From Micro to Meso-Level Blockchain Adoption: Redefining Supply Network Dynamics and Collaboration

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Acknowledgement

The journey toward academic achievement is rarely one walked alone, and as an international student pursuing my doctoral studies abroad, I have been fortunate to be supported by remarkable individuals whose guidance, encouragement, and care have made all the difference. As I reflect on this transformative experience, I am filled with profound gratitude for those who have helped me navigate this path and made it truly meaningful.

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This achievement is a reflection of the collective support I have received from both my academic mentors and my family. To my supervisors and my family, I extend my heartfelt thanks. Your belief in me, your guidance, and your endless encouragement have made this journey not just possible, but deeply meaningful.

Research Motivation

About seven years ago, I began exploring blockchain in food supply chains through a marketing lens, focusing on its potential to enhance transparency, traceability, and consumer trust. My Master's research deepened this inquiry by examining how blockchain-enabled transparency influenced consumer behavior, revealing the critical role of trust in adoption. However, I soon realized that understanding blockchain's impact required a broader perspective—one that considered the entire supply chain ecosystem rather than just consumer perceptions.

This realization shaped my PhD research, which explores blockchain adoption across supply chain stakeholders, including suppliers, manufacturers, retailers, and regulators. By integrating both individual and organizational perspectives, my research introduces a comprehensive model that captures key adoption drivers, such as trust, organizational readiness, and external pressures. Initially focused on the food and fashion industries—both of which face challenges in traceability and ethical sourcing, I expanded my scope to automotive and pharmaceuticals, enabling comparative analysis of adoption patterns across sectors.

Engaging with industry professionals and mentors further refined my approach, highlighting the complexities of blockchain adoption and the need for a multi-dimensional framework. These discussions reinforced the importance of trust dynamics, regulatory constraints, and sector-specific challenges, shaping a model that offers actionable insights for both academia and industry. Ultimately, my research aims to bridge the gap between theoretical understanding and practical implementation, empowering organizations to navigate blockchain adoption with greater clarity and confidence.

1.Introduction

In recent years, blockchain technology has garnered widespread recognition for its transformative potential across various industries. Within the domain of supply chain management, blockchain presents an unparalleled opportunity to revolutionize traditional practices by addressing critical issues such as lack of transparency, limited traceability, and inefficiencies in data sharing. By leveraging blockchain's decentralized and immutable ledger, supply chains can enhance trust among stakeholders, reduce the risk of fraud, and optimize operations across complex networks. These features are particularly relevant in industries where accountability and real-time data are paramount, such as food safety, pharmaceuticals, and automotive manufacturing.

Despite its evident promise, the adoption of blockchain technology in supply chains is neither uniform nor straightforward. Organizations face a diverse array of challenges and considerations when deciding whether to implement blockchain-based solutions. These decisions are influenced by a constellation of factors, including individual perceptions of utility, organizational readiness, regulatory environments, and sector-specific demands. The intricate nature of these factors often leads to significant variations in adoption rates across industries and geographic regions.

This research seeks to unravel the complexities underlying blockchain adoption in supply chains, providing a nuanced understanding of the motivations, barriers, and decision-making processes involved. It aims to investigate how individual actors, organizational entities, and sectoral dynamics converge to shape blockchain implementation. By adopting a mixed-methods approach, the study will explore the interplay between Micro-level motivations of individual actors, Meso 1-level organizational strategies, and Meso 2 power dynamics at a broader institutional level. Through this comprehensive examination, the research aspires to generate actionable insights and theoretical frameworks that advance both academic and practical understanding of blockchain adoption.

The scope of the study extends beyond a singular lens, exploring blockchain adoption from multiple perspectives to provide a holistic view. At the individual level, the research delves into personal attitudes, perceptions, and behavioral drivers that influence decisions regarding blockchain. At the organizational level, it examines how internal policies, resource availability, and strategic priorities affect the decision-making process. At the sectoral level, the study investigates external pressures such as market trends, regulatory frameworks, and competitive dynamics that drive or hinder adoption.

The findings of this research will not only enrich the scholarly discourse on blockchain technology in supply chains but also offer practical value for businesses navigating the challenges of digital transformation. By identifying the critical factors that influence blockchain adoption and understanding their interdependencies, the study will provide organizations with a clearer roadmap for implementation. Additionally, the development of a comprehensive adoption framework applicable across diverse industries will contribute to bridging the gap between theory and practice, enabling more informed decision-making in the era of supply chain digitization.

1.1. Research Plan

The complexity of blockchain adoption in supply chains necessitates a systematic and multi-layered research approach. This study adopts a mixed-methods methodology to explore the factors influencing adoption decisions, examine the interplay between key stakeholders, and identify the strategic considerations at various levels of the supply chain ecosystem. The research plan is designed to ensure a thorough analysis by integrating qualitative and quantitative data, enabling a comprehensive understanding of the multifaceted adoption process through the introduction of a conceptual model.

1.1.1. Research Objectives

The primary objectives of this research are to:

Identify and analyze the critical factors influencing blockchain adoption in supply chains: This includes both enablers and barriers at individual, organizational, and sectoral levels. Examine the differences in adoption motivations between upstream and downstream actors: For example, suppliers and manufacturers may prioritize operational efficiency, whereas retailers and consumers might focus on transparency and trust. Investigate decision-making processes across different levels of analysis: This involves exploring how decisions are made by individuals, organizations, and sectoral stakeholders within the broader supply chain context. Explore the roles of trust, transparency, and consumer behavior in adoption of driving: These elements are particularly crucial in industries where authenticity and accountability are key drivers of competitiveness.

Develop a comprehensive framework: The framework will synthesize insights across sectors such as food, fashion, and automotive, providing practical guidance for blockchain implementation.

1.1.2. Research Methodology

To achieve the research objectives, the study is structured into three levels of analysis: Micro-level, Meso1-level, and Meso2-level. A mixed-methods approach, integrating both qualitative and quantitative techniques, ensures a comprehensive understanding while maintaining generalizability.

Phase 1: Micro-Level Analysis (Individual Actors)

Objective: To investigate personal attitudes, perceptions, and behavioral factors influencing blockchain adoption within supply chain management. This phase will focus on understanding the human dimensions of adoption, such as motivations, concerns, and potential barriers, across different industry sectors (e.g., food, fashion, IT).

Data Collection: Semi-structured, open-ended interviews will be conducted with supply chain managers, IT professionals, end users, and other relevant stakeholders from industries such as food, fashion, and IT. This diverse range of participants ensures a comprehensive understanding of the adoption process across different sectors.

Methodology: A grounded theory approach will be employed to facilitate qualitative analysis. This approach will allow for the identification of key themes, including motivations for adopting blockchain, perceived benefits, and barriers to adoption. The research will leverage both qualitative and quantitative analysis techniques to provide a more nuanced view of the data.

*Data Analysis:*Thematic analysis will be conducted using Atlas.ti for coding. The iterative coding process will follow these stages:

1. Open Coding: Identifying initial concepts and themes in interview responses (e.g., trust, transparency, technological challenges).
2. Axial Coding: Establishing relationships between identified codes to form broader categories (e.g., transparency categorized as a driver of trust).
3. Selective Coding: Refining these categories into key themes most relevant to blockchain adoption, which will be statistically validated.

To measure the prominence and relative importance of each theme across different stakeholder groups, code frequency analysis and weighted scoring will be applied.

Ensuring Validity:

- Triangulation: Interview data will be triangulated with secondary sources and relevant literature to ensure robust findings.
- Member Checking: Participants will be asked to review the interpretations of their responses to validate accuracy and reduce researcher bias.
- Thematic Saturation: Interviews will continue until thematic saturation is reached, ensuring that all relevant themes and variations are captured.

Phase 2: Meso 1-Level Analysis (Organizational Dynamics)

Objective: To quantitatively assess organizational factors affecting blockchain adoption and analyze decision-making frameworks employed by companies.

Data Collection: A large-scale survey will be conducted among organizations across Europe, the USA, Canada, Turkey, and Dubai. The sample will include diverse sectors to allow for comparative analysis.

Survey Design: Insights from Phase 1 inform the survey, ensuring the inclusion of key organizational dynamics. A 3-point scale will be used for rating factors such as organizational readiness, strategic alignment, and cost considerations. The scale allows for clear comparative insights while reducing emotional biases.

Methodology: The Analytic Hierarchy Process (AHP) will be employed for structured pairwise comparisons of organizational factors. This method minimizes socially desirable response biases by focusing on relative factor importance.

Analysis Approach:

Step 1 – Data Preparation in Excel: Construction of pairwise comparison matrices and calculation of consistency ratios to assess response reliability.

Step 2 – Statistical Validation in R-Studio: Replication of calculations in R-Studio for cross-validation. Additional statistical tests, including regression and correlation analyses, will be performed to confirm relationships between organizational factors and blockchain adoption.

Validity Considerations:

- AHP's consistency ratio ensures logical response coherence.
- Cronbach's alpha will assess internal consistency reliability.
- Convergent and discriminant validity will be evaluated through factor analysis.

Phase 3: Meso 2-Level Analysis (Sectoral Power Influences)

Objective: The objective of Phase 3 is to explore the strategic and external influences that shape blockchain adoption at the sectoral level, with particular focus on sector-specific challenges, power dynamics, and external forces that drive or hinder adoption.

Data Collection: Data collection will be carried out through semi-structured interviews and focus groups involving decision-makers from both large enterprises and small-to-medium enterprises (SMEs) across multiple sectors. This will ensure a comprehensive perspective on sectoral power dynamics and external influences within the blockchain adoption process.

Focus Groups: Four groups, each consisting of 4–6 participants, will be conducted. The discussions will center around key themes such as:

- Regulatory challenges in blockchain implementation.
- Market pressures and competitive dynamics influencing blockchain adoption.
- Power hierarchies and decision-making structures within various sectors, particularly between larger corporations and SMEs.

Triangulation: To enhance the validity of the findings, triangulation will be employed across multiple data sources:

The findings from these interviews and focus groups will be cross-referenced and validated with the quantitative data collected in Phase 2. This will ensure that the sectoral insights are identified through the qualitative data align with trends identified through the survey and regression analysis.

Analysis Tools: Qualitative data will be coded and analyzed using Atlas.ti, facilitating the identification of key themes across interviews and focus groups and the qualitative insights derived from Atlas.ti will be supported by regression modeling from Phase 2 to assess the statistical significance of sectoral differences, decision-making power, and external influences.

Validity Considerations:

To ensure the validity and reliability of the study, several strategies will be employed:

1. Data Triangulation: Triangulating findings from the interviews, focus groups, and survey data ensures consistency and enhances the robustness of sectoral insights.
2. Thematic Saturation: Monitoring for thematic saturation will ensure that all relevant themes are explored comprehensively, providing a rich dataset for analysis.
3. Member Validation: Member validation will be used to cross-check the findings with participants, ensuring that the interpretations of the sectoral dynamics and blockchain adoption drives align with their lived experiences and perspectives.

1.1.3. Data Collection Strategy

Qualitative - Interviews (Phase 1): Conducted with upstream actors, supply chain stakeholders, including professionals from food and fashion brands, blockchain technology experts, downstream actors (end-users).

Quantitative - Surveys (Phase 2): Participants include diverse sectors, roles (e.g., supply chain managers, IT specialists, decision-makers), and geographical regions. Structured questionnaires ensure standardized data collection.

Qualitative - Focus Groups (Phase 3): Discussions among representatives from various company sizes and sectors will provide sectoral insights, emphasizing the interplay between different industry actors.

2.Blockchain Technology Role in Sustainable Supply Chains

2.1. Blockchain Overview

Blockchain technology is rapidly transforming industries across the globe, including the food and fashion sectors, where it is proving to be an invaluable tool for enhancing supply chain transparency, sustainability, and efficiency (Cui, Gaur, & Liu, 2023). Initially associated with cryptocurrency, blockchain’s capacity to secure transactions and provide immutable records has now been extended to tackle significant issues such as fraud, waste, and inefficiencies that hinder both industries (Joshi, 2023). As consumer demand for sustainability grows, blockchain is increasingly becoming a crucial component in the journey toward more ethical and responsible supply chains (Martínez-Peláez et al., 2023).

One of the major challenges in the food industry has been food waste, which is an enormous economic and environmental problem (Liu et al., 2023). One-third of all food produced for human consumption is lost or wasted every year, according to the Food and Agriculture Organization (FAO) of the United Nations. This not only represents a tremendous loss of resources but also contributes to environmental degradation through unnecessary waste management and landfill use. Blockchain helps in mitigating this issue by providing precise tracking of products in the supply chain. For instance, Walmart's implementation of blockchain technology in partnership with IBM has resulted in a 50% reduction in the time it takes to trace produce back to its origin, from days to mere seconds. This capability allows for more accurate forecasting, which reduces overproduction and ultimately helps minimize food waste.

Blockchain also plays an important role in tackling food fraud, estimated to cost the global food industry about $40 billion annually (Aslam et al., 2023). Application of blockchain in food traceability ensures that every stage of a product's journey-from farm to processing facility or from processing facility to consumer-is tracked transparently. Companies like Nestlé and Unilever have integrated blockchain into their processes to ensure the origins of key ingredients in their products. For instance, Nestlé uses blockchain in its dairy supply chain; hence, consumers can trace the entire lifecycle of their milk products to help ensure integrity in sourcing and reduce fraud or mislabeling.

Blockchain's role in transparency and sustainability extends to food safety as well. The use of blockchain ensures that foodborne illnesses can be tracked easily and quickly, protecting the health of the public (Li et al., 2022). A 2018 E. coli outbreak in Romaine lettuce caused widespread sickness across the U.S. and prompted massive recalls (Bray et al., 2018). With blockchain's ability to track produce in real time, such outbreaks can easily be contained much faster, so authorities can trace contamination to certain batches and regions within just hours, preventing unnecessary waste and potential harm (Zheng et al., 2017).

The fashion industry also sees a big impact from blockchain, particularly in cases of counterfeiting, waste, and environmental sustainability. The global fashion industry loses $30 billion annually to counterfeit goods, with luxury brands particularly affected (Zhang et al., 2023). Authentication through blockchain-institute means is one of the keyways in which the prevalence of fake goods can be reduced. For instance, LVMH (Moët Hennessy Louis Vuitton) has just introduced the Aura blockchain platform, which can trace luxury goods, such as handbags and watches, right from the manufacturing stage up to their sale (Franke et al., 2020). By linking each product with a digital certificate stored on the blockchain, Aura ensures that consumers can verify the authenticity of luxury products, safeguarding both the brand's reputation and consumers' investments.

Fashion is one of the most polluting industries in the world, accounting for an estimated 92 million tons of textile waste every year. For this, blockchain helps solve the problem by enhancing supply chain visibility, enabling brands to track the sustainability of materials and manufacturing processes (Patil & Bhosale, 2023). One leading brand in sustainable fashion, Stella McCartney, uses blockchain to trace the origin of materials to ensure they meet the highest ethical and environmental standards. This transparency, therefore, encourages consumers to be more responsible in their choices while buying fashion items.

Beyond waste reduction, blockchain is playing an important role in the circularity of fashion. A circular economy is all about reusing, recycling, and repurposing materials, and blockchain is essential in enabling such a model (Kirchherr et al., 2017). House Pangaia, a sustainable fashion label, utilizes blockchain to allow traceability of every process in the life cycle, from the sourcing of materials to their eventual recycling, of its products. That means using blockchain to make trackable the life cycle of textile products helps Pangaia reduce reliance on new materials that are virgin and positively makes statements over resources reuse. This aligns well with the broader goal: to reduce the environmental impact stemming from the fashion industry in general.

Blockchain is also fostering the development of more sustainable agricultural practices (Saberi et al., 2018). Inefficient resource usage and poor land management in agriculture result in deforestation, water wastage, and soil depletion (Gichuhi, Khakata, & Kofi, 2023). Blockchain technology helps farmers make data-driven decisions on optimizing resource use. AgriDigital's blockchain platform, for instance, helps farmers access real-time data on market conditions, weather patterns, and crop performance. By providing accurate data on the optimal use of water, fertilizers, and pesticides, blockchain helps farmers reduce waste and increase crop yields sustainably.

Moreover, blockchain allows a system where farmers can be incentivized for the implementation of sustainable practices. CarbonX applies blockchain in tracking and rewarding farmers for their reduced carbon footprints (Wang et al., 2023). CarbonX monitors carbon emissions for different farming practices, ensuring that farmers earn from transitioning to eco-friendly measures such as reduced usage of pesticides or organic farming methods. This will create an incentive for farmers to switch to more sustainable, climate-friendly forms of agriculture. In addition, with the challenges of climate change and reduction of carbon emissions, blockchain allows companies in both industries to measure and monitor the carbon footprints of their supply chains (Zheng et al., 2017).

In areas like South America, where cattle ranching is a leading cause of deforestation and greenhouse gas emissions, blockchain technology can verify the traceability of leather products to ensure they come from responsibly managed farms that comply with environmental and ethical standards (Zheng et al., 2017). Leather producers in Brazil are using blockchain as a means of proving that their materials are not sourced from illegal deforestation or environmental damage, which in turn demonstrates their commitment to sustainability.

Despite the many benefits of blockchain, its adoption is not without challenges. For most businesses in both the food and fashion sectors, the cost of implementing blockchain technology, especially at scale, can be out of reach. Small and medium enterprises may find it difficult to integrate blockchain into their existing systems. Besides, fragmented supply chains with a lot of actors may complicate the integration of blockchain technology across industries. Then there is the issue of standardization: different regulations and standards across borders may impede the creation of unified cross-industry solutions (Smith & Jones, 2020).

However, the benefits of blockchain in creating more sustainable, transparent, and efficient supply chains outweigh these challenges. As companies continue to witness tangible benefits of blockchain-from increased consumer trust to improved resource management-the technology's adoption is likely to grow. With the global trend for transparency, sustainability, and ethics on the rise, blockchain technology is surely going to be one of the major tools in restructuring the food and fashion industries as more responsible and sustainable industries.

The future of global supply chains is interconnected, transparent, and sustainable, and blockchain is at the heart of it.

2.2. Blockchain as a Solution for Supply Chain Challenges

Blockchain technology offers innovative solutions to many of the pressing challenges within modern supply chains, particularly in industries like food and fashion. These sectors, while both unique in their products and processes, share common concerns: inefficiency, lack of transparency, fraud, and the complexity of managing information across multiple stakeholders. With these, blockchain's immutability and transparency of records can help fix many of these issues to create a much more sustainable, ethical, and, ultimately, better supply chain for both industries (Patil & Bhosale, 2023).

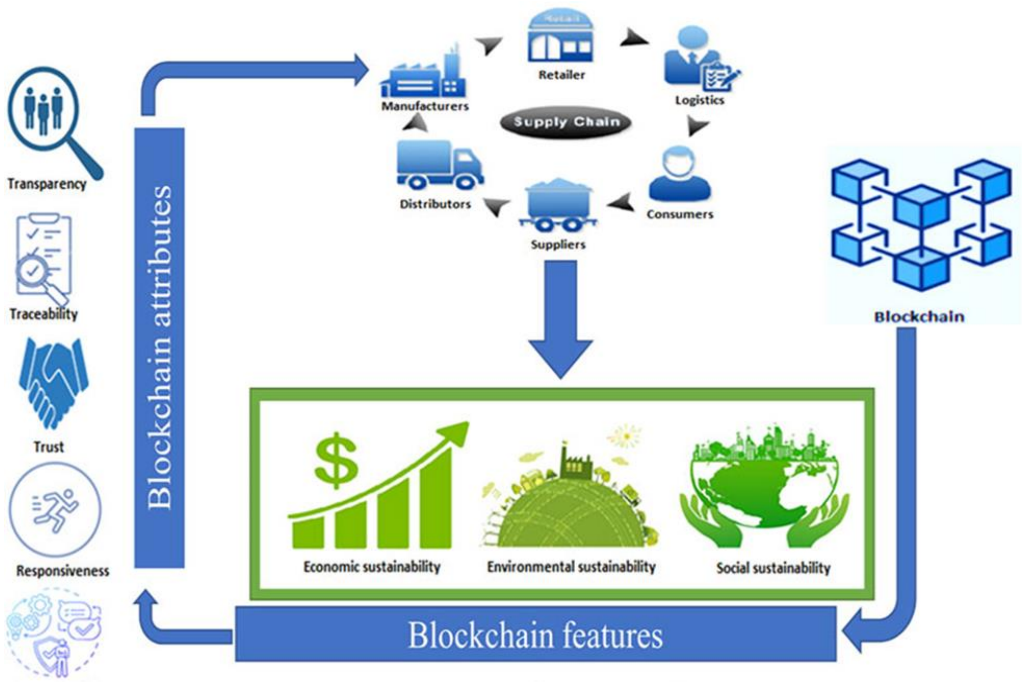


Figure 01. Blockchain Adoption for Sustainable Supply Chain Management*:*

Economic, Environmental, and Social Perspectives

2.2.1. Enhancing Transparency

Transparency is one of the key benefits that blockchain provides to any supply chain. In most cases, traditional supply chains of industries like food and fashion have a tough time maintaining transparency in their operations (Liao & Vaughan, 2023). Lack of transparency undermines consumer trust (Wongkitrungrueng & Assarut, 2020), complicates regulatory compliance (Okogwu et al., 2023), and makes it difficult for businesses to ensure that ethical and environmental standards are met at each stage of the production process (Tian et al., 2023). Blockchain resolves this through a decentralized, tamper-resistant ledger recording every transaction. Every step in the chain of production and distribution is visible to every stakeholder, which helps securely tracing the product from origin to final sale.

This transparency has its key benefits: it helps consumers verify the authenticity of the products they buy. This is especially relevant for the food industry, as more and more consumers want to know the origin of their food, the way it is produced, and whether it is safe to eat (Hassoun et al., 2022). Blockchain could give consumers extensive, real-time information on food products-from origin to production practices to distribution-all the way through the value chain, giving them more control over their purchasing decisions (Saberi et al., 2018). One very good example of how blockchain works in product traceability is in the seafood industry (Rowan, 2023). Thai Union, a global seafood producer, uses blockchain to track tuna's journey from the sea to the supermarket. This transparency gained consumers' trust in their products and helped the company reduce risks connected with IUU fishing.

In fashion, blockchain transparency gives consumers verification of the origin of raw materials and confirmation that the products of some brands are indeed sustainable (Goharriz, 2019). One such example is how The Textile Exchange recently developed a blockchain-based chain-of-custody traceability system for sustainable fabrics, which traces raw materials through to the final product-including detailed information on environmental impact, such as water use and carbon emissions (Ye et al., 2023). Greater transparency like this helps curb greenwashing but also keeps fashion brands under pressure in terms of better sourcing and ethical behavior.

2.2.2. Reducing Fraud

Fraud, especially regarding counterfeiting, presents a big problem in both food and fashion. Counterfeit products not only affect brand reputation but also pose health and safety risks and huge economic losses (Zhang et al., 2023). Counterfeit luxury items within the fashion industry are said to account for $30 billion in estimated global losses annually (Huang et al., 2023). Within the food industry, mislabeling and product adulteration could also lead to harm in consumer health and integrity in the marketplace, especially where high-value goods like olive oil, honey, and seafood are concerned (Pinedo et al., 2022; Adhitama & S.Sos, 2020). Blockchain makes these issues impossible because each transaction is immutably recorded on the blockchain for supply chain tracking. Product information can never be tampered with or fabricated after recording; thus, authenticity at the level of a product and transaction is ensured (Agnihotri et al., 2023). For example, Avery Dennison and EVRYTHNG have worked to develop a blockchain platform which identifies products, such as high-end garments and luxury goods, that help confirm their authenticity. To authenticate their products, shoppers only need to scan the QR code on it. It confirms that what consumers are buying is authentic and real (Bhatia & Albarrak, 2023).

In foodstuffs, blockchain represents an unparalleled way to prevent selling fraudulent or mislabeled foods (Patil & Bhosale, 2023). For example, Nestlé has been working with blockchain technology to track the origin of ingredients like cocoa and coffee. This ensures that products labeled "fair trade" or "organic" are sourced according to these standards (Saberi et al., 2018). This also helps in preventing fraud in labeling, where ingredients may be misrepresented to increase marketability, for example, sales of "organic" foods not produced to the organic farming standards.

2.2.3. Improving Efficiency

Inefficiency, driven by redundant processes, slow information exchange, and a multitude of intermediaries, is one of the persistent challenges in supply chain management (Sullivan et al., 2012). Blockchain can improve efficiency significantly by simplifying such processes, reducing the need for intermediaries, and automating transactions through smart contracts (Zheng et al., 2018). These self-executing contracts automatically enforce the terms of an agreement once predefined conditions are met, removing the need for intermediaries or manual verification.

In the fashion world, blockchain can make a difference in product development, inventory management, and even distribution. On, a Swiss fashion retailer, has chosen to automate its order and payment processing with blockchain technology (Saberi et al., 2018).All this is possible with blockchain integrated into its supply chain that enables on to reduce administrative work, improve product traceability, and enhance the management of inventories (Guan et al., 2023). Additionally, by monitoring the product journey using blockchain, the company can shorten the time it takes to react to supply chain disruptions or quality control issues, reducing costs and smoothing operations (Wang et al., 2023).

In the food industry, this could mean quicker, more accurate inventory management-a key factor in sectors like perishables, where timing is of essence (Tynchenko et al., 2023). Carrefour, a major French retailer, has integrated blockchain technology into its supply chain to enhance traceability and ensure the freshness of products (Zheng et al., 2018). By using blockchain to track product movements in real time, the company has optimized its inventory management and reduced waste, particularly for products with a short shelf life. This leads to reduced food spoilage, thus improving consumer satisfaction, with products being delivered in fresher and more efficient states (Istif et al., 2023).

2.2.4. Ensuring Ethical Practices

While food and fashion industries are feeling an increased heat to act upon labor exploitation, environmental degradation, and unsustainable sourcing, blockchain is a way for the industries to monitor and independently verify compliance with ethical standards (Zheng et al., 2018). The reason: Blockchain allows every step of the supply chain to be recorded in an indelible, transparent ledger so that businesses can show that their products are manufactured in fair working conditions and materials are responsibly sourced.

In the fashion industry, for example, Levi’s has partnered with H&M and Kering to implement a blockchain-based system that tracks the sustainability of the cotton used in their products (Papamichael et al., 2023) .This initiative aims to reduce the environmental impact of cotton farming by tracing the cotton’s journey from farm to finished garment, ensuring that it meets environmental standards, such as water conservation practices. The consumers can then have access to information, hence making it easier to make purchasing decisions based on ethical consideration.

Similarly, within the food industry, blockchain has been in use for the monitoring of social and environmental conditions in which food products are produced. Fair Trade International is looking into blockchain technology to enhance its certification processes and make it easier to trace the journey of certified products (Nowicki & Kafel, 2021). Technology helps to combat the exploitation in agriculture by introducing a transparent, verifiable record of farm conditions including the wage paid for workers, hours of working, use of pesticides, and other chemicals.

Blockchain technology presents one unique and powerful solution to a set of complex challenges with food and fashion supply chains. With blockchain, improved transparency, reduced fraud, greater efficiency, and a commitment to ethical practices, the sustainability challenges of these industries will be addressed and develop resilience in their supply chains (Patil & Bhosale, 2023). As consumer demand for ethical production and transparent sourcing continues to grow, the role of blockchain in these sectors will be expected to grow accordingly. By embracing this technology, companies can improve their operations and reduce costs while also contributing to a more sustainable and ethical global economy. As more and more users adopt the technology, blockchain may just be the key to transforming supply chains in every industry into a more transparent, efficient, and accountable world for businesses and consumers alike.

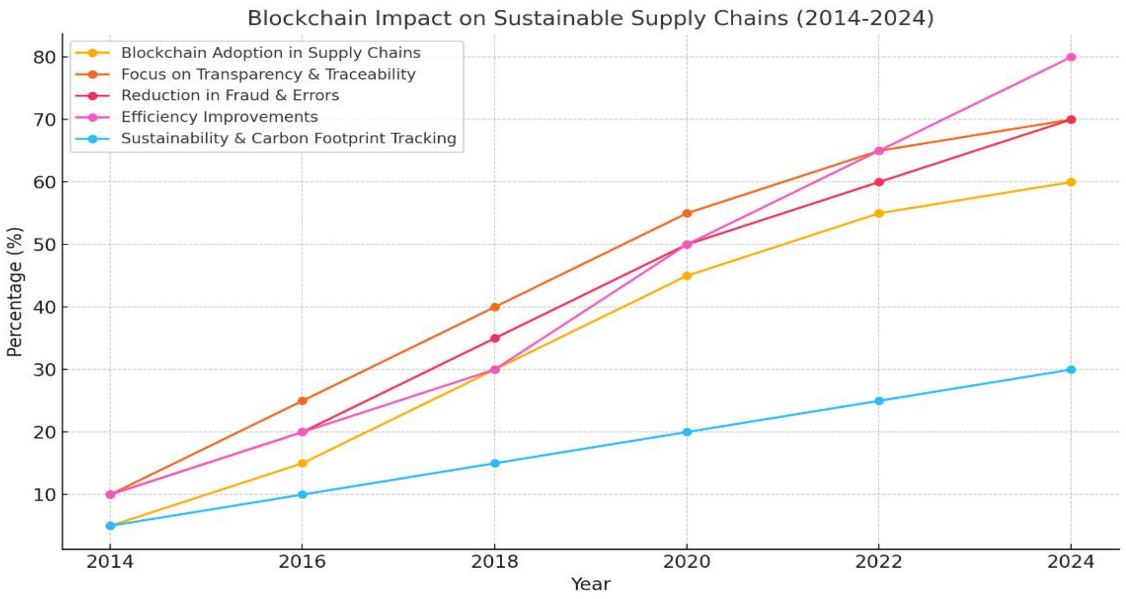


Diagram 01. Blockchain Impact on SSC

Source: World Economic Forum (WEF), Accenture Blockchain Reports and McKinsey & Company report.

2.3 Blockchain in Food Supply Chains

The food industry is one of the most extended and complex supply chains in the world, from production to the final consumer. This involves several steps, sometimes with many middlemen. In this situation, vulnerabilities such as fraud, inefficiency, and safety can arise. Blockchain provides a solution to this issue by offering transparency, traceability, and food safety (Zheng et al., 2017). By allowing a secure and immutable recording of transactions, blockchain enhances food supply chain integrity and enables stakeholders through better managing and optimizing their value chains.

2.3.1. Improving Safety and Traceability of Food

Among developed and developing markets alike, food safety stands out as a core concern (Awuchi, 2023). Whether contamination or fraud, in any scenario, it presents severe risks to health while triggering substantial product recalls and high financial losses. These challenges highlight increasing demands for transparency in supply chains in the food industry (Jagtap et al., 2022). It is here that blockchain provides a strong tool to meet this need: an indelible, time-stamped record of the movement of a food product from farm to table (Zheng et al., 2017). Each transaction processing, packaging, or distribution is immutably recorded on the blockchain to ensure that any potential issues can be identified and resolved with much speed.

One of the most prominent examples of how blockchain can affect food safety is the collaboration between Walmart and IBM (Latha et al., 2023). The collaboration resulted in the development of a blockchain-based system for tracking the origins of fresh produce (Esmael et al., 2023). The system, launched in 2018, reduced tracing time in the case of contamination of leafy greens from day to seconds. Whereas tracing the source of foodborne illness could take days or even weeks before blockchain, delaying recalls and increasing potential health risks, blockchain now allows Walmart to identify the origin of contaminated products in seconds. This allows for quicker and more effective recalls, thereby minimizing consumer risk. This quick response is critical in the food industry, which can quickly spread contamination from one location to another due to global health concerns.

Moreover, blockchain technology solves the most important problem of all: food fraud, prevalence in industries like seafood, olive oil, and honey (Li et al., 2023). Blockchain does this by giving an immutable record of the product's journey, assuring consumers of getting what they are promised and preventing fraud, like mislabeling products. For instance, French retailer Carrefour has introduced blockchain to track its chicken products right from farms to stores; it enables consumers to verify the origin of meat. This level of traceability builds consumer trust in the retailer's commitment to food safety.

Besides safety, blockchain allows businesses to prove and show ethical sourcing practices (Wade, 2022). Among the high-priority issues in the food industry, sustainability in agriculture and social concerns about raw material sourcing are paramount. Nestlé, one of the largest food companies in the world, uses blockchain technology to track the origin of its palm oil-a commodity that is responsible for deforestation and abuses of human rights. By using blockchain, Nestlé can provide its customers with transparency regarding the sustainability of its palm oil supply chain and give customers the assurance that their purchases have been sourced responsibly. This not only increases accountability in the supply chain but also boosts consumer confidence in the brand's ethics.

2.3.2. Promoting Sustainability and Reducing Waste

Aside from improving food safety and traceability, blockchain can help further sustainability by efficiently using resources and reducing food waste. Food waste is considered one of the major problems in supply chains all over the world. An estimated one-third of all food produced annually is lost or wasted. Food is wasted at every stage of production, transportation, retail, and consumption. The environmental cost related to food waste is tremendous, adding to increased carbon emissions and excessive use of natural resources such as water and energy.

Blockchain technology reduces food waste by improving the forecast of demand and enhancing coordination at the supply chain (Zheng et al., 2018). It enables companies to bring supply closer to real demand with up-to-the-minute, accurate data regarding inventory levels, consumer preference, and purchase behavior. This reduces overproduction and cuts the possibility of unsold food going to waste. For instance, Carrefour has already integrated the blockchain into its supply chain for better inventory management and operational waste reduction. By having real-time visibility at stock levels and consumer demand, the retailer can ensure that the right amount of food is produced and distributed, reducing excess stock and unnecessary waste.

Blockchain can also contribute to sustainability efforts by facilitating food redistribution. Surplus food, especially from retailers and producers, is often discarded due to logistical or regulatory barriers, despite being perfectly edible. It does. Blockchain provides a secure and transparent forum for food donation and reuse. For example, many blockchain-based systems, including Food for All, were designed to trace surplus food back to retailers, who were then able to transfer surplus food to charities or some other community groups that could give them to people who need it (Ayala et al., 2022). This was a system through which a surplus of food was made available rather than wasted. Blockchain enhances the efficiency of food donations, hence reducing food waste while at the same time addressing food insecurity in communities.

2.3.3. Optimizing Supply Chain Efficiency

Blockchain can also bring much-needed efficiency to food supply chains by improving traceability and reducing waste. In a traditional supply chain, the involvement of many intermediaries often results in delays, increased costs, and higher chances of errors or fraud (Masuda et al., 2022). Blockchain reduces the need for many of these intermediaries by using a decentralized ledger that captures every transaction in a secure, transparent, and immutable manner (Zheng et al., 2018).

In view of improving its supply chain and reducing its ecological impact, blockchain technology has also been adopted by Unilever, a large, popular multinational food and consumer products corporation (Hu, 2023). By applying blockchain technology for source material movement and product tracking, Unilever managed to rationalize their inventory and enhance sourcing. Additionally, with a two-way reduction in overall wastage and improved traceability, the company considerably brought down its carbon footprint and overall resource consumption, hence assisting in achieving its sustainability goals.

