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Trust Dimensions in Blockchain and Process Industries

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Abstract

For some supply chains, the information flows between stakeholders are still manual, based on emails and paper exchanges that are kept in data silos. This research investigates how innovative technologies can improve the data flows in the milling industry, specifically in the flour supply chain. We explore whether adopting blockchain improves supply chain visibility, reduces operating costs, and increases collaboration and trust among supply chain partners. Using interactive research and participant observation as research methodology, we map the information flow between a miller and its buyers to replicate manual, paper-based information flows in a digital environment. Semi-structured interviews and process observations showed that blockchain technology provided visibility, automation, and reliability to the current manual, paper-based, and time-consuming information flows. We build theoretical knowledge on how blockchain, as an enabling technology, can provide a fairground to share data and consequently build trust. Managerial implications include guidelines for companies operating in comparable supply chains, specifically those in the food supply chain, in adopting blockchain primarily and other Industry 4.0 technologies. Future research could focus on building analytical models on immutable digitised information for forecasting and optimisation purposes and for process automation.

Keywords: flour supply chain; blockchain; visibility; traceability; quality; trust; interactive research

1 Introduction

The flour milling industry plays a vital role in feeding people as flour is an ingredient in the majority of the foods sold in supermarkets. As with any other industry, the milling industry also adopts new technologies, starting from production lines. For example, new smart mills are at the forefront of technology adoption, improving internal operations, increasing the production capacity, and overall increasing the "yield" of the milling operations. However, these technology solutions have historically focused on the material flow from wheat to flour.

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Information about products, processes, and testing parameters (e.g., water content, ash content, wet gluten) is usually recorded in forms which are maintained in document editing software like MS Word and communicated across the relevant players in the supply chain via emails. Contrary to the advances in the production technology used in the industry, the supply chain information flow between stakeholders is, in many ways, still manual, with prominent use of email, paper-based movement of data sets and data silos in every supply chain step. Moreover, the lack of visibility renders current supply chain information systems inadequate to cope with the new global market requirements (Santiago-Cajaraville, 2021).

While the ISO 22005:2007 traceability in the feed and food chain outlines the general principles and basic requirements for system design and implementation, it does not prescribe how these principles will be adhered to and what implementation technologies could be used to meet the standard's requirements. To ensure the quality of end-products made from flour, several operations related to the transformation process, such as farming, milling, and baking, should be coordinated with supply chain operations such as drying, blending, storage, and transportation (Nadimi et al., 2023).

This research aims to investigate whether innovative technologies such as blockchain has the potential to improve the data flows in the milling industry, specifically in the flour supply chain. In line with this research aim, the research question we answer in this paper is the following: "How innovative technologies like blockchain can improve data flows in the flour milling industry?" Our objectives are to understand if adopting recent technologies can improve supply chain visibility, reduce operation costs, and increase stakeholder collaboration and trust.

Food supply chain visibility, especially food traceability, is a critical aspect of food supply chain management to ensure the food that reaches the consumer is safe to consume, and we can identify the source of contamination if a food product is found to be non-compliant with the standards and specifications expected. Traceability is challenging as a variety of raw materials are mixed, different batches are combined, and safety information is crossed when food is processed. Novel technologies such as artificial intelligence to optimise the mixing of batches, big data to forecast the quality of products and blockchain to ensure credibility in tracing are becoming more prominent in improving the traceability performance of food supply chains, specifically those for processed food products (Qian et al., 2022).

The technology we investigate in this paper is blockchain, which provides a secured platform for the players in the flour supply chain to initially share product quality data records in a digital form and then use the unique version of the data to improve the service and operations downstream and upstream in the supply chain. Blockchain is a distributed, immutable ledger

technology that ensures the integrity of data without the need for a third, trusted party (Cocco et al., 2021). The application of a blockchain enables the secure transfer of data between supply chain actors, providing transparency around the exact process parameters being used in the milling of their product.

The research presented in this paper strongly links with three United Nations Sustainable Development Goals: SDG9 Industry, Innovation, and Infrastructure, which aims to build resilient infrastructure, promote sustainable industrialisation, and foster innovation, SDG12 Ensure sustainable consumption and production patterns, and SDG 3 Good Health and Wellbeing. The introduction of blockchain technology into the flour milling supply chain provides increased resilience owing to increased visibility of operations (Sharma et al., 2021). In terms of the technology's contribution to sustainable industrialisation and innovation, blockchain reduces the time to identify the source and the transport path of fresh produce from 6.5 days to a few seconds (Qian et al., 2022), enabling further analysis which could inform decisions related to transport optimisation and sourcing. The connection with good health and well-being is underpinned by the information that could be communicated to the consumers, hence facilitating healthy diets and informed food choices (Lopez-Barreiro et al., 2023).

2 Literature Review

The flour supply chain consists of three main facilities: 1) those involved in storing the wheat (i.e. cooperatives / silos), 2) those involved in milling, and 3) those involved in manufacturing products from flour (i.e., bakeries). Not only products, but also information and finances must flow through this supply chain. Over time, with changing supplier capacities, processing costs, and demand locations, it becomes necessary to reoptimize these supply chains (Yousefi-Babadi et al., 2023). However, information visibility is necessary to initiate such optimization studies. Blockchain is a technology that allows the immutable recording of information, but implementing blockchain faces some challenges.

Blockchain implementation in the supply chain necessitates a discussion of trust since supply chain management is built on trust and commitment (Lee et al., 1997). Trust and commitment among the supply chain members promote and increase efficiency, productivity, and effectiveness (Morgan & Hunt, 1994). Trust is expecting positive or non-negative outcomes from the actions of another in an interactive relationship characterised by uncertainty (Sahay, 2003). It is perceived as the cornerstone of strategic partnerships (Spekman, 1988). Trust is the belief that a party's word or promise is reliable, and that party will fulfil their obligations in an exchange relationship (Dwyer et al., 1987).

