aimed at certifying the relationships that develop among multiple actors in a peer-to-peer context.

The adoption of blockchain technology implies overcoming traditional operational schemes and leads to the revision of operational processes. In other words, a reengineering of the processes involved in the domain of blockchain intervention is necessary. Therefore, process reengineering must be framed as an operational prerequisite for the implementation of blockchain logic and technology. It is impossible to imagine an implementation of blockchain within a relational context—such as a supply chain—without first reconstructing and revising, in blockchain digital terms, the processes responsible for managing material, financial, and informational exchange relationships. The risk would be similar to that arising from the installation of management software in a company without first adopting specific procedures and adequately training staff to use the software’s functionalities, namely the risk of partial use, if not non-use, of the software.

According to our interpretation, the concept of trustless connected to blockchain technology and smart contracts can be interpreted in a different sense, whereby the actors involved in the system are induced to greater cooperation due to the trust they place in the specific functional characteristics of the technology, particularly the security, transparency, and traceability of exchanges.

The greater visibility of information along the supply chain and the wider sharing of information and data within the supply chain, thanks to the functionalities of blockchain

technology, can create an atmosphere of greater serenity and trust among the various operators belonging to the supply chain, with positive consequences in the planning and management of exchange relationships.

Therefore, blockchain technology can contribute to reducing informational asymmetries in a supply chain. In Akerlof's study (Akerlof 1970), the term "lemons" refers to the possibility of exchanging a product with defects known exclusively by the seller, of which the buyer becomes aware only when receiving the product and becoming its owner. Some tracking applications are able to represent the visibility advantages achievable through blockchain, as well as by resorting to IoT technologies.

Therefore, if we say that the broader sharing of information within supply chains leads to a higher level of trust among supply chain operators, we can assert that blockchain technology is an enabling technological factor for this trust, as blockchain technology is capable of expanding the sharing and reliability of information along the supply chain. Thus, the characteristic of being an enabling factor, a tool for better supply chain management, emerges.

Our viewpoint, developed through the analyses and elaborations conducted in this study, can be summarized as follows:

Blockchain technologies are potentially able to play a role as an enabling factor in increasing the structural consonance among operators involved in exchange relationships within supply chains. Their contribution to improving information transparency, the traceability of processes, supply chain visibility, and operational efficiency implies an increase in the levels of security and reliability of exchanges, accompanied by the optimization of resources used in managing operational flows. Therefore, the involved operators are potentially induced to ease the tension towards seeking trust among parties but are put in a position to trust the context within which they operate and the assurance that technologies associated with blockchain can provide in creating and maintaining those conditions of security, reliability, and efficiency. From this, there is a reconfiguration of transaction costs and a change in the determinants for make-or-buy decisions.

It is certainly important to evaluate the following critical points of disadvantage and weakness of blockchain technologies before implementing blockchain-based solutions for managing supply chain relationships:

1. The first blockchains developed had limitations in terms of scalability, meaning the number of transactions per second was limited;
2. Some consensus algorithms require high energy consumption, with resulting environmental implications. However, this was mostly observable in the early blockchains;
3. Transactions on blockchain can be slower than those on other centralized solutions due to the distributed verification process;
4. Blockchain is still a relatively young technology and may not be fully mature for some critical applications;
5. There are regulatory uncertainties that can complicate the adoption of blockchain technologies (BTs);
6. The user interfaces of BT applications can be complex for inexperienced users;
7. While BT ensures transparency, it can raise privacy concerns due to the immutable nature of transactions.

In light of the above, we believe it is important to emphasize the need to balance the advantages of implementing blockchain technologies highlighted in this work with the disadvantages and critical points outlined above, adopting a critical approach and focusing on the specific supply chains and relationship contexts. This aspect will represent—among others mentioned below—an area on which the further investigation of this research can be directed.

Certainly, the results drawn from this study pose new research challenges and lead to the hypothesis of new lines of study and investigation.

Among these, it will certainly be interesting to initiate a broader reflection on the change in the paradigm of “trust” proposed within this study. Specifically, it will be useful to analyze whether, in blockchain logic, trust can be considered as follows:

- Replaced by technology, meaning that trust is no longer sought at all costs among supply chain operators in a collaborative perspective but is instead generated and guaranteed by the automation and functionalities of technology;
- Still underlying smart contracts, which incorporate agreements reached beforehand between parties, and then are executed through smart contract automation;
- Generated as a result of greater visibility and broader information sharing along the supply chain thanks to blockchain technology, the latter as an enabling tool. Consider also the trust placed in blockchain technology when it tracks the credentials and references of various suppliers, helping buyers make rational and informed decisions;
- Linked to the favorable and transparent atmosphere of the context within which supply chain exchanges take place, resulting from the implementation of blockchain technologies. As described in the managerial implications section, this configuration can be considered the new paradigm of the concept of “trust”, namely trust placed in the expression of security, transparency, traceability, and efficiency that blockchain technologies may be able to guarantee for supply chains.

Another topic that will be the subject of future research is related to the preservation of document flows generated in supply chain exchanges and managed within a blockchain-based context. This line of research will involve specific skills and analyses in the development and technological configuration, compliance of digital document flows, and their preservation with vertical regulations and cybersecurity.

As mentioned above—and considering the methodological note—the purpose of the work is to present a hypothesis regarding the impact of blockchain technologies (BTs) on the dimensions of traceability, transparency, and efficiency by analyzing an AS-IS scenario and a TO-BE scenario and describing the impact on structural consonance and the trust paradigm. The work is, in fact, a conceptual work and is not intended to demonstrate quantitative results.

Future research directions may certainly include the aim of reconstructing and demonstrating quantitative results.

From now on, it is possible to anticipate the importance that these aspects can represent for the growth of that favorable atmosphere and “trust” context discussed in the sections above. Therefore, they will certainly require a thorough analysis aimed at completing the framework within which we have contextualized the implications of implementing blockchain technologies on supply chain processes.

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Notes

¹ Scopus search: Article title, Abstract, Keywords: *blockchain AND business AND process AND reengineering*.

² The Digital Administration Code (CAD) is a unified text that gathers and organizes the regulations concerning the computerization of Public Administration in its relations with citizens and businesses. <https://www.agid.gov.it/it/agenzia/strategia-quadro-normativo/codice-amministrazione-digitale> (accessed on 25 March 2024). The eIDAS Regulation (electronic IDentification

Authentication and Signature)—EU Regulation No. 910/2014 on digital identity: <https://www.agid.gov.it/it/piattaforme/eidas#:~:text=Il%20regolamento%20eIDAS%20fornisce%20una,commercio%20elettronico%20nell%27Unione%20Europea> (accessed on 25 March 2024).

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