Blockchain also allows for better traceability of ingredients, enabling companies to make more informed decisions regarding sourcing and production (Cui et al., 2023). Danone, one of the world's largest dairy companies, uses blockchain to track the source of milk to ensure it meets both quality standards and ethical sourcing criteria. This transparent and efficient tracking process helps the company maintain its commitment to sustainability while improving its supply chain resilience.

The complexities and globality of food industries create several challenges in making their supply chains safe, sustainable, and ethical. Most of these challenges are addressed by blockchain technology since it enhances transparency, improves traceability, and facilitates smooth functioning (Chandan et al., 2023). Blockchain ensures an immutable and time-stamped record of every transaction so that the stakeholders can trace the journey of food products right from origin to consumption. This helps to ensure the integrity and safety of products. Besides, blockchain aids in reducing waste, better usage of resources, and following ethics for the sourcing of materials, hence it has become one of the key tools in developing a more sustainable food system. As pressures on food production from a growing global population, environmental degradation, and a shift in consumer demand toward ethical products continue to rise, too will blockchain's potential to transform supply chains, paving the way to a more transparent, sustainable, and efficient future.

2.4 Blockchain in Fashion Supply Chains

The fashion industry has been consistently facing huge challenges regarding environmental degradations, labor exploitations, and proliferation of counterfeit goods (Butt et al., 2023; Guidi & Berti, 2023; Yudha et al., 2023). These challenges not only affect the brands' reputation but also deter the progress toward a sustainable and ethical global supply chain (Kolcava et al., 2022). Blockchain technology has emerged as a game-changer in responding to these challenges by promoting unprecedented transparency, ensuring ethical practices, and combating fraud (Joshi, 2023). Blockchain fosters a more trustworthy, sustainable, and accountable fashion industry through a decentralized and immutable ledger for tracking products from origin to final sale.

2.4.1. Fighting Counterfeiting and Ensuring Authenticity

Counterfeiting is quite an issue in the fashion industry, with counterfeit goods flooding markets worldwide of all kinds of luxury goods (Dahlia, 2023). These counterfeit products hurt the brands they counterfeit, which erodes value and brand equity (Araújo et al., 2023), and their customers, who are sold an inferior product at premium prices. Counterfeit merchandise often involves illegal activities of many types and also results in unethical labor practices. With blockchain, the need for authenticity of products could be met in a highly transparent manner while tracking their path down to the supply chain (Zheng et al., 2017).

The VeChain platform, which has partnered with several luxury brands, including Louis Vuitton, for authenticating products, embeds Radio Frequency Identification (RFID) chips and QR codes in the products, creating a digital fingerprint for each product (She, 2022). These chips record every step in the journey of a product right from production to sale, providing the brand with unequivocal proof of provenance for the product in question and reducing the opportunity for counterfeit items to enter the market.

2.4.2. Ensuring Ethical Sourcing and Improvement of Labor Conditions

Fashion brands have been under long years of criticism for exploiting cheap labor, especially in developing countries where workers are exposed to poor working conditions and meager wages (Murphy, 2016). Fast-fashion brands like H&M and Nike have faced criticism regarding their involvement in sweatshops and other labor rights abuses (Perry & Peksen, 2023). This lack of transparency in the supply chain has fueled concerns over workers' rights, safety, and the overall ethical implications of purchasing fast fashion products. Blockchain technology offers a solution by providing transparent and immutable records of each step in the supply chain, ensuring that products are ethically sourced and manufactured (Patil & Bhosale, 2023).

One example of blockchain's role in improving labor conditions is the Provenance platform. Provenance is a blockchain service that allows brands to see where their products come from and what kind of labor was used to make those products (Ding et al., 2023). Provenance documents each transaction and touchpoint of the supply chain, providing consumers with decision-making tools based on effective sourcing practices, such as proving if workers were well- or underpaid, sustainable material was used, and even whether there was child exploitation involved. Provenance helps companies maintain ethical behavior through its transparency and enlightens consumers to support such businesses. The fashion brand Everledger uses blockchain in tracking the origin of diamonds, metals, and other luxurious materials used on fashion accessories (Holm & Goduscheit, 2020). Everledger guarantees that every diamond, for instance, is conflict-free and that those working in the mines receive fair labor practice and get paid adequately.

By using blockchain, fashion companies can build a more ethical supply chain, where labor conditions and product sourcing are transparent and verifiable. Blockchain gives consumers the ability to trust that brands are upholding labor rights of workers and are committed to fair trade practices, increasing demand for ethically produced goods.

2.4.3. Promoting Environmental Sustainability

Promoting Environmental Sustainability: The fashion industry is among the most resource-consuming industries in the world. This is due to the amount of water, chemicals, and energy used to produce clothes (Papamichael et al., 2023). From raw material extraction, such as cotton to dyeing and finishing, the footprint of fashion on the planet is massive. The industry contributes to immense textile waste due to the trend of discarding garments after a few uses (Wang & Memon, 2020). All these issues can be overcome by the use of blockchain technology, which helps to trace the sustainable sourcing of materials, adherence to production processes, and minimization of waste (Zheng et al., 2017).

Stella McCartney, a pioneer in ethical fashion, has implemented blockchain technology into her fashion brand to drive sustainability (Lee & Eum, 2023). Using blockchain, Stella McCartney traces the origins of its materials to ensure that they are sourced in a sustainable manner, using minimal environmental impact during production. Blockchain makes it possible for the brand to trace raw materials such as organic cotton, recycled polyester, and leather alternatives, thus making information available to consumers about the environmental impact of the products they purchase (Nguyen et al., 2022). This level of traceability helps ensure that the materials used meet high standards of sustainability and empower customers to make environmentally conscious purchasing decisions.

In addition to material sourcing, blockchain also plays a role in waste management and garment recycling. For instance, the Fashion for Good online platform-a global initiative that fosters innovation and sustainability in the fashion industry-has used blockchain to track and recycle garments (Kadnikova et al., 2019). Thanks to blockchain, brands and consumers can trace the life cycle of their clothes from purchase to eventual recycling or reuse. This transparency helps to close the loop in the fashion industry for the adoption of circular economy principles where garments are repurposed rather than disposed of, reducing waste and conserving resources.

It gives the capability to track a product throughout its life, from raw material through end-of-life-a very potent tool in driving environmental sustainability in the fashion industry. Blockchain can be used by brands to ensure that their operations follow strict standards of environmentalism, while consumers can have more reason to believe in those brands for their eco-friendly approach towards manufacturing.

2.4.4. Impact of Blockchain on Fashion Supply Chain Transparency

Traditionally, supply chains in the fashion industry have been opaque and not very transparent about how materials are sourced, under what conditions products are made, and what the footprint of the production processes might be (Nguyen et al., 2022). Blockchain, though, provides a secure way to document and track in real-time every step from the supply chain. By leveraging blockchain, brands can provide consumers with a full picture of how their products were made, where materials were sourced, and under what conditions. The platform SAP Leonardo, in use by major fashion brands such as Adidas and Kering, uses blockchain technology to extend transparency and sustainability. Companies can ensure the traceability of materials with ethical sourcing and reduce environmental impacts of their operations by integrating blockchain into their supply chain management systems (Kshetri, 2022). This way, they will enhance the visibility and traceability of their supply chains and enable consumers to make responsible choices more easily.

The fashion industry finds itself at a crossroads, with increasing pressure from consumers, regulatory bodies, and advocacy groups to address growing environmental and ethical concerns. Blockchain technology is one of the important means through which counterfeiting, labor conditions, and sustainability challenges can be overcome. Blockchain offers transparency, traceability, and accountability in the supply chain, thereby enabling brands to fight fraud, authenticate products, ensure fair labor, and enable sustainable sourcing (Smith, A., & Jones, B, 2020). As more and more fashion companies embrace blockchain, technology will be able to continue pushing positive change within the industry, toward a more circular and ethical fashion ecosystem for both brands and consumers.

2.5 Key Aspects: Security, Transparency, and Behavioral Factors

While blockchain technology offers numerous advantages for food and fashion supply chains, its adoption does not come without challenges. As seen in the earlier discussion, both the food and fashion industries are increasingly turning to blockchain to solve problems related to transparency, traceability, sustainability, and ethical sourcing (Chandan et al., 2023). However, the successful implementation of blockchain requires overcoming several obstacles related to security, the balance between transparency and confidentiality, and the behavioral tendencies of supply chain actors.

2.5.1. Security vs. Transparency: A Delicate Balance

One of the most important concerns in the adoption of blockchain technology in supply chains is finding the right balance between transparency and security (Patil & Bhosale, 2023). As pointed out in the previous sections, transparency is one of the most important benefits of blockchain, especially in terms of ensuring the authenticity of products, tracing their origins, and enabling ethical sourcing practices (Agnihotri et al., 2023). For instance, blockchain's transparency allows both the food and fashion industries-where consumer trust is so integral-to trace every step in the journey of a product, from raw material sourcing through to finished goods, that standards around ethics, environment, and safety are maintained.

Whereas transparency is one of the most crucial things, it often demands sharing sensitive data, and therefore, raises concerns linked with security (Wang et al., 2022). For instance, companies in food and fashion are very cautious about divulging business secrets, like contracts with suppliers, methods of production, and pricing strategies, since the revelations could give them a competitive disadvantage or even some kind of security risk. Intellectual property-like designs and sourcing strategies in fashion can make one very vulnerable in case too much data becomes public. In the food industry, this could be anything from farming practices to supply chain costs to negotiations with suppliers. The very nature of blockchain-transaction recording on a decentralized, immutable, and cryptographically secure platform significantly enhances data security. While in centralized systems, data is easily hacked or altered, blockchain's decentralized nature ensures that no single entity controls the entire network, hence reducing the risk of data manipulation. How much do they need to be open to allow trust? Using permissioned blockchains and permission over which data gets shared might answer that question. For example, IBM's Food Trust blockchain, a blockchain applied in companies such as Walmart and Nestlé, keeps all stakeholders' information of the product traceability private without exposing sensitive business information.

2.5.2. Behavioral Factors in Blockchain Adoption

In addition to technical concerns such as security and transparency, the adoption of blockchain technology is also influenced by behavioral factors within the supply chain (Shahzad et al., 2023). As discussed in the earlier sections, industries like food and fashion are highly complex and involve multiple actors, including suppliers, manufacturers, distributors, and retailers. These actors must collaborate and share data for blockchain to be effective. However, the factors of human influence prevail in either adopting or not adopting blockchain. Many supply chain actors resist the adoption of blockchain due to perceived barriers such as complexity, cost, and the disruption of established processes (Zakerabasali, et al, 2021).

In the food industry, especially in smaller companies or farms, the adoption of blockchain may seem overwhelming due to the perceived high costs of technology implementation and the complexity of training staff (Vern et al., 2023). The digital divide between larger corporations and smaller producers can exacerbate this resistance, making it challenging to create universal adoption across the entire supply chain (Afzal et al., 2023). In addition, even when blockchain could provide benefits, such as safer food and traceability, many smaller players will not see the benefit or may fear that blockchain would disrupt their operations.

On top of this, organizational culture and institutional pressures significantly influence how supply chain actors perceive blockchain. The organizational culture of companies used to traditional, paper-based processes may be very wary of adopting a new technology requiring an overhaul of existing systems (Meisenbach & Brandhorst, 2018). This is more evident in the fashion and food industry, where work may be ill-equipped to manage this disruptive blockchain technology effectively (Papamichael et al., 2023). Traditional, embedded ways of business operation, for example outsourcing and dealing with third-party agents using their respective legacy system to raise disincentives toward encouraging cooperation from every player along the supply chain (Zhao & Zhao, 2021). In combating these pitfalls, coordination among key players will go a long way. For blockchain to be effectively integrated into supply chains, all participants must be involved, from suppliers and producers to regulators and even consumers (Babaei et al., 2023). Incentives for collaboration could be provided by industry-wide initiatives, such as Food Trust in the food sector or Provenance in the fashion industry, where multiple players along the supply chain come together to create a single blockchain network (Murphy et al., 2021; Celik et al., 2023). These initiatives help alleviate concern by showing the real value of blockchain, building trust, and driving adoption at various levels along the supply chain (Niu et al., 2021).

2.5.3. Blockchain’s Role in Enhancing Supply Chain Efficiency and Sustainability

Blockchain opens ways for food and fashion industries to enhance their sustainability and deal with the critical challenges related to waste, fraud, and unethical practices (Zheng et al., 2018). Providing an immutable record of transactions will help in making better decisions, enhancing efficiency, and maintaining ethical practices across the value chain. The transparency of blockchain can drastically reduce instances of fraud in the fashion industry, where counterfeiting is a big issue, and in the food sector, where traceability can enhance food safety and prevent contamination (Zhang et al., 2023).

At the same time, blockchain can enhance supply chain efficiency. It would mean that with blockchain, many of the administrative functions currently being handled manually today could be automated, such as verification of payment or shipment confirmation, using smart contracts (Zhang et al., 2023). These will reduce delays, operational costs, and increase speed within the supply chain. Such efficiencies can help reduce waste-whether it's food that doesn't meet demand or fashion items that go unsold-in both the food and fashion industries.

Blockchain also contributes to the promotion of ethical sourcing and sustainability. Tracing a product's journey allows consumers to make better choices, while encouraging businesses to go greener and more socially responsible (Muldoon et al., 2023). This is especially critical in the food industry, where concerns are rising over sustainability, and in the fashion industry, where eco-consciousness is an increasingly significant factor in purchasing decisions.

The challenges that blockchain presents for the supply chains of both food and fashion are enormous, but it is equally evident that no disruptive technology will be entirely immune from considerations of security, transparency, and behavioral factors. It is by the careful management of these trade-offs, the facilitation of collaboration, and the incentivizing of the take-up of blockchain through supply chains that businesses can gain the most value from this technology. In the end, blockchain can help create more sustainable, transparent, and efficient supply chains in both the food and fashion industries, which would support a shift toward ethical sourcing, improved consumer trust, and reduced environmental impacts.

3. Technological Evolution and Challenges in Supply Chains

3.1 Overview of Modern Supply Chains: From Linear to Complex Networks

Supply chains (SCs) rapidly expanding from a traditional linear system towards complex networked systems driven by the development of globalization and technology evolution (Adebayo & Kırıkkaleli, 2021). Transformation will need to take place across the industry beginning with better inter- and intra-organizational collaboration, as businesses look for more real-time information sharing to alleviate inefficiencies and fraudulent activity that hampers a more transparent efficient collaborative investment process (Adomako & Nguyen, 2023; Ghouri et al., 2021). Among other things, it is crucial for industries such as agri-food with food safety and traceability issues or luxury goods where counterfeiting and authenticity need verification (Li et al., 2022). This productive problem necessitates improved means of information dissemination and transparently tracing the origin of goods across the supply network (Feng et al., 2023).

3.1.1. Technological Evolution: Digitizing the Supply Chain for Greater Efficiency

The digitization of supply chains changes the very character of how companies do business in several ways, including new technologies driving efficiencies, transparency, and resilience (Cobbe et al., 2023). The Internet of Things-IoT-enabled real-time tracking and monitoring offers unprecedentedly granular insight into products' movement and condition (Li, Xu, & Zhao, 2014). Cloud computing allows seamless storage and access to information for multiple stakeholders in the value chain (Armbrust et al., 2010). Moreover, AI and machine learning are helping optimize decision-making and logistics by providing predictive models, automating tasks such as demand forecasting, and identifying anomalies (Rasool et al., 2022). These changes bring about massive improvements in cost reduction and operational performance (Belanche et al., 2020). Furthermore, blockchain technology introduces a whole new way of thinking about building a shared, transparent ledger due to its decentralized and immutable nature, which increases trust and accountability across the entire supply chain (Zheng et al., 2017).

3.1.2. Innovative Applications: Real-World Examples of Technology in Action

In practical terms, different industries have started implementing these technologies in their operation optimization. For instance, in the agri-food industry, IoT sensors are highly utilized for temperature and humidity monitoring while transporting food to maintain the required quality and safety standards of the products (Palanisamy et al., 2023). This real-time data collection supports the compliance of strict safety regulations and increases consumer confidence. In the luxury industry, for example, blockchain plays a large role in product authentication, which allows the tracking of each merchandise from production to the time it reaches the consumer (Subapriya et al., 2023). Large companies such as Louis Vuitton and De Beers have opted for blockchain to show verifiable proof of the origin of products, thereby minimizing fraud and increasing brand credibility. Blockchain adoption by the pharmaceutical industry in tracking drugs along the supply chain helps maintain product integrity and keeps the potential for counterfeit products from being put on the market (Musamih et al., 2023). Such examples demonstrate that integrated technologies help make not only operational improvements but transform supply chains into value-creating networks, building brand reputation, assuring sustainability, and guaranteed product authenticity.

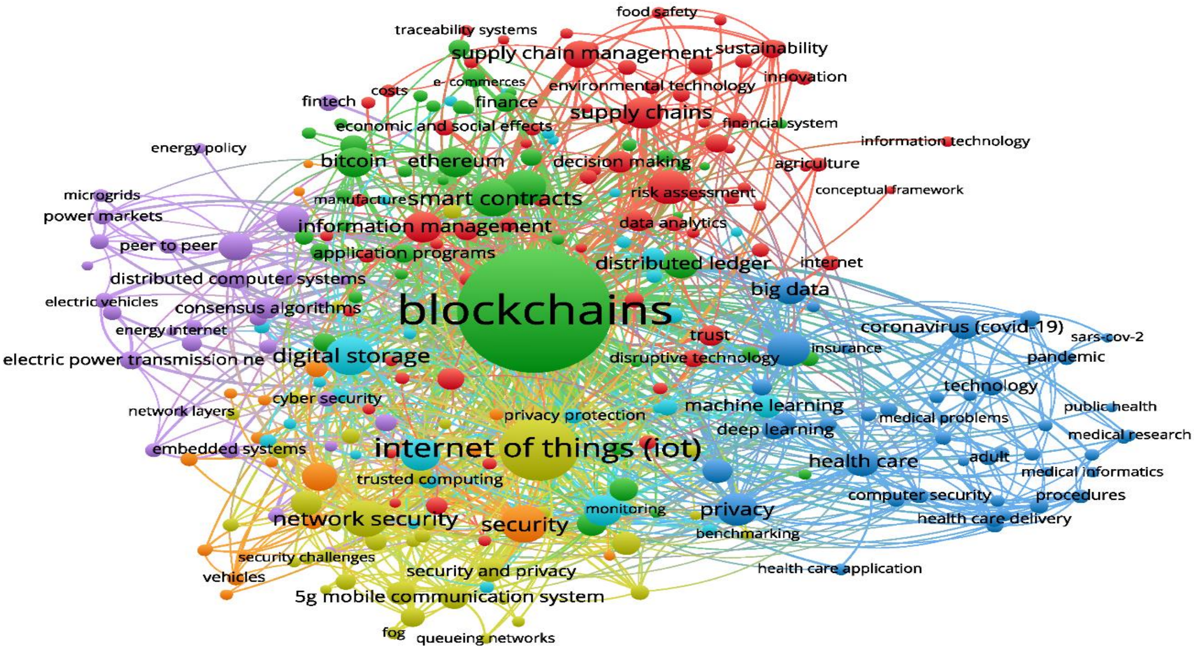


Figure 02: VOS viewer, Blockchain technology role in world ,2020-2024

VOS viewer *(figure 02)*, three clusters out of six, red, green, and blue ones, are more extensive than the rest. The red area consists of topics related to blockchain technology, supply chain management, and sustainable development. The main element in chain management is data exchange for carrying out which of the latest developments in blockchains can be used; for instance, smart sensors can be helpful for the companies to gather information regarding the supply chain, and blockchain technology can be used for disruptive transformation for efficient and secure supply chains and network (Zheng, et al.,2018).

3.1.3. The Shift Towards Value-Creating Networks: Unlocking Competitive Advantage

In a network of value creation, competitive advantages will be increasingly related to technology adoption within the supply chains (Crouzet, Gupta, & Mezzanotti, 2023). The move to integrate IoT, AI, and blockchain will not only make companies more efficient but also provide a strong value proposition to companies (Neto et al., 2023). Meeting strict certification requirements, operational sustainability, and authenticity of products will have a direct impact on a company's market position (Johnson & Wallington, 2021; Payel et al., 2023; Żak & Wilczyńska, 2023). It becomes particularly critical in those lines of business where consumer confidence is a major factor of success (Huang, 2023). For example, Walmart has used blockchain technology to enhance its traceability efforts within the food supply chain, reducing the time it takes to trace the origin of contaminated products from days to mere seconds, improving the quality of food and customers' confidence (Ramasami et al., 2023; Musamih et al., 2023). These technological innovations turn the supply chain from a back-office operation to a core building block of competitive strategy, enabling companies not only to survive but to thrive in a fiercely competitive, information-intensive environment (Chandan et al., 2023).

3.1.4. Statistical Impact of Technological Integration

These advanced technologies are finding their real application in supply chains, proving impactful not only in terms of efficiency but also in cost reductions and sustainability improvements. For example, the use of the blockchain in Walmart's food supply chain has been shown to drastically improve traceability. According to the IBM Food Trust Network, Walmart has been able to reduce tracing time for finding the origin of food products from days to mere seconds using blockchain (Cui, Hu, & Liu, 2023). This, in turn, reduces tracing time and increases food safety by a large margin, greatly reducing the risk of widespread recalls, which can be expensive. Walmart's blockchain pilot for leafy greens, in cooperation with IBM, saved $1.5 million in operational costs alone (Ernayani et al., 2022), underlining how digital traceability can save millions, sometimes billions, of dollars in industries like agri-food.

Another remarkable example is from the luxury goods industry, where the fight against counterfeiting with the help of blockchain technology has been ensuring product authenticity (Zheng et al., 2018). The global market for counterfeit goods was valued at approximately US$500 billion in 2020, according to OECD estimates (OECD, 2020), which is quite a huge loss to brands. Companies like De Beers are using blockchain to track diamonds from mine to retail, creating a secure, transparent system that guarantees the authenticity of each stone. De Beers says its blockchain initiative, Tract, has certified the origin of more than 1 million diamonds since its launch (Lindner et al., 2023). This is not only combating fraud but also reinforcing the brand's commitment to ethical sourcing practices-a key factor for the modern consumer. With over $70 billion in annual revenue generated by the diamond industry, the financial implications of blockchain adoption are significant (Meltsner, 2023).

In the pharmaceutical industry, when the world is facing a growing problem of counterfeit medicines, blockchain has been implemented to ensure traceability from production to consumption of drugs (Adeshokan & Ro, 2023). According to an estimate by the World Health Organization, 10-30% of medicines circulating in developing countries are counterfeit, thereby posing life-threatening consequences to patients. By adopting blockchain, companies such as Pfizer and GSK will improve traceability so that drugs are able to reach consumers safely and as intended. In 2020, the application of blockchain to track shipments of drugs through the supply chain reduced the risk of counterfeit drugs reaching the market by 99%, according to a joint pilot program run by the European Union (Yaroson et al., 2023). These improvements within the pharmaceutical supply chain show not only the impact on safety but also how blockchain might help drive regulatory compliance, fraud reduction, and improved public health outcomes globally.

3.1.5. The Economic and Operational Benefits: Cost Savings and Increased Efficiency

Beyond improving traceability, the integration of technologies such as blockchain and AI also goes a long way in reducing operational costs. According to the World Economic Forum, blockchain can reduce supply chain management costs by as much as 20% (Saberi et al., 2018). This is particularly true in industries with heavy logistics, where inefficiencies in paperwork, tracking, and validation processes often lead to increased costs and delays. Companies like Maersk, a global container shipping leader, estimate that blockchain's role in digitizing trade documents could save the shipping industry up to $6 billion annually (Zheng et al., 2018). Maersk's collaboration with IBM on the Trade Lens platform has already reduced the time it takes for shipping containers to clear customs by 40%, which ultimately leads to faster deliveries and a reduction in overhead costs. Also, AI-based predictive analytics is contributing to supply chain optimization by predicting fluctuations in demand and adjusting delivery schedules to decrease transportation costs (Chen, Yang, & Xu, 2021; Badawy, Ramadan, & Hefny, 2023). For example, DHL estimates it has saved up to $50 million per year with the use of AI and machine learning-based route optimization in logistics by cutting fuel costs and improving delivery accuracy (Liu, 2023; Abadi et al., 2016).

3.1.6. Enhancing Transparency: The Role of IoT and Blockchain in Sustainability

The integration of IoT sensors and blockchain technology is optimizing not only operational efficiency but also driving significant improvements in sustainability practices (Palanisamy et al., 2023). According to a study conducted by Boston Consulting Group, 70% of supply chain executives believed that IoT devices and blockchain will be key to achieving their sustainability goals back in 2020 (Rahamneh et al., 2023). IoT sensors can help monitor environmental factors, including temperature, humidity, and carbon emissions across supply chains (Gacesa et al., 2022; Guo et al., 2023; Tomczyk et al., 2020). For example, within the food industry, IoT sensors ensure that temperature-sensitive items such as dairy and seafood maintain the required ranges in transport, thus contributing toward the reduction of waste and spoilage (Angane et al., 2022; Harper et al., 2022; Abedi-Firoozjah et al., 2023). Blockchain, when combined with IoT, allows companies to create tamper-proof records of their environmental performance, which can be used to prove claims related to sustainability (Shekhtman & Waisbard, 2021). For instance, French retailer Carrefour has partnered with IBM to use blockchain and IoT in tracing the environmental impact of products from farm to table, thus making it easier for consumers to make informed decisions about their purchases (Osman et al., 2022). Such integration does not only create transparency but also fosters much more consumer trust and loyalty, thus impacting sales and brand reputation (Wongkitrungrueng & Assarut, 2020; Chen et al., 2023).

3.1.7. Looking Ahead: The Future of Supply Chain Technology Adoption

As these examples show, blockchain, AI, and IoT integration in supply chains are no longer concepts of the future but have become quite real for industries (Patil & Bhosale, 2023). In the future, the pace of adoption is likely to continue to accelerate, with the global blockchain market for supply chain management alone expected to grow from $3 billion in 2020 to over $9 billion by 2025 (Qin et al., 2023), according to Marketsand Markets. These technologies will continuously improve and drive even greater efficiencies, cost savings, and further sustainability practices (López-Gamero et al., 2023). As this technology is adopted by a greater number of companies, the overall global supply chain will become more transparent, resilient, and sustainable and will give organizations a more competitive advantage in a dynamically changing marketplace (Raymond et al., 2023). However, in order to fully realize such benefits, companies must focus on overcoming integration challenges (Martínez-García & Hernández-Lemus, 2022), collaborate with stakeholders, and work towards seamless adoption at every level of the supply chain (Amaldoss & Du, 2023).

3.2. Challenges and Solutions in Technological Integration

3.2.1. Ongoing Weaknesses in Digitized Supply Chains: A Closer Look at Vulnerabilities

However, even with all these significant improvements in digitizing supply chains, various weaknesses have not allowed such systems to realize their full potential. For example, the recent ransomware attack on one of the major trucking companies shows how vulnerable the supply chain is to cyber-attacks. This attack resulted in massive disruptions, which ground operations to a halt and saw the company suspend its services for some time, underscoring the risk that digital dependencies can bring to a traditionally physical industry. According to a report by the Center for Strategic and International Studies (CSIS) in 2020, the cost of cybercrime reached $600 billion annually, underlining serious economic consequences of cyber vulnerabilities in supply chains (Huang & Zhao, 2022).

The lack of seamless data sharing between farms, processors, and retailers hampers real-time visibility and results in inefficiencies, as seen during several food recall events (Joy, 2012). For example, in 2018, the E. coli outbreak linked to romaine lettuce had more than 200 people sickened in the U.S. and Canada, forcing a recall involving over 30 major brands (Joensen et al., 2014). Because the source was not traceable in a timely and precise manner, there were huge losses in wasted products and lost consumer trust. A study by IBM found that 73% of consumers would be more likely to purchase food from brands offering transparency regarding sourcing and safety (Lan et al., 2023), further emphasizing the need to overcome data silos for improved traceability.

3.2.2. The Challenge of Standardization: Hindering the Full Potential of Technology Like Blockchain

Another critical challenge is a lack of standardization in various blockchain platforms within the supply chain. As much as blockchain may hold great potential in efforts toward better traceability and complete transparency, it is only being gradually integrated into global supply chains due to the absence of universal standards (Cacciamani et al., 2021). Quite often, companies have to choose from different blockchain platforms that don't communicate well with one another, which reduces the possibility of smooth data sharing across networks (Gupta et al., 2023). This fragmentation has been one of the main barriers to achieving the full benefits of blockchain-for example, in industries that rely on provenance and authenticity, such as luxury goods and pharmaceuticals (Lou et al., 2022; Pan et al., 2023).

The pharmaceutical industry has tried to integrate a variety of blockchain solutions to trace the movement of drugs and fight counterfeit drugs (Kordestani, Oghazi, & Mostaghel, 2023). The World Health Organization estimated that in 2021, counterfeit medicines accounted for up to 10% of global pharmaceutical sales, causing up to $200 billion in losses annually (Nandi, Pecetta, & Bloom, 2023). Blockchain could greatly reduce this problem, but the lack of industry-wide standards for data sharing and integration continues to hinder progress (Sorensen & Butcher, 2011). As big companies like Pfizer and Merck begin to adopt blockchain, they are often forced to navigate different technologies, creating inefficiencies in an otherwise promising field (Fleming-Dutra et al.,2023; Merck, 2022).

3.2.3. The Skills Gap: How Lack of Expertise Is Limiting AI Implementation

Besides the technological challenges, there is still a significant skills gap in supply chain management, especially regarding AI and predictive analytics. While AI-powered solutions provide powerful tools for demand forecasting, inventory management, and predictive maintenance, many smaller manufacturers lack the expertise to leverage these technologies effectively. According to a report by McKinsey & Company, it is estimated that 50% of supply chain leaders consider the shortage of skilled personnel as one of the biggest barriers to AI implementation (Nelson et al., 2022). This skills gap drives overstocking, stockouts, and missed opportunities for supply chain optimization.

For instance, most manufacturers still depend on traditional forecasting techniques, which introduce inefficiency into their inventory management. AI-powered predictive analytics can optimize production schedules and inventory levels based on real-time demand signals. Companies such as Amazon and Walmart have successfully adopted AI for demand forecasting, resulting in a reduction of excess inventory by 20% and a reduction of stockouts by 30%, thus reducing costs by making operations more efficient. Smaller manufacturers, which do not have access to AI expertise, however, continue to struggle with inefficient stock management, adding to the overall inefficiency in the supply chain.

3.2.4. Organizational Inertia: The Slow Adoption of Sustainable Practices

The most manufacturers still depend on traditional forecasting techniques, which introduces inefficiency into their inventory management. AI-powered predictive analytics can optimize production schedules and inventory levels based on real-time demand signals (Christakou et al., 2014). Companies such as Amazon and Walmart have successfully adopted AI for demand forecasting, resulting in a reduction of excess inventory by 20% and a reduction of stockouts by 30%, thus reducing costs by making operations more efficient (Aguiar & Pérez-Juárez, 2023). Smaller manufacturers, which do not have access to AI expertise, however, continue to struggle with inefficient stock management, adding to the overall inefficiency in the supply chain.

For instance, within the fashion industry, it has been criticized for failing to adopt sustainable sourcing practices despite consumer preferences for eco-friendly products (Prajaputra et al., 2023). Companies such as H&M and Zara have initiated sustainable sourcing, but overall, the industry's adoption pace is slow. This can be explained by organizational inertia and the challenge of breaking free from traditional supply chain models into more sustainable and transparent ones (Rogers & Srivastava, 2021). In the same light, McKinsey & Company state that 60% struggle to implement sustainability into the corporations due to a lack of appropriate tracking systems, and all this adds to complications of the journey toward supply chain sustainability (Dekkiche et al., 2023).

3.2.5. Privacy Concerns and Governance Frameworks: Protecting Consumer Data in the Supply Chain

As supply chains increasingly adopt digital technologies, data privacy concerns have become a pressing issue (Minin et al., 2021). The collection of extensive consumer data—ranging from purchasing preferences to behavioral insights—demands that retailers and manufacturers implement strong governance frameworks to safeguard sensitive information (Hemker et al., 2021). For example, the 2022 Optus data breach exposed personal information of nearly 10 million customers, emphasizing the risks of inadequate data security measures in interconnected systems (Yeoh et al., 2023). Such breaches not only carry significant legal and financial repercussions but also significantly damage consumer trust, which is vital for business sustainability (Lou & Yuan, 2019).

Recent research by Cisco's 2022 Consumer Privacy Survey revealed that 81% of consumers believe the way an organization handles their data reflects its overall trustworthiness, with over 50% reporting they have stopped doing business with companies due to privacy concerns (Braulin, 2023). As supply chains adopt emerging technologies like IoT devices and advanced cloud systems, robust data governance becomes indispensable. Companies must establish clear, transparent data-sharing policies and invest in cutting-edge cybersecurity protocols (Raghuwanshi, 2023). The adoption of blockchain technology can also enhance security, as its immutable and decentralized architecture helps detect unauthorized changes to consumer data (Zheng et al., 2017). However, achieving meaningful protection requires a cohesive approach, including comprehensive data protection frameworks and enforceable regulations, to uphold consumer rights effectively (Septyaningsih et al., 2023).

3.2.6. The Path Forward: A Multifaceted Approach to Overcoming Challenges

Overcoming the above weaknesses requires a multilayered approach involving collaboration, investment, and strategic decisions along the supply chain network. Firms need to collaborate to break down the silos of data, standardize blockchain platforms, improve the skill gap, and shake off organizational inertia (Kirchhof et al., 2016). Wide industry collaboration is needed in order to develop best practices for technology adoption, including blockchain and AI, so that this can be beneficial for all players in the supply chain.

These success stories-from Walmart's blockchain food traceability program to the use of AI by Amazon to aid demand forecasting- demonstrate how technology can be effectively leveraged to enhance efficiency, transparency, and sustainability across the supply chain (Patil & Bhosale, 2023). What such success stories also bring up is the issue of cooperation and the need for everybody to be on the same page. Companies that successfully navigate these challenges will find not only operational efficiencies but also leadership in sustainability and ethical practices, thereby gaining a competitive advantage in an increasingly exacting market (Hagiu & Wright, 2023).

3.3. Food and Fashion Supply Chains: Common Challenges, Consumer Impact, and Technological Solutions

The food and fashion industries, while very different in many aspects, are both at the core of the global economy and consumer behavior. They are deeply intertwined with how consumers interact with brands, make purchasing decisions, and contribute to broader societal issues (Friedrich.,2021). They have major implications for supply chains across the globe, which then influence both production methods and consumer expectations (Cobbe et al., 2023). Despite these differences, each of these industries shares similar vulnerabilities: safety concerns (Duffourc, M., & Gerke, S.2023), labor conditions (Min et al., 2019), sustainability challenges (Rosário, A., & Dias, J. C.,2023), and ethical sourcing (Muldoon et al., 2023). These issues have become more pronounced in recent years due to the growing demand for transparency and accountability, especially in light of global awareness of supply chain inefficiencies and human rights violations (White, 2016).