There is a virtuous cycle between trust and data sharing: the more supply chain actors work together, the more data they will share and the more data they share, the more they will trust one another (Akkermans et al., 2004). A higher degree of interdependence between companies forces them to collaborate and share information, which requires a high level of trust (Handfield & Bechtel, 2002). Trust is at the centre of theories related to collaboration among supply chain partners. It reduces the uncertainty in the relationship between supply chain actors (Chandra & Kumar, 2001). This uncertainty arises because parties in a supply chain are vulnerable to one another's behaviour (Blois, 1999). Yet the globalisation and decentralisation of supply chains increased the complexity of building trust and sharing data.

Trust within a supply chain has been analysed from different perspectives. It is expressed as the sharing of information and assets (Handfield & Bechtel, 2002). It is categorised into three as 1) Contractual Trust, 2) Competence Trust, and 3) Goodwill Trust (Sako & Helper, 1998). Contractual trust is satisfied when the other party meets the contractual agreement. Competence Trust is satisfied when the other party is capable of doing what they agreed to do. To build goodwill trust, parties make an open-ended commitment to take initiatives for mutual benefit while refraining from unfair advantage-taking, in other words, opportunism. It is the strongest form of trust as it does not depend on a contract or a skill.

Four main reasons push the supply chain actors to look for more trust. *1) Economic and Financial:* Organisations and individuals calculate the cost or reward of another party cheating or staying in a relationship (Williamson, 1988). The trusting party will assume that it is in the best interest of the other party not to cheat, as the benefits outweigh its drawbacks. *2) Better Prediction:* Goodwill trust refers to the ability to forecast another party's behaviour. Behaviour uncertainty and potential opportunism negatively impact trust (Kwon & Suh, 2004) among the supply chain members. Past information is pivotal to assessing the credibility of the other party. Delivering on promises increases trust among parties (Swan et al., 1985). *3) Information Sharing:* Several studies put information sharing as a critical agent for trust-building in supply chain management (Sahay, 2003). Information sharing has a direct impact on reducing behaviour uncertainty, consequently improving the level of trust (Kwon & Suh, 2004). *4) Meeting Obligations:* Competence trust is about determining another party's ability to meet its obligations (Sako & Helper, 1998). Underpinning this idea of competence, assets dedicated to the relationship between firms will increase the level of trust as it will directly impact the confidence level in fulfilling obligations (Kwon & Suh, 2004).

Trust is the basis of long-term and collaborative relationships (Sahay, 2003). It can lower transaction costs via stable relationships (Heide & John, 1990). It facilitates dispute resolution (Ring & van de Ven, 1994) and reduces legal costs, reducing the extent of formal contracts. Creating a competitive advantage based on trust facilitates long-term relationships among

suppliers and makes the supply chain actors more interested in final customer needs (Zineldin & Jonsson, 2000), facilitating improvements and mutual planning. All these factors enable parties to focus more on long-term benefits than opportunistic behaviours.

Traceability is critical to food supply chains. It is designed to ensure food safety, quality and provenance and facilitate food recalls. In addition, it requires the supply chain partners to monitor the composition of the final product, including each ingredient along its history. Blockchain's immutable timestamping of transactional data makes it a promising technology for addressing food safety challenges (Qian et al., 2020). Similar to the flour supply chain, the rice supply chain suffers from poor reliability and traceability, which has led to trust issues between supply chain stakeholders (Farooq et al., 2023). The transparency needed to ensure trust in the system can be achieved by implementing a blockchain system which can be used to record readings from sensors and other equipment used for data capture.

The Internet of Things (IoT) technologies are used in the recent implementation of a blockchain for the supply chain management of a particular Italian bread (Cocco et al., 2021). The system guarantees a transparent and auditable traceability of the Carasau bread where each actor in the supply chain can verify the quality of the products and the conformity to the norms about the hygienic-sanitary conditions along the chain. The use of digital technologies reduces data entry errors and the risk of tampering. Furthermore, the system allows end consumers to have a transparent view of the whole journey from raw material to the final product and for supervisory authority to perform online inspections on the products' quality and good working practices. While the blockchain reported in this paper is still experimental, it is one of the projects that are close to real-life implementation.

Blockchain implementation's most frequently highlighted benefits for the agrifood sector are its tamper-proofness and traceability. In a traceability system based on blockchain technology for storage and query of product information in the supply chain of agricultural products, safe sharing of private information and reputation-based smart contracts were implemented (Yang et al., 2021). Furthermore, smart contracts were used to incentivise the nodes in the network to upload traceability data. A performance analysis of the practical application shows that the proposed system improves query efficiency and security of private information, guarantees the authenticity and reliability of data, and meets application requirements.

Gasol flour is made from rice which still has its epidermis (broken skin). Therefore, it has high nutrition, and the production process requires each supplier to know how much raw material or product is sent to a buyer, the price of raw material from the initial supplier, the date and time of the receipt of raw material or product, the origin of the product, and the quality of the raw material as well as the final product. In the gasol flour supply chain, a smart

contract system based on blockchain technology is implemented to provide a fair and transparent contract for each stakeholder (Kurnia et al., 2020). Contract rules determined by using a tree algorithm were executed in smart contracts to ensure fair distribution of supply chain profits across the supply chain.

As can be seen from these examples, blockchain not only increases the trust of each stakeholder of the supply chain in the system but also helps ensure fair distribution of profits across the supply chain. The potential for implementing the technology is virtually limitless. Still, the initial phase of implementation projects takes time to generate the starting trust from companies already operating without the blockchain in the proposed technology and information-sharing approach.

3 Design/methodology/approach

We followed interactive research, a collaborative approach characterised by recurrent interactions and joint learning activities between researchers and practitioners in commonly agreed-upon efforts to study change and innovation in organisations (Sandberg et al., 2022). This entailed participant observation (Vlachos & Malindretos, 2021) in the technology implementation process to document the development and deployment of a data-sharing platform backed by blockchain technology in the milling industry. The process has implied mapping the information flow between a miller and one of its buyers to replicate it in a digital solution.

We show how blockchain ledger records critical product information in a trustworthy manner (Garrard & Fielke, 2020). Furthermore, blockchain provides a unique version of the quality data and the events in the process, ensuring the full traceability of products through a specific part of the supply chain. We present the blockchain implementation as a case study in which we conduct a series of semi-structured interviews and process observations with members of two tiers in the UK milling industry. We have chosen this use-case study on blockchain technology's relatively advanced development and implementation, pioneering its use in the milling industry. We show the methodology followed in five steps: 1) Problem Identification and Sample Groups, 2) Data Collection, 3) Design and Development, 4) Testing and 5) Evaluation. These steps are shown in Figure 1.

In the first step, the problem to address was visibility. The project team identified the research problem as improving the visibility of information in the milling industry using the blockchain technology. To understand the problem and perspectives of key stakeholders, the project team interviewed miller operational teams and bakery operational teams. Each team

expressed their expectations from the project and what improved visibility of information flow meant for them.

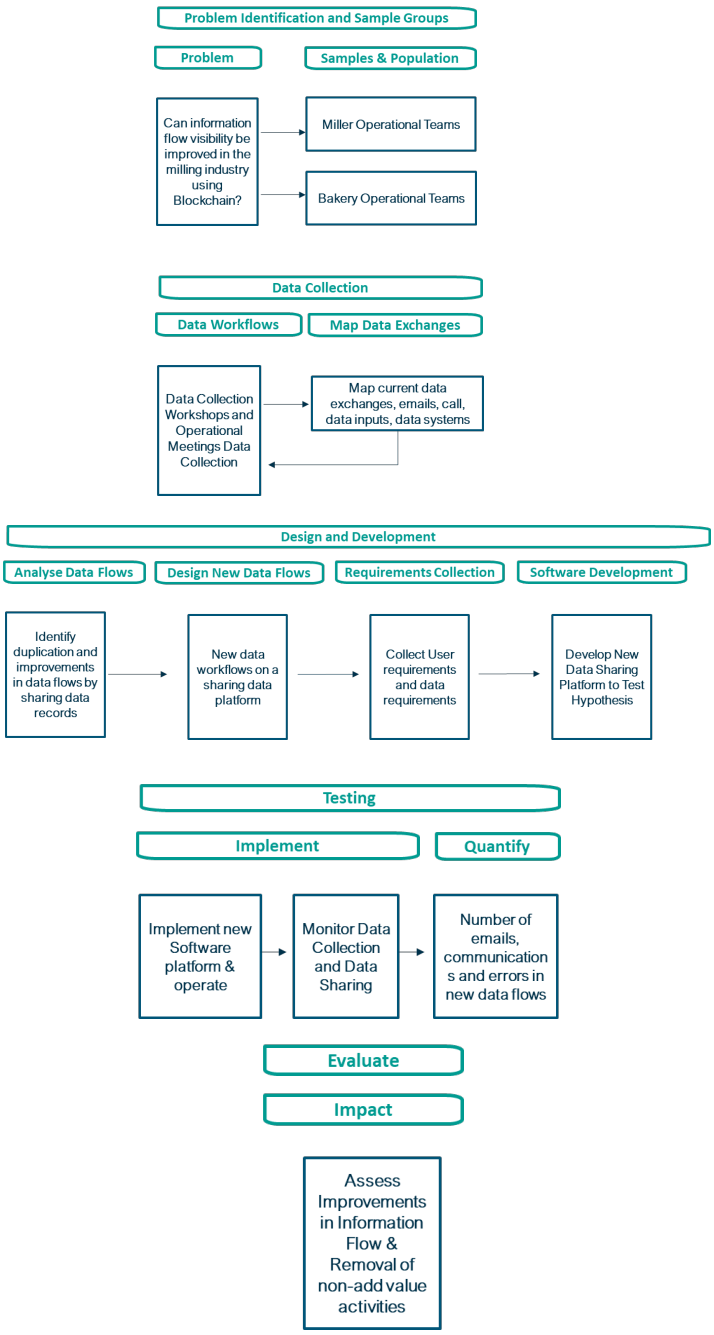

Figure 1 Research Methodology, Source: Authors' own creation

In the second step, the project team run several workshops to collect data about the current data exchanges, how long each information flow took, which medium was used (e.g., emails, calls), where the data was stored and how the data was stored.

In the third step, the design and development of the technology took place. This involved identifying duplication of efforts, multiple data entries, what steps could be removed without negatively affecting the process. A new data sharing platform was devised and new data workflows for sharing data were introduced. User and data requirements were a significant input to software development of the new data sharing platform. Once the platform was developed, it could be used to test hypotheses.

The fourth step involved testing of the platform. Once it was operational, it was used to do collect more data in a shared environment. The reduction in email communications was reported against the base case to show the impact of the new tool.

Finally, the fifth step was to evaluate the test results and assess the impact of the solution. This step finalised the project, suggesting to remove non-value added activities from the workflows.

Observations were carried out during the last year of the project implementation. Around 24 meetings were attended and observed, with different stakeholders, technology providers, miller, miller's buyer, developers and blockchain providers were part of the data collection process. The topics covered in the meetings range from operations and information flows mapping, information flow redesign, and automation to quality requirements.

Scrum methodology was used to project management the development, from requirement gathering to delivering the prototypes and final production. In addition, weekly meetings were attended with development, technology and blockchain teams.