Product safety is at the forefront of concerns related to both industries. Gross incidents, such as contamination or widespread foodborne illnesses, can inflict tremendous harm on the population. According to a report presented by the World Health Organization, an estimated 600 million cases of illness and 420,000 deaths due to foodborne diseases alone occur annually worldwide (Singha et al., 2022). This problem is further worsened by the fact that many supply chains are opaque and non-transparent, so it is difficult to trace where the contamination took place (Hobbs, 2020). On the other hand, similar challenges in ensuring product safety are faced in the fashion industry, especially concerning the compliance of materials and garments with health and safety standards (Moretta, Whyte, & O'Neill, 2021).. These issues raise concerns for more supply chain visibility and accountability to ensure consumer health and well-being (Swink et al., 2023).

Added to safety, sustainability and ethics have become a growing concern for both the food and fashion industries. Within the food industry, there is an increased concern for environmental sustainability, especially relating to food waste, carbon emission, and the use of unsustainable farming practices (Guo et al., 2023).The FAO estimated that a third of all food produced globally is lost or wasted, adding up to an incredible environmental burden. On the other hand, the fashion industry has been under criticism for a long time because of its impact on the environment, especially fast fashion. The manufacturing of low-priced, low-quality clothes has resulted in excessive waste, water pollution, and high carbon emissions (Sharma & Jha, 2023). A 2018 report by the Ellen MacArthur Foundation estimated that the fashion industry was responsible for 10% of global carbon emissions, more than international flights and shipping combined. These environmental concerns have spurred a shift in consumer behavior, with many demanding greater sustainability from the brands they purchase from (Jain et al., 2023).

To solve these challenges, both industries are turning to technology for answers. In the food supply chain, blockchain technology has been implemented to increase transparency, traceability, and safety (Sharma, A.et al., 2023). Companies like Walmart and IBM have collaborated on the Food Trust blockchain, which enables consumers and retailers to track the origins of food products in real-time to guarantee their safety and reduce the risk of contamination (Zheng et al., 2018). By improving traceability, blockchain also makes it easier to conduct recalls if there is an outbreak of foodborne illness (Musamih et al., 2023). The fashion industry also uses blockchain for verifying authenticity, fighting counterfeiting, and ensuring ethical sourcing (Ponte et al., 2023). Prada and LVMH are among brands that have adopted blockchain technology in tracing the origin of luxury goods to ensure they are produced in a responsible and sustainable manner. Besides blockchain, fashion also employs AI, IoT, and machine learning in better inventory management, waste reduction, and the manufacturing process (Abadi et al., 2016). As these technologies continue to evolve, they hold great promises for further revolutionizing food and fashion supply chains toward efficiency, sustainability, and ethical responsibility. These technologies have the potential to revolutionize industries that have traditionally been considered opaque and difficult to regulate, offering new pathways to address long-standing issues in both sectors.

3.3.1. Key Issues in Both the Food and Fashion Industries: Real-World Examples and Practical Applications

The food and fashion industries are two of the most influential sectors in the world, shaping consumer behavior, global supply chains, and societal norms (Friedrich, 2021). Despite their differences in product offerings, target markets, and production processes, both industries face common challenges related to product safety, labor conditions, quality, fraud, counterfeiting, and transparency. These sectors are increasingly adopting technological solutions to address these issues, making them crucial areas for innovation and improvement (Manyika, 2011). This section explores these key challenges and provides real-world examples of how technology and strategic decision-making help mitigate these problems in the food and fashion supply chains.

3.4. Food Safety in the Limelight: Ensuring Consumer Trust and Health

The food industry has one fundamental principle: to ensure consumer safety. Every food safety failure not only risks public health but also severely damages consumer trust and brings huge financial and reputational losses (Daniel et al., 2022). Real-life examples of incidents, such as the 2011 cucumber scandal in Europe where contaminated cucumbers were linked to a deadly outbreak of E. coli that affected over 1,000 people (Kobayashi et al., 2018), have highlighted the vulnerabilities present in the food supply chain. Similarly, the 2013 horse meat scandal revealed how widespread mislabeling and fraud in the supply chain can have damaging effects, including undermining consumer confidence in the integrity of food labeling and safety (Scott et al., 2019).

3.4.1. Technological Interventions for Safety

The food industry is increasingly resorting to technologies that can help ensure product integrity due to increasing concerns about the safety of food (Gadre et al., 2022). One key technological solution has been the IBM Food Trust blockchain, which offers end-to-end visibility and traceability across the entire food supply chain (Zheng et al., 2018). Technology allows companies to track food products from farm to table. Therefore, companies can locate the precise source of contamination in case there is an outbreak (Musamih et al., 2023). For example, Walmart has already introduced blockchain into its supply chain, which reduced the time taken to trace the origin of contaminated food drastically (Yao, 2023). It used to take several weeks, and sometimes several months, to trace the source of the foodborne illness; today it takes a few seconds. Apart from blockchain, IoT sensors are applied at every stage of transportation and storage of food products (Xi et al., 2023). These sensors continuously monitor temperature, humidity, and air quality in real time. These sensors ensure that the food products are stored and transported under appropriate conditions, hence maintaining the quality of food and reducing food spoilage and the risk of foodborne illness.

3.4.2. Regulatory Measures and Consumer Confidence

As a result of these scandals, various schemes and certifications have been developed to restore consumer confidence. Schemes like Fairtrade, Organic, and EU AB certifications all serve to inform the consumer that the food they purchase will not only be safe but also ethically produced (Murphy et al., 2022). Although these schemes are important in restoring consumer confidence, they simultaneously create pressure for food producers to maintain rigid quality standards. Traceability technology is, therefore, increasingly important in verifying these claims and ensuring that products meet safety standards at every stage of production.

3.5. Labor Conditions: Ethical Dilemmas in Fashion Supply Chains

3.5.1. Rana Plaza Collapse and the Cost of Unethical Practices

Labor exploitation remains a significant issue in the fashion industry, particularly in developing countries where workers often face unsafe conditions, long hours, low wages, and minimal rights (Karthikeyan, Chang, & Hsiung, 2023). The 2013 Rana Plaza collapse in Bangladesh, which resulted in the deaths of over 1,100 garment workers, brought global attention to the dangerous working conditions in many fashion supply chains (Pham et al., 2023). This tragedy underscored the need for greater transparency and ethical practices in the fashion industry (Chouaibi et al., 2021). Fashion products, while not directly threatening the health of consumers as safety issues within food might still create significant ethical dilemmas regarding human ethics in labor practices. Increasing awareness of labor exploitation has created a growing consumer demand for ethically produced goods (Back, 2017). Consumers have become aware of working conditions in the fashion supply chain and urge brands for more transparency about how their products are manufactured.

3.5.2. Labor Conditions Improved by Technological Solutions

As consumers increasingly push for transparency and ethicality, several brands have used new technologies as an opportunity to better track their supply chains (Singh et al., 2023). Brands such as H&M and Patagonia have been large investors in sustainability and fair labor practices (Slotnick & Sobel, 2021). Both these companies have vowed to make their supply chain conditions better through third-party certifiers and making their factories more responsible (Galland, 2015). Brands like Everlane have introduced the "Radical Transparency" model, which provides detailed information about their factories, the wages paid to workers, and the production processes used to create their clothing (Husain et al., 2023). Additionally, technologies such as blockchain are being used to track the origin of materials and labor practices throughout the supply chain (Zheng et al., 2017). Fair Trade and Ethical Trading Initiative are some of the initiatives that use blockchain for the tracking of materials in production, ensuring ethical sourcing and decent work (Kshetri, 2022). This will help companies offer consumers greater transparency into working conditions behind the products they buy.

3.6. Quality and Value: Meeting Consumer Expectations Across Sectors

3.6.1. Quality and Safety in Food

In the food industry, quality is measured by safety, taste, nutritional content, and ethical sourcing. Consumer expectations are high when it comes to food quality, with a growing trend toward organic, sustainably sourced products that are free from injurious additives. Consumers are increasingly willing to pay more for organic and locally produced food, with the global organic food market expected to reach $320 billion by 2025 (Tohidi et al., 2022).

3.6.2. Fashion and Consumer Expectation for Aesthetic Quality

Fashion is more emphasized on aesthetics, craftsmanship, and brand reputation. The consumers give importance to the quality of materials, fashionable aspect of the clothes, and ethically produced garments (Foroughi et al., 2020). Nevertheless, overproduction, non-sustainable practice, and fast fashioning has often led this industry to lower-quality outcomes. The rise of slow fashion and an increased awareness about sustainability have shifted consumer expectations: increasingly, consumers are willing to pay a premium for well-made, durable clothes that reflect their values. A 2020 Fashion Revolution survey found that 77% of consumers are concerned by the environmental impact of their clothing, and 58% would pay more for clothes that were made in conditions with decent labor standards (Jain, Wadhwani, & Eastman, 2023). This is a growing tide of awareness that's pushing and pulling both food and fashion brands to integrate sustainability with quality in their value proposition.

3.6.3. Technology Integration to Meet Demands of Quality

To match consumer expectations across these industries, technology plays an essential role in improving quality and building transparency around their products. In the food industry, this will be supported by traceability platforms where consumers will get details about where and how food is grown or processed; in fashion, technologies such as QR code and blockchain become normal ways to prove product authenticity and sustainability. These technologies help ensure that consumers get high-quality goods that are also ethically produced, while holding brands accountable for the claims they make (Brandín & Abrishami, 2021).

3.7. Fraud and Counterfeiting: Battling Deceptive Practices

3.7.1. Fashion Counterfeiting

Counterfeiting within the fashion industry has run into a riot. Counterfeit products-which include fake designer handbags, clothes, and other fashion accessories-compromise the authenticity of the brand and fraudulently sell low-quality products to consumers at a very high price. The global trade in counterfeit products in 2019 equaled about 3.3% of world trade, which comes up to approximately $509 billion, according to the report provided by OECD and EUIPO (Anjum & Dutta, 2022). Counterfeiting has brought huge financial losses to brands but also erodes consumer trust and distorts the market.

Food Fraud: Mislabeling and Adulteration

Another important aspect is fraud in the food industry, particularly mislabeling and adulteration. The honey scandal, in which honey was adulterated with sugar syrup and then passed off as pure honey, is very well known (Egido et al., 2023). Food fraud presents a significant consumer health risk and may further deteriorate confidence in food producers. For example, mislabeling of fish species or ingredients can result in allergens being present in food that consumers may not know they are ingesting (Guryanova et al., 2022).

3.7.2. Combating Fraud Using Blockchain

The food and fashion industries are making increasing use of blockchain to help prevent fraud and counterfeiting. In food, companies can confirm the origin and authenticity of ingredients with blockchain, thereby minimizing the chances of fraud and mislabeling (Zheng et al., 2018). Blockchain helps build consumer trust in the product and helps avoid deceitful practices by making transparent, immutable records of a product's journey through the supply chain.

3.7.3. Consumer Awareness and Demand for Transparency

Conscious consumers today are more aware of product origin and production processes than ever (Ngamsomchat et al., 2022). Increasingly, they seek more transparency about sustainability, environmental impact, and even ethical labor practices in all aspects of the production of goods. However, often the complexity and obscurity of global supply chains mask the truth from a truly conscious consumer who is seeking out more information on the products that they buy (Alfaro & Chor, 2023).

3.7.4. Technology's Role in Bringing Much More Transparency

Addressing this challenge, both the food and fashion industries are increasingly using technology to arm consumers with the information they want. Likewise, fashion brands are turning to QR codes and blockchain for sourcing detailed information about the origin, materials, and labor practices behind their products.By using these technologies, brands can meet the growing demand for transparency, build consumer trust, and ensure that products are ethically and sustainably produced (Rotsios et al., 2022).

Safety concerns, labor exploitation, fraud, and counterfeiting are among the many challenges that face both the food and fashion industries. However, with growing consumer awareness, both sectors are increasingly adopting technological solutions to enhance transparency, quality, and sustainability (Liao & Vaughan, 2023). From blockchain and IoT to AI and QR codes, this sets a modern supply chain in motion that is increasingly efficient, ethical, and transparent. As these innovations continue to evolve, they have the potential to transform both industries and ensure greater safety, improved labor conditions, and increased consumer trust in the products they buy.

3.8. Consumer Behavior in Supply Chains: A Comparative Analysis of Transparency, Trust, and Technology

Food and fashion are among the most influential industries in the world, driving consumer preference, economic trends, and global supply chains (Kustosch et al., 2023). While different in product and consumer engagement, both industries face many of the same challenges regarding supply chain transparency, safety, labor conditions, and sustainability (Adewusi et al., 2023). Consumer behavior will continue to drive change in these industries as expectations evolve toward increased transparency, ethical sourcing, and environmental responsibility (Wang, 2023). This section sets the baseline on how consumer expectations are different for food and fashion and how technological innovation can help businesses overcome many of these challenges while rebuilding trust and enabling consumer choices.

3.8.1. Consumer Behavior and Expectations in Food Industry: Health and Safety at the Forefront

The food industry is very consumer-driven, and most consumers are concerned with health, safety, and ethical sourcing (Min et al., 2023). Most consumers are interested in the quality and safety of the food they eat and often seek products that contain no harmful additives, preservatives, or contaminants (Polack et al., 2020). Consumers are increasingly making choices based on the environmental impact of food products and the ethical production of food. As a result, for example, a lot of consumers look for organic, Fairtrade, or locally sourced food because they perceive these foods as safer, healthier, and being produced in an ethical manner that is better for the environment (Golijan & Dimitrijević, 2018). According to the 2019 Organic Food Market Report, the global organic food market accounted for $220 billion in sales and is projected to rise to $320 billion by 2025, thereby highlighting a clear preference towards those products that align well with consumer values on health and sustainability.

3.8.2. Transparency and the Demand for Traceability

Consumers of food items increasingly demand transparency in its sourcing and production processes (Shahzad et al., 2023). They want to be aware of its origin, means of production, and what environmental and social practices have been involved with it. For example, Nespresso has created a Sustainable Quality Program (SQP): it uses technology to monitor coffee beans, starting at farms and working their way to consumers' cups. It provides details about the location in which the coffee was grown, the style of farming used, and environmental measures farmers have instituted. The QR codes on packaging may be used to understand the story behind their coffee, providing the consumers with more intelligent choices based on sustainability and ethical sourcing. All these are particularly appreciated in view of various controversies that appeared in the supply chain: Nespresso guarantees quality and responsibility regarding social and environmental values, which is in harmony with modern consumers' values. These types of initiatives further demonstrate how transparency builds trust, differentiates brands, and meets the growing demand among shoppers today for ethical and sustainable merchandise.

3.8.3. The Rise of Ethnical and Sustainable Consumerism

The rise in consumer awareness over sustainability and food ethics leads them to pay more for commodities that align with their values (Kaiser, 2022). Plant-based and sustainable foods are in high demand (Tachie et al., 2023). Beyond Meat and Impossible Foods have taken advantage of the new consumer behavior pattern. Beyond the issue of the environment, contamination and mislabeling in foods have raised the call to consumers for food clearly labeled as organic or ethically produced (Ho et al., 2022). Blockchain, cloud computing, and transparency these technologies enable a brand to convey its credo with consumers who aim not only to eat healthily but also in tune with their ethics (Zheng et al., 2017).

3.8.4. Consumer Behavior and Expectations in the Fashion Industry: Aesthetic, Affordability, and Increasing Demand for Sustainability

In contrast with the food industry, ethical and environmental concerns have long taken a backseat to aesthetic, price, and brand reputation when it comes to fashion consumption. Fashion is inherently a trend-driven industry, and most consumers still buy clothes based on the latest fashions, without considering at all the sustainability of the process of production. But that's slowly changing. With the increase in environmental issues like climate change and labor exploitation in developing countries, there has been a greater demand for more sustainable and ethically produced fashion.

3.9. Shifting Expectations and Digital Transformation

Recent surveys indicate a great shift in consumer expectations as it relates to fashion purchases. A 2020 survey by Fashion Revolution found that 77% of consumers are concerned about the environmental impact of their clothing (Lundén, 2021), and 58% would be willing to pay more for fashion items produced under ethical conditions (Díaz & Albanese, 2023). That means that although price and style still are very relevant, consciousness of the environmental and social impact of fashion purchases is also a growing influence on the decisions made by the consumer. Especially, millennials and Gen Z consumers are pushing for transparency in fashion production and are more likely to purchase from brands that show environmental sustainability and ethical labor practices (Gomes et al., 2023).

3.9.1. Rise of Ethical Fashion and Transparency

There is a growing demand for transparency among consumers about where and how their clothes are made. In response, many fashion brands have moved to employ green production methods and good labor practices, adding technology to communicate this to consumers. Everlane and Patagonia are among the very first in this revolution that use blockchain for material traceability, QR codes for disclosure of factory conditions, and more to boast about sustainability (Billups & Singh, 2018). In turn, all these brands, by being transparent, not only answered the increasing demand for ethical fashion but also won consumer trust (Choi et al., 2022). This trend is further being exacerbated by the popularity of a slow fashion movement, wherein quality, durability, and the ability for sustainable production are stressed (Nardoni et al., 2022). Thus, in recent years, there has been a growing interest in sustainable fashion, which focuses on environmentally friendly and ethical practices (Vladimirova et al., 2023). This approach stands in stark contrast to fast fashion, which prioritizes mass production and cheap prices. Slow fashion aims to produce long-lasting and more ethically produced garments (Foroughiet al., 2020). The latter has started to prevail among those who are more inclined toward refusing to wear disposable garments and instead prefer high-quality and sustainable alternatives.

3.9.2. The Importance of Transparency and Technology in Shaping Consumer Trust and Expectations

Both the food and fashion industries share the need for more supply chain transparency. Historically, supply chains within both industries were opaque, making it impossible for consumers to know whether the products they purchased were ethically produced, safe, or environmentally friendly (Ho et al., 2022). Today, consumers are asking for more from brands, and companies are responding by investing in technologies that enable them to be transparent and accountable (Venkatesh et al., 2012).

3.9.3. Technologies Empowering Transparency

Key to providing this transparency in both industries is blockchain technology. Real-time traceability in food, made possible by blockchain, ensures that consumers can track the origin of their food and verify any claims about its safety and sustainability (Wattanakul et al., 2017). AI and data analytics help both industries predict consumer trends, optimize supply chains, and manage production more efficiently to reduce waste and improve the sustainability of operations (Ponte et al., 2023; Arrieta et al., 2019).

3.9.4. IoT and Cloud Computing in Consumer-Oriented Innovations

Both sectors are also implementing Internet of Things sensors to enhance supply chain efficiency and visibility. For instance, in the food logistics segment, IoT sensors monitor temperature, humidity, and other environmental variables during transport to guarantee that sensitive perishable commodities are delivered in safe and optimal conditions (Akmandor, Yin, & Jha, 2018). IoT is being used in fashion to track inventory, manage production schedules, and reduce waste (Karras et al., 2023). Coupling these technologies with cloud computing allows brands to share real-time data throughout their supply chains, offering greater transparency and allowing consumers to access information regarding the production, storage, and shipping of products.

3.9.5. Addressing Ethical Concerns Through Data-Driven Insights

At this point, however, this shifts to companies looking at their products and considering the level of their carbon footprint as concerns by consumers of the social and environmental impacts of what they purchase elevate. For both the food and fashion industries, technological investments help them become resource-efficient, reduce waste, and continue striving for environmental efficiency. Food firms, for instance, use the insights drawn from data analytics to optimize their inventory management and reduce food waste, apart from being more sustainable about sourcing and packaging (Castaño et al., 2023). Equally, fashion brands have used supply chain analytics to spot opportunities for sustainability, like reducing water usage in textile production or using greener fabrics.

3.10. The Future of Consumer-Centric Supply Chains

The expectations of consumers regarding food and fashion have changed a lot in the last few years. Food consumers are increasingly concerned about safety, health, and ethical sourcing of products (Li et al., 2022), while for fashion consumers, environmental and social impacts of purchases are increasingly important, with sustainability and ethics becoming key purchase drivers (Ray & Nayak, 2023). While both industries have their ways of trying to meet consumer concerns, technology has emerged as a critical tool in improving supply chain transparency and ensuring product authenticity to foster consumer trust (Singh et al.,2023).

This is where blockchain, IoT sensors, and AI make the difference in both sectors and help companies answer consumer demands for more transparency, sustainability, and ethics (Zheng et al., 2018). As technology keeps developing, in the future, both food and fashion industries will be in a better position to tackle most of the challenges posed by evolved consumer behavior and create a more ethical and transparently sustainable future for both industries. Eventually, those businesses that can leverage these technological tools for transparency, traceability, and accountability will find themselves in a good position to prosper in an increasingly aware and demanding marketplace.

3.11. Sustainable Supply Chains in Food and Fashion: Shared Challenges and Opportunities

In today's connected world, the food and fashion industries face an increasing demand for sustainability in their supply chains (Geissdoerfer et al.,2017). Although the food and fashion industries are two vastly different business segments, they share several issues that pertain to environmental impacts, inefficiency in resource use, and waste generation (Huang, 2023). With consumers increasingly clamoring for greener products, both industries are courting new innovations and significant strides toward sustainability (Oliveira et al., 2016). The meeting of food and fashion supply chains gives insight into the ways in which these two sectors can work together to resolve challenges and realize opportunities for long-term sustainability. Technology can significantly change the face of supply chain management for ethical improvements that reduce carbon emissions across the industries involved (Henseler, Hubona, & Ray, 2016; Liu et al., 2023).

3.11.1. Resource Inefficiency: Environmental Costs in Food and Fashion

The food and fashion industries play significant contributing roles to various global environmental issues. About a third of the total amount of food produced worldwide gets lost, creating an enormous environmental cost to pay, says the FAO (Abbas et al., 2023). Not only food security is put in a tight corner because of waste, but basic resources such as water, land, and energy are being used wastefully. In another light, fashion was considered one of the leading polluters globally. The industry's carbon footprint accounts for about 10% of global greenhouse gas emissions, mainly emanating from energy-intensive manufacturing processes and the overexploitation of natural resources such as cotton, leather, and synthetic fabrics (Robinson et al., 2023).

Resource inefficiency is also a major environmental challenge facing both industries. Water-intensive materials, such as cotton, used in the fashion industry contribute to water shortage, especially in those regions already experiencing drought. For example, it takes around 2,700 liters of water to produce a single cotton T-shirt, which is the amount of water a person drinks in two and a half years (Qian et al., 2022). In the case of food production, agriculture is very water-intensive, with crops like rice and almonds being the most resource-intensive. In some regions, food waste is directly related to the overconsumption of resources that could otherwise be optimized.

3.11.2. Circular Economy: A Model for Sustainability in Food and Fashion

The adoption of the circular economy is, perhaps, one of the most promising solutions to these inefficiencies. The circular economy is supposed to reduce to a minimum the production of waste, while the maximum amount of material should be reused or recycled. Such a shift away from the linear economy-where products are manufactured, used, and then discarded-is essential for both the food and fashion industries (Kirchherr, Reike, & Hekkert, 2017).

Patagonia has pioneered the adoption of circular economic practices within the fashion industry by using only recycled materials in its production. Patagonia has promised to use recycled fabrics and materials, such as polyester made from plastic bottles and wool from pre-loved garments, that have considerably reduced the waste and carbon footprint of their operations (Seif, Salem, & Allam, 2023). Also, its Worn Wear program makes people inspire and educate to repair the garments and use them rather than discarding them, which contributes to the circular economy and encourages a culture of sustainability.

Similarly, in the food sector, companies are embracing circular practices by reducing food waste and finding ways to repurpose food by-products. An example is the increasing amount of food waste that's being used as a resource to create new products (Bhatia et al., 2023). Through these innovative solutions, both the food and fashion sectors can reduce waste, optimize resource use, and minimize environmental harm.

3.11.3. Technological Advancements: Driving Sustainability Through Data and Innovation

New technologies are an enabler for reaching sustainability goals in both industries. Supply chains are becoming more digital, and companies use big data analytics, IoT, AI, and blockchain to enhance transparency and traceability, and hence efficiency (Wanof, 2023). These technologies give organizations very effective tools to optimize their processes, reduce waste, and make more-informed decisions in line with the goals of sustainability (Geissdoerfer et al., 2017).

For instance, AI-driven demand forecasting tools help both food and fashion industries predict consumer demand more accurately (Zachariah et al., 2023). This helps minimize overproduction, a significant contributor to waste in both sectors. In the food industry, overproduction often leads to unsold goods that are discarded, while in the fashion sector, overproduction contributes to surplus stock, which ends up as waste or is sold at heavily discounted prices, further promoting the culture of "fast fashion."

Another critical innovation is the use of blockchain technology. Blockchain offers both food and fashion companies a decentralized, transparent ledger that enables them to trace products right from their origin to their destination (Patil & Bhosale, 2023). In the case of food, blockchains make sure that consumers can track the journey of their food from farm to table. This ensures better transparency in sourcing and that products are sourced ethically. Examples of these can be found in the use of IBM's Food Trust blockchain platform by large retailers like Walmart and Carrefour for tracking the origin of food products to ensure safety and sustainability standards are met. In fashion, blockchain is used by luxury brands like LVMH and Kering to verify product authenticity, reducing counterfeiting, and ensuring sourcing materials in an ethical way.

Moreover, IoT sensors are very crucial in symptomatic resource utilization in both sectors (Neto et al., 2023). Temperature and humidity IoT sensors are used in the food industry to monitor the conditions of perishable items during transportation and storage. This keeps the products fresh, hence reducing possible incidences of food spoilage and waste. Similarly, IoT sensors are increasingly used in fashion supply chains to monitor the environmental impact of production facilities, helping brands reduce their energy consumption and improve sustainability efforts.

3.11.4. The Role of Decision-Makers in Promoting Sustainability

Notwithstanding the technological changes, decision-makers both in the food and fashion industries are not washed away. It is important that companies committed to sustainability embed the practice in their business models, supply chain management, and consumer engagement (Bhandal et al., 2022). For Patagonia and Unilever, for instance, sustainability is not just a buzzword but a driving force for brand identity and operational success.

Patagonia is an example of a company that has implemented a broad sustainability strategy that includes sourcing organic cotton, improving labor practices, and encouraging environmental activism. The company's commitment to sustainability has earned it loyal customers; increasingly, consumers will go out of their way to purchase from brands with values that match their own (Geissdoerferet al., 2017). Similarly, Unilever is one of the world's largest food companies that has taken bold steps to minimize its environmental impact (Vera rt al., 2023). The company wants to become carbon-neutral by 2039, source 100% of its agricultural raw materials sustainably, and cut down on single-use plastics. Long-term sustainability in both industries is not without its challenges, though. Some major implementation costs, resistance to change from traditional industry ways, and a lack of standardized guidelines for sustainable production all make it very difficult (Choi et al., 2023). Moreover, it is not all at once that consumer behavior changed toward being sustainable; affordability and convenience are still substantial drivers of both food and fashion markets (Jain, Wadhwani, & Eastman, 2023). Overcoming these challenges will require decision-makers to drive innovation, collaboration down the value chain, and the use of enabling sustainable technologies to ensure profitability in a clean environment (He et al., 2023).

3.11.5. Collaborative Approaches and the Future of Sustainable Supply Chains

With sustainability becoming an increasingly central concern for both industries, collaboration between stakeholders along the supply chain is essential. Governments, businesses, and consumers all have roles to play in making supply chains more sustainable and ensuring that companies meet the growing demand for ethical and environmentally conscious products (Martínez-Peláez et al., 2023).

One possible avenue is the incorporation of sustainability measurements throughout supply chains. Because of setting indicators of key performance, such as KPIs in terms of sustainability, the two industries can monitor trends towards sustainability and make management decisions based on facts to ensure environmental responsibility. Examples of such metrics include reduced carbon footprint, waste handling practices, water consumption, and ethical labor practices along the chain (Robinson et al., 2023; Zhang et al., 2020; Preite et al., 2023).

It therefore goes without saying that continued adoption of the circular economy concept, technological innovation, and collaboration along the supply chains are the key to sustainable supply chains for the future in both food and fashion. By using the power of technology to eliminate some of the inefficiencies while aligning themselves with what consumers value, both industries can pave a path forward that is sustainable and more ethical (Ghisellini, Cialani, & Ulgiati, 2016).

Both the food and fashion industries face many of the same challenges in developing sustainable supply chains. The adoption of circular economic principles, new technologies such as blockchain and AI, and collaboration between stakeholders can go a long way toward reducing environmental impacts and improving overall sustainability (Oliveira & Andrade Oliveira, 2023). Companies like Patagonia and Unilever that lead the industry in sustainability prove it's possible to take a transparent approach to sourcing, prioritize waste reduction, and show consumers the truth. It is within these industries-some of the fastest growing in the world-that one will find the driver in growth, consumer loyalty, and long-term success in sustainability.

4. Individual vs. Organizational Adoption Factors

An SSC perspective, therefore, goes far beyond the concept of Ethical Sourcing and Environmental Impact through a dynamic network comprising several actors whose role both as forerunners or diffusers of practices in consistency with environmental, social, and economic sustainability objectives holds crucial importance. These start right from upstream suppliers through the downstream distributors, their different perspectives, responsibilities, and constraints. These actors are very important in shaping the future of the supply chains in this modern era of blockchain. Understanding how upstream and downstream actors are interrelated and how trust, decision-making, and the mental model affect the adoption of blockchain is critical to maximizing the impact of blockchain on sustainable supply chains (Khan et al., 2022).

4.1 Trust and Decision Makers

Trust is always the basis of any sustainable supply chain since it ensures much cooperation, less conflict, and increased reliability of transactions (Khan et al., 2022). Blockchain technology is decentralized and irrevocable, and it could provide a method for establishing trust across the value chain and within global networks where actors have limited direct relationships (Buterin, 2015). Applying blockchain may change how one builds trust by ensuring secure sharing of data, transparency, and prevention of fraud (Liao & Vaughan, 2023).

4.1.1. Organizational Trust

At the organizational level, systemic factors like corporate reputation, certifications, and compliance with industry standards are often causes of trust (Wang et al.,2023). For example, major multinational companies such as Nestlé and Unilever have been using blockchain in the raw material supply chain for ethical sourcing (Kshetri, 2022). Nestlé, through its blockchain initiative with IBM's Food Trust, provides consumers with the ability to trace the origin of its products and confirm sustainable sourcing practices, such as the company's palm oil traceability to ensure it does not contribute to deforestation and human rights abuses (Pareira, 2023). The application of blockchain in these cases reduces fraud risks, enhances data integrity (Ridge et al., 2023), and builds trust throughout the supply chain. The transparency offered by blockchain ensures stakeholders—from farmers to consumers—have access to immutable data about the product's journey (Zheng et al., 2018

4.1.2. Individual Trust

At the individual level, trust is built upon personal relationships and experiences. The case of suppliers and retailers in long-standing partnerships may lead them to rely on interpersonal trust, which could reduce the need for blockchain in the immediate context (Lin et al., 2023). In cases where relationships break down or supply chains lengthen across the globe, blockchain becomes an extremely important means of providing that open, verifiable record of all transactions, thus lowering fraud risk and enhancing quicker responses to issues like foodborne illness or counterfeit products (Zheng et al., 2017). Consumers can use QR codes to verify the authenticity of their products, ensuring they are purchasing genuine luxury items, rather than counterfeits (Chen et al., 2023). This example shows how blockchain enables supply chains to extend trust beyond direct relationships in the face of problems such as counterfeiting, which have been quite prevalent in the fashion industry.

4.2 Organizational Versus Individual Perspectives

The perspectives of organizational and individual actors on the adoption of blockchain can differ significantly, especially when considering the broader implications of technology versus its immediate, operational benefits.

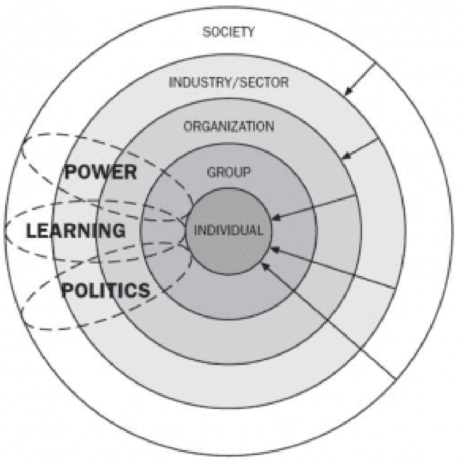


Diagram 02. The perspectives of organizational and individual actors

This diagram illustrates the interconnected levels of influence within society, from individuals to groups, organizations, industries, and society at large (Liu, Wang, & Xiong, 2023). It highlights how power, politics, and learning dynamically shape and are shaped by interactions at each level. Individual behaviors influence group dynamics, which impact organizational structures, broader industry norms, and societal systems, creating a two-way flow of influence. The model underscores the importance of analyzing these interconnections to understand complex issues like change, adaptation, and decision-making in organizations or broader societal contexts.

4.2.1. Organizational issues

Most of the decision-makers would seek long-term benefits such as scalability and strategic benefits. Large companies like Walmart and Unilever understand that blockchain will help solve some very stubborn systemic issues, including integrity of data, contract enforcement, and supply chain resilience (Zheng et al., 2017). Consider that Walmart has tracked the origin of its leafy greens using IBM's blockchain. It reduced the tracing contamination process from days to a couple of seconds. This, in turn, helps to make your food safe, and not waste it, thereby saving health for consumers.

From the sustainability perspective, organizations also look upon blockchain to reach their Corporate Social Responsibility goals. Blockchain helps the organization meet consumer demands for sustainability and ethical sourcing through its features of transparency and traceability (Eggleston et al., 2021). According to an Accenture report in 2020, 71% of global consumers prefer buying from companies committed to sustainability and transparency, underlining the growing business value of adopting blockchain in supply chains.

At the operational level, these individual decision makers are generally procurement officers, supply chain managers, or even the employees on the shop floor. They have to get accustomed to the blockchains gradually, especially in such organizations with well-established mutual trust relations. For example, if a small food supplier has built up a number of good years with any particular retailer, then blockchains don't make more sense in such cases when no relationship is challenged on frauds, inefficiency, and changes in the market situations (Zheng et al., 2018).Individual-level resistance to the adoption of blockchain is basically driven by perceived complexity and costs, besides concerns regarding the disruption of existing workflows. Manufacturers and suppliers accustomed to performing business face-to-face or with paper-based records will consider blockchain an added and unnecessary complication. Exposure to operational disruptions or inefficiencies may prompt them to reconsider the value of blockchain in improving data visibility and streamlining operations (Lee, 2023).

4.3 Mental Models in Decision-Making

Mental models represent the frameworks of cognition that guide one's observation and interpretation of reality, accordingly, making decisions for the use of new technology, like blockchain (Bansal et al., 2019). It is cultivated by experiences gained in the past, cultural norms, and problems peculiar to a certain industry.

• Consumers want more transparency and trust, particularly when buying products with an ethical or sustainability claim. For example, consumers purchasing Fair Trade or organic products may be interested in learning about the supply chain practices behind these products. Blockchain helps provide the transparency necessary to assure consumers that their products have been ethically sourced and produced without exploiting workers or damaging the environment (Bommasani et al., 2023).