The roles involved in the solution design and interviewed for this research were technical, quality and milling directors on the miller side and quality and technical directors on the buyer side. In addition, users were interviewed to know the solution's impact on their daily tasks and operations and to refine the different versions of the solution. Operators range from customer service, transport, and laboratory.

From the conception of the idea to the final solution, it took approximately 36 months to deploy the project on-site and embed the operations of the mill and its buyer on the platform.

4 Findings

The solution combines IoT devices collecting quality data through mill operations and a platform based on blockchain technology to share those quality data. The entire stack has allowed the digitalisation of the information flow among different supply chain members. Furthermore, using a blockchain platform allowed the stakeholders to share unique datasets brought in real-time from the mill operations through IoT devices. The platform provides

immutability to the data records and events data, removing redundant reconciliation, double-checking operations, and catalysing the removal of data duplications and data silos.

Consequently, sharing a single version of the information flow improved the transparency supply chain from a translucent supply chain to a transparent one (Lamming et al., 2001). In addition, operation on both sides was improved by removing redundant processes and quality checks. The new information flow is expected to remove the need for contractual and competence trust and increase goodwill and trust among business partners (Sako & Helper, 1998).

4.1 Certificate of Analysis

The flour quality specifications are embedded in the commercial agreement among parties. A certificate of analysis accompanies every flour delivery from the mill to a buyer (see Table 1 for an example). The certificate of analysis determines whether a batch is approved or rejected. In addition, it documents the results of all quality tests performed on the final product, along with other delivery information. Without the certificate of analysis, the buyer cannot accept the batch of flour being delivered, as critical data about the product would be missing.

Table 1 An example of a certificate of analysis with mean data entry fields, Source: Authors' own creation

Flour Description		
Customer	Batch	
Customer Order	Delivery Date	
Supplying Site	Delivery Number	
TEST	RESULTS	SPECIFICATION
Moisture NIR		
Protein NIR		
Water Absorption NIR		
Starch Damage NIR		
Colour NIR		
Hagberg NIR		
Bran %		
Bran Specs		
Signed		
Position		
Date		

Nowadays, the certificate of analysis has become a data standard in the milling industry. Therefore, it contains the critical data to be shared among suppliers and buyers in the industry. The certificate of analysis is shared on a paper-based form as part of the physical

documents that a delivery driver needs to submit to unload a tank on the buyer's sites, along with the delivery note. Therefore, both supply chain tiers need a series of manual and redundant processes to issue a certificate of analysis.

4.2 Release Process

A standard practice in the UK milling industry is assessing batch quality by taking samples. Samples taken from a specific batch are analysed on both sides of the supply chain (supplier and buyer). Until the results are satisfactory for both parties, a certificate of analysis cannot be issued, and consequently, the flour cannot be delivered. Preparing a certificate of analysis implies several manuals and redundant steps in the information flow (see Figure 2).

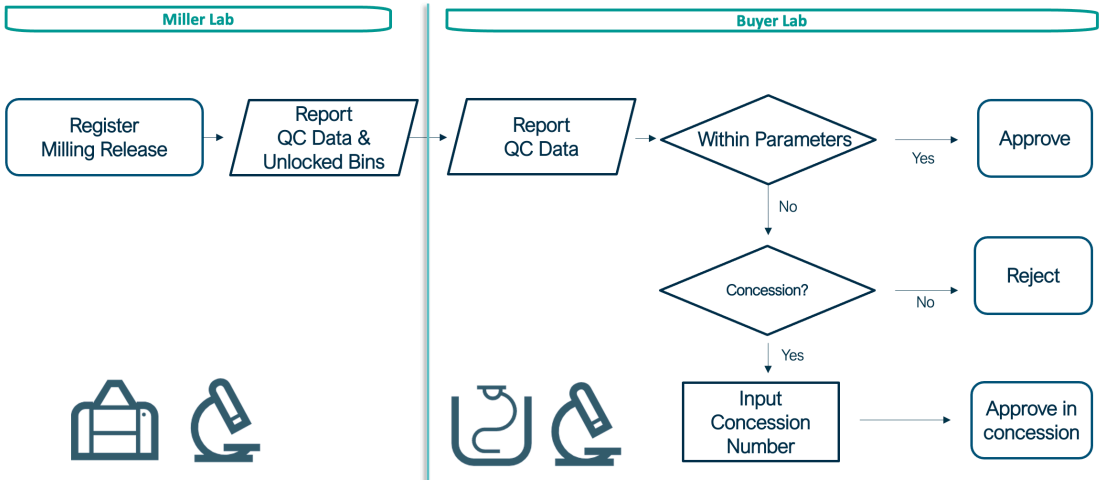

Figure 2 Supplier release workflow, Source: Authors' own creation

The sample analysis is carried out on both sides of the supply chain. The current process takes several emails from both companies. Different internal departments and companies need to agree before issuing a certificate of analysis. The technological advances in the milling industry have allowed the development of a new generation of smart mills that can take 15,000 data points in a single milling process. As a result, several IoT devices installed throughout the mill can thoroughly monitor milling operations, mill performance, and quality parameters in real time.

For quality control, IoT devices such as the NIR Multi Online Analyzer MYRG allows real-time analysis of raw material and end products at various measuring points. The MYRG systems are equipped with digital cameras capable of detecting colour differences. This image processing allows specks and the flour colour to be automatically measured and quantified. One spectrometer evaluates up to six different measuring points and colours. These data can replace, to a large extent, the current laborious processes of taking a sample and analysing it in the lab.

The data availability was, until now, centralised on the supplier side. The lack of trust in centralised data systems had deterred the acceptance of those data from clients, creating redundant reconciliation processes. Through the Bühler Dash Network, the industry is now in a position to share data directly from MYRG sensors in an immutable and reliable way. Furthermore, sharing data will allow both parties of the process to use those data as the single version of the truth.