• IT Managers are concerned with the operational benefits of blockchain, such as automating, making things more efficient, and securing (Opazo-Basáez et al., 2023). An IT manager in a retail chain may look at the blockchain as a way of simplifying procurement and inventory management, ensuring accuracy in transactions, and reducing operational costs.

• Supply Chain Managers and Procurement Officers take a view on blockchain regarding efficiency and risk management. Their mental models predominantly focus on the reliability of suppliers, cost optimization, and the need to overcome specific issues such as fraud, traceability, and inefficiency (Schilling & Seuring, 2023). Blockchain's capacity for reducing fraud and automating contracts through smart contracts presents certain key benefits. Yet initial implementation costs, technological difficulty, and potential resistance by other supply chain actors may weigh against the decision to adopt it.

• Manufacturers and Suppliers at the operational level may have established relationships with customers and suppliers and mental models that are shaped by years of experience. They may be skeptical of blockchain unless they experience disruptions that illustrate the need for greater transparency or operational improvements (Schwenteck et al., 2023).

4.3.1. The Role of Trust in Adoption

Especially within the context of sustainable supply chains, blockchain adoption plays a significantly instrumental role in developing interpersonal trust and inter-organizational trust.

1.Interpersonal Trust

This kind of trust is developed from direct interactions and shared experiences among people. In long-term relationships between suppliers and retailers, trust could be based on personal contact, dependability, and past performance, which could lower the perceived need for blockchain (Ahmad et al., 2023).However, blockchain protects in cases where relationships are disrupted, such as personnel changes or new business partners in the supply chain (Zheng et al., 2018).For instance, Provenance, a blockchain platform, enables brands such as Stella McCartney to trace the origins of materials to ensure that their sustainability credentials are in place (Rowe & Uitto, 2023). Suppliers may be far away from the brand or completely new, so blockchain can offer a clear and unalterable record, thus fostering trust along the entire value chain (Saberi et al., 2018).

2.Inter-organizational Trust

In multi-tiered, complex supply chains, organizations may not have direct relationships with all participants. In such cases, mechanisms such as audits and certifications, and increasingly blockchain, help establish inter-organizational trust (Khan et al., 2022). For example, Unilever's blockchain system traces the sustainability of its palm oil supply chain, ensuring that its suppliers source the product ethically. Blockchain ensures that data shared between partners is secure, accurate, and transparent, thus fostering trust across the entire supply chain.

The adoption of blockchain in sustainable supply chains is based on a complex interplay between organizational and individual perspectives, mental models, and trust dynamics (Zheng et al., 2018). Large organizations can recognize the long-term strategic benefit of blockchain in enhancing transparency, traceability, and sustainability (Liao & Vaughan, 2023), while smaller actors are more cautious and rely on traditional methods of trust. However, the increasing relevance of sustainability and ethical sourcing, coupled with the potential of blockchain to provide transparency, traceability, and efficiency (Zheng et al., 2017), pushes the pace of adoption both in food and fashion industries (Ponte et al., 2023). As blockchain continues to evolve, collaboration and understanding among supply chain actors will be the key to maximizing its full potential in the creation of sustainable, resilient, and ethical supply chains (Konstantinides et al., 2019).

4.4 The Role of Trust in Adoption: The Shadow of the Past and Shadow of the Future

In supply chain management, the shadow of the past and the shadow of the future are two critical factors that shape how trust influences the decision to adopt technologies such as blockchain (Kunzelmann, 2019). These concepts explain how experiences from the past and perceptions of the future shape the decision-making process in general, and especially about disruptive innovations that would upset the status quo. Integration of blockchain into supply chains, especially sustainable supply chains, is influenced by these two forces.

4.4.1. The Shadow of the Past

The shadow of the past represents the accumulated experiences, established relationships, and practices that shape how individuals and organizations perceive new technologies (Piglowski et al., 2010). Past interactions, organizational norms, and existing trust-based systems heavily influence decision-making.

1. Established Trust: Many supply chain actors build trust over time through personal relationships. For example, when a supplier and retailer have had a long-term relationship, mutual understanding will most likely eliminate the perceived need for supplementary technological systems, such as blockchain (Musamih et al., 2023). If past relations between the two parties have gone smoothly with no major problems, then the idea of blockchain may be considered an over-complicating solution. The shadow of the past can also foster resistance to change since actors feel safe in their routines.

2. Resistance to Change: Over time, both individuals and organizations develop mental models or routines based on their experience (Gero et al., 2020). These models shape their way of conducting business and make them resistant to new technologies. For instance, a procurement manager who is used to handling transactions manually may feel very uneasy with the adoption of blockchains. What casts shadow here is comfort with established methods; the comfort produces inertia, making the new system difficult to implement.

3. Cultural and Institutional Factors: The historical and cultural backgrounds of supply chain actors shape their attitudes toward innovation (Kim & Lee, 2023). Small family-owned businesses, for example, may prioritize personal relationships over technological solutions. These businesses might view blockchain as a very expensive and impersonal solution that undermines their traditional way of doing hands-on. The shadow of the past, shaped by industry practices and organizational culture, can make new technologies seem disruptive.

4.4.2. The Shadow of the Future

The shadow of the future denotes anticipation of future risks, opportunities, and shifting market dynamics (Dung, 2023). This represents how actors would actually foresee technology shaping the industry and business practices in light of evolving demands for sustainability and consumer preference (Geissdoerfer et al., 2017).

1. Anticipation of Market Changes: The shadow of the future encourages decision-makers to consider how emerging trends, such as consumer demand for sustainability and transparency, will affect their operations. For example, fashion brands like Patagonia and Everlane have embraced blockchain technology to trace the origins of their materials and demonstrate ethical sourcing practices (Muldoon et al., 2023). These brands believe that consumer taste will shift to more transparent products in the future. Therefore, blockchain is part of the strategy to be better off in the competitive market whenever the future sets in.

2. Shadow of the future: Risk mitigation and robustness also imply external factors such as fraud, interruptions, or changing regulations. Blockchain technologies promise to make supply chains more transparent and traceable, with data security boosted (Dung, 2023). For instance, the food industry is using blockchain to enhance traceability of products for ethical sourcing and reduction of risks such as contamination (Biswas et al., 2023). The adoption of blockchain will cushion supply chains from future disruptions caused by issues such as fraud or non-conformity to regulatory standards.

3. Regulatory Compliance: As the global regulatory frameworks get increasingly strict-particularly with regards to sustainability and traceability-the shadow of the future compels companies to resort to blockchain to satisfy these demands (Saberi et al., 2018).The Green Deal by the European Union, coupled with the growing supply chain regulations around sustainability, raises the bar for what technology needs to keep pace with. By adopting blockchain now, companies are positioning themselves for upcoming regulations and will remain compliant in a shifting landscape.

4.4.3. Interplay Between Shadow of the Past and Shadow of the Future

The shadow of the past and the shadow of the future do not operate independently of each other. This tension between established practices that were followed, that is the shadow of the past, and the expectation of challenges from the future-the shadow of the future-account for the adoption of blockchain technology (Kunzelmann, 2019).

1. Overcoming Resistance to Change: In many cases, it is the shadow of the past that contributes to a kind of resistance to blockchain adoption—when stakeholders are comfortable in their present systems. But in some cases, the shadow of the future, including heightened transparency demands, market pressures, and shifting regulation—can prompt the very same actors to reassess their reluctance. A company that has always relied on personal relationships may realize that blockchain is the way to future-proof their operations and provide the much-needed transparency and traceability required in the years to come (Jang et al., 2023).

2. Gradual Transition: Often, new technologies, including blockchain, get integrated gradually. The shadow of the future will inspire enterprises to innovate. However, the shadow of the past could pull companies to integrate blockchains in such a way as to be complementary to established practice, not necessarily overriding it. A supplier may, for example, start recording only some highly risk-sensitive products on the blockchain with a view to full supply-chain reform. This gradual approach gives the company the benefits of blockchain while retaining the trust and processes of the past (Inomata et al., 2019).

3. Balancing Tradition with Innovation: Only those organizations which can negotiate a proper balance between tradition and innovation-or to frame it better, shadow of the past and shadow of the future-can get blockchain advantage. Larger companies that supply complex items to diversified marketplaces have a great hope for blockchains since doing it via blockchain promises transparency and uniformity. These businesses amalgamate history and block chain's cutting-edge technology using a well-balanced strategy (Manyika, 2011).

The shadow of the past and the shadow of the future are important factors in shaping perceptions and adopting blockchain technology by supply chain actors. The shadow of the past emphasizes established relationships and practices that discourage change, whereas the shadow of the future highlights the shifting landscape of consumer expectations, regulatory requirements, and market risks that make the adoption of blockchain more appealing (Jang, Yoo, & Cho, 2023).

Understanding the interplay of these two forces is crucial for any organization that wants to embed blockchain into its supply chains. By solving yesterday's problems and preparing for tomorrow's challenges, supply chain actors will overcome the complexity of blockchain adoption. Whether it's enhancing sustainability in food or fashion supply chains, or bringing more transparency and efficiency, today's decisions will determine a company's competitive edge tomorrow.

4.5 The Role of Power Dynamics and Leadership Ego in Blockchain Adoption

The power dynamics between larger organizations and smaller suppliers, as well as the psychological factors affecting decision-makers, play a crucial role in the adoption of blockchain technology in sustainable supply chains (Kaaristo, 2022). Large organizations like Walmart have immense influence in imposing the use of blockchain on their supply chains. For example, Walmart has asked its suppliers to implement blockchain technology of product tracing for products such as leafy greens to enhance food safety and traceability (Ramasami et al., 2023). With its finances and leverage, Walmart pushes for these changes down its supply chain, setting the pace for possible industry-wide changes. In turn, smaller suppliers are usually put under stress because they may not have either the technological infrastructure or even the finances to comply with these kinds of mandates (Ryu & Sueyoshi, 2021). This creates friction in the fact that the small players usually must invest in sophisticated technologies of the big boys, hence making the integration of this blockchain technology smooth. This kind of disparity should be addressed with support mechanisms, such as training or finance, to ensure blockchain adoption goes as smoothly across the entire supply chain (Ouyang et al., 2022).

Besides power structures, the ego of a person is another important factor affecting the adoption of blockchain. In this respect, decision-makers that have been engaged with the traditional practice of a supply chain for a long period of their careers may be very resistant to blockchain because it might damage their expertise and professional identity (Zhou et al., 2017). For instance, companies like those dealing in luxury fashion or foodstuffs may have their senior managers, who have built their careers on legacy practices, resistant to the introduction of blockchain because it challenges their authority and operational control. This resistance is often rooted in the fear that blockchain could render their established systems obsolete or undermine their career achievements. A key approach to overcoming this ego-driven resistance involves reframing blockchain adoption as a chance to build a positive legacy (Freitas et al., 2023). By positioning blockchain as a tool that enhances operational efficiency, sustainability, and traceability, decision-makers can position it in alignment with their long-term goals, enabling them to embrace innovation while safeguarding their professional standing.

More strategically, blockchain adoption has significant benefits beyond overcoming resistance: it's a powerful means to enhance supply chain transparency, reduce fraud, and improve traceability (Sharma et al., 2023). This is illustrated by the fact that fashion brands such as Gucci and Burberry have started using blockchain to track the journey of products, from raw materials to retailers, to meet increasing consumer expectations for sustainability and ethical sourcing. These brands leverage blockchain to verify the authenticity and origin of their materials, enhancing their reputation among eco-conscious consumers. Similarly, Walmart's initiative to track food products using blockchain not only ensures product safety but also strengthens the retailer's position as a leader in supply chain transparency. Despite resistance from traditional players, the long-term benefits of blockchain in improving efficiency, sustainability, and consumer trust are undeniable. It calls for overcoming resistance through collaboration, education, and mutual support across supply chain actors. In addition, the understanding of how power dynamics and individual biases influence blockchain adoption may help stakeholders work together to integrate this transformative technology, paving the way toward a more transparent, efficient, and sustainable future in supply chain management.

5. Problem statement

Blockchain technology has emerged as a disruptive innovation that may bring a sea change in supply chains regarding increased transparency, traceability, security, and efficiency. Many organizations have explored its promise, especially in industries such as food, fashion, and pharmaceuticals, where trust, traceability, and data integrity are critical. However, despite these advantages, blockchain adoption within supply chains is still slow and uneven, with organizations facing various challenges in fully realizing its benefits.

The decision to adopt blockchain solutions is very different across industries and even organizations. Some sectors moved faster and more readily than others. Technological readiness, organizational culture, regulatory complexity, and sectoral dynamics are all significant influences on the pace and extent of blockchain implementation. Moreover, while some studies have explored the role of blockchain in supply chains, they often focus on isolated aspects—be it technological benefits, consumer behavior, or the adoption challenges faced by individual organizations—without addressing the broader, systemic interactions across the entire supply chain ecosystem.

The literature does not yet offer a well-rounded, multilevel model that captures all the decision-making processes at both individual and organizational levels. Current studies either over-simplify the adoption process of blockchain by narrowing down to one perspective or fail in integrating the different interdependencies from the actors along the supply chain. Secondly, the interaction between these pressures and blockchain adoption, under varying contexts of the market trend, regulatory forces, and competitive dynamics, needs to be deeply discussed.

The objective of this research, therefore, is to fill the knowledge gap by proposing an integrated framework that helps comprehend the dynamics of blockchain technology adoption in supply chains. This study will identify various actors—ranging from individual professionals in supply chains to organizational decision-makers—and investigate intersectoral relationships within the food, fashion, and automotive sectors that could influence blockchain adoption. Eventually, this research will add to the development of an integrated model of blockchain adoption, which considers the complexities of both technological and nontechnical factors at multiple levels of decision-making.

5.1. Research Gap

1. Lack of comprehensive multi-level adoption models: Despite the growing literature about the adoption of blockchain, most studies fail to develop comprehensive models that encompass the decision-making process across different levels. Exiting frameworks have focused on an isolated set of factors, for instance, technological readiness and the behavior of individual consumers in isolation from the interrelationships that exist between individual actors, organizational forces, and sector-specific challenges. There is one major gap in research, however, regarding how Micro-level and Meso-level factors can come together to influence blockchain diffusion on a larger scale within the supply chain.

The Need for a holistic model: Current models does not consider the holistic nature of blockchain adoption, which involves multiple actors at different levels within an organization, such as individual decision-makers, managers, and IT professionals. There is a need for an integrated model that combines these dimensions to better understand the process of adoption.

2. Industry-Specific Adoption Challenges: The blockchain adoption in industries like food, fashion, and automotive is not homogenous. There is very limited literature which highlights specific challenges and drivers of its adoption in the mentioned sectors. Industries having similar supply chain characteristics, like food and fashion, might share some common barriers to adoption; for example, apprehensions concerning data security, interoperability, or regulatory compliance. Other industries, such as pharmaceuticals and automotive, might have different challenges because of the complexity of the supply chain, sensitivity of products, or scale of operations.

Sector-specific dynamics: There is a lack of understanding of how these industries vary in their readiness and willingness to adopt blockchain technology. For example, traceability in the food sector may be of interest, while in the fashion industry, the issues of counterfeiting and sustainability may drive adoption. Understanding such nuances is key for the development of targeted strategies in the implementation of blockchain across sectors.

3. Limited Investigation into Cross-Level Interactions: Most of the available literature related to blockchain adoption in supply chains focuses on either Micro-level factors-issues of individual attitude and behavior -or Meso-level factors- organizational dynamics-in isolation. Adoption is a complex process that, in real life, involves interaction among these levels. Inadequate research explores how individual behaviors, influenced by trust, perception of technology, and risk tolerance, for example, affect organizational decisions to adopt blockchain. Similarly, organizational-level factors, such as culture, technological infrastructure, and strategic goals, influence the actions and decisions of individual actors within the supply chain.

The Need for cross-level insights: Understanding how Micro-level and Meso-level factors interact and influence each other is essential for creating a complete picture of blockchain adoption. A deeper analysis of these cross-level dynamics will enable organizations to design more effective strategies for implementing blockchain solutions.

4. Inadequate Attention to Non-technological Factors: Most blockchain adoption studies have placed a high level of focus on technological aspects, including infrastructure requirements, security protocols, and scalability, at the expense of non-technological factors such as trust, regulatory pressures, and consumer behavior. These non-technical influences are crucial drivers for blockchain adoption in supply chains, with technology in many instances involving several stakeholders with different motivations, expectations, and concerns. Trust among supply chain actors, whether between producers, distributors, or consumers, is a very critical issue in the adoption process but underexplored in many studies.

The need for a broader perspective: This literature gap indicates how necessary it is to include non-technological factors within blockchain adoption models. By addressing such aspects, this research will provide a more holistic framework in understanding the various forces that shape blockchain adoption.

5. Lack of Practical Implementation Frameworks

While a lot has been written about the potential of blockchain, few actionable frameworks exist that might lead organizations through the actual implementation of blockchain solutions within their supply chains. Many companies lack the ability to evaluate the viability of adopting blockchain, the resources required, or how it should be integrated into their current systems. This gap presents an excellent opportunity, which this research can utilize by developing a hands-on framework that guides organizations through an examination of the feasibility and benefits blockchain could offer their specific supply chain contexts.

The need for actionable frameworks: The research seeks to propose a structured framework to drive the decision-maker through complex blockchain adoption from initial exploratory thinking towards full implementation.

Therein lays a multilevel dimensional blockchain supply chain adoption gap regarding multilevel adoption models, depth into sector-specific challenges, lack of depth into cross-level interaction and limited view of non-technological factors at play, and there lies a practical implementation gap with no sufficient and actionable frameworks. By addressing these gaps, this research will not only enhance the theoretical understanding of blockchain adoption but also provide practical insights and tools for organizations across industries looking to harness the transformative potential of blockchain technology in their supply chains.

6. Conceptual Model for Blockchain Adoption in Supply Chains

This chapter introduces the first version of the conceptual figure 03, developed to understand the factors influencing blockchain adoption in supply chains. The figure is based on insights derived from a comprehensive literature review, meta-analysis, and participative discussions.

The three-arena model provides a comprehensive framework for analyzing the multi-faceted dynamics influencing blockchain adoption. Arena 1 focuses on individual decision-making processes, Arena 2 explores organizational strategies and structures, and Arena 3 examines network-level dynamics of power. This multi-layered approach offers a nuanced understanding of the interplay between individual, organizational, and relational factors in the process of blockchain integration.

To validate the robustness and applicability of the model, different research methodologies were employed for each arena, ensuring a well-rounded exploration of the barriers and enablers of blockchain adoption. These methodologies included qualitative interviews, quantitative surveys, case studies, social network analysis, and power analysis, providing valuable insights for companies seeking to implement blockchain technology in their supply chains.

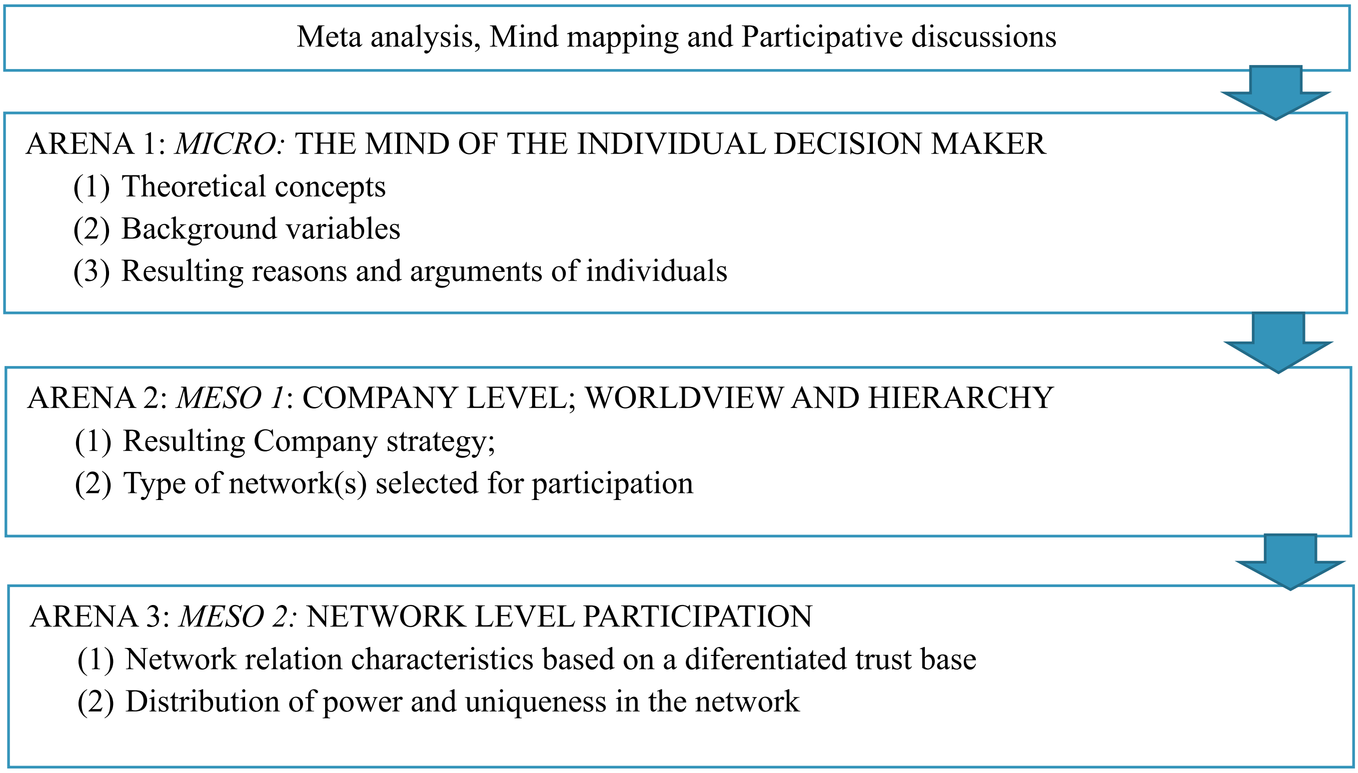


Figure 03: The 4 steps taken and the 3 arenas of decision making

6.1 Arena 1: Micro – The Mind of the Individual Decision Maker

At the Micro level, the model focuses on the cognitive processes and personal factors that influence the decisions of individual actors within the supply chain. This arena captures the psychological and behavioral factors that shape how decision-makers perceive, evaluate, and ultimately adopt blockchain technology.

Theoretical Concepts

The first component of Arena 1 concerns the theoretical concepts that help explain how individual decision-makers form attitudes towards new technologies like blockchain. Drawing from established frameworks such as the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT), the model suggests that individuals' attitudes towards blockchain are largely shaped by perceived ease of use, perceived usefulness, and potential risk (Liu & Ma, 2023). These theoretical concepts provide a foundation for understanding how personal beliefs and mental models about blockchain impact their adoption. The model recognizes that adoption is not simply a matter of technological feasibility, but also a process deeply embedded in individual cognition, which involves perceptions of value, benefits, and potential disruption.

Background Variables

Background variables are the personal characteristics, experiences, and prior knowledge that influence an individual's decision-making process (Fresko & Levy-Feldman, 2023). These variables include factors such as professional background (Diaz-Serrano & Kallis, 2022), past experiences with technology (Chen et al., 2022), and individual biases (Eldar et al., 2016). For example, individuals with a deep-rooted background in traditional supply chain management may approach blockchain adoption with skepticism or resistance due to their reliance on established practices (Bhandal et al., 2022). Meanwhile, decision-makers with experience in digital transformation or emerging technologies may be more inclined to recognize the potential benefits of blockchain (Verhoef et al., 2021; Diseiye et al., 2023). The model posits that understanding these variables is crucial for analyzing adoption behaviors at the individual level, as they directly influence how blockchain is evaluated and approached by different stakeholders (Golant, 2017).

6.2. Arena 2: Meso 1 – Organizational Level: Worldview and Hierarchy

Arena 2 involves looking at the level of organizational decision-making, wherein corporate strategy, hierarchical structure, and internal policies affect the process of blockchain adoption. Such an arena examines organizational worldviews in shaping technology adoption, how hierarchical power structures facilitate or hinder the integrating process of blockchain.

Company Resulting Strategy

The component of the corporate strategy examines how organizational objectives and goals influence the choice of adopting blockchain. At the level of an organization, blockchain adoption isn't solely motivated by isolated decision-makers but is all part of big corporate strategies aimed at achieving efficiency in operation, reduction of fraud, elevation of transparency, and sustainability goals (Sullivan et al., 2012). The model indicates that companies with an innovative mindset or a focus on long-term value creation are more likely to pursue blockchain adoption. Companies that are more traditional or conservative may resist new technologies due to concerns about implementation complexity, cost, or disruption to existing processes. Understanding the company's strategic priorities is crucial in terms of how blockchain fits within its overall vision.

6.3. Arena 3: Meso 2 – Network Level Participation: Trust and Power Dynamics

Arena 3 moves to the network level, where attention is given to how power dynamics and trust between supply chain actors impact blockchain adoption. This arena thus explores how relationships among different organizations in the supply chain-structured by trust, power, and uniqueness affect participants' ability and willingness to adopt blockchain technology.

6.3.1. Network Relationship Characteristics Based on Differentiated Trust Base

The network relationship characteristics component shows how trust shapes blockchain adoption at the network level. Trust is a cornerstone of Blockchain technology (Joshi, 2023), and different actors within the network will have varying levels of trust in the technology, the system, and each other. Trust is not homogeneous in all relationships of a supply chain, and the model considers that blockchain adoption will be based on the differentiated trust base within the network (Yang et al., 2021).Larger, more influential actors in the supply chain may have a higher level of trust in the technology's potential to streamline operations and enhance transparency (Bommasani et al., 2023), while smaller, less powerful suppliers may be more cautious or resistant to adopting blockchain. It posits that understanding such dynamics of trust is critical to the successful integration of blockchains across the network.

Three-Arenas Model:

This is a multi-dimensional model useful for analyzing blockchain diffusion at supply chains. This addresses psychological, organizational, and network-level issues as contributory factors that address the complexity of integrating blockchains and provide actionable insight in overcoming barriers. This robustness and generalizability of the model are validated through various diversified methodologies. This chapter sets a foundation to explore individual, organizational, and network-level dynamics that will contribute to an in-depth understanding of the factors that shape blockchain adoption in modern supply chains.

7. Theoretical Framework: Foundations, Relevance, and Application

This section presents the theoretical foundation guiding this research. The study primarily draws from Institutional Isomorphism (DiMaggio & Powell, 1983) to explain how organizations within supply chains respond to external pressures when adopting blockchain technology. Institutional isomorphism describes the forces that drive companies to converge toward similar behaviors, structures, and technologies due to three key pressures: mimetic, coercive, and normative isomorphism.

Understanding these pressures is essential in examining how blockchain adoption occurs in sustainable supply chains, particularly in food and fashion industries. To operationalize this theory, this research uses meta-analysis and mind mapping to:

1. Identify common patterns of blockchain adoption across industries.
2. Categorize adoption drivers under the three isomorphic forces.
3. Assess whether isomorphic pressures lead to actual performance improvements or mere compliance.

By integrating this theoretical framework, the study develops a structured approach to analyzing decision-making, trust, and power dynamics in blockchain-enabled supply chains.

7.1 Institutional Isomorphism:

Understanding the Forces Shaping Supply Chain Decision-Making

Institutional isomorphism explains why firms in the supply chain industry adopt similar technologies and practices, often in response to uncertainty, regulatory pressures, or professional norms (Junior, 2021). This concept is particularly relevant for blockchain adoption, where companies move toward digital transparency and traceability due to market expectations, legal mandates, and industry best practices.

The three primary mechanisms through which institutional isomorphism influences blockchain adoption are:

- Mimetic Isomorphism (Imitation) – Firms copy others in uncertain environments (Silva & Júnior, 2023).
- Coercive Isomorphism (Regulatory Pressure) – Firms comply due to legal or governmental requirements (Romdoni, 2022).
- Normative Isomorphism (Professional Standards) – Adoption is driven by industry norms and values (Fany ,2022).

In this research, these mechanisms are used as analytical lenses to categorize blockchain adoption drivers and assess their impact on sustainability in supply chains.

7.1.1 Mimetic Isomorphism: Conformity Through Imitation

Literature Perspective:

Mimetic isomorphism occurs when firms adopt technologies by imitating industry leaders, especially in times of uncertainty (DiMaggio & Powell, 1983; Campos-Alba et al., 2023). Organizations often follow competitors or market leaders to reduce decision-making risks and align with perceived best practices.

Application in This Research:

This study analyzes how blockchain adoption in supply chains follows a mimetic pattern, where firms integrate blockchain not necessarily because of direct benefits, but because others in the industry have done so.

Example: Blockchain in Fashion Supply Chains

- Large brands (e.g., H&M, Nike) adopted blockchain to improve supply chain transparency and sustainability (Zheng et al., 218).
- Smaller fashion brands followed suit, fearing competitive disadvantage.
- Everledger and Provenance blockchain solutions enabled companies to track material origins and sustainability claims (Saberi et al., 2018).

This study maps blockchain adoption trends in fashion supply chains to determine whether firms are adopting blockchain due to actual performance benefits or merely because industry leaders are doing so.

7.1.2 Coercive Isomorphism: Compliance with External Pressures

Literature Perspective:

Coercive isomorphism occurs when companies adopt specific practices due to government regulations, legal mandates, or industry compliance requirements (Musina et al., 2021). In supply chains, this is particularly evident in food safety laws, sustainability regulations, and environmental directives.

Application in This Research:

This study examines how blockchain adoption is driven by legal and regulatory mandates in sustainable supply chains. Blockchain enables companies to comply with EU sustainability laws, traceability requirements, and ethical sourcing regulations.

Example: EU Green Deal & Blockchain Compliance

- The EU's Circular Economy Action Plan mandates transparent supply chains (Geissdoerfer et al., 2017).
- EBSI (European Blockchain Services Infrastructure) ensures blockchain-based regulatory compliance (Zheng et al., 218).
- Volkswagen uses blockchain to track ethically sourced cobalt and lithium for EV batteries, ensuring compliance with OECD Due Diligence Guidelines (Ahmed, 2021).

This research categorizes regulatory-driven blockchain adoptions and evaluates whether coercive pressures lead to genuine sustainability improvements or mere legal compliance.

7.1.3 Normative Isomorphism: The Influence of Professional Standards and Values

Literature Perspective:

Normative isomorphism is driven by industry standards, professional expectations, and ethical norms (Wüstner et al., 2022). Companies adopt certain practices not because they are forced to, but because they align with shared values and professional ethics (Biggs et al., 2022).

Application in This Research:

This study explores how blockchain adoption in supply chains is influenced by industry certifications, ethical sourcing expectations, and corporate sustainability commitments.

Example: Ethical Sourcing in the Coffee Industry

- Starbucks and Nespresso use blockchain to verify sustainable sourcing of coffee beans (Shahzad, Rehman, Zafar, & Masood, 2023).
- Fairtrade certification programs drive adoption of transparency tools in supply chains (Chen & Miraldo, 2022).
- Industry bodies (e.g., Global Supply Chain Council) establish blockchain as a best practice for sustainability (Zheng et al., 2017).

This research investigates whether blockchain adoption truly enhances ethical sourcing or merely serves as a reputational tool to align with industry norms.

7.1.4. Blockchain as a Catalyst for Isomorphism in Sustainable Supply Chains

Blockchain technology serves as a key enabler of institutional isomorphism in sustainable supply chains, reinforcing the three isomorphic pressures:

Mimetic isomorphism – Companies adopt blockchain due to industry-wide trends (e.g., major fashion brands using blockchain for sustainability).

Coercive isomorphism – Blockchain ensures compliance with legal frameworks (e.g., EU regulations on traceability and sustainability).

Normative isomorphism – Ethical sourcing and industry standards drive blockchain adoption (e.g., Fairtrade and supply chain transparency certifications).

Research Contribution:

This study applies institutional isomorphism theory to analyze whether blockchain adoption genuinely enhances sustainability or if firms are merely responding to external pressures. By using meta-analysis and mind mapping, this research categorizes blockchain adoption trends and evaluates their impact on decision-making, trust, and power dynamics in sustainable supply chains.

7.2 The Three Arenas: Integrating Institutional Isomorphism in the Supply Chain Context

Institutional isomorphism significantly influences decision-making in supply chain management. Organizations operate within three primary arenas of influence: the technological arena, the regulatory arena, and the professional arena. Each of these arenas exerts distinct pressures, leading to convergence in practices and behaviors across industries (Phin, Zámborský, & Kruesi, 2023).

1. The Technological Arena: Innovation Through Mimetic Isomorphism

The technological arena is primarily shaped by mimetic isomorphism, wherein firms adopt new technologies by imitating industry leaders or peers. This often occurs when companies face uncertainty regarding the benefits of emerging innovations such as blockchain, artificial intelligence (AI), and automation (Zheng et al., 2017). Rather than conducting independent evaluations, firms tend to follow competitors to avoid being left behind, creating a bandwagon effect (Gaol & Wahyudi, 2023).

2. The Regulatory Arena: Compliance Through Coercive Isomorphism

The regulatory arena is driven by coercive isomorphism, where firms conform due to government regulations, legal requirements, and industry standards. Unlike mimetic isomorphism, which is voluntary, coercive pressures mandate compliance to ensure operational legitimacy (Chughtai et al., 2021). Businesses must adapt their supply chain strategies to meet sustainability laws, labor standards, and compliance protocols enforced by regulatory bodies (Roxani et al., 2023).

3. The Professional Arena: Ethical Legitimacy Through Normative Isomorphism

The professional arena is influenced by normative isomorphism, which emerges from shared industry values, ethical expectations, and professional standards. Unlike the other two forms, which stem from competition or legal mandates, normative isomorphism is shaped by industry norms, professional networks, and institutional training (Kashem & Haque, 2014). Companies integrate sustainability initiatives and corporate social responsibility (CSR) strategies to align with professional expectations and maintain legitimacy in the industry (Javaid et al., 2022).

A Holistic Framework for Understanding Supply Chain Decision-Making

Institutional isomorphism provides a structured perspective on how supply chain organizations respond to external pressures and navigate industry changes. By analyzing the technological, regulatory, and professional arenas, we can understand how firms adapt and standardize practices:

- Mimetic isomorphism drives firms to adopt innovations due to industry-wide imitation (Campos-Alba et al., 2023).
- Coercive isomorphism enforces compliance with legal and regulatory standards (Romdoni, 2022).
- Normative isomorphism encourages organizations to align with ethical and professional expectations (Sartono et al., 2022).

This integrated framework helps explain why supply chain practices become increasingly standardized and how firms balance innovation, compliance, and ethical considerations in an evolving business environment.

7.3 Operationalizing Theory: Meta-Analysis and Mind Mapping in Research

This Meta-analysis chart and Mind Mapping *(Appendix, Model 06)* summarizes key studies on blockchain applications in supply chains, trust, and technology acceptance. It includes diverse research methodologies, ranging from grounded theory and narrative research to systematic literature reviews and case studies. The studies explore various themes, such as blockchain's role in traceability, consumer security, sustainability barriers, and technology adoption frameworks. Notably, the Unified Theory of Acceptance and Use of Technology (UTA) is highlighted in some studies, emphasizing factors influencing blockchain adoption (Lawan & Ringim, 2020). This synthesis provides a structured overview of existing literature, helping to contextualize blockchain's evolving role in supply chain management and trust-building mechanisms.