The elements of MYRG technology coupled with blockchain technology will allow the removal of redundant processes in Figure 2. In addition, sharing unique, reliable, and immutable records from Bühler sensors has improved the operations removing manual processes to reconcile and agree on the quality records of a batch. This is part of the current information flow digitalisation in the milling industry. The new information flow is presented in Figure 3.

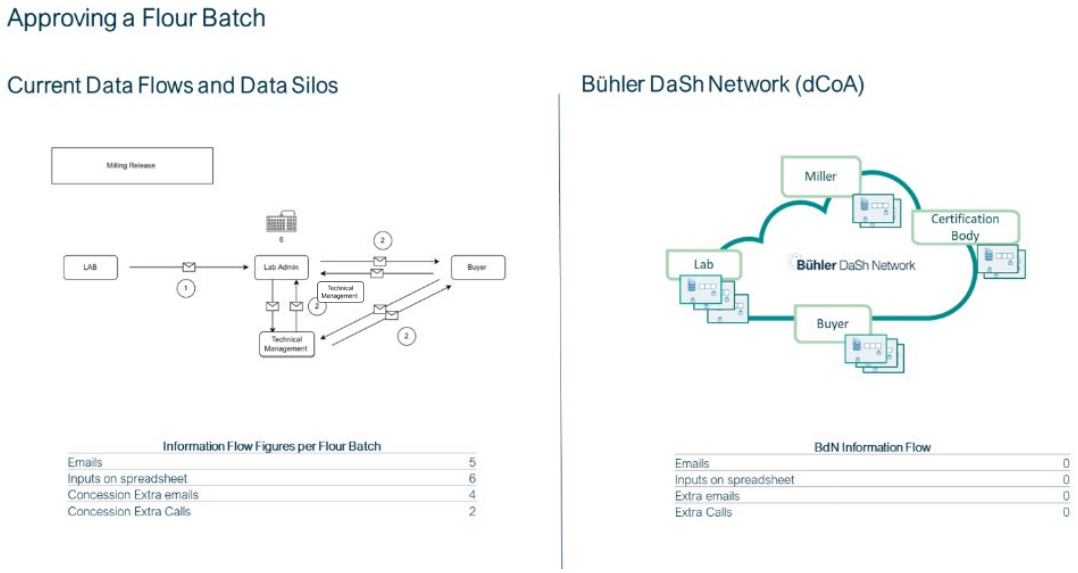

Figure 3 Mapping of information flow, Source: Authors' own creation

Figure 3 shows that with the Bühler DaSh network, no emails, no paper-based exchanges, and no spreadsheet inputs will be needed to share data between the supplier and the buyer. Instead, a single and immutable record is shared among the stakeholders through the Bühler DaSh Network. No-add value processes and times have been removed from the information flow. For example, real-time approval of flour batches has been removed from no-add value processes as waiting times to get the approval from both stakeholders' labs, usually a three-days' process.

4.3 Delivery Process

Once the buyer and the miller have agreed upon the milling releases' quality parameters, the operations to deliver the batch in question are initiated. As part of the standards of the flour

industry, every single delivery (material flow) should be supported with the right documents (information flow). Therefore, the standard data sharing along with the flour comprises a certificate of analysis for each delivery (quality parameters) and a delivery note.

Before the project started, the information exchange was purely paper based. For example, a truck driver should carry a delivery note and the subsequent certificate of analysis. To generate these documents, a series of communication is needed among the different departments of the supplier to reconcile delivery numbers, flour quality parameters and batches. Internal data silos were in place between supplier's departments (Customer Service, Production, Lab, Transport, and Drivers). Several emails are crossed between departments and information systems to build up the data sets to share with the supply chain downstream.

Historically, information systems have been built around functions within the companies; over time, has bequeathed several data silos within the organisations. Turning to spreadsheets and email to link those systems has become standard practice. As a result, the efficiency of information flow has fallen behind the current material flows.

The solution to fill this gap is to create a system to share data among the stakeholders. A blockchain approach allows all the data under one unique and distributed system, removing several no-add value processes from the information systems as data gathering and reconciliation tasks. A shared platform has removed "hundreds" of emails among stakeholders, several spreadsheets and data silos between companies and departments. Instead, stakeholders can use a single version of the data (a single version of the truth) to record events along the flour supply chains. Figure 4 shows the customer order information flow under a unique platform.

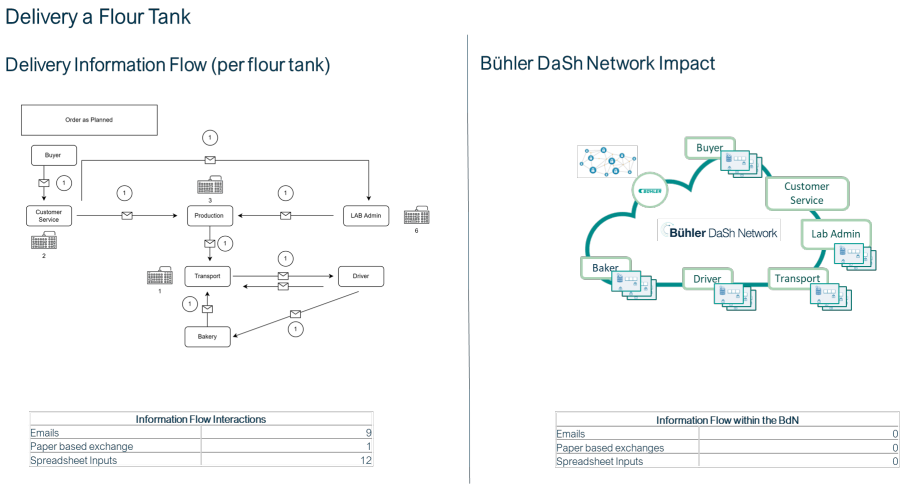

Figure 4 Customer order workflow, Source: Authors' own creation

Sharing unique records in a common platform, the mill improved its internal processes by removing data silos and communications, and paper-based documents were removed from the

system by digitalising the certificate of analysis. The buyer accepts the deliveries digitally and has visibility of the order processing (Figure 5).