1. Meta-analysis:

A systematic review was performed using the available information bases such as Google Scholar, Ebsco, Scopus, and WOS. The keywords included "blockchain effectiveness", "(slow) food SC", "(slow) fashion SC", and "transparency and secrecy" to guide the search.

2. Mind Mapping

Mind mapping techniques were useful in facilitating the interpretation and systematic review of data collection; this visualization depicts an overview of the most important aspects, issues, and topics derived from the literature.As a tool for connecting ideas, they present an organized structure of the research findings that may guide further analysis and the synthesis of the data.

Authors	Year	Method	Key words
Xiaoning Qian and Eleni Papadonikolaki	*2020*	Mixture of grounded theory research andnarrative research	Trust, Blockchain, Experience,Supply Chain
Alessandro Scuderi and Giuseppo Timpanaro	*2019*	A review of systematic literature; case studies	Blockchain, Traceability, Consumers, Security
Alexander Kharlamov and Glenn Parry	*2018*	The reviewed literaturestudied	Blockchain, SC, Habits, Biases
Viswanath Venkatesh and James Thong	*2016*	The reviewed literaturestudied	Theory Evaluation, Technology Acceptance and Use, Unified Theory of Acceptance and Use of Technology, Research Context, Literature Review, Multi-Level Framework
Sara Saberi, Mahtab Kouhizadeh, Jospeh Sarkis and Lejia Shen	*2018*	The reviewed literaturestudied	Blockchain, SCM, Sustainability,barriers
Kristoffer Francisco and David Swanson	*2018*	Introduction of Unified Theory of Acceptance(UTA)	Blockchain, Innovation, Traceability, Provenance, SCM, Transparency, Trust, UTA

Chart 01. Meta-analysis

8.Research questions, hypotheses and applied research methods

8.1. Questions Raised

Research questions serve the purpose of showcasing the key questions that arise in the researcher's mind. Answering them can help understand the *From Micro to Meso-Level Blockchain Adoption: Redefining Supply Network Dynamics and Collaboration*. After reviewing the conceptual background and theoretical literature and concluding missing pieces in currently available academic results, research questions are formulated in accordance with the research purpose with the intent to scientifically improve examined areas. Table 01 presents the research questions of this dissertation.

RQ1:	**Given the blockchain capabilities, what is the motivation for actors to adopt the technology within supply networks?**
RQ1a:	What motivates upstream actors to adopt blockchain technology?
RQ1b:	What motivates downstream actors to adopt blockchain technology?
RQ1c:	How do differences in supply chain roles and responsibilities influence the adoption of blockchain technology?
RQ1d:	What external pressures (e.g., regulations, market competition) drive blockchain adoption in upstream and downstream supply chain actors?
RQ2:	**What goes on in the mind of the individual decision maker?**

RQ2a:	What factors (external / internal) affect the individual decision-maker’s choice to adopt blockchain?
RQ2b:	What are the key arguments for and against adopting blockchain technology in the supply chain?
RQ3:	**Which factors are persuasive for participants to insert the required strategic information?**
RQ3a	How do economic and reputational factors influence the sharing of strategic information?
RQ3b	How does competitive pressure affect the willingness to share information?
RQ4:	**How does blockchain adoption contribute to sustainability goals in supply chains?**
RQ4a:	How does blockchain improve transparency and traceability of sustainable practices in supply chains?
RQ4b:	To what extent do stakeholders view blockchain as a tool for meeting sustainability requirements, such as ethical sourcing and energy consumption reduction?

Table 01. Research questions

8.2 Research Methodology

This study adopts a stepwise qualitative-quantitative exploratory approach (Mixed-Method) with a Grounded Theory approach. The basis for this choice is its strong potential to accommodate and extract meaningful insights from complex data; it connects qualitative narratives to quantitative analysis. The subsequent sections highlight the advantages, the process of data collection, and the strategies of analysis.

Advantages of Methodology

Completeness: The mixed-methods approach combines qualitative and quantitative data to ensure comprehensiveness regarding the research questions (Leso et al., 2022). This captures narratives from interviews and, through qualitative software, allows quantitative analysis to take place, enabling a deeper view of participants' experiences and patterns in the data.

Flexibility: Because of the step-by-step approach to methodology, this provides flexibility to adapt the emerging themes and questions as the research progresses (Uddin, 2021). Such a framework is useful in studies that are more exploratory in nature.

Contribution of Grounded Theory: The use of the approach of Grounded Theory ensures that the findings of the research are embedded in the data collected, thus facilitating the building up of theories from the experiences of participants rather than the basis of preexisting frameworks. This approach strengthens the findings for relevance and applicability in real life.

Enhanced Validity: Triangulation of data sources-that is, qualitative narratives and quantitative analysis- enhances validity in the present study through the provision of different perspectives on the phenomena under investigation. Such a multifaceted view diminishes possible biases and reinforces the credibility of the findings.

Participative Data Collection: The qualitative part of the research involves the collection of narratives and interview responses from participants. This becomes important in understanding participants' perceptions and experiences of the research topics, such as blockchain effectiveness in food and fashion supply chains (Patil & Bhosale, 2023). The interviews are designed to be in-depth, with the freedom for participants to express their views in their own words.

Theme		Sources of data (interview or public Theme lecture)
Blockchain	Interviewee 1A Interviewee 1B Public lecture 1C Public lecture 1D	Research fellow in blockchain solutions Professor on computer security 6 Blockchain experts in technology Blockchain experts in applications
Applications of Blockchain in SC	Interviewee2A Interviewee2B Interviewee 2C	Professional operating in electronic payment Business developer of Internet of Things (IoT) Economics expert researching & developing smart contracts
ConstructionSCM	Interviewee3A Interviewee3B Interviewee3C Interviewee 3D Interviewee 3E	Construction procurement manager Director of a logistics firm on construction materials Operation officer of logistics firm for construction materials Professional in port warehouse (logistics recorder) Project manager of a construction firm

Table 02. Participants in discussions in the First Stage: gathering and checking viewpoints

8.3 Overview of Methodology

This section outlines the methodological 3 steps undertaken in the research and provides a detailed explanation of the validity measures implemented to enhance the robustness and credibility of the findings. To ensure the validity and reliability of the study, a multi-method approach was employed, incorporating both qualitative and quantitative techniques with built-in verification processes.

Step 1: Qualitative Approach to Data Collection

Considering the "Micro-level revolution" of blockchain technology adoption in supply networks as the focus of the study, the qualitative approach for data collection was multi-dimensional and diversified. The adoption process is so complex that the technical-only angle would not suffice for an adequate understanding of the various stakeholders' perceptions, motivations, and cognitive changes in the supply chain ecosystem.

Selection of Participants

In-depth interviews were carried out among a carefully sampled range of participants to allow diversified representation of experiences and views concerning the blockchain and supply chain landscape. Specifically, the breakdown entailed the following categories:

1.Upstream Actors:

These are people or organizations who fall within production, manufacturing, sourcing, and distribution sections of the supply network. The focus was on food and fashion industries because these are very key areas to understand in the applicability of blockchains. This category includes producers, manufacturers, logistics providers, and distributors, thereby providing a wealth of insights into the operational perspectives and day-to-day realities of blockchain adoption.

2.Downstream Actors:

The respondents in this category represented "end-users" who interact directly with products and services within the supply network. This includes consumers, customers, retailers, and other stakeholders positioned toward the latter end of the supply chains. Engaging with downstream actors is crucial to assessing the impact of blockchain technology on customer experience, product transparency, and trust.

3. Experts:

Besides actors from the supply chain, an additional selection of industry experts was interviewed, which consisted of the management, IT professionals, or other key decision-makers who drive the process of implementing blockchain solutions for organizations.Their insights offer a strategic perspective on challenges and opportunities that the adoption of blockchain presents across industries.

Atlas.ti Analysis Software

The interview data were analyzed qualitatively with the help of Atlas.ti software, a tool used for qualitative data management by coding (Soratto, Pires, & Friese, 2020). The steps involved in analysis included:

• Coding: Major themes, patterns, and relationships were identified through systematic coding of interview transcripts (Baldoni et al., 2018). This allows the data to be organized in a manner that underlines critical insights and recurring motifs in the participants' narratives.

• Theme Identification: The analysis sought to extract key themes related to the motivations, perceptions, and decision-making processes of the participants regarding blockchain adoption.

Fuzzy Cognitive Mapping (FCM) Model

One of the most important results of the qualitative analysis is the development of the FCM model. This model expresses in a complex way the interaction of factors that influence decision-making processes regarding blockchain adoption (Reddy & M, 2023). Concretely, it covers the following aspects:

• Interdependencies: The FCM model describes how different factors are interrelated and influence one another, thus providing a visualization of the main drivers for actors' decisions to adopt or not to adopt blockchain technology (Brankovic et al., 2023).

• Motivations and Influences: The study extracted a number of reasons for the adoption of blockchain, supportive and inhibitive motivations. This would be very important for organizations considering how to get around the complexities of blockchain implementation (Malone & Lepper, 2021).

Significance of Qualitative Methodology

The qualitative research methodology provides depth in the "microlevel revolution" occurring with blockchain adoptions in Arena 1 of the supply chain. It emphasizes perspectives not only from a technical point of view but also discusses human aspects, like:

Motivation: "Participants' intrinsic and extrinsic motivations to adopt blockchain technology, an area critical for organizations considering successful implementation of the technology,".

Perceptions: Understanding the perception of different actors about blockchain technology, its benefits, and challenges for their strategic decisions.

Cognitive Changes: Assessing changes in thinking patterns or cognition among stakeholders as an effect of the introduction of blockchain solutions in supply networks.

Step 2: Quantitative Methodology

In the second stage of the research, a quantitative approach is used to complement the qualitative findings from Arena 1. This stage seeks to quantify perceptions and influences of decision-makers in the adoption of blockchain across industries. In this regard, an online survey of large scale was designed based on the insights from the first qualitative study and an extensive literature review.

Survey Design

The survey questionnaire was designed to carefully capture the perceived decision-making power of blockchain adoption across different functional areas within organizations. Some of the key attributes of the survey are as follows:

1. *Sample Size:* The sample size for the study is quite robust respondents, a sizeable number on which to base the analysis. This wide array of respondents also covered professionals belonging to various industries such as fashion, food, pharmacy and automotive, which increases the generalizability aspect of the results.

2. *Demographic Diversity:* The survey had a heterogeneous sample drawn from various geographical locations, such as Europe, the USA, Canada, Turkey, and Dubai, and from different company sizes, both large and small. This diversity is important to ensure findings are representative of various contexts and organizational settings.

Decision-Making Power Analysis

This questionnaire contained some qualitative aspects that asked the respondent to assess the relative powers of the different departments within their organizations to understand the perceptions of decision-makers about their influence on the blockchain adoption, Scenario-Based Evaluations.

Analytical Hierarchy Process

Based on the scenario analyses, the overall hierarchical ranking was calculated using the Analytical Hierarchy Process (AHP) applied to the collective responses of all participants (Yu et al., 2019). AHP is a structured technique for organizing and analyzing complex decisions; it provides a systematic evaluation of options based on multiple criteria. In this study, a 3-point scale was used for participants to rate the relative importance of various organizational factors in each of the 10 scenarios presented. The 3-point scale allowed respondents to evaluate pairwise comparisons of factors by assessing whether one factor was stronger, weaker, or equal to another, ensuring a consistent and clear approach to data collection.

By applying AHP, the study quantified the relative importance of various functional areas in driving blockchain adoption, providing a clearer picture of decision-making hierarchies. The pairwise comparison matrices were constructed using Excel to facilitate the AHP process, ensuring a structured and consistent analysis of the organizational factors. Subsequently, the results were visualized with Tableau to allow for dynamic exploration of how different departments influence blockchain adoption decisions. To validate the accuracy and reliability of the findings, the analysis was cross verified using R-Studio software, where additional statistical tests confirmed the robustness of the results. This multi-tool approach ensured the credibility and scientific rigor of the research.

Contextual Factor Considerations

To facilitate comprehensive analysis and deeper insights, the research also examined several contextual factors influencing organizational decision-making:

1. *Sector:* Different industries may prioritize different departments based on their operational needs and unique market challenges. For example, a heavy marketing industry may reflect a stronger influence of that department in the decision-making process compared to others.

2. *Years of Experience:* This gives information about the job experiences of the respondents, authority, and influential levels in a hierarchy on a decision-making body. More seasoned decision makers may possess greater normative or actual power to drive adoption decisions.

3. *Gender:* Gender can also provide an insight into how these gender roles, especially concerning the adoption of blockchain, can shape perceptions of powerful departments.

4. *Organization Size:* The size of the organization also forms the basis of different layers and tiers in the company and makes many decisions. The bigger ones might have a more structural organization, whereas small-scale businesses may have flexible, fluid decision-making patterns.

5. *Geographic Location:* Cultural influence and substructures of local power are a further modification factor for the dynamics inside the organization. Technology adoption decisions can be influenced highly based on regional norms and practice guidebooks for doing business.

Rationale for Excluding a Literal Model

In this study, a literal model refers to an explicitly structured framework, such as the LISREL model, that directly represents power dynamics or departmental hierarchies in decision-making. While such models can provide clarity in structural analysis, their use carries the risk of influencing participant responses due to social desirability bias. For instance, participants might overemphasize the role of highly regarded departments like Research and Development (R&D) or underreport the influence of less traditionally prominent departments, potentially distorting the authenticity of the findings.

To mitigate this bias, the study adopted scenario-based evaluations and the Analytical Hierarchy Process (AHP) instead. These methods enable an indirect assessment of decision-making hierarchies without making participants overtly aware of the framework being applied to their responses. This approach preserves the objectivity of the data collection process, ensuring that insights emerge naturally rather than being shaped by predefined structures.

Furthermore, excluding a literal model aligns with the study's emphasis on contextually driven, data-derived insights. Rather than imposing a rigid framework that could precondition responses, this methodology allows for the organic identification of patterns and trends, enhancing the validity and reliability of the findings.

Step 3: Qualitative Focus Group Discussions (FGD)

Arena 3 consisted of the final phase of qualitative research, wherein, based on findings from the previous stages in qualitative and quantitative ways, focus group discussions were undertaken. This phase of the research allowed us to deeply understand the communicative dynamics, power, and decision-making structures in supply chain networks, with particular emphasis on the use of blockchain. Participants in the focus group discussions were purposively selected to cover a broad range of sectors, geographical dispersion, gender balance, and firm size, with a group composition of 4 to 6 participants. This will ensure diversity to capture multiple viewpoints and factors affecting blockchain diffusion across varying contexts.

Validity of Focus Group Discussions

Focus group discussions are one of the recognized qualitative research methods that offer several benefits in the investigation of complex social phenomena, such as blockchain adoption in supply chains. The application of focus groups in this study adds value to the issues of validity and data triangulation in the following ways:

1. Ensuring Rich and Diverse Data: The diverse pool of participants allowed the capture of multiple perspectives, hence increasing the richness of the data (Wu et al., 2023). It also includes representatives of various industries, company sizes, and geographic locations, making the research findings representative of the variability in perceptions and adoption of blockchain across different types of supply chains. This variability is very relevant when researching technology such as blockchain that may be adopted in different ways depending on the challenges and needs of each industry.

2. Triangulation of Findings: The use of focus groups in addition to the earlier qualitative interviews and the quantitative survey data serves to enhance the validity of the research findings (Lyon et al., 2019). By comparing insights from different data sources, such as interviews, surveys, and focus groups, the research is in a better position to triangulate findings and confirm patterns and relationships observed in earlier stages of the study. It ensures that the conclusions drawn are strong and based on multiple points, reducing any biases that may result from relying on a single source of data.

3. Building Consensus: Focus groups are very valuable in determining group interaction and building consensus in a group of participants (Davies et al., 2023). For this case, the discussion allowed interactions such that the responses of some participants were reacted to or built upon, enabling deeper investigation of factors contributing to blockchain diffusion. This kind of interaction helps in exploring shared understanding and conflicting ideas of perceptions about blockchain technology with a supply chain context.

4. Uncovering Hidden Factors: In group discussions, participants often bring up factors that may not have been directly addressed in individual interviews or surveys (Zhou et al., 2020). For instance, discussions of company size and strategic network positions showed how larger companies usually do not favor innovative but rather stable solutions-a pattern that was not as well-developed in earlier stages. By encouraging participants to elaborate on their views and interact with one another, focus groups are particularly effective at uncovering these subtle, yet important insights.

5. Encouraging Open Dialogue: The semi-structured format of the focus group interviews allowed flexibility in how topics were explored. The facilitators led the discussions through open-ended questions to get the participants to share their views freely, which is important in discussions that are sensitive, like those on power dynamics and pressures from suppliers and buyers (Mosse et al., 2023). Informal discussions in focus groups can allow participants to speak more freely about the challenges they face, providing valuable insights into the barriers to blockchain adoption.

8.3.1. Validity Considerations of methodology

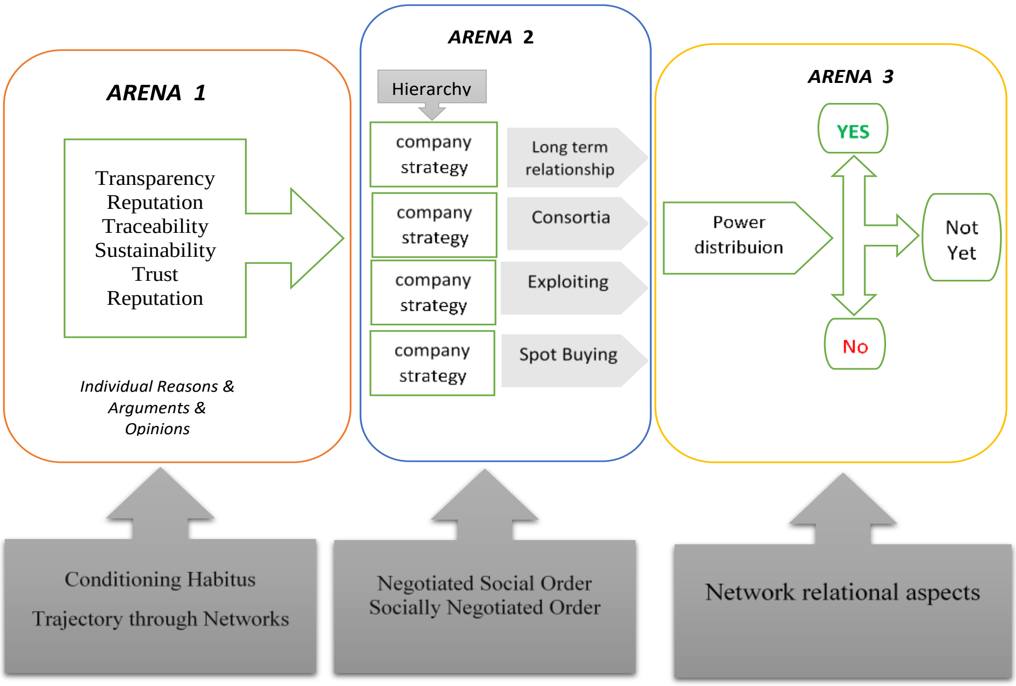
The qualitative interviews, quantitative survey, and qualitative focus group discussions (FGDs) together form a holistic and multi-dimensional approach to understanding blockchain adoption in supply chains. Qualitative interviews offer deep insights into individual perspectives, shedding light on nuanced factors influencing decision-making (Robinson, 2023). The quantitative survey applies Analytical Hierarchy Processing to quantify the perceptions and decision-making power of diverse organizational stakeholders (Wang et al., 2018). These insights are further enriched by FGDs, which explore collective viewpoints and address communication and power dynamics within supply networks (Brancier et al., 2014).

This methodology seamlessly integrates theoretical aspects with practical insights, effectively aligning with the concept of isomorphism. It provides a clear and structured framework for examining organizational behavior and its alignment with broader institutional norms.

By leveraging triangulation, the study ensures methodological rigor, with each approach validating and complementing the others. This integrated strategy enhances the reliability and depth of the findings, offering a comprehensive understanding of the drivers of blockchain adoption across sectors (Donkoh, 2023).

8.3.2. Conceptual Layout for the Redesigned Figure 4: *The 3 Arenas Model*

Model 01 can be redesigned to illustrate the 3 Arenas Model, which integrates three methodologies—qualitative interviews, quantitative surveys using Analytical Hierarchy Process (AHP), and focus group discussions (FGDs)—to provide a holistic view of blockchain adoption in supply chains. These methodologies are interconnected, with qualitative interviews offering individual insights, the survey quantifying stakeholder perceptions, and FGDs exploring group dynamics. The concept of isomorphism ties these approaches together, emphasizing how organizational behavior aligns with institutional norms. Triangulation validates and reinforces the findings, ensuring methodological rigor by cross-verifying insights from each method, leading to a comprehensive, multi-dimensional understanding of blockchain adoption.



Model 01 - The 3 Arenas Model

9.Empirical research

This chapter presents the empirical analysis of the study, focusing on the methods and results derived from the mixed-method approach employed throughout the research. The mixed-method approach used in this research is crucial for providing a comprehensive understanding of the factors influencing blockchain adoption in supply chains .The qualitative phase involved conducting interviews with experts from the blockchain technology and supply chain management sectors ,while the subsequent quantitative phase utilized a survey to validate key findings and identify broader patterns and trends across sectors and types of organizations .Additionally, focus group discussions were employed to qualitatively triangulate the findings from the interviews and survey .The research methodology will integrate both quantitative and qualitative data collection and analysis techniques to provide a more holistic understanding of the factors that influence blockchain adoption across various supply chains.

The core of this study, therefore, is built on a mixed-method design based on model, wherein the qualitative phase initially lays the foundation by identifying key factors that influence blockchain adoption, followed by a quantitative phase to further validate and measure these factors. The research then follows up with a qualitative approach to analyzing Meso 2 and Arena 3, giving further in-depth studies of specific cases and providing detailed insights that enrich the quantitative findings. This duality in approach enables the collection of diverse data, thereby enhancing overall research outcomes by integrating the strengths of both qualitative and quantitative methods. By using both approaches, the study hopes to achieve a deeper and more detailed understanding of the research issue that would not have been possible with one approach alone.

This research about empirics is based on various steps: qualitative interviews with experts from the area of blockchain technology and supply chain management, covering several sectors, in order to go more in-depth on specific challenges, motivations, and decision processes about blockchain adoption; and afterwards, a quantitative phase represented by the big survey designed according to the findings from the qualitative parts and for quantifying perceptions and experiences for a larger set of respondents. This step allowed the research to validate key findings and identify broader patterns and trends across sectors and types of organizations. The focus group discussions, in turn, were used to qualitatively triangulate the findings from the interviews and survey by allowing participants to explore dynamics and power issues that shape blockchain adoption in supply chains.

The research was conducted in such a way to ensure that the results are valid at both individual and organizational levels of the supply chain, with three clear-cut arenas: Arena 1 (Micro-level), Arena 2 (Meso 1-level), and Arena 3 (Meso 2-level). Arena 1 concentrated on the individual actors' mindset, investigating how personal perceptions, behaviors, and decision-making affect blockchain adoption. This Micro-level analysis provided insight into the factors that drive or hinder blockchain acceptance at an individual level. Arena 2 shifts focus to the organizational level: how companies in the supply chain interact and how their internal structures and dynamics affect the adoption process. In Arena 3, research was directed at the last decision-makers, or those at the top of the organizational hierarchy, and at the wider external forces, such as market pressures and sectoral trends, that influence strategic decisions on blockchain integration.

Dividing the research into these three arenas, each of which is addressed in a dedicated chapter, helps to ensure that the findings are tested and validated at each level of analysis. This layered approach provides an excellent way to understand how the adoption of blockchain unfolds at different levels of the supply chain. Arena 1 provides insights into personal issues that influence adoption, Arena 2 organizational interaction and structures, and Arena 3 to the final decision-making processes shaped by higher-level strategic considerations. This clear classification strengthens the overall validity of the research and ensures that the findings reflect the complexity and multifaceted nature of blockchain adoption within the supply chain.

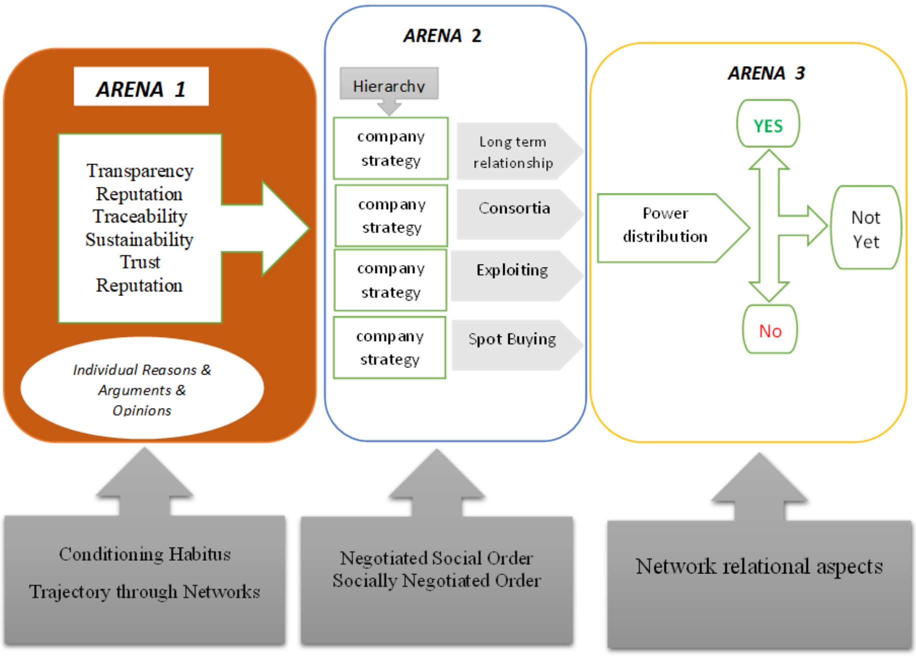
Although the mixed-method approach may be challenging, such as in data collection and analysis, which is time-consuming, and expertise in both qualitative and quantitative research methods is highly needed, its benefits are patent. Mixed-method research is increasingly recognized for its ability to provide a richer, more comprehensive analysis that blends numerical data with in-depth insights. The idea has gained considerable traction in both academic and practical applications because it can provide an additional level of understanding for complex phenomena, such as the adoption of emerging technologies like blockchain in supply chains. Merging multiple sources of data with various analytical techniques would mean that the findings were both reliable and generalizable across a range of different organizational contexts, hence contributing valued knowledge to the field.

9.1 Arena 1: Micro Level

9.1.1. The Genesis of Decision makers Mental Maps

Like all human beings, perceive the world through subjective mental maps, which are shaped by personal experiences and social conditioning. These mental maps filter and prioritize information based on relevance or importance (Bakker & Kamann, 2007). Each actor's perspective is guided by a unique reference model, influenced by their social environment or 'habitus' (Bourdieu, 1972, 1977; Kamann, 1995,1996). The habitus is a "structured structuring structure" (Bourdieu ,1977) that conditions individuals to solve familiar problems in established ways but also influences how they tackle new, unfamiliar challenges.

The habitus carries with it a certain modus operandi, a sense in which behaviors and actions are conducted within any one social space. Such conditioning, however, is not limited to present environments but is also related to historical trajectories such as educational institutions, organizational cultures, and broader cultural experiences (Bakker & Kamann, 2007). The cues the manager observes, the values they embrace, and the actions they pursue have deep roots in their structured experience.



Model 02 -Arena 1. Micro Level - The 3 Arenas Model

9.1.2. Methodology

This study aims to capture the micro-level human dimensions of blockchain adoption within various industries. The methodology utilized both qualitative and quantitative techniques to ensure thorough data collection and analysis. Below is a breakdown of the key methods used:

Data Collection

Data was gathered from a range of sources to capture the perspectives of diverse stakeholders:

Participant Diversity: The sample consisted of 34 individuals, including 23 upstream actors (e.g., producers, manufacturers, distributors) and 11 downstream actors (e.g., consumers, retailers, end-users) from sectors such as food and fashion.

Expert Knowledge: Input from professionals with expertise in blockchain technology, sustainable supply chains, and industry sectors was also gathered to provide a comprehensive understanding of adoption dynamics.

Collaborative Dialogue

Focus group discussions and peer-to-peer interviews were conducted to foster collaborative exchanges among participants. This allowed them to engage in open discussions, promoting in-depth sharing of insights related to blockchain adoption.

Open-Ended Exploration

Semi-structured interviews with open-ended questions were used to allow participants to freely express their beliefs, motivations, and attitudes towards blockchain adoption. This approach ensured that both technical and human dimensions of blockchain adoption were explored.

Data Analysis and Key Themes

The interview data were analyzed using Atlas.ti, a qualitative data analysis software. The analysis followed an iterative coding process:

Open Coding: The initial step involved identifying raw data segments and categorizing them into individual concepts (e.g., transparency, data privacy).

Axial Coding: Relationships between these initial concepts were examined to create broader categories (e.g., transparency as a trust factor, data privacy concerns as barriers to adoption).

Selective Coding: Key themes were refined and prioritized, focusing on factors most relevant to blockchain adoption.

Chart 02 provides a detailed view of the varying perspectives and priorities of each stakeholder group in relation to blockchain adoption. The differences in emphasis reflect the unique concerns and interests of each group, which are essential for understanding the broader dynamics of blockchain integration across industries.

Code	Key Words	Set 1: SSC Experts	Set 2: BC Experts	Set 3: End Users	Set 4: Org Experts
T1	Transparency	**20.2%**	**21.5%**	2.8%	**36.5%**
T2	Traceability	14.8%	**26.6%**	3.6%	**17%**
B1	BC Advantages	9.6%	12.4%	3.2%	9.2%
B2	BC Disadvantages	4.3%	5.3%	2.4%	2.8%
S	Sustainability	**21.4%**	9.8%	14.8%	10%
U	Trust	9.7%	2.8%	**34.9%**	5.8%
O	Other technologies: QR Bar Code Scanning - RFID-Excel	12.6%	18.2%	12.5%	10.7%
R	Reputation	7.4%	3.4%	**25.8%**	8%
	Total	*100*	*100*	*100*	*100*

Chart 02. reveals factors most relevant to blockchain adoption

9.1.3 Statistical Validation and Results

Once the coding process was completed, the frequency of each code was calculated, providing insight into the prominence of specific themes. To assess the relative importance of each theme across different stakeholder groups, several statistical techniques were employed:

Code Frequency Analysis

This method quantified the occurrence of each theme across the four stakeholder groups (e.g., SSC experts, BC experts, end users, and organizational experts). The frequency (f) of each theme was calculated as:

$$f_i = (n_i / N) \times 100$$

Where:

f_i = Frequency of theme i

n_i = Number of occurrences of theme i across all interviews

N = Total number of occurrences of all themes across all interviews.

Weighted Score Calculation

A weighted scoring system adjusted for the relative importance of each stakeholder group based on their perceived relevance to blockchain adoption. The weighted score (WS) for each theme was calculated as:

$$WS_i = \Sigma^{k}_{j=1} (f_{ij} \times w_j)$$

Where:

WS_i = Weighted score of themes *i*

f_{ij} = Frequency of theme *i* for stakeholder group *j*

w_j = Weight assigned to stakeholder group *j* (e.g., based on perceived relevance, expertise, or contribution to the adoption process)

k = Total number of stakeholder groups.

Example: Weighted Score Calculation for "Transparency" *(Chart 02)*

To illustrate the weighted score calculation, let's consider the theme "Transparency." Assume we have the following data for each stakeholder group:

SSC Experts: Frequency ($f_{Transparency, SSC}$) = 20.2, Weight (w_{SSC}) = 1.5

BC Experts: Frequency ($f_{Transparency, BC}$) = 21.5, Weight (w_{BC}) = 1.2

End Users: Frequency ($f_{Transparency, End\ Users}$) = 2.8, Weight ($w_{End\ Users}$) = 1.0

Organizational Experts: Frequency ($f_{Transparency, Org}$) = 36.5, Weight (w_{Org}) = 1.3

Using the weighted score formula:

$WS_{Transparency} = (20.2 \times 1.5) + (21.5 \times 1.2) + (2.8 \times 1.0) + (36.5 \times 1.3)$

$WS_{Transparency} = 30.3 + 25.8 + 2.8 + 47.45$

$WS_{Transparency} = 106.35$

The weighted score for 'Transparency' is 106.35, reflecting both its frequency across stakeholder groups and the applied weighting for each group's importance. A full table of these weighted codes, derived from the Atlas.ti analysis, is available in the Appendix.

9.1.4. Major themes identified include:

Managers: transparency, traceability, sustainability

IT Managers: technical advantages and challenges.

Consumers: Trust and reputation come first.

9.1.5. Chart 02 Outcomes

Set 1. Sustainable Supply Chain Experts: Emphasized ecological and social sustainability.

Set 2. Blockchain Experts: Tossed on transparency, traceability, and technological integration.

Set 3. End-user customers: Focused trust and reputation.

Set 4. Organizational Experts: Reckon with operational efficiency and cost-effectiveness.

The results showed that upstream players focus on operational and production efficiencies, while downstream players are mostly concerned with the trust and satisfaction of end-users.

9.1.6. Fuzzy Cognitive Mapping: Understanding the Interconnected Factors

To analyze the interconnected factors associated with blockchain adoption, Fuzzy Cognitive Mapping (FCM) was employed (Hu, Guo, & Fu, 2023). Using the software tool *Mental Modeler*, the FCM model graphically illustrates the relationships between drivers and interdependencies, shaping the nature of adoption decisions (Xu et al., 2023).

Mental Modeler is intuitive software specifically designed for creating Fuzzy Cognitive Maps. It allows users to represent concepts as nodes and their relationships as weighted arrows, making it easy to visualize and analyze complex systems. Additionally, it provides functionality to simulate "what-if" scenarios, helping to understand how changes in one factor might ripple through a system.

The FCM model provided several key insights into the dynamics of blockchain adoption:

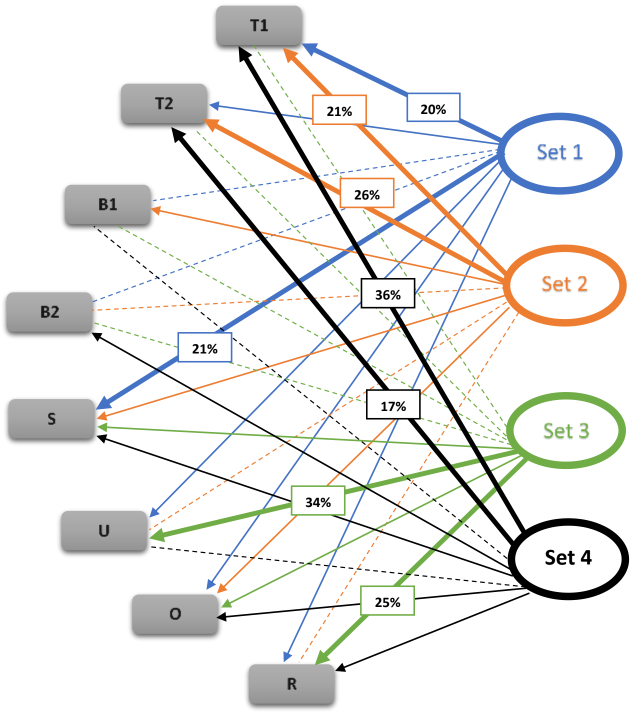
Different Drivers:

Upstream actors prioritize transparency and traceability, whereas downstream actors emphasize trust and reputation. In the FCM model, *Figure 04,* the arrows illustrate these dynamics: transparency emerges as the most significant driver for upstream actors, while trust is the dominant factor influencing downstream demand.

Push-and-Pull Dynamics:

The model highlights how technological benefits like transparency resonate strongly with upstream stakeholders, while downstream stakeholders focus on ethical practices, brand reputation, and sustainability to align with consumer expectations.

These insights underline the importance of addressing distinct stakeholder priorities in blockchain adoption strategies.



T1=Transparency
T2=Traceability
B1=BC Advantages
B2=BC Disadvantages
S=Sustainability
U=Trust
O = Other Technologies
R=Reputation

Figure 04. Fuzzy Cognitive Mapping

ARROWS	*EFFECT*	*LEVEL*
	Strong	+ + +
	Medium	+ +
	Light	+

9.1.7. Analysis of Key Motivations

• **Set 01:** The interviews with SSC experts on the main driving forces of using blockchain technology pointed to transparency at 20.2%, traceability at 14.8%, and sustainability at 21.4%. This shows their commitment to establishing ethical supply chains that can be sustained. While acknowledging the beneficial aspects of blockchain, these experts also recognize the need for due consideration of its comparative advantages against prospective disadvantages, especially with respect to issues on scalability, data privacy, and security concerns. SSC experts also apply blockchain to build trust and accountability by enhancing transparency toward making more ethical and sustainable supply chains.

• **Set 02:** BC experts in their technical knowledge about the technology focused on functional aspects of blockchain adoption. Transparency and traceability were strongly stressed as facilitators by them at 21.5% and 26.6%, respectively, since it provides the facility to create verifiable and un-hackable records along the supply chains. They also mentioned inherent advantages such as efficiency gains, cost reduction, and better collaboration, all at 12.4% each. While they mention a number of possible disadvantages-such as scalability or security issues-their main focus is on technological benefits. Sustainability, 9.8%, is another significant driver: "This is driven by the belief that blockchain could foster more responsible and traceable supply chains. They say that in conclusion, experts in BC are optimistic about blockchain bringing revolutionary change in chains, focusing on the technical capability and prospective sustainability of the future.

• **Set 03:** The customers are the very end-users; they represent the last entity within the supply chain, which places trust in the supplier and reputation above all else in considering blockchain adoption at 34.9% and 25.8%, respectively. Basically, assurance of the integrity and reliability of the products and services is needed. While they also believe in the potential benefits of transparency 2.8% and traceability 3.6%, it is less important than the assurance of trust and a good reputation for the brands they interact with. Sustainability at 14.8% is also a significant driver impelled by the need to be ethical and ecologically responsible. In any case, for the end users, there is even less emphasis on technical aspects, such as advantages or disadvantages of blockchain, at 3.2% and 2.4%, respectively, than among upstream actors. Their interests remain with tangible implications for themselves, wherein trust and reputation are paramount in the decision-making process.

• **Set 04:** From the perspective of the organizational experts, like managers, blockchain professionals, and other decision-makers in organizations that have already implemented blockchain solution offerings, the main drive toward the adoption decisions is based on the reasons of transparency. It accounted for a total of 36.5% of the responses. This is to show how they are fully aware of clarity and verifiability in supply chains. The second best, traceability, was also welcome as a positive contribution to product and process tracking. While the advantages are very real, with blockchain improving efficiency and reducing costs, a variety of disadvantages that it can present are taken into consideration, from the point of view of difficulty of implementation and security. Sustainability issues also come into consideration here, impelled above all by an increased sensitivity towards environmentally responsible practice. The other less dominant motivations among them are those relating to trust and reputation, though important, at 5.8% and 8%, respectively, because organizational experts have shown greater interest in the operational and technical areas of blockchain implementation.

9.1.8. Key Conclusions from the FCM Model

• Upstream Actors (*Sets 1, 2, and 4*): The use of blockchain is primarily driven by transparency, as denoted by strong arrows that connect upstream actors to this driver. Poor associations with the technical advantages of blockchain suggest that the attention of upstream actors is more operationally focused.

• Downstream Actors (*Set 3*): Trust is the main enabler, having a strong link with brand reputation and sustainability. These drivers show that the decisions of downstream actors are based on ethical practices and perceived reliability.

9.1.9. Hypothesis Validation: The FCM model supports the hypotheses:

Fuzzy Cognitive Mapping (FCM) was employed to analyze the interconnected factors influencing blockchain adoption (Hu, Guo, & Fu, 2023). The FCM model offers a graphical representation of relationships, drivers, and interdependencies shaping adoption decisions. Key insights include:

Players with Different Drivers: The upstream actors base their actions on transparency and traceability, while the downstream actors base their trust and reputation. Arrows in the FCM model represent these dynamics-strong for transparency that drives the decision of upstream and trust for downstream.

Push-and-Pull Dynamics: FCM brings out that the technological benefits, such as transparency, attract upstream, whereas ethical practices, brand reputation, and sustainability interest the downstream players more.

9.1.10. Hypothesis Validation: The FCM model supports the hypotheses:

H1: Upstream actors prioritize transparency and traceability as key drivers for blockchain adoption.

H2: Downstream actors prioritize trust and reputation in blockchain adoption.

H3: Downstream decision-making is significantly influenced by the perceived reputation of the platform's providers.

H4: Trust and reputation, when effectively communicated, enhance downstream blockchain adoption.

H5: Significant differences exist in the hierarchical importance of factors between upstream and downstream actors.

	Hypotheses
	Hypotheses Related to Upstream Actors:
H1:	Upstream actors prioritize transparency and traceability as key drivers for blockchain adoption.
	Hypotheses Related to Downstream Actors:
H2:	Downstream actors prioritize trust and reputation in blockchain adoption.
H3:	Downstream actors' decision-making regarding blockchain adoption is significantly influenced by perceived reputation of the platform's providers.
H4:	Downstream actors are more likely to adopt blockchain technology when trust and reputation are effectively communicated and reinforced.
	Hypotheses Related to the Fuzzy Cognitive Map (FCM):
H5:	The FCM will demonstrate significant differences in the hierarchical importance of factors influencing decision-making between upstream and downstream actors.

Table 03. Research Hypothesis

9.1.11. Validation of the Research Hypotheses

The FCM model, developed from interview data, supports the research hypotheses in a visual manner by showing the clear priorities and drivers of upstream and downstream actors (Abramiuk, 2023; Abdel-Fattah & Al Hiary, 2023; Newton, Newton, & Rep, 2016). It also emphasizes how blockchain strategies need to be aligned with consumer needs and expectations (Liu et al., 2023). Upstream actors are looking for technological benefits, such as transparency

(Baenas et al., 2019), while downstream actors need trust-building measures and sustainable practices to spur the adoption process (Langgat et al., 2023).

9.1.12. Linear Structural Equation Modeling (LISREL)

The use of LISREL complements the qualitative insights derived from Atlas.ti and FCM, enhancing the analytical depth of this study. LISREL is a powerful statistical tool designed to examine complex relationships between observed and latent variables. By constructing hypothetical models, researchers can assess the influence of specific factors on others and validate theoretical frameworks grounded in qualitative data (Gale et al., 2013). In this study, a LISREL-style model was utilized to represent and analyze how key factors interact, with initial models developed from interview data (Arenhart, 2021). By integrating the findings from Atlas.ti and FCM this research achieves a balance of qualitative depth and quantitative rigor, providing a holistic understanding of the Micro-level revolution in blockchain adoption.

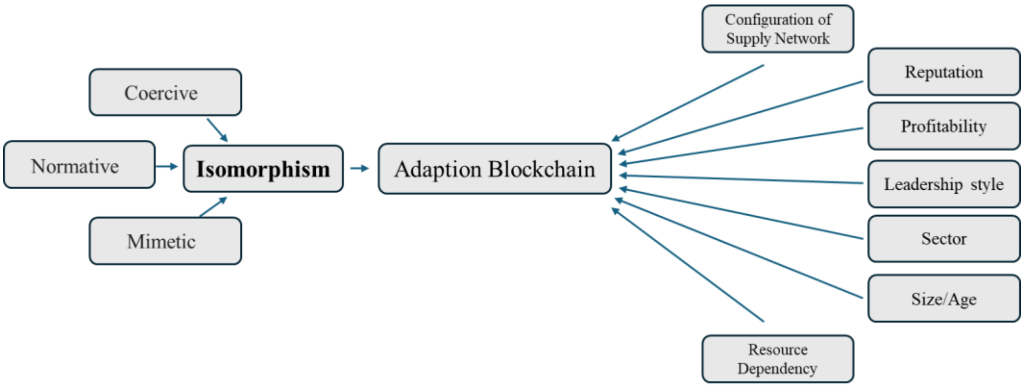


Figure 05. The LISREL-Style *(Primary Concept)*

9.1.13. Discussion of Significance and Practical implications

Interpretation of Findings

The results align with the available literature on blockchain adoption, particularly highlighting the importance of trust, transparency, and sustainability as major drivers of adoption. The findings also confirm the five hypotheses formulated above.

Transparency is more stressed by upstream actors, in tune with research that illustrates how blockchain could further bring about increased visibility and accountability within supply chains. This is reflected in the weighted score for 'Transparency', which stands at 106.35. This score reflects both its frequency across stakeholder groups and the applied weighting for each group's importance, emphasizing its significant role. A full table of these weighted codes, derived from the Atlas.ti analysis, is available in the Appendix Table 11. The dominance of trust in the decisions of downstream actors is supportive of theories positioning consumer trust at the core of technology adoption. This would then suggest that the successful implementation of blockchains requires a multi-faceted approach, considering the distinct motives of all stakeholders.

Comparison with Existing Research

These findings support the existing literature that points to the need to bridge the gap between upstream and downstream motivations. Indeed, previous studies have emphasized that blockchain adoption strategies should match consumer needs if they are to realize successful implementation. Our study further supports such an understanding by using a specific FCM model showing the difference in motivation and priorities between upstream and downstream actors, hence giving an in-depth look at the complex relationships involved.

9.1.14. Micro-Level Revolution

This research provides a deep understanding of the "Micro-level revolution" driving blockchain adoption. It emphasizes the human aspects-motivations, perceptions, and cognitive shifts-that underpin successful implementation within supply networks. The research focuses on these subtle factors and the validation of hypotheses through the FCM model, therefore providing valuable insights into how individual mental maps and social conditioning influence the adoption of blockchain technology in Arena 1.

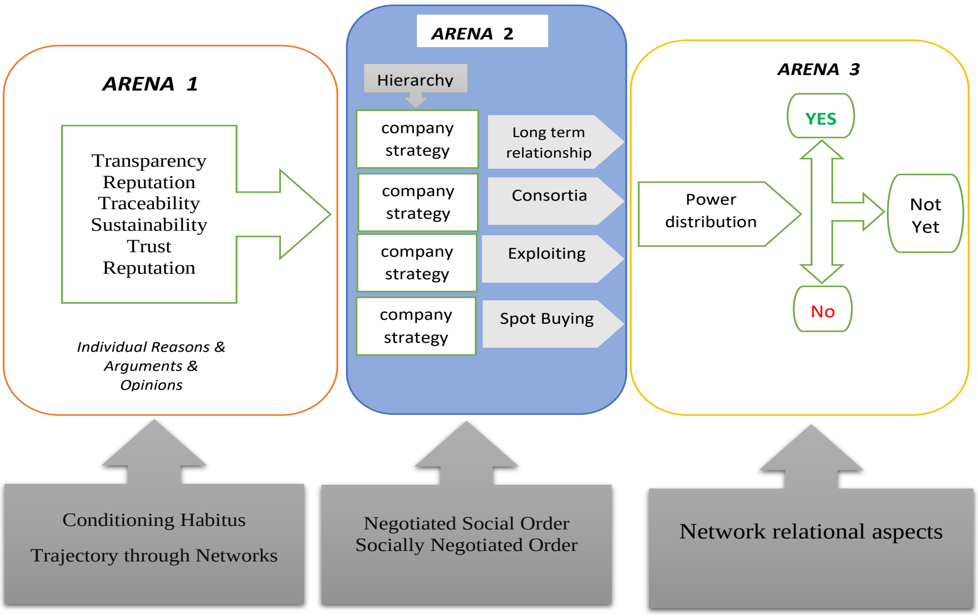
9.2 Arena 2: Meso 1 Company Level

9.2.1. The Battle of the Egos

The process-or 'battle'-that leads to the accepted and shared modus operandi of an organization includes the collective view on the usefulness or desirability of blockchain technology. This process can be seen as one of negotiation (Barnhill et al., 2021). The resulting worldview or 'order' is mainly determined by those who are leading the discussion. This leading is a matter of the hierarchical ranking within the organization. The CEO is usually at the top, while other important functions include finance, marketing, and HRM. However, this hierarchy can change from organization to organization and may be re-negotiated over time.

In many organizations, the buying function has a lower level of influence than other functions such as finance and marketing. There are obvious exceptions, however, such as trading and retailing firms where the buying function is more dominant and branding and high-fashion organizations where the marketing function will often have greater control. The interplay between these rankings and the influence of outside consultants and lobbyists creates a negotiated social order that dictates strategic decisions on adoption technology.

This study identifies the hierarchy of functions in organizations: finance, marketing, HRM, purchasing, and production, and assesses their power in influencing decisions related to the adoption of technologies like blockchain. It specifically investigates the status of the purchasing function in the context of technology-related decision-making.



Model 03. Arena 2 – Meso Level. The 3 Arenas Model

9.2.3. Methodology

This study is a critical component of empirical analysis, connecting organizational dynamics with blockchain adoption. The methodology incorporates survey questionnaires (SQ), scenario-based evaluations, the Analytic Hierarchy Process (AHP) by Saaty (2022), and advanced data analysis tools (Excel, Tableau, and R-Studio). These elements collectively ensure a rigorous and comprehensive examination of how hierarchical structures and inter-departmental dynamics influence blockchain adoption decisions (Li et al., 2023).

Survey Design and Sample

The study sample comprised 156 respondents from diverse industries and countries, capturing a wide range of perspectives on organizational dynamics (see Chart 03). The survey was designed to collect insights into how various functional areas influence decision-making concerning blockchain adoption, particularly focusing on hierarchical structures and inter-departmental influence. The diversity in the sample enhances the generalizability of the findings across different organizational contexts.

Participants were selected through professional networks, industry events, and academic conferences to ensure a diverse and representative sample. A stratified sampling approach was employed, ensuring balanced representation across industries and regions. The final sample includes participants from Europe, North America, and the Middle East, with the highest numbers from the Netherlands (22%), Germany (19%), and Turkey (12%).

Most participants had more than six years of work experience (see Figure 06), indicating that the study includes insights from experienced professionals who likely hold influential positions in their companies. The gender distribution was 67% male and 33% female, reflecting existing industry leadership demographics.

Scenario-Based Evaluations and the Use of a Three-Point Scale (+/- 3)

To assess the perceived power of different functional areas, respondents evaluated 10 scenarios comparing the influence of two departments using a three-point scale:

- **Marketing > Finance** (Marketing has a stronger influence than Finance)
- **Marketing = Finance** (Both have equal influence)
- **Marketing < Finance** (Marketing has a weaker influence than Finance)

This scale was chosen based on prior AHP studies, which found that simpler scales yield more consistent responses, even when participants have different emotional biases or interpretations of power dynamics. While a more granular scale (e.g., a seven-point scale) could offer greater detail, the three-point scale ensures clarity and ease of interpretation, particularly when ranking departmental influence. This approach simplifies complex decisions, akin to preference questions (e.g., "Do you prefer tea, coffee, or neither?"). The survey questions are detailed in Appendix, Arena 2**.**

Analytic Hierarchy Process (AHP)

AHP was employed to transform qualitative judgments into a quantitative ranking of departmental influence. This method is particularly useful when subjective perceptions must be synthesized into a mathematically sound framework. AHP enables pairwise comparisons between departments, integrating them into a comprehensive ranking that reflects hierarchical power structures within organizations.

Data Analysis Approach

Phase 1: Initial Analysis with Excel

The survey data were first analyzed using Excel to construct pairwise comparison matrices. The three-point scale was used to assess the relative importance of organizational factors in each of the 10 scenarios. A key focus of this phase was calculating consistency ratios**,** which are critical in validating the internal consistency of the AHP model. This ensured that the hierarchical rankings were mathematically sound and aligned with participants' perceptions.

Additionally, Tableau was employed to dynamically visualize the results. The interactive dashboards provided stakeholders with a clear and intuitive interpretation of how departmental influences impact blockchain adoption decisions.

Phase 2: Validation with R-Studio

To further validate the results**,** R-Studio was used to cross-verify the AHP calculations and perform statistical tests assessing consistency and reliability. Specifically, R-Studio facilitated the replication of AHP calculations and the execution of robustness checks. This step added an additional layer of confidence in the accuracy and scientific rigor of the analysis.

Integrated Approach for Enhanced Validity

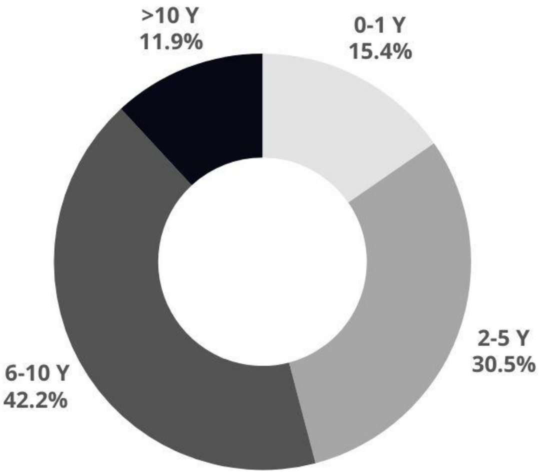
The combination of Excel for AHP computations, Tableau for data visualization, and R-Studio for validation provided a comprehensive and multi-dimensional analysis of organizational dynamics. This integrated methodology ensured the reliability and internal consistency of the ranking process, enhancing the validity of the findings. By leveraging advanced data analysis tools, the study delivers robust and interpretable results, offering clear insights into how organizational structures influence blockchain adoption decisions.

Participants' Profiles

Chart 03 illustrates the distribution of participants across different industries and countries. Understanding the demographic breakdown of respondents is crucial for contextualizing the study's findings. The participant distribution is as follows:

S I Z E	**Industries**	**Netherlands**	**USA**	**UK**	**Germany**	**Turkey**	**Hungary**	**Canada**	**Belgium**	**Dubai**	**Romania**
L.S	Fashion	3				5					
L.S	Food	4					4		6		
L	Automotive				9			5		1	
L.S	IT	2			8						
L	Education			1			7				4
L.S	Finance		3							2	
L	Real state									6	
L	Quality control		2		1				1		
L	Construction- wood				4	7		2			
L	Social network	2			1						
L	Sustainable development	8					1				
L	Medical	1	2					1			3
L.S	E-commerce				4						
L.S	Design	7	1			2				3	1
S	Biotechnology		2	2					5		
S	Regulatory	1									
L.S	Customer Service	4				3		2			
L	Logistics	2	4		2	2		3			
	Total	**34**	**14**	**3**	**29**	**19**	**12**	**13**	**12**	**12**	**8**
	Participants	**22%**	**9%**	**2%**	**19%**	**12%**	**8%**	**8%**	**8%**	**8%**	**5%**

Chart 03. Distribution of Participants by Company Size, Sector, and Geographical Location



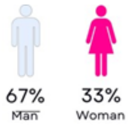


Figure 06. Respondents' job experience and genders

9.2.4. Data Analysis with Excel

First Phase:

This study aimed to assess the perceived influence of various organizational departments—Finance, Marketing, Purchasing, Production, and Human Resource Management (HRM)—on decision-making across multiple organizational scenarios. In this context, perceived influence refers to the extent to which respondents believed each department played a role in shaping decisions within different organizational situations.

Table 4 ("A Sample of the Survey Responses") presents the total responses collected from organizational actors across diverse sectors. For instance, in Scenario 6, the data indicate the following distribution of influence: Finance (51.1%), HRM (18.2%), and Equal (30.7%), collectively summing to 100%. Respondents evaluated the relative influence of each department, and the reported percentages in Table 4 reflect the proportion of total influence attributed to each department within a given scenario. These percentages were normalized to ensure that the total influence across all departments equaled 100% for each scenario. The "Equal" column represents cases where respondents perceived decision-making power as evenly distributed across multiple departments rather than concentrated within a single function.

Scenarios	Finance	Marketing	Purchasing	Production	HRM	*Equal*	**Total**
Scenario 1	**29.5**	**24.2**	0	0	0	*46.3*	**100**
Scenario 6	**51.1**	0	0	0	**18.2**	*30.7*	**100**
Scenario 7	**42.0**	0	0	**23.6**	0	*34.4*	**100**
Scenario 10	0	**53.8**	**16.3**	0	0	*29.9*	**100**

Table 4: A Sample of the Survey Responses

Process of Analysis Using the Analytic Hierarchy Process (AHP)

Organizational decision-making often requires evaluating the relative influence of different departments. To facilitate a structured and systematic analysis, the Analytic Hierarchy Process (AHP) was employed (Ulang, 2013). AHP quantifies subjective judgments through pairwise comparisons, followed by a series of mathematical calculations to derive a hierarchical model of influence. The following section outlines the step-by-step methodology, using *Scenario 1* (Finance vs. Marketing) as an illustrative example.

Example: Scenario 1 – Finance vs. Marketing

Step 1: Input the Data Respondents were asked to compare Finance and Marketing in terms of perceived influence, selecting one of three possible outcomes:

Finance is more influential than Marketing (Finance > Marketing)

Finance and Marketing are equally influential (Finance = Marketing)

Marketing is more influential than Finance (Finance < Marketing)

For *Scenario 1*, Finance was perceived as more influential than Marketing, resulting in the designation: **Finance > Marketing**

Numerical values were assigned as follows:

1 if the first department was more influential.

0.5 if both were equally influential.

0 if the second department was more influential.

Since Finance was deemed more influential, the assigned values were:

Finance: **1**

Marketing: **0**

Step 2: Assign Numerical Values for All Comparisons The same approach was applied across all 10 scenarios, generating total scores for each department by summing assigned values across all comparisons.

After evaluating all scenarios, the following total scores were obtained:

Finance: **3.5**

Marketing: **3.0**

Production: **2.1**

HRM: **1.8**

Purchasing: **1.4**

These scores represented raw influence levels before normalization.

Step 3: Normalize the Scores To ensure comparability, each department's total score was normalized by dividing it by the total number of scenarios (10):

Normalized Score = Total Score / Number of Scenarios (10)

Applying the formula:

Finance: **3.5 ÷ 10 = 0.35**

Marketing: **3.0 ÷ 10 = 0.30**

Production: **2.1 ÷ 10 = 0.21**

HRM: **1.8 ÷ 10 = 0.18**

Purchasing: **1.4 ÷ 10 = 0.14**

Total Normalized Scores :0.35 + 0.30 + 0.21 + 0.18 + 0.14 = 1.18

Step 4: Convert Normalized Scores to Percentages Each department's percentage influence was determined using:

*Percentage Influence = (Normalized Score / Total Normalized Scores) * 100*

Finance: (0.35 / 1.18) * 100 = 29.66%

Marketing: (0.30 / 1.18) * 100 = 25.42%

Production: (0.21 / 1.18) * 100 = 17.80%

HRM: (0.18 / 1.18) * 100 = 15.25%

Purchasing: (0.14 / 1.18) * 100 = 11.86%

Step 5: Final Hierarchical Model After completing all calculations, the final ranking of departmental influence was established:

```
+-------------------+    +-------------------+    +-------------------+    +-------------------+    +-------------------+
| Finance |------>| Marketing |------>| Production |------>| HRM |------>| Purchasing |
| (29.66%) | | (25.42%) | | (17.80%) | | (15.25%) | | (11.86%) |
+-------------------+    +-------------------+    +-------------------+    +-------------------+    +-----------------+
```

Model 04. Hierarchical Model:

Departmental Influence (overall perceived influence based on aggregated data from all scenarios)

While our initial data collection involved assigning values of "1," "0.5," or "0" to represent the relative influence of departments in pairwise comparisons, the Analytic Hierarchy Process (AHP) utilizes this information in a specific way. These values serve as the foundation for constructing pairwise comparison matrices, where each cell reflects the relative importance of one department compared to another. For example, a value of "1" assigned to "Finance > Marketing" directly translates into an entry in the pairwise comparison matrix indicating that Finance is considered more important than Marketing in that specific comparison. The departmental influence weights will then be derived using the AHP methodology implemented in R, as described in the subsequent sections. These findings underscore the predominant influence of Finance and Marketing in strategic decision-making, as departments controlling financial resources and market positioning tend to have a higher impact on organizational outcomes. HRM and Production, while essential for operational efficiency, exhibit relatively lower influence at the strategic level. The Purchasing department, though crucial for procurement functions, exerts the least influence on high-level decision-making. This structured analytical approach provides data-driven insights that can aid organizations in optimizing resource allocation, strategy development, and leadership decision-making.

9.2.5. Validation with R-Studio software

Second Phase:

This section builds upon the scenario-specific departmental influence weights and consistency ratios generated from the Excel-based AHP analysis. The primary goal of this R analysis, conducted using R-Studio, is to validate these findings and assess the stability of the departmental rankings through statistical testing. This involves calculating descriptive statistics, assessing data distribution, performing correlation analysis, and conducting ANOVA and regression analyses. The results will provide insights into the consistency and robustness of the rankings across different scenarios and performance metrics.

This included:

- Addressing missing or inconsistent values to ensure completeness across departments.
- Normalizing key performance metrics (Total Score, Percentage, Average Score, and Standard Deviation) using standard statistical techniques (z-scores: $Z=X-\mu$ / σ) to ensure meaningful comparisons across departments. The normalization process enabled more accurate and fair comparisons between departments, enhancing the validity of the statistical tests performed (such as correlation analysis and ANOVA), by reducing scale-related biases between performance metrics.

The final departmental rankings, based on weighted scores and associated metrics, are presented in Table 5 and visualized in Figure 9 (Appendix)**.** These visualizations, generated using Tableau, enhance clarity and interpretation.

Statistical Validation Using R-Studio

To assess the stability of rankings and evaluate sensitivity to input variations, multiple statistical tests were conducted:

Descriptive Statistics: Mean and standard deviation were calculated for each department to summarize performance.

Data Distribution Validation: Normality tests, histograms, and box plots were used to detect outliers and assess data assumptions.

Correlation Analysis: Pearson's correlation test examined relationships between key variables (Total Score, Percentage, and Average Score).

Comparative Analysis (ANOVA): A one-way ANOVA test determined whether significant differences existed in departmental performance.

Regression Analysis: A multiple linear regression model was developed to explore predictive relationships among key performance metrics.

Department	Total Score	Percentage	Weighted Department Score	Average Score	Std Deviation	Best Case	Worst Case
Finance	186	18.8	3496.8	18.6	24.35	53	*0.0*
Marketing	161	16.3	2624.3	16.1	20.91	45	*0.0*
Purchasing	100	10.1	1010.0	10.0	13.61	33	*0.0*
Production	129	13.1	1699.9	12.9	17.21	42	*0.0*
HRM	133	13.5	1795.5	13.3	17.90	42	*0.0*
Equal	11	11.0	121.0	11.0	11.00	11	*0.0*

Table 5: Original Metrics Across Departments

ANOVA Results

A one-way ANOVA test was conducted to examine whether significant differences existed in **Total Scores** across departments.

- **F-statistic**: 4.57
- **p-value**: 0.0052

Since the p-value is below the 0.05 significance threshold, we reject the null hypothesis, indicating significant differences in performance across departments.

Post-Hoc Analysis (Tukey's HSD Test)

Tukey's HSD test was performed to identify which departments significantly differed in performance. The findings are as follows:

- Finance and Marketing performed significantly better than Purchasing and Production ($p < 0.05$).
- HRM did not show significant differences in performance compared to the other departments.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-statistic	p-value
Between Groups	221.83	4	55.46	4.57	0.0052
Within Groups	443.89	25	17.76		
Total	665.72	29			

Table 6: ANOVA output
(ANOVA table with department performance data)

Regression Model Specification

To further analyze predictors of performance, a multiple linear regression model was developed. This model examined the relationship between Total Score and key factors such as Best-Case and Worst-Case Scenarios across departments.

$$\text{Total Score} = \beta 0 + \beta 1(\text{Best Case}) + \beta 2(\text{Worst Case}) + \beta 3(\text{Department Category}) + \varepsilon$$

Where:

Dependent Variable: Total Score (overall performance score of each department)

Independent Variables:

- Best Case Scenario (optimistic projections for department performance)
- Worst Case Scenario (pessimistic projections for department performance)
- Department Category (categorical variable representing department type)

β0: Intercept

β1,β2,β3: Coefficients for independent variables

ε: Error term

However, upon further examination, it was found that the Worst-Case variable had the same value of zero across all departments. This uniformity rendered the Worst-Case scenario statistically irrelevant as a predictor of departmental performance. Here's why:

1. *Lack of Variability:* The Worst-Case values did not vary across departments, meaning there was no meaningful information that could be drawn from this variable. In regression analysis, it's critical that the independent variables provide variability to explain the dependent variable. A constant value does not help in explaining differences in performance across departments.
2. *Impact on Model Accuracy:* Including the Worst-Case variable, which contributes no variation, would distort the interpretation of the regression results. Its inclusion could lead to inefficiencies and reduce the clarity of the analysis, so it was removed to ensure that only relevant, varying factors were included in the model.
3. *Focus on Meaningful Variables:* By excluding the Worst-Case variable, the regression model was streamlined to focus on Best-Case projections and Department Category,

both of which showed meaningful variation and clear relationships with the Total Score. This improves the accuracy and interpretability of the results.

Excluding the Worst-Case variable enhanced the regression model's ability to produce clear, meaningful, and actionable insights. All subsequent analyses (ANOVA, Tukey's HSD, etc.) reaffirm that the refined model accurately captures the factors that drive departmental performance, reinforcing the reliability and validity of the results.

Therefore, the regression model was simplified to:

$$\textbf{Total Score} = \beta 0 + \beta 1(\textbf{Best Case}) + \beta 3(\textbf{Department Category}) + \varepsilon$$

This decision ensured the integrity of the analysis, focusing on variables that meaningfully explain departmental performance.

By addressing the non-contributory nature of the Worst-Case variable and refining the analysis to include only relevant, varying factors, we ensure the integrity and validity of the results. All tests, including ANOVA, Tukey's HSD, and regression analysis, support the conclusion that department type and Best-Case projections are meaningful predictors of departmental performance. The thorough cleaning and statistical validation reinforce the reliability of the data, confirming that the findings reflect true performance differences between departments.

Interpretation of ANOVA Results from Regression Analysis

To explain the results in the chart from the multiple linear regression analysis, let's break down each part of the table and connect it with the model you're working with:

1. Sum of Squares:

Regression Sum of Squares (SSR): The SSR of 221.83 indicates the portion of the total variation in Total Scores that is explained by the independent variables in the model (Best-Case Scenario and Department Category).

Residual Sum of Squares (SSE): The SSE of 443.89 represents the unexplained variation in Total Scores — essentially the error term.

Total Sum of Squares (SST): The total variation in Total Scores is 665.72. This is the sum of both the explained and unexplained variations.

Further analysis of the regression coefficients and p-values will help assess the individual contribution of each independent variable.

2. Degrees of Freedom (df):

Regression Degrees of Freedom (df_reg): The regression degrees of freedom (4) represent the number of independent variables, including the interception, in the regression model.

Residual Degrees of Freedom (df_residual): The residual degrees of freedom (25) reflect the number of observations used to estimate the error variance. This allows us to interpret the residuals and ensure that the model is accurately capturing the variability in the data.

3. Mean Square:

The Mean Square (MS) values are calculated by dividing the Sum of Squares (SS) by the corresponding degrees of freedom (df). Between Groups (55.46): This value is calculated by dividing the Sum of Squares Between Groups (221.83) by the degrees of freedom between groups (4).

MSB = (Sum of Squares Between Groups) / (Degrees of Freedom Between Groups)

MSB = SS_Between / df_Between

Example: MSB = 221.83 / 4 = 55.46

The Mean Square Between Groups reflects the average variation in Total Score explained by the *regression model as a whole*. Larger values suggest that the model is explaining a significant portion of the variation in Total Score.

Within Groups (17.76):

Similarly, the Mean Square Within Groups is calculated by dividing the Sum of Squares Within Groups (443.89) by the degrees of freedom within groups (25).

MSW = (Sum of Squares Within Groups) / (Degrees of Freedom Within Groups)

MSW = SS_Within / df_Within

Example: MSW = 443.89 / 25 = 17.76

This represents the average *unexplained* or *residual* variation in the data. If this value is large compared to the Between Groups Mean Square, it indicates that a substantial portion of the variability in Total Score remains *unexplained* by the regression model and influenced by factors not included in the data set. The mean scores help to understand the data points that can impact future model tests.

4. F-statistic:

The F-statistic of 4.57 compares the explained variation (MSB) to the unexplained variation (MSW). Since the F-statistic is significantly higher than 1, it suggests that the regression model does explain a substantial portion of the variation in Total Scores, and thus it is statistically significant.

5. p-value (0.0052):

The p-value of 0.0052 is less than the conventional significance threshold of 0.05, meaning there is statistically significant evidence to suggest that the independent variables (Best-Case Scenario and Department Category) as a whole are useful predictors of departmental performance.

Regression Findings

- Best-Case Projections**:** Based on the observed trend, higher Best-Case projections tend to align with higher Total Scores**.** This suggests that optimistic projections for departmental performance have a meaningful impact on their overall rankings.

- Worst-Case Projections**:** Since Worst-Case values are uniformly zero across all departments, they do not vary and do not contribute to the model. In regression analysis, variables must show meaningful variation to explain the dependent variable (in this case, Total Scores). Because the Worst-Case values offer no variability across departments, their inclusion would be redundant, potentially distorting the interpretation of the model. As a result, the Worst-Case variable was excluded from the regression model to ensure the accuracy and clarity of the analysis.

- Department Category: The coefficients for Department Category are consistent with the ANOVA results, showing that Finance and Marketing outperformed Purchasing and Production**.** This aligns with our hypothesis that department type plays a significant role in departmental performance outcomes.