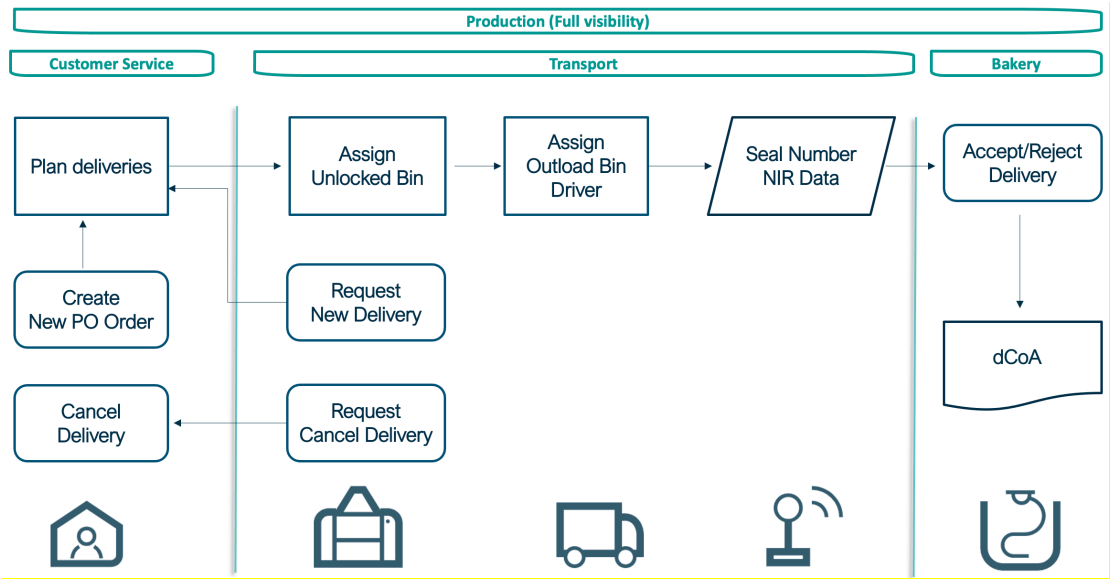

Figure 5 Miller - Buyer Workflow under Bühler DaSh Network, Source: Authors' own creation

Elimination of redundant and manual processes and communications, reduced lead times, higher data accuracy and granularity of the quality records are some of the recorded impacts of using a platform based on blockchain technology. For example, communications (emails) and data inputs in spreadsheets needed to issue a certificate of analysis are reduced from 223 to zero.

Overall, the solution has the potential to provide visibility, automation, and reliability to the current manual, paper-based, and time-consuming information flows. In addition, this initial work of the supply chain events mapping and digitalisation of the quality data information flow would have the potential to support other data sets relevant to the milling industry motivating a potential extension of the use of technology to capture other data, such as stock levels, vehicle movements or CO2 emission in the future.

5 Discussion and Conclusions

This paper set out to investigate how innovative technologies can improve the data flows in the supply chain with a case study from the flour supply chain by reporting blockchain implementation between a flour mill and its buyer. We elaborated on three dimensions of trust: contractual, performance, and goodwill. Blockchain will increase contractual and performance trust but will not impact goodwill trust. Blockchain is an enabling technology that will catalyse trust among stakeholders, but it will not bring trust for itself.

Trust and information sharing go hand-in-hand, perpetuating each other. The more information is shared, the more trust increases, which increases data sharing. In this case study, we take the data-sharing standards already in place and make them digital. It digitalises existing paper records, making immutable records directly from sensors. The same data sets are shared to remove redundant operations, such as reconciliation and double-checking. The blockchain platform is designed to store quality data in the first instance, but it is open to extension by including other operational and logistics data.

The desired outcome of this project is to enable the buyer and supplier supply chain synchronisation, which will allow them to take joint decisions and, in the future, create smart rules to trigger them automatically. Blockchain, as a technology enabler, provides a single version of the truth that is immutable. Therefore, smart contracts running on the top of the blockchain platform can trigger automated supply chain decisions embedded in the algorithms that consume immutable data stored in the blockchain (events, delivery times or orders placed etc.) to eliminate non-value-added processes between the supplier and the buyer. Once supply chain actors experience working on a blockchain platform, we expect the level of trust needed to continue the relationship will be lower.

Many blockchain advocates argue that you will not need trust (Morrison, 2016), but this can be misleading. In the short term, you need much more trust between the parties to embark on a blockchain implementation project. Trust will always be needed. While both parties trusted each other to share quality data on paper-based documents, moving these records to digital removes the reconciliation processes needed from a trusted business relationship.

We conclude from our observations and the literature on trust that parties needed to increase their initial levels of trust to get involved in a blockchain environment. Without initial levels of trust between all parties, it would be challenging to realise blockchain implementation.

Long-term commitments between supply chain actors help reduce the uncertainty in the relationship, increasing contractual trust. Commitments to building common systems to be shared over the next decades help increase competence and goodwill trust. The blockchain implementation that started with sharing quality data serves the purpose of building and increasing the level of trust in the network by increasing the visibility and transparency of operations.

In Cocco et al.'s (2021) case study, the IoT is used in the packaging system with Non-Fungible Tokens and Radio Frequency Identification to control the logistics and provenance of the distribution. In our use-case, we use IoT directly in the production line to measure quality specifications of the product as it moves through machines. While Yang et al. (2021) show the use of smart contracts to incentivise the nodes participation in the network to upload

traceability data, in our case, the use of smart contracts is limited to the automatic approval of quality data shared when quality requirements are met.

Once the proof of concept is complete, all parties in the network will be able to see what blockchain implementation can offer to them. It will be easier for all to decide which other data to put on the blockchain, for example, logistics solutions to improve the use of the current transportation resources. By setting up the blockchain channel of communication and information sharing, each actor can explore other collaboration opportunities.

5.1 Contribution to Knowledge

The research findings reported in this chapter have theoretical and managerial implications. Theoretically, we build on the diffusion of innovation theory (Agi & Jha, 2022), and technology organisation, environment framework (Kouhizadeh et al., 2021) to elaborate on how the theory manifests in a real-world setting with a case study from the flour supply chain.

Trust is the centre of any collaboration in the supply chain. We build theoretical knowledge on how blockchain, as an enabling technology, can provide a fairground to share data and consequently build trust. We provide a framework to build trust and data sharing in an encompassed manner.

Managerial implications of the research include guidelines for companies operating in comparable supply chains, specifically those in the food supply chain in adopting blockchain primarily and other Industry 4.0 technologies subsequently to benefit from not only digitising the supply chain information in an immutable manner but also building analytical models on the digitised information for forecasting and optimisation purposes.

5.2 Implications for Practice

At present, material flow operates without human intervention, yet the information flow remains largely manual. In most instances, reports are generated from the system, but the resulting analyses are manually produced and disseminated via email.

The establishment of a unique single register for product quality records harmonizes material and information flow. This eliminates quality information silos both upstream and downstream, thereby overcoming the limitations of proprietary quality data.

The adoption of data sharing systems within supply chains will directly influence operational practices for managing information flow and, consequently, material flow. Initially, it will have implications for managing the quality data. However, data sharing systems allow for the synchronization of not only quality data but also inventories, demand, and production plans. This paves the way for fully autonomous systems in both material and information flow.

Activities that do not add value, such as data entry, sending emails, and other communication tasks can be reduced to a single-entry point in daily operations. Consequently, resources allocated to these tasks can be minimized.

5.3 Limitations and Future Work

This research paves the way toward an autonomous mill, establishing the foundation for supply chain synchronisation. The blockchain application described in this paper and the supporting Bühler DaSh Network will eliminate spreadsheet-based data analysis and stop double data entry, allowing a single version of the truth in one system. It also builds customer intimacy and facilitates further analytics applications on accurate and real-time data.

Limitations include the work being reported on a single case study from the flour supply chain with a miller and one of its customers. While the process explained in this paper is expected to be transferable to other comparable buyer-supplier relationships, there may be company-specific variations in levels of automatisation and digitalisation that necessitate modifications to the explained system. In addition, the social aspects of deploying a new technology to increase visibility are reported only as perceptions of the observers and project participants. The next iteration could devise a questionnaire survey to gather reflections from the system users before and after implementation to measure the impact of deploying this new technology.

References

Agi, M. A. N., & Jha, A. K. (2022). Blockchain technology in the supply chain: An integrated theoretical perspective of organizational adoption. *International Journal of Production Economics*, *247*. https://doi.org/10.1016/j.ijpe.2022.108458

Akkermans, H., Bogerd, P., & van Doremalen, J. (2004). Travail, transparency and trust: A case study of computer-supported collaborative supply chain planning in high-tech electronics. *European Journal of Operational Research*, *153*(2). https://doi.org/10.1016/S0377-2217(03)00164-4

Blois, K. J. (1999). Trust in business to business relationships: An evaluation of its status. *Journal of Management Studies*, *36*(2). https://doi.org/10.1111/1467-6486.00133

Chandra, C., & Kumar, S. (2001). Enterprise architectural framework for supply-chain integration. *Industrial Management & Data Systems*, *101*(6). https://doi.org/10.1108/EUM0000000005578

Cocco, L., Mannaro, K., Tonelli, R., Mariani, L., Lodi, M. B., Melis, A., Simone, M., & Fanti, A. (2021). A Blockchain-Based Traceability System in Agri-Food SME: Case

Study of a Traditional Bakery. *IEEE Access*, *9*. https://doi.org/10.1109/ACCESS.2021.3074874

Dwyer, F. R., Schurr, P. H., & Oh, S. (1987). Developing Buyer-Seller Relationships. *Journal of Marketing*, *51*(2). https://doi.org/10.1177/002224298705100202

Farooq, M. S., Riaz, S., Rehman, I. U., Khan, M. A., & Hassan, B. (2023). A Blockchain-Based Framework to Make the Rice Crop Supply Chain Transparent and Reliable in Agriculture. *Systems*, *11*(9). https://doi.org/10.3390/systems11090476

Garrard, R., & Fielke, S. (2020). Blockchain for trustworthy provenances: A case study in the Australian aquaculture industry. *Technology in Society*, *62*. https://doi.org/10.1016/j.techsoc.2020.101298

Handfield, R. B., & Bechtel, C. (2002). The role of trust and relationship structure in improving supply chain responsiveness. *Industrial Marketing Management*, *31*(4). https://doi.org/10.1016/S0019-8501(01)00169-9

Heide, J. B., & John, G. (1990). Alliances in Industrial Purchasing: The Determinants of Joint Action in Buyer-Supplier Relationships. *Journal of Marketing Research*, *27*(1). https://doi.org/10.1177/002224379002700103

Kouhizadeh, M., Saberi, S., & Sarkis, J. (2021). Blockchain technology and the sustainable supply chain: Theoretically exploring adoption barriers. *International Journal of Production Economics*, *231*. https://doi.org/10.1016/j.ijpe.2020.107831