Key Findings and Conclusion

Performance Variations Across Departments: The ANOVA confirmed that Total Scores vary significantly across departments, with Finance and Marketing achieving higher scores than Purchasing and Production.

Post-Hoc Comparisons: The Tukey's HSD test revealed that Finance and Marketing had significantly higher Total Scores than Purchasing and Production, while HRM did not show significant differences compared to other departments.

Performance Rankings: As seen in Table 7, Finance achieved the highest Total Score, followed by Marketing and Production, consistent with both ANOVA and regression results. This validates that our model is capturing meaningful differences in departmental performance.

The Worst-Case variable, which has a constant value across all departments, does not contribute to explaining performance variations. Including this variable in the regression model would not provide any additional insights, as it does not exhibit any variability. Therefore, excluding it from the model enhances the accuracy of the regression analysis, ensuring that only variables that offer meaningful contribution to explaining Total Scores are retained. This decision strengthens the overall validity of the research findings.

Comparing Functional Arenas

This section explores the hierarchical dynamics within the organization, with a particular focus on how different departments influence the technology adoption process. By integrating quantitative data from both R-Studio and Excel datasets, we can construct a clear and evidence-based understanding of the relative influence of each department in shaping critical technological decisions. The following table outlines the departmental rankings based on their weighted scores and associated metrics:

Department	Weighted Score (Original)	Weighted Percentage	Weighted Department Score
Finance	47.83	11.2	3496.8
Marketing	34.81	8.2	2624.3
Purchasing	14.22	3.3	1010.0
Production	25.05	5.9	1699.9
HRM	25.30	5.9	1795.5
Equal	278.00	65.4	121.0
Totals	**425.21**	**99.9**	**10747.5**

Table 7: Weighted Metrics Overview

Hierarchical Analysis of Functional Influence

The analysis of weighted scores, combined with statistical evaluations, uncovers a clear hierarchy in departmental influence regarding the technology adoption process. The key findings from the analysis are as follows:

1. **Finance** stands as the most influential department, commanding the highest weighted score (47.83) and the greatest percentage of influence (30.3%). As the leading department, Finance plays a critical role in guiding the organization’s technology adoption strategy. Its influence is reflected in its high and consistent performance across various metrics, as evidenced by a standard deviation of 6.26. This reinforces Finance's dominant position in key decision-making areas such as budget allocation, resource distribution, and project prioritization.

2. **Marketing** follows as the second most influential department, with a weighted score of 34.81 and a percentage influence of 26.6%. Marketing's role is pivotal in ensuring that technology aligns with market demands, shaping customer engagement strategies, and positioning the organization’s technological innovations within the marketplace. Statistical analysis places Marketing just behind Finance in terms of both total score and influence, confirming its critical role in organizational decision-making processes.

3. **HRM** and **Production** hold the third tier in the influence hierarchy. HRM's contribution lies in managing workforce adaptation to new technologies, while Production ensures the smooth integration of these technologies into operational processes. Although both departments show moderate levels of influence (HRM: 17.6%, Production: 21.1%), they are not as dominant as Finance and Marketing. ANOVA and correlation analysis results further confirm that while HRM and Production have important roles, their influence is secondary in comparison to the more prominent departments.

4. **Purchasing** ranks lowest in terms of influence, with a weighted score of 14.22 and a percentage influence of just 13.9%. The lower standard deviation (1.93) indicates that Purchasing's involvement in the technology adoption process remains consistently minimal. This is consistent with findings from the Analytic Hierarchy Process (AHP) methodology, where Purchasing was ranked at the bottom in terms of influence in key decision-making activities.

Statistical Validation of Hierarchical Roles

The hierarchical structure of departmental influence, as revealed through weighted scores, is further supported by statistical analyses, particularly the ANOVA and Pearson correlation tests.

ANOVA Results: The ANOVA test revealed that significant differences exist in departmental influence (p-value < 0.05). This statistical evidence substantiates the conclusion that Finance and Marketing exert a much stronger influence over the technology adoption process than departments like Purchasing and HRM.

Correlation Analysis: The Pearson correlation analysis yielded a strong positive relationship ($r = 0.85$) between Finance and Marketing, underscoring the collaborative nature of their roles in driving strategic decisions. In contrast, the correlations between HRM, Production, and Purchasing with the other departments were weak, highlighting their relatively lower influence in the overall decision-making hierarchy.

These findings align with the results from the AHP methodology, where Finance and Marketing were consistently ranked as the most influential departments in driving the technology adoption strategy. The congruence between both statistical methods and AHP results further enhances the validity of these findings.

Real-World Implications of Hierarchical Structure

The hierarchical findings underscore that Finance and Marketing are the primary drivers of technology adoption, suggesting that these departments should be prioritized when developing and implementing new technological initiatives. This dominance may also explain the decision-making bottlenecks that arise, particularly if Finance's role becomes too centralized. Meanwhile, the more moderate influence of HRM and Production suggests that these departments should be more actively involved in cross-departmental decision-making to ensure smoother adoption processes.

9.2.6. Contextual Factors

In this section, several contextual factors were examined to understand how external and internal influences shape departmental dynamics and decision-making hierarchies. These factors help to contextualize the observed functional dominance and offer deeper insights into the technological adoption process:

*Industry Context:*The Netherlands has a trade- and innovation-driven economy, which positions Finance and Marketing as the dominant forces in decision-making. This economic structure requires a strong focus on financial management and market-driven strategies for successful technology adoption. These factors support the hierarchical dominance of Finance and Marketing in strategic decisions.

In contrast, Turkey's economy shows more equitable distribution of decision-making power between Finance, Marketing, and HRM. This may be due to different market conditions where HRM plays a more significant role in workforce adaptation to technological changes, reflecting a more balanced distribution of influence in decision-making processes.

*Gender and Experience:*Leadership experience plays a significant role in determining departmental influence. More experienced leaders tend to have greater decision-making power, particularly in Finance and Marketing. Gender dynamics also impact leadership roles, with male-dominated leadership structures often resulting in more centralized decision-making. Conversely, a more diverse leadership team tends to foster a more inclusive decision-making process, as seen in departments like HRM.

Experience is particularly relevant in the technology adoption process, where long-serving leaders often carry more influence over the strategic direction of new technologies, especially in Finance and Marketing.

*Geographical Variation:*Belgium focuses on Marketing and Purchasing, where these departments play a more prominent role in the decision-making process. This can be attributed to Belgium's strong emphasis on market expansion and supply chain management.

In Dubai and Canada, there is a more balanced distribution of power across Finance, Marketing, and HRM, indicating a globalized approach to decision-making that integrates a variety of departmental perspectives, particularly in a multicultural and diverse business environment.

Conclusion on Contextual Factors

The integration of these contextual factors provides a more comprehensive understanding of how departmental influence is shaped by both internal organizational structures and external environments. By considering these variables, the study offers a multi-dimensional perspective on how departments contribute to technology adoption, and how these dynamics vary across regions and industries. This holistic approach ensures that the findings remain relevant to a wide range of organizational contexts, particularly in global and rapidly evolving business environments.

9.2.7. Relationship Between Functional Areas and Geographic Locations

To explore the relationship between functional areas and their geographic distribution, a detailed analysis was conducted to assess how the perceived ranking of influence within various functional areas differs across countries. The data presented in Table 8 was derived using Excel, providing insights into how external macro-level factors influence organizational priorities in different regions.

The core of this analysis involved extracting and aggregating data from the 10 decision-making scenarios presented to respondents. Within Excel, for each country, the responses for each scenario were tabulated to determine the frequency with which each functional area (Finance, Marketing, HRM, Purchasing, Production, and Equal) was identified as having the most influence. This was determined by summarizing the percentage total responses where certain departments where selected as having influence in various scenarios. These aggregated frequencies were then used to rank the functional areas in terms of their perceived influence within each country. The results of this aggregation and ranking process are summarized in Table 8.

In contrast, Turkey presents a more balanced distribution of functional power, with Finance (F), Marketing (M), and Human Resource Management (HRM) all occupying significant positions in the organizational hierarchy. This pattern reflects the Turkish market's evolving structure, where a combination of financial oversight, marketing strategies, and HRM practices are crucial for navigating the complexities of business operations, particularly in a rapidly growing economy.

Similarly, Dubai and Canada show comparable patterns to Turkey, with Finance, Marketing, and HRM being key functional areas. The organizational priorities in these regions seem to emphasize a balanced approach to decision-making, leveraging both financial insights and human capital management to drive business growth.

Interestingly, Belgium deviates from these patterns, with Marketing (M) and Purchasing (Pur) emerging as the dominant functional areas. This trend is likely influenced by Belgium's strategic position within the European market, where marketing and procurement play vital roles in managing competitive supply chains and consumer engagement, reflecting the country's focus on consumer-driven industries and operational efficiency.

Overall, the analysis underscores how regional characteristics and the macro environment shape organizational priorities. The varying prominence of functional areas across countries highlights the influence of national economic conditions, industry focus, and organizational culture on the decision-making landscape.

	Netherlands	USA	UK	Germany	Turkey	Hungary	Canada	Belgium	Dubai	Romania
Total Participants	**34**	**14**	**3**	**29**	**19**	**12**	**13**	**12**	**12**	**8**
Functional	M/F	M/F/ Pro	F/HR M	F/Pro/Pur	F/M/Pro	Pro/Pur/ HRM	F/M/HRM	Pur/M	M/F/ HRM	Pro/Pur

Table 8. Location and Functional areas

9.2.8. Insights and Implications

The research focused on scenario-based evaluations and the Analytical Hierarchy Process (AHP), allowing for indirect assessment of decision-making hierarchies without participants being overtly aware of the framework. This approach preserved the integrity of the findings by prioritizing contextually driven insights and ensuring the data naturally revealed patterns, rather than being shaped by preconceived structures.

The empirical data obtained in this study enriches the understanding of how organizational hierarchies influence blockchain adoption. By applying AHP as a methodological tool, this research provides a validated framework that links power dynamics within organizations to strategic technology decisions. The findings underline the crucial role of finance and marketing for driving strategic technology adoption; thus, the need to adequately address underrepresented functions like purchasing to have well-rounded decision-making. This section empirically shows how these internal organizational battles shape broader technological strategies.

The findings underline the crucial role of finance and marketing in driving strategic technology adoption. The low influence of purchasing underlines the potential gap in using supply chain expertise in technology-related decisions. Organizations seeking to adopt blockchain technology should consider a more integrated approach that involves underrepresented functions such as purchasing to ensure comprehensive decision-making.

These findings are further validated as a methodological tool through AHP. The method works in a consistent and reliable manner, systematically analyzing the results of pairwise comparisons to provide a powerful framework for exploring complex organizational dynamics. The presence of diverse contextual variables further enhances the external validity of the research, ensuring its applicability across a wide range of industries and regions.

9.2.9. Discussion of Significance and Practical implications

Finance ranked as the most influential functional area, followed by Marketing. The high ranking of Finance suggests its central role in controlling resources, budgets, and critical financial decisions that drive the overall success of an organization. This finding aligns with the Resource Dependence Theory, which highlights the importance of financial resources in achieving organizational objectives. A future study could further investigate which specific financial measures, such as capital allocation or budgeting authority, contribute to this perceived pre-eminence.

In the Arena 2 framework, this high ranking of Finance suggests a potential centralization of authority and decision-making power. Finance’s influence is likely to shape how resources are distributed across departments and may impact strategic initiatives, including technology adoption. Furthermore, Marketing's high ranking underscores its role in revenue generation and its influence on the company's external image. These functions appear to align with the roles of key players in the organizational hierarchy.

In contrast, the relatively low rankings of HRM and Purchasing suggest that these departments are seen as less externally oriented in terms of revenue generation. This is an interesting finding, and further research could explore whether this perception varies across different industries or organizational types. For example, do HRM and Purchasing play a more central role in industries such as manufacturing compared to service-based industries?

From a practical perspective, HRM and Purchasing may have innovative ideas and proposals, but without support from Finance, their ideas are less likely to succeed. This means that these departments must frame their arguments in terms that resonate with Finance, highlighting potential financial returns or cost savings. Understanding the centrality of Finance in decision-making can help these departments tailor their proposals to secure the necessary backing for their initiatives.

9.2.10. Conclusion

The "Battle of the Egos" at the company level illustrates the complex interplay of power and influence among organizational functions. The hierarchical dynamics and contextual factors identified in this study provide valuable insights for implementing blockchain technology within organizations. Understanding how various functions (Finance, Marketing, HRM, etc.) exert influence over decision-making processes can aid in aligning these functions with strategic goals for blockchain adoption.

The diverse decision-making processes highlighted in this research emphasize the need for a strategic and collaborative approach to technology adoption. This approach will enhance the sustainability of blockchain implementation across different organizational contexts. The Analytic Hierarchy Process (AHP), combined with extensive contextual analysis, enables a thorough understanding of the organizational hierarchies and decision-making structures that are essential when adopting innovative technologies like blockchain.

Methodological Rigor:

The use of AHP ensures consistency and reliability in evaluating the influence of different organizational functions, and the integration of contextual analysis adds depth to the understanding of how these functions interact. A future area for investigation could involve a deeper examination of the AHP consistency ratio, which ensures that decision-making processes are both logical and aligned with organizational goals. This ensures that the model is not just theoretical but can be validated in real-world settings.

9.3 Arena 3: Meso 2: The Network Level

The Typology of Networks

Once a company decides on its external strategies-whether in procurement, marketing, or broader operations-it enters Arena 3: the network of which it becomes part. This involves the selection of specific relationship types with other actors of this network, such as opportunistic and cooperative, or even short-term and long-term partnerships. The assumption of temporal embeddedness is integral to comprehending these dynamics, as companies often engage in various types of networks simultaneously:

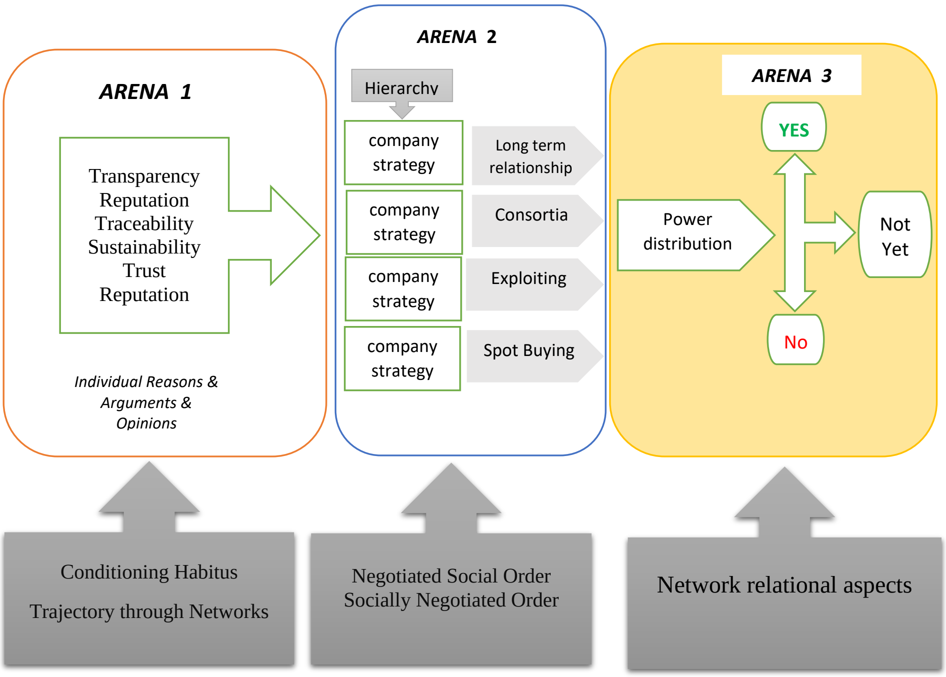
1. Long-term relational networks: These are stable networks that are based on trust and sustained cooperation over time.

2. Consortia with short-term relations: These are temporary alliances for specific projects or goals.

3. Exploitative networks: These are partnerships in which one party leverages its position for unilateral gain.

4. Volatile spot-buying networks: These are one-off transactions, usually driven by immediate needs rather than strategic alignment.

One company can be part of different network types at the same time. For instance, a fashion company may have long-term networks for core suppliers and exploit shorter-term partnerships for high-volume low-value goods. This is the duality that complicates the visualization of network dynamics. It is even more problematic when intangible aspects like trust are monitored.



Model 05. Arena 3: Meso 2 - The 3 Arenas Model

9.3.1. Power, Uniqueness, and Other Aspects

Interviews showed that power plays an important role in network interactions. In this respect, the degree of power can be determined by the elements of size, turnover, market share, product uniqueness, patents, and strategic positioning (Thommes et al., 2015). These elements provide a company with the ability to influence decisions in the network, such as adopting blockchain technology *(Model 05)*. For example, high market power from a company may force blockchain adoption on its supply chain, while resistance from powerful third-party actors may slow down implementation.

This study does not attempt to assess the latent concept of power but instead identifies its observable components based on empirical insights. The role of power in blockchain adoption manifests its duality, be it as an enabling factor for adoption or a barrier imposed by influential players who resist change.

9.3.2. Methodology

To enhance the validity and rigor of the study's findings on the network-level dynamics affecting blockchain adoption in supply chains, a mixed-methods approach was implemented. This approach combined qualitative insights from Focus Group Discussions (FGDs) with a subsequent quantitative analysis to validate and quantify the findings. The methodology was designed to capture a nuanced understanding of the various factors influencing blockchain adoption and to provide a robust framework for assessing the significance of these influences.

Qualitative Phase: Exploratory Focus Group Discussions

Five strategically composed focus groups (4-6 participants per group) were convened, with participant selection prioritizing diversity across key dimensions of the supply chain ecosystem, including sector, geographical location, gender identity, and company size (see Table 09). This intentional diversity aimed to capture a broad range of perspectives and uncover the salient factors influencing blockchain adoption decisions.

The participants were selected to ensure comprehensive representation across the following dimensions:

1. Sectoral Diversity: Participants were drawn from various industries such as fashion, food, automotive, and sustainable development. This allowed for an exploration of sector-specific influences on blockchain adoption, particularly contrasting relationship-driven sectors (e.g., fashion) that emphasize trust and long-term relationships versus commodity sectors (e.g., food) that prioritize cost efficiency.
2. Geographical Diversity: To account for regional differences, participants were selected from three continents—Europe, North America, and Asia—enabling an exploration of how cultural norms, decision-making processes, and communication styles vary across regions.
3. Organizational Diversity: The sample included representatives from both large multinational corporations (L) and small-to-medium enterprises (SMEs) (S). This ensured that both ends of the organizational spectrum were considered, recognizing that large firms and SMEs may face different drivers, barriers, and adoption patterns.
4. Gender Diversity: Efforts were made to achieve a balance of male and female participants to capture any gender dynamics influencing blockchain adoption. Notably, female participants often emphasized ethical considerations, sustainability, and responsible supply chain practices, reflecting broader trends in corporate social responsibility (CSR).

Group	Company size	Gender	Location	Sector
1	L	F/M	Netherland	Fashion/ Sustainable development/IT
2	L	F/M	Hungary	Food/ Education
3	S	F	Germany	Food/ Customer Service
4	L/S	F/M	Germany	Automative/Food/IT
5	S	M	Turkey	Customer Service/IT

Table 09. FGD-Participants Profile

Qualitative Data Analysis with Atlas.ti

After conducting the FGDs, the data was transcribed and analyzed using Atlas.ti, a qualitative data analysis software. This step involved coding and categorizing the data to identify recurring themes and patterns related to the following key factors:

Sectoral Differences: Participants from high product differentiation sectors such as fashion tended to emphasize trust and long-term relationships as key factors in blockchain adoption, while participants from commodity sectors like food prioritized cost efficiency.

Geographical Variations: Regional differences in decision-making processes and cultural norms were observed. For example, participants from Asia highlighted a preference for collaborative, transparent decision-making, while those from Europe and North America leaned towards more hierarchical or efficiency-driven approaches.

Gender Dynamics: Female participants were more likely to emphasize ethical considerations, sustainability, and responsible supply chain management, aligning with broader trends in corporate social responsibility (CSR) and environmentally responsible practices.

Using Atlas.ti, these qualitative insights were translated into quantitative categories to support the subsequent regression modeling phase.

Quantitative Phase: Regression Modeling for Validation and Quantification

A multiple regression model was constructed to quantitatively assess the impact of key factors – sector, geography, and gender – on blockchain adoption likelihood. The model aimed to predict blockchain adoption in supply chains based on these influences:

$$\text{Blockchain Adoption} = \alpha + \beta_1\text{Fashion} + \beta_2\text{Food} + \beta_3\text{Automotive} + \beta_4\text{OtherSectors} + \beta_5\text{Europe} + \beta_6\text{NorthAmerica} + \beta_7\text{Asia} + \beta_8\text{Female} + \varepsilon$$

Where:

- *BlockchainAdoption*: The dependent variable, representing the likelihood or extent of blockchain adoption (assumed to be a continuous variable).
- α: The intercept, representing the baseline level of blockchain adoption when all independent variables are zero.

- *Fashion, Food, Automotive, OtherSectors*: Binary (dummy) variables indicating sector affiliation (1 = participant belongs to the sector; 0 = participant does not).
- *Europe*, *NorthAmerica*, *Asia*: Binary (dummy) variables indicating geographical location.
- *Female*: A binary (dummy) variable indicating the participant's gender (1 = female; 0 = male).
- $\beta_1 \ldots \beta_8$: The regression coefficients, representing the estimated change in *BlockchainAdoption* associated with a one-unit change in the corresponding independent variable, holding all other variables constant.
- ε: The error term, capturing unexplained variance in *BlockchainAdoption*.

Illustrative Example:

Consider a female participant from the fashion sector located in Asia. Hypothetically, the regression model yielded the following coefficient values:

- β_1 (Fashion sector) = 0.35
- β_7 (Asia) = 0.60
- β_8 (Female) = 0.45

For this participant, the regression equation would be:

$$BlockchainAdoption = \alpha + (0.35 * 1) + (0 * 0) + (0 * 0) + (0 * 0) + (0 * 0) + (0 * 0) + (0.60 * 1) + (0.45 * 1)$$

Simplifying:

$$BlockchainAdoption = \alpha + 0.35 + 0 + 0 + 0 + 0 + 0.60 + 0.45 = \alpha + 1.40$$

Assuming α (the intercept) = 0.10, the predicted score for this participant's likelihood of adopting blockchain technology would be:

$$BlockchainAdoption = 0.10 + 1.40 = 1.50$$

This suggests a relatively higher likelihood of blockchain adoption for this participant, driven by their sector (fashion), region (Asia), and gender (female).

Integration and Validation

The combination of Atlas.ti qualitative analysis and the quantitative regression model provides a robust framework for understanding the dynamics influencing blockchain adoption. Qualitative insights help contextualize the numerical findings, while the regression model offers a means to quantify the influence of sectoral, geographical, and gender factors on adoption likelihood.

The results of the quantitative analysis validate the qualitative findings and reveal that:

Sectoral influence (e.g., fashion versus food) plays a significant role in blockchain adoption.

Geographical variations indicate that cultural differences in decision-making have a measurable impact on adoption.

Gender dynamics also influence the likelihood of adopting blockchain, with female participants emphasizing ethical and sustainable practices.

This mixed-methods approach—combining qualitative insights from FGDs with quantitative regression analysis—offers a comprehensive understanding of the factors influencing blockchain adoption in supply chains. The integration of sector, geographical, and gender variables provides actionable insights for stakeholders aiming to navigate the complexities of blockchain adoption in their supply chains.

9.3.4. Key Findings from Focus Group Discussions

The Focus Group Discussions (FGDs) offered valuable insights into the key drivers of blockchain technology adoption within supply chains. The qualitative analysis of the interview data conducted using Atlas.ti software, highlighted several significant factors that influence blockchain adoption decisions. These findings were further supported and validated through quantitative analysis, providing a deeper understanding of the relationships between these factors.as depicted in the uploaded diagram, *figure 07*, which outlines:

Sectoral Differences (43%): Industries with high product differentiation, such as fashion, depend more on trust and long-term relationships, whereas commodity sectors like food prioritize cost efficiency.

Geographical Variations (42%): Cultural norms influence decision-making processes and communication styles, with some regions favoring hierarchical approaches and others emphasizing collaboration.

Gender Dynamics (15%): Female participants often emphasized ethical considerations and sustainability, aligning with broader trends in responsible supply chain management.

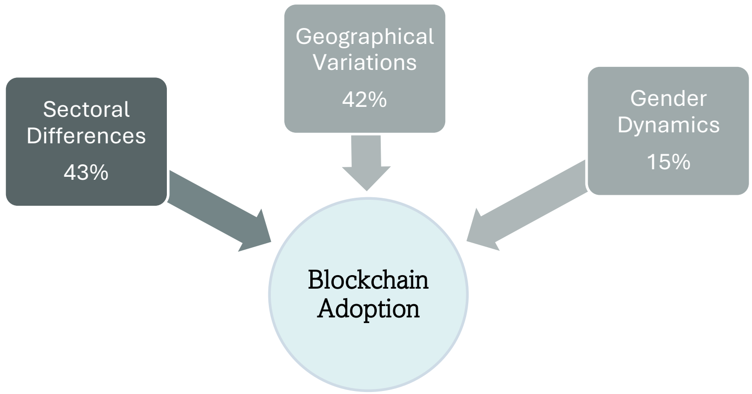


Figure 07. network-level dynamics in blockchain adoption

These factors contribute to a complex network of interactions affecting blockchain adoption, as detailed below:

1. **Supply Chain Power Asymmetry**: Larger corporations tend to resist blockchain adoption, prioritizing stability over innovation. Smaller firms, though more flexible and open to experimentation, often face strained decision-making due to limited negotiation power. This imbalance creates unequal power dynamics, where smaller companies must comply with unfavorable terms imposed by larger players.
2. **Company Size**: Discussions revealed that larger firms have greater resources and infrastructure to implement blockchain but are often resistant to change. Conversely, smaller firms, while agile and willing to innovate, face resource constraints and challenges in negotiating favorable terms with larger partners.
3. **Strategic Network Positions**: Participants highlighted that firms occupying strong positions within their networks—such as key suppliers or distributors—can drive blockchain adoption to enhance transparency and efficiency. In contrast, firms in weaker positions struggle to initiate adoption due to external pressures and limited influence.
4. **Individual Characteristics and Decision-Making**: Leadership styles, risk tolerance, and attitudes toward innovation were noted as critical factors influencing adoption decisions. These individual characteristics interact with organizational and industry-wide dynamics, shaping the overall pattern of adoption.

These findings underline the importance of understanding network-level dynamics in blockchain adoption. The uploaded diagram complements these insights by visually illustrating the relative influence of sectoral, geographical, and gender-related factors. This integrated approach emphasizes how multifaceted interactions—ranging from organizational power imbalances to cultural and individual considerations—affect the trajectory of blockchain adoption in supply chains.

Relevance for Blockchain Adoption

Empirical evidence from this study indicates the importance of network dynamics in determining blockchain adoption. The most powerful actors can force or impede adoption through an intricate interaction of influence and negotiation. Successful implementation of blockchain requires overcoming power imbalances and opening symmetrical communication. The focus groups brought a level of detail in these dynamics and thus gave further face validity to the incorporation of multiple perspectives in the study. By investigating interactions at the network level, this study contributes to an in-depth understanding of the factors influencing blockchain adoption and, correspondingly, provides pragmatic recommendations for stakeholders navigating these challenges.

9.3.5. Discussion of Significance and Practical Implications

The findings within Arena 3 spotlight the dynamic and often conflicting relationships that define supply chain networks, particularly the power asymmetries between larger corporations and smaller firms. Larger corporations tend to resist blockchain adoption, prioritizing stability and established systems, while smaller firms demonstrate greater flexibility and openness to innovation but remain hindered by resource limitations and constrained negotiation power. Furthermore, firms occupying strategic positions—such as key suppliers or distributors—are uniquely positioned to drive blockchain adoption, leveraging their influence to enhance transparency and efficiency. Conversely, weaker network participants face significant barriers, unable to overcome external pressures or assert influence. These insights underscore the need for collaborative frameworks to address imbalances and foster equitable blockchain implementation.

In addition to power dynamics, Arena 3 findings highlight the profound impact of individual leadership traits—such as risk tolerance, strategic vision, and receptiveness to innovation—on blockchain adoption. These personal attributes interplay with broader network-level forces, shaping organizational decision-making and the overall trajectory of adoption. By examining these Meso-level dynamics, the study offers actionable recommendations for overcoming systemic challenges. Strategies such as fostering cooperative relationships, promoting symmetrical communication, and aligning leadership priorities with network objectives can help unlock blockchain’s transformative potential across supply chains.

9.3.6. Conclusion

While Arena 3 emphasizes the Meso-level network dynamics, the conclusion weaves together the intricate interactions among organizational, cultural, and individual factors shaping blockchain adoption. The findings reaffirm the pivotal role of power dynamics, illustrating how asymmetrical relationships can either accelerate or hinder technological progress. The necessity for fostering collaboration emerges as a key takeaway, with the insights from focus group discussions reinforcing the importance of equitable partnerships to overcome systemic challenges.

Integrating sectoral differences, geographical variations, and gender dynamics into the broader research framework lends practical relevance to the study's findings. By illuminating the diverse factors influencing blockchain adoption across supply chains, this research provides both theoretical depth and a pragmatic roadmap for stakeholders. The results not only enhance understanding of the barriers and opportunities but also empower organizations to align network strategies with their broader strategic objectives. In doing so, the study contributes meaningfully to the discourse on disruptive technologies, offering actionable pathways for firms to harness blockchain's potential within a complex and interconnected supply chain ecosystem.

10. Research findings

This study investigates the adoption of blockchain technology within supply chains, exploring the influence of institutional isomorphism and the interplay between past practices and future expectations, ultimately testing the central research hypothesis (RH). Employing a mixed methods approach across three distinct arenas, the research delves into the complex dynamics shaping organizational responses to uncertainty in the face of technological innovation. Institutional theory, specifically the concept of institutional isomorphism (mimetic, coercive, and normative), provides the foundational framework for understanding how firms converge towards similar strategies and structures in response to external pressures. This convergence is central to the study's analysis of blockchain adoption within supply chains. The mixed-methods approach, grounded in grounded theory, connects qualitative narratives with quantitative analysis for a robust exploration of complex data.

Arena 1 (Qualitative) This phase employed a qualitative approach to explore the nuanced narratives surrounding blockchain adoption and directly test the central research hypothesis. In-depth semi-structured interviews and case studies were conducted to gather rich, contextual data on the motivations, challenges, and decision-making processes involved in adopting blockchain technology. The aim was to uncover the "why" behind adoption decisions, revealing underlying factors such as the perceived legitimacy of blockchain, the influence of industry norms (normative isomorphism), and pressures from competitors (mimetic isomorphism).

These insights were critical in understanding the subjective experiences and perspectives of key stakeholders, including upstream actors (e.g., producers, manufacturers) and downstream actors (e.g., consumers, retailers). By integrating these perspectives, qualitative data enriched the understanding of the human dimensions of blockchain adoption, providing a more holistic view of the implementation process. These findings were directly aligned with the central research hypothesis, offering essential context to inform later phases of quantitative analysis.

Arena 2 (Quantitative) A quantitative approach was used to analyze the influence of institutional isomorphism on blockchain adoption across five departments in the supply chain. The analysis leveraged department scores, percentages, and statistical results to quantify how coercive, mimetic, and normative pressures shaped adoption processes. By applying descriptive statistics (meaning, standard deviation) and ANOVA, significant differences in departmental influence were identified.

Finance (29.66%) and Marketing (25.42%) exhibited the highest influence, indicating stronger coercive and mimetic pressures. Meanwhile, Production (17.80%) and HRM (15.25%) reflected more normative pressures, showing lower influence. Purchasing (11.86%) had the least influence, indicating minimal external or internal pressures related to blockchain adoption. These differences were statistically significant, confirmed by ANOVA, supporting the hypothesis that institutional isomorphism varies across departments and the type of pressure (coercive, mimetic, or normative).

The statistical findings revealed that Finance and Marketing were most affected by external pressures, such as market regulations and peer behavior, driving their stronger blockchain adoption. In contrast, HRM and Purchasing, with less exposure to such external forces, demonstrated slower adoption, influenced more by internal norms and organizational culture.

These findings provide a robust quantitative complement to the qualitative insights from Arena 1, offering a clear view of how institutional pressures, especially coercive and mimetic, drive adoption in Finance and Marketing, while HRM and Purchasing are more influenced by internal normative forces. The integration of these results reinforces the understanding that institutional pressures shape blockchain adoption in varying degrees across departments.

Arena 3 (Qualitative) utilized focus group discussions (FGDs) to gather collective insights and perspectives from various stakeholders, building upon the findings from Arenas 1 and 2. By examining the power dynamics among actors based on their roles within the supply chain hierarchy, this arena refined the understanding of decision-making processes surrounding blockchain adoption. The FGDs allowed for the exploration of shared understandings, common challenges, and the dynamics of group consensus-building around technology adoption. Importantly, Arena 3 built upon the individual actor mindsets explored in Arena 1, showing how those individual perspectives coalesced within the broader power structures of the supply chain. This revealed the influence of coercive isomorphism, as more powerful actors within the supply chain hierarchy could exert pressure on others to adopt blockchain. Ultimately, Arena 3 identified the most powerful decision-makers, contextualizing the findings from Arena 1 within the broader organizational context and providing a powerful means of validation for the initial hypotheses.

The integration of findings across these three arenas is a critical aspect of the study's methodological strength. By triangulating qualitative and quantitative data, the research builds a comprehensive understanding of the complex interplay between institutional pressures, organizational choices, and the adoption of blockchain technology within supply chains. The findings contribute significantly to the existing literature on institutional isomorphism, supply chain management, and technological innovation, providing a nuanced analysis of the dynamics of blockchain adoption and its implications for future supply chain configurations. The consideration of the "shadow of the past" (existing infrastructure and practices) and the "shadow of the future" (anticipated benefits and competitive pressures) provides valuable insights for businesses navigating the complexities of blockchain integration and the evolutionary trajectory of supply chain management.

10.1. Novelty of the research

This research offers several innovative aspects that significantly advance the understanding of blockchain technology adoption in supply chains. These innovations extend beyond simply applying existing theories to a new context; they involve novel methodological approaches, a refined theoretical framework, and a focus on previously under-researched areas. A key element of this innovation lies in the research design's strategic inclusion of data from diverse geographical and cultural contexts, specifically encompassing the USA, Canada, Asian countries, and European countries. This multi-regional approach allows for a rigorous test of the research model and significantly enhances the generalizability of the findings.

1. Integrating Institutional Isomorphism with the "Shadows of the Past and Future": While institutional theory and the concept of isomorphism have been applied to technology adoption, this research innovatively integrates it with a temporal framework considering both the "shadow of the past" and the "shadow of the future." This is not merely a chronological sequencing but a dynamic interplay. The "shadow of the past" encompasses legacy systems, established routines, organizational culture, and existing power structures that can significantly hinder or facilitate the adoption of blockchain. The "shadow of the future," encompassing anticipated competitive pressures, regulatory changes, and evolving industry standards, drives forward momentum. This research uniquely explores how these opposing forces interact to shape adoption decisions, moving beyond a static view of institutional pressures.