Kurnia, E., Djatna, T., & Udin, F. (2020). Analysis and design of transparent smart contract based on blockchain technology for supply chain in "gasol flour" industry. *IOP Conference Series: Earth and Environmental Science*, *443*(1). https://doi.org/10.1088/1755-1315/443/1/012027

Kwon, I. W. G., & Suh, T. (2004). Factors affecting the level of trust and commitment in supply chain relationships. *Journal of Supply Chain Management*, *40*(1). https://doi.org/10.1111/j.1745-493X.2004.tb00165.x

Lamming, R. C., Caldwell, N. D., Harrison, D. A., & Phillips, W. (2001). Transparency in supply relationships: Concept and practice. *Journal of Supply Chain Management*, *37*(3). https://doi.org/10.1111/j.1745-493X.2001.tb00107.x

Lee, H. L., Padmanabhan, V., & Whang, S. (1997). The bullwhip effect in supply chains. *Sloan Management Review*, *38*, 93–102.

Lopez-Barreiro, J., Alvarez-Sabucedo, L., Garcia-Soidan, J.-L., & Santos-Gago, J. M. (2023). Creation of a Holistic Platform for Health Boosting Using a Blockchain-Based

Approach: Development Study. *Interactive Journal of Medical Research*, *12*. https://doi.org/10.2196/44135

Morgan, R. M., & Hunt, S. D. (1994). The Commitment-Trust Theory of Relationship Marketing. *Journal of Marketing*, *58*(3). https://doi.org/10.1177/002224299405800302

Morrison, A. (2016). Blockchain and smart contract automation: How smart contracts automate digital business. *PwC*.

Nadimi, M., Hawley, E., Liu, J., Hildebrand, K., Sopiwnyk, E., & Paliwal, J. (2023). Enhancing traceability of wheat quality through the supply chain. In *Comprehensive Reviews in Food Science and Food Safety*. https://doi.org/10.1111/1541-4337.13150

Qian, J., Dai, B., Wang, B., Zha, Y., & Song, Q. (2022). Traceability in food processing: problems, methods, and performance evaluations—a review. In *Critical Reviews in Food Science and Nutrition* (Vol. 62, Issue 3). https://doi.org/10.1080/10408398.2020.1825925

Qian, J., Ruiz-Garcia, L., Fan, B., Robla Villalba, J. I., McCarthy, U., Zhang, B., Yu, Q., & Wu, W. (2020). Food traceability system from governmental, corporate, and consumer perspectives in the European Union and China: A comparative review. In *Trends in Food Science and Technology* (Vol. 99). https://doi.org/10.1016/j.tifs.2020.03.025

Ring, P. S., & van de Ven, A. H. (1994). Developmental Processes of Cooperative Interorganizational Relationships. *The Academy of Management Review*, *19*(1). https://doi.org/10.2307/258836

Sahay, B. S. (2003). Understanding trust in supply chain relationships. *Industrial Management and Data Systems*, *103*(8–9). https://doi.org/10.1108/02635570310497602

Sako, M., & Helper, S. (1998). Determinants of trust in supplier relations: Evidence from the automotive industry in Japan and the United States. *Journal of Economic Behavior and Organization*, *34*(3). https://doi.org/10.1016/S0167-2681(97)00082-6

Sandberg, E., Oghazi, P., Chirumalla, K., & Patel, P. C. (2022). Interactive research framework in logistics and supply chain management: Bridging the academic research and practitioner gap. *Technological Forecasting and Social Change*, *178*. https://doi.org/10.1016/j.techfore.2022.121563

Santiago-Cajaraville, F. (2021). The Impact of Blockchain on the Visibility and Trust of Supply Chains. In C. de Vartavan (Ed.), *Blockchain Impact!: Success, Productivity, Innovation* (pp. 81–93). Projectis Publishing .

Sharma, M., Joshi, S., Luthra, S., & Kumar, A. (2021). Managing disruptions and risks amidst COVID-19 outbreaks: role of blockchain technology in developing resilient food supply chains. *Operations Management Research*. https://doi.org/10.1007/s12063-021-00198-9

Spekman, R. E. (1988). Strategic supplier selection: Understanding long-term buyer relationships. *Business Horizons*, *31*(4). https://doi.org/10.1016/0007-6813(88)90072-9

Swan, J. E., Trawick, I. F., & Silva, D. W. (1985). How industrial salespeople gain customer trust. *Industrial Marketing Management*, *14*(3). https://doi.org/10.1016/0019-8501(85)90039-2

Vlachos, I., & Malindretos, G. (2021). Supply chain redesign in the aquaculture supply chain: a longitudinal case study. *Production Planning and Control*. https://doi.org/10.1080/09537287.2021.1959663

Williamson, O. E. (1988). The logic of economic organization. *Journal of Law, Economics, and Organization*, *4*(1). https://doi.org/10.1093/oxfordjournals.jleo.a036949

Yang, X., Li, M., Yu, H., Wang, M., Xu, D., & Sun, C. (2021). A Trusted Blockchain-Based Traceability System for Fruit and Vegetable Agricultural Products. *IEEE Access*, *9*. https://doi.org/10.1109/ACCESS.2021.3062845

Yousefi-Babadi, A., Bozorgi-Amiri, A., Tavakkoli-Moghaddam, R., & Govindan, K. (2023). Redesign of the sustainable wheat-flour-bread supply chain network under uncertainty: An improved robust optimization. *Transportation Research Part E: Logistics and Transportation Review*, *176*. https://doi.org/10.1016/j.tre.2023.103215

Zineldin, M., & Jonsson, P. (2000). An examination of the main factors affecting trust/commitment in supplier-dealer relationships: An empirical study of the Swedish wood industry. *TQM Magazine*, *12*(4). https://doi.org/10.1108/09544780010325831

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