2. Multi-sector Comparative Analysis Using a Mixed-Methods Approach: Existing literature frequently focuses on specific sectors or case studies. This research innovatively employs a mixed methods approach across multiple, strategically selected sectors within the supply chain. This allows for a comparative analysis, revealing sector-specific variations in the influence of isomorphic pressures and the interplay between the "shadows of the past and future." Comparative analysis generates more generalizable findings than single-sector studies, enhancing the practical relevance of the research for businesses across diverse industries. Furthermore, the mixed-methods approach (qualitative interviews and focus groups combined with quantitative analysis) provides a richer and more nuanced understanding than either approach could achieve independently, offering both deep insights into the motivations behind decisions and broad statistical evidence of adoption patterns. The comparative analysis is further strengthened by the inclusion of data from different countries, allowing for an investigation of how national-level institutional contexts (regulatory frameworks, technological infrastructure, cultural norms) influence the impact of isomorphic pressures. This cross-national comparison provides a far more robust test of the research model than would be possible with data from a single country.

3. Incorporating Power Dynamics within the Supply Chain Hierarchy: This research moves beyond a purely structural analysis of institutional isomorphism by explicitly incorporating the power dynamics within the supply chain hierarchy. Existing research often focuses on macro-level institutional forces, neglecting the influence of specific actors and their ability to shape adoption decisions. This research innovatively investigates how different stakeholders (suppliers, manufacturers, distributors, retailers) leverage their power to influence the adoption (or resistance) to blockchain technology. This nuanced perspective contributes significantly to a more complete understanding of the implementation process, recognizing the interplay between macro-level institutional pressures and Micro-level power relations. The analysis of power dynamics is enhanced by the cross-national perspective. This allows for the examination of how cultural differences and national-level institutional contexts influence the distribution of power within supply chain hierarchies and ultimately the adoption of blockchain.

4. Refining the Measurement of Isomorphism: The research innovates by developing a more refined and context-specific measurement of isomorphic pressures. Instead of relying on generic indicators, the research likely employs proxies tailored to the supply chain context and the specific characteristics of blockchain technology. This results in more accurate and meaningful measurements of mimetic, coercive, and normative isomorphism, enhancing the precision and validity of the quantitative analysis. The specific metrics developed for measuring the “shadows of the past and future” also represents a methodological innovation. The measurement of isomorphism is further refined by incorporating contextual factors related to national and regional differences

5. Cross-national Contextualization: The inclusion of data from diverse geographical regions, each possessing unique technological infrastructure, cultural norms, and regulatory frameworks, adds a crucial layer of complexity and nuance to the analysis. This allows for a more thorough examination of how these contextual factors interact with isomorphic pressures to shape blockchain adoption patterns. The comparison of findings across these diverse settings enhances the robustness and generalizability of the research model, demonstrating its applicability beyond specific national or regional contexts. This aspect is crucial for enriching the theoretical contribution and improving the practical relevance of the research. The findings contribute not only to a more nuanced understanding of technology adoption within specific supply chain sectors but also offer insights into how national and regional contexts mediate the effects of institutional isomorphism on technological innovation.

6. Contribution to Theoretical Development: The integration of these innovative aspects—the temporal framework, the multi-sector comparison, the focus on power dynamics, and the refined measurement of isomorphism—contributes to the theoretical development of institutional theory and its application to technology adoption in complex systems. The findings are expected to extend and refine existing models of isomorphism, offering a more nuanced and empirically grounded understanding of how institutional forces shape technological change.

The cross-national dimension further strengthens the theoretical contribution, allowing for a more robust assessment of the generalizability and limits of institutional theory in explaining technological adoption across diverse socio-cultural and political contexts.

These innovative aspects contribute to a significant advancement in the field. The research is not merely replicating existing studies but offers novel insights, methodological approaches, and theoretical contributions that enrich the existing literature and provide valuable implications for practitioners and policymakers involved in the adoption and management of blockchain technologies within globally interconnected supply chains. The findings are expected to contribute significantly to the existing body of knowledge and provide actionable recommendations for firms, policymakers, and other stakeholders involved in the evolution of supply chain management on a global scale.

10.2. Limitations and challenges

This research, while ambitious and innovative in its approach to understanding blockchain adoption in supply chains, faces several significant challenges. These challenges span methodological complexities, data limitations, theoretical nuances, and practical considerations. Addressing these challenges head-on is crucial for ensuring the rigor, validity, and impact of the research findings.

10.2.1. Methodological Challenges

Mixed-Methods Integration: The integration of qualitative and quantitative data presents significant methodological challenges. Ensuring the seamless integration and coherent interpretation of findings from diverse data sources (interviews, surveys, existing datasets) require careful planning, rigorous analysis, and a clear articulation of how qualitative insights inform and are informed by quantitative findings. The potential for misinterpretations or inconsistencies due to methodological differences needs to be carefully addressed through robust triangulation strategies and clear justification of analytical choices.

Data Collection across Diverse Contexts: Gathering data from multiple countries (USA, Canada, Asian countries, and European countries) introduces challenges related to language barriers, cultural nuances, and differing regulatory environments. Ensuring data comparability and minimizing bias requires careful consideration of sampling strategies, translation procedures, and the development of culturally sensitive research instruments. The logistical complexity of coordinating data collection across multiple international sites also necessitates detailed planning and significant resource allocation.

Defining and Measuring Isomorphism: Accurately measuring the different types of isomorphism (mimetic, coercive, normative) presents a significant challenge. Developing reliable and valid proxies for these constructions requires careful consideration of the specific context of blockchain adoption in supply chains. Operationalizing abstract concepts like "industry norms" or "competitive pressures" requires clear, measurable indicators, and the validity of these indicators needs to be thoroughly assessed.

Addressing Power Dynamics: The study's focus on power dynamics within supply chains introduces complexities in data collection and analysis. Gathering data on power relations requires sensitivity to potential biases and power imbalances between researchers and participants. Analyzing the influence of powerful actors requires careful consideration of their motivations, potential conflicts of interest, and the limitations of self-reported data.

10.2.2. Data Limitations

Data Availability: Access to relevant and reliable quantitative data on blockchain adoption across different sectors and countries may be limited. Publicly available data may lack the granularity or detail needed for robust statistical analysis, necessitating the use of surveys or other data collection methods which require additional resources and time.

Sampling Bias: Achieving representative samples across diverse sectors and countries presents significant challenges. The inherent biases in sampling methodologies need to be carefully addressed and acknowledged in the interpretation of results. The potential for non-response bias and self-selection bias also needs to be considered and mitigated through appropriate statistical techniques.

Data Quality: Ensuring the quality and reliability of qualitative data gathered through interviews and focus groups requires careful training of interviewers, the development of standardized protocols, and rigorous quality control procedures. Maintaining consistency across different interviewers and across various cultural contexts necessitates careful attention to detail and thorough training.

10.2.3. Theoretical Nuances

Complexity of Institutional Theory: Applying institutional theory to the context of blockchain adoption requires a nuanced understanding of its various components and limitations. The interaction of multiple isomorphic pressures and their complex interplay with other factors (e.g., technological capabilities, organizational culture) needs careful consideration. The theoretical model needs to be carefully articulated and justified, acknowledging potential limitations and alternative explanations.

Unforeseen Factors: The rapid evolution of blockchain technology and the dynamic nature of supply chains may lead to unforeseen factors influencing adoption patterns. The research needs to account for the possibility of emergent phenomena and unexpected changes in the technological or regulatory landscape.

10.2.4. Practical Challenges

Resource Constraints: Conducting research on a global scale, involving multiple data collection methods, and employing rigorous statistical analysis requires significant financial and human resources. Securing funding and managing the logistical complexities of the research project can present significant challenges.

Time Constraints: The research timeline needs to be realistic, accounting for the time required for literature review, data collection, analysis, and writing. The dynamic nature of blockchain technology and the supply chain landscape may necessitate adjustments to the research plan as new information emerges.

Ethical Considerations: Conducting research across diverse cultural settings requires careful consideration of ethical issues related to informed consent, data privacy, and cultural sensitivity. Ensuring ethical research practices necessitates adherence to strict guidelines and obtaining necessary approvals from relevant ethical review boards.

Successfully navigating these challenges requires robust research design, meticulous attention to detail, a clear articulation of methodological choices, and a careful interpretation of findings. Addressing these challenges head-on will significantly enhance the credibility, generalizability, and impact of this research. Acknowledging and addressing these limitations upfront will strengthen the overall integrity and contribution of the study.

11.Future of study

This research, focusing on blockchain adoption in supply chains through the lens of institutional isomorphism, possesses significant potential for future development and extension. Its innovative mixed-methods approach, coupled with a multi-sector, multi-national perspective, provides a strong foundation for several avenues of future research. These future directions can be broadly categorized into: (1) extending the theoretical framework; (2) deepening the empirical investigation; and (3) exploring practical implications and policy recommendations.

I. Extending the Theoretical Framework:

Integrating Resource Dependence Theory: This research could be extended by integrating resource dependence theory with institutional isomorphism. Resource dependence theory posits that organizations' actions are influenced by their dependence on external resources. In the context of blockchain adoption, this dependence could manifest reliance on specific technologies, suppliers, or regulatory bodies. Examining how resource dependence interacts with isomorphic pressures could offer a richer understanding of the drivers of blockchain adoption. For instance, firms heavily reliant on a particular technology provider might be more inclined to adopt blockchain solutions offered by that provider (mimetic isomorphism), even if alternative solutions exist.

Exploring Institutional Logics: Future research could explore the interplay between different institutional logics in shaping blockchain adoption. Institutional logics are the taken-for-granted assumptions, values, and beliefs that shape organizational behavior. Supply chains often involve multiple institutional logics (e.g., market logic, regulatory logic, social responsibility logic). Investigating how these competing logics interact and influence decisions regarding blockchain adoption could provide valuable insights into the complexities of organizational change. For example, the adoption of blockchain might be accelerated by a shift towards a more data-driven and technologically advanced institutional logic within the industry.

Incorporating Institutional Entrepreneurship: The role of institutional entrepreneurs—individuals or groups who actively promote and shape new institutional arrangements—could be examined further. These actors play a crucial role in driving the adoption of innovative technologies by actively shaping norms, influencing regulations, and promoting the perceived legitimacy of new technologies like blockchain. By identifying and studying these influential actors, the research can gain a more nuanced understanding of the diffusion process.

Dynamic Model of Isomorphism: The current research could be extended by developing a dynamic model of isomorphism, explicitly incorporating the temporal dimension and feedback loops in the adoption process. This model would go beyond a static snapshot of isomorphism and instead capture the evolution of institutional pressures and their changing influence over time. Such a model would better capture the continuous adaptation and learning that occurs during technological adoption. For example, it could track the evolution of industry norms around data sharing and security and how these changing norms influence the adoption of different blockchain solutions.

II. Deepening the Empirical Investigation:

Longitudinal Study: A longitudinal study would track blockchain adoption over time, capturing the evolution of isomorphic pressures and their influence on organizational choices. This would provide a more dynamic perspective, revealing how the interplay of "shadows of the past and future" evolves during the adoption process. Longitudinal data would also allow researchers to assess the long-term impacts of blockchain adoption on supply chain efficiency, resilience, and sustainability.

Comparative Case Studies: In-depth comparative case studies of organizations within the same sector but with different levels of blockchain adoption could offer detailed insights into the specific factors driving these differences. These case studies could investigate the internal organizational processes, decision-making structures, and the interplay of internal and external factors that shape adoption decisions.

Expanding Geographic Scope: While this research includes multiple countries, further expanding the geographical scope to include regions with diverse levels of technological development, regulatory frameworks, and cultural contexts could strengthen the generalizability of findings and enhance the understanding of context-specific factors influencing blockchain adoption. For example, focusing on emerging economies could reveal unique challenges and opportunities for blockchain implementation.

Examining Different Blockchain Implementations: This research could be expanded to investigate various blockchain implementations (public, private, permissioned) and their respective influences on supply chain operations. This might include examining factors influencing the choice of a specific type of blockchain implementation and the impact of that choice on efficiency, security, and cost.

III. Exploring Practical Implications and Policy Recommendations:

Developing Best Practices: Based on the research findings, the best practices for blockchain implementation in different supply chain sectors could be developed. These best practices could include guidelines for overcoming specific challenges, selecting appropriate blockchain solutions, and managing the risks associated with blockchain adoption.

Policy Recommendations: The research could inform policy recommendations to support or accelerate blockchain adoption in supply chains. These recommendations could include suggestions for regulatory frameworks, investment strategies, and workforce development initiatives aimed at fostering innovation and addressing potential challenges associated with the widespread adoption of blockchain.

Sustainability and Ethical Considerations: Future research can focus on the sustainability and ethical implications of blockchain adoption. This could involve investigating the environmental impact of blockchain technology, exploring its potential to promote ethical sourcing and transparency, and addressing potential risks related to data privacy and security. The research could investigate how blockchain can contribute to building more sustainable and responsible supply chains.

Impact on Small and Medium-sized Enterprises (SMEs): Given the potential costs and technical expertise required for blockchain implementation, future research should assess the challenges and opportunities for SMEs in adopting this technology. Specific policies and support mechanisms could be designed to facilitate blockchain adoption among SMEs and ensure equitable access to the benefits of this technology.

The future of this research lies in building upon its current strengths—the rigorous mixed-methods approach and the multi-sector, multi-national perspective—to further refine our understanding of blockchain adoption in supply chains. By addressing these future research directions, this study can contribute significantly to both theoretical advancement and practical applications, ultimately shaping the future of supply chain management in the age of blockchain technology.

12.Discussion

This dissertation investigated the adoption of blockchain technology within global supply chains, exploring the interplay of institutional isomorphism, the “shadows of the past and future,” and power dynamics. Employing a rigorous mixed methods design across three interconnected arenas; this study generated a nuanced understanding of the complex forces shaping organizational responses to this transformative technology.

Arena 1 employed a qualitative approach, utilizing in-depth interviews and case studies to explore the motivations, challenges, and decision-making processes surrounding blockchain adoption. The analysis revealed a dynamic interplay between individual actor mindsets and contextual influences, shaped by both past experiences and future expectations. Established infrastructure, organizational routines, and cultural norms—what can be termed “the shadow of the past”—often acted as significant barriers to adoption, limiting flexibility and willingness to change. On the other hand, the anticipation of competitive advantages, evolving regulatory landscapes, and emerging industry best practices—collectively referred to as “the shadow of the future”—served as powerful drivers pushing organizations toward blockchain integration.

These qualitative insights offered a deeper understanding of the contextual factors influencing adoption decisions, providing critical background for the subsequent quantitative analyses. The integration of this contextual data was essential in refining the understanding of power dynamics and stakeholder behavior, particularly as they related to factors influencing adoption, which were later quantitatively assessed.

Arena 2 adopted a quantitative methodology to analyze the influence of institutional isomorphism across five strategically selected sectors within the global supply chain ecosystem. This arena assessed the relative impact of mimetic, coercive, and normative isomorphism on blockchain adoption rates. The results demonstrated significant variations across sectors, revealing the nuanced interplay of institutional pressures and sector-specific characteristics. These quantitative findings offered a robust empirical basis for understanding the broader patterns of blockchain adoption and validated the initial qualitative observations.

Arena 3 leveraged focus group discussions to explore power dynamics within the supply chain hierarchy. By examining the perspectives and influence of various stakeholders (suppliers, manufacturers, distributors, retailers), this arena illuminated how the distribution of power shaped the adoption process. This analysis revealed that actors with greater market control or hierarchical authority often exerted disproportionate influence on the decision-making process, potentially accelerating or hindering adoption based on their individual incentives and strategic objectives. This finding provided a crucial contextual layer, integrating the Micro-level power dynamics with the macro-level institutional pressures identified in Arenas 1 and 2.

The integration of findings across these three arenas provides a comprehensive and robust understanding of blockchain adoption, exceeding the scope of previous research by incorporating a multifaceted perspective. The study’s multi-national scope, encompassing geographically and culturally diverse regions, demonstrated the significant role of contextual factors in shaping the impact of institutional pressures. The findings highlight the limitations of simplistic generalizations and emphasize the importance of considering the interplay between global and local contexts when analyzing technological adoption in complex supply chain networks.

13.Conclusion

This dissertation makes significant contributions to the literature on technological adoption within complex organizational networks. It offers a nuanced, multi-faceted perspective by integrating institutional theory with a temporal framework and a power dynamics analysis. The findings challenge overly simplistic views of technological adoption, revealing the complex interplay of individual motivations, institutional pressures, and power relations shaping decisions regarding blockchain integration. The multi-national, multi-sector approach enhances the generalizability of the findings while simultaneously acknowledging the contextual heterogeneity of supply chains across different geographical and cultural settings.

Despite these limitations, this research provides substantial implications for both academics and practitioners. The findings offer valuable insights for organizations navigating the complexities of blockchain integration, emphasizing the importance of understanding and managing both internal and external influences on adoption decisions. The rigorous theoretical framework and empirical findings also inform the development of future research directions and offer valuable insights for policymakers seeking to foster responsible and effective adoption of blockchain technologies within global supply chains. This dissertation contributes significantly to the growing body of knowledge on technological innovation and its transformative impact on the modern global economy.

14. Summary Table of Research Findings

Research Questions	Research Hypothesis	Key findings	3 Arenas
RQ1: Given the blockchain capabilities, what motivates actors to adopt the technology within supply networks?	**H1:** Upstream actors prioritize transparency and traceability as key drivers for blockchain adoption.	Upstream actors are motivated by transparency and traceability, which enhance supply chain visibility and reinforce blockchain adoption.	Arena 1 (Qualitative)
RQ2: What goes on in the mind of the individual decision-maker?	**H2:** Downstream actors prioritize trust and reputation in blockchain adoption.	Downstream actors emphasize trust and platform reputation, with adoption decisions strongly influenced by these factors.	Arena 1 (Qualitative)
	H3: Downstream actors' decision-making regarding blockchain adoption is significantly influenced by the perceived reputation of the platform's providers.	The reputation of blockchain platform providers is a crucial determinant in downstream adoption decisions.	Arena 1 (Qualitative)
	H4: Downstream actors are more likely to adopt blockchain technology when trust and reputation are effectively communicated and reinforced.	Effective communication of trust and reputation fosters higher adoption rates among downstream actors.	Arena 1 (Qualitative)
RQ3: Which factors are persuasive for participants to insert the required strategic information?	**H5:** The FCM will demonstrate significant differences in the hierarchical importance of factors influencing decision-making between upstream and downstream actors.	The FCM analysis reveals hierarchical differences in decision-making factors between upstream and downstream actors.	Arena 2 (Quantitative)
RQ4: How does blockchain adoption contribute to sustainability goals in supply chains?	**H1:** Blockchain improves transparency and traceability of sustainable practices in supply chains.	Blockchain enhances transparency and traceability in sustainable supply chain practices, aiding compliance with ethical sourcing standards.	Arena 1 & Arena 2 (Qualitative & Quantitative)
	H2: Stakeholders view blockchain as a tool for meeting sustainability requirements, such as ethical sourcing and energy consumption reduction.	Stakeholders recognize blockchain as a tool for achieving sustainability goals, particularly in ethical sourcing and energy efficiency.	Arena 3 (Qualitative)

Summary of Key Insights from Each Arena:

Arena 1 (*Qualitative*): Explored individual actors' motivations, focusing on upstream and downstream perspectives. Transparency and traceability were key for upstream actors, while reputation and trust played a stronger role for downstream actors.

Arena 2 (*Quantitative*): Provided statistical evidence on how institutional isomorphism (mimetic, coercive, and normative pressures) influenced blockchain adoption across different supply chain sectors, highlighting the different roles of Finance, Marketing, HRM, and Purchasing.

Arena 3 (*Qualitative*): Focus group discussions refined the understanding of decision-making, particularly in how hierarchical power dynamics within supply chains affect blockchain adoption. Larger, more powerful actors could push others toward adoption, indicating a significant role of coercive isomorphism.

This table synthesizes the core elements of your research findings, integrating them across different research questions, hypotheses, and research arenas.

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16.Appendix

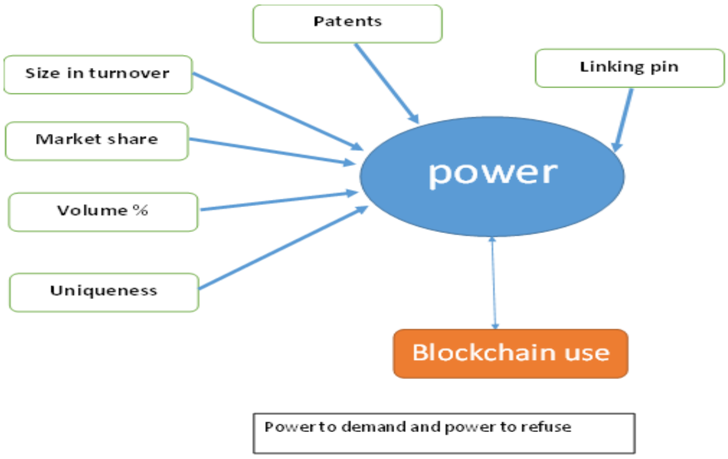
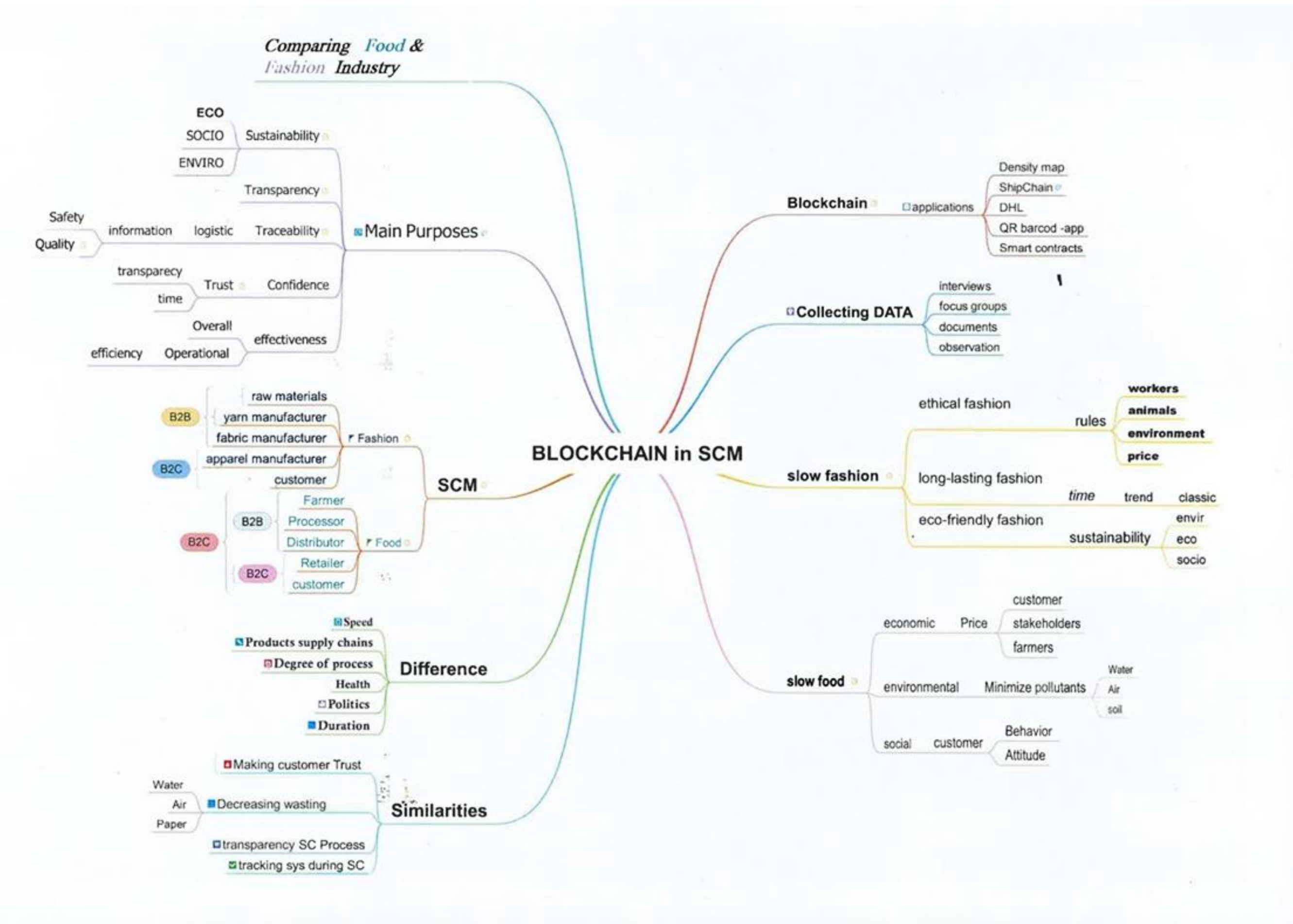
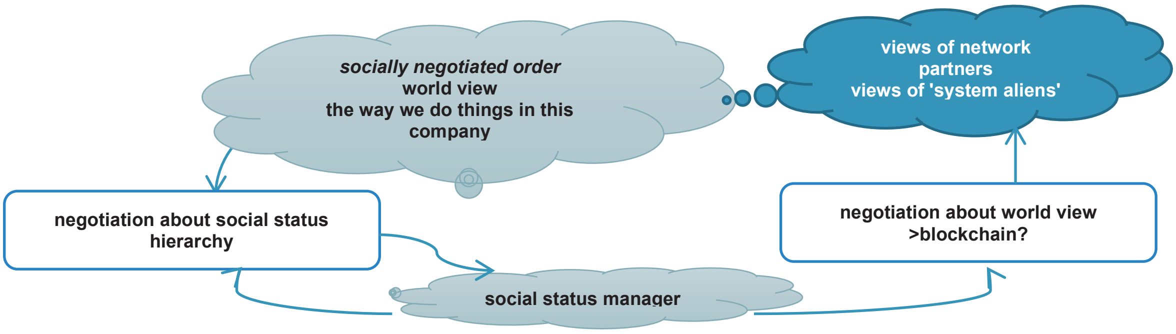


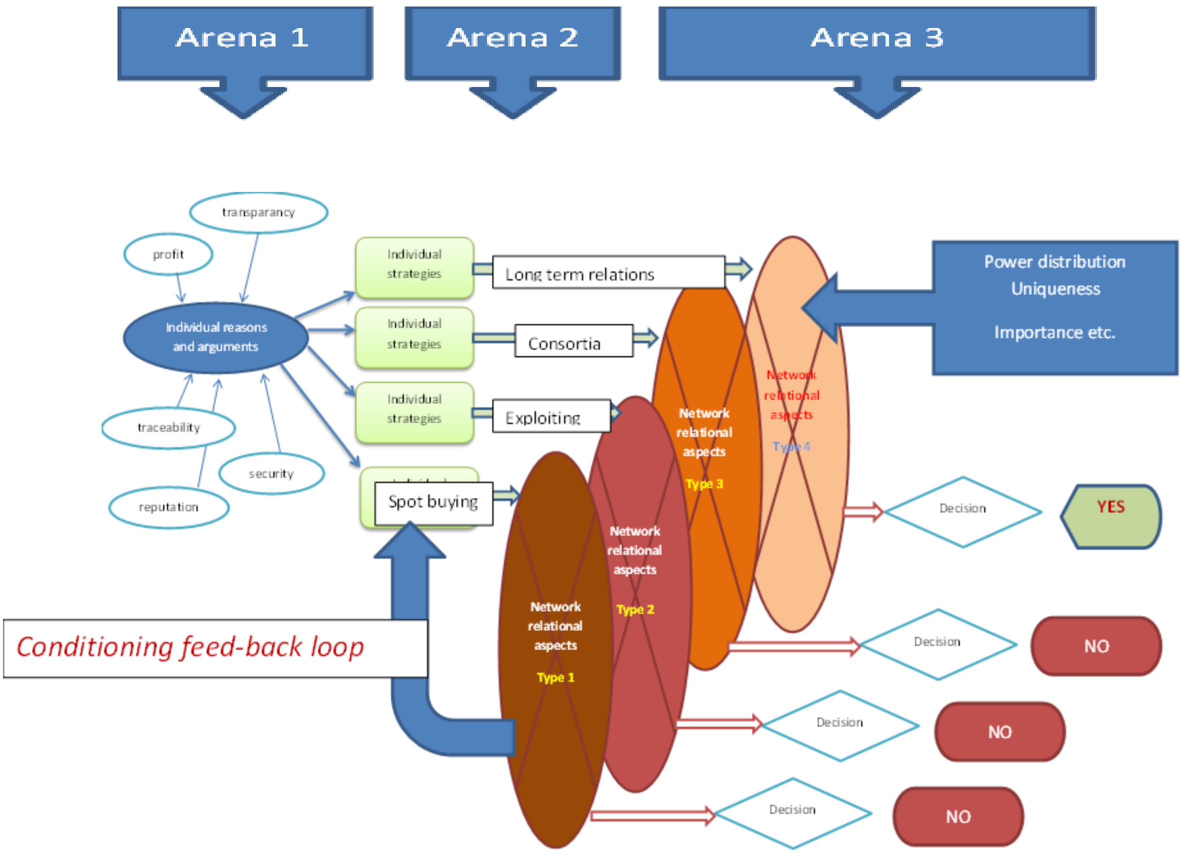
Figure 08 : Factors determining the power of network participants



Model 06. Mind map



Model 07: The Battle of the Egos: Socially Negotiated Order and Negotiated Social Hierarchy



Model 08: First Version of Arena 3: The decision flow about adoption of Blockchain technology

Arena 1, Interview Questions *(Qualitative)*:

Background Information

1. **Position and Role**:
    - What is your current role, and how does it relate to technology implementation within your company?
    - Are you involved in decision-making regarding technological adoption, such as blockchain?
2. **Experience and Company Context**:
    - How many years of experience do you have in this industry?
    - Could you describe your company in terms of size, structure, and focus areas?
    - Does your company have a history of being an early adopter of new technologies?
3. **Education and Knowledge**:
    - What is your academic background, and how has it influenced your understanding or adoption of blockchain technologies?
    - Have you or your team undergone any specific training related to blockchain?

Exploring Blockchain Usage

4. **Adoption Status**:
    - Does your company currently use a blockchain platform?
        - **Yes**:
            - How long has it been in use?
            - What were the initial motivations for adopting it: marketing, logistics, strategic operations, or something else?
            - Can you share specific use cases where blockchain has been impactful?
        - **No**:
            - Why hasn't blockchain been adopted?
            - Are you using other technologies like RFID, QR code scanning, or centralized databases?
            - Do you see a future for blockchain in your organization?
        - **Not yet**:
            - What barriers or concerns are delaying its adoption?

        - Are there ongoing discussions or pilots exploring blockchain integration?

5. **Characteristics of Products**:
    - What are the key characteristics of your products (e.g., perishability, luxury, traceability)?
    - How do you think blockchain can or does enhance these product characteristics (e.g., provenance, authenticity, safety)?

Blockchain and Sustainability

6. **Defining Sustainability**:
    - How does your company define sustainability in the context of your industry?
    - What are the most critical sustainability challenges you face today?

7. **Blockchain's Impact on Sustainability**:
    - In your view, does blockchain contribute to sustainability goals?

        If Yes:

        - In which dimensions (economic, social, environmental) does blockchain have the most significant impact?
        - Can you provide specific examples or metrics of its effectiveness?

        If No:

        - What limits blockchain's potential as a sustainability tool in your industry?

Blockchain as a Solution

8. **Problems Solved by Blockchain**:
    - What are the major problems your company has solved (or could solve) using blockchain technology?
    - Are there any industry-wide problems that blockchain could address but has not yet?
9. **Future Potential**:
    - In your opinion, what new opportunities or innovations could blockchain unlock in the next 5–10 years?
    - What improvements or developments in blockchain technology would make it more valuable to your organization?

Motivations for Adoption

10. **Primary Motivations for Blockchain**:
    - What was the main driver for considering or adopting blockchain technology in your company?
    - Rank the following factors in order of importance:
        - **Financial** (e.g., cost savings, revenue generation).
        - **Social** (e.g., trust with end users, improved transparency).
        - **Environmental** (e.g., reducing carbon footprint, promoting green practices).

11. **Challenges in Adoption**:
    - What challenges did your company face when adopting or considering blockchain?
    - Were these challenges technical, financial, cultural, or regulatory?

Open-Ended Exploration

12. **Perception of Blockchain**:
    - How do you see blockchain evolving in your industry?
    - Do you believe blockchain is overhyped, underutilized, or appropriately applied today?
13. **Advice and Insights**:
    - Based on your experience, what advice would you give to companies considering blockchain?
    - Are there any lessons learned or best practices you'd like to share?
14. **Future Outlook**:
    - How do you see blockchain intersecting with other emerging technologies like AI, IoT, or quantum computing?
    - What do you think the role of blockchain will be in creating more resilient and sustainable business models?

Notes on Improvement:

1. **Clarity and Depth**: Questions have been rephrased to ensure clarity and to encourage detailed responses.
2. **Exploratory Nature**: Open-ended questions allow participants to share insights freely, offering richer data.
3. **Categorization**: Grouping questions into sections helps maintain a logical flow during interviews.
4. **Customizable**: Questions can be adapted based on the specific focus of the research or the interviewee's role.

Would you like further refinements or assistance tailoring these questions to a particular industry or use case?

Topics:	Fashion				Food			Tech			HRM		Consumer			
Interviewee #	1	4	9	%	2	10	%	3	5	%	6	%	7	8	11	%
Transparency	8	6	10	20%	3	11	19%	4	3	10%	8	25%	8	6	2	12%
Traceability	5	3	7	12%	1	4	7%	2	2	6%	10	**31%**	2	3	2	5%
Advantages/Disadvantages	6	8	4	15%	7	5	16%	10	12	**32%**	1	3%	1	3	1	3%
Sustainability	7	14	7	**23%**	9	11	**27%**	6	3	13%	3	9%	8	4	9	16%
Trust	2	8	5	12%	6	8	19%	3	1	6%	7	22%	12	16	14	**32%**
Other technologies	5	3	1	7%	1	3	5%	9	6	22%	0	0%	2	4	4	8%
Reputation	2	8	2	10%	1	4	7%	5	3	12%	3	9%	12	10	8	23%

Selected interviewees, *M = Male interviewee F= Female ++ <> --- = advantages versus disadvantages; blue background: most mentioned topic*

Table 10 : Frequencies of topics mentioned by clustered interviewee res

Code	Key Words	Weighted Score
T1	Transparency	106.35
T2	Traceability	79.82
B1	BC Advantages	44.44
B2	BC Disadvantages	18.85
S	Sustainability	71.66
U	Trust	60.35
O	Other Technologies	67.25
R	Reputation	51.38

Table 11: The code, key words, and weighted score

Arena 2, Survey questionnaire *(Quantitative)*:

Decision makers Role in Organization

Mandana Gharehdaghi
Your insights are crucial to my research!

1. Email *

____

2. **Please choose your functional area :**

Mark only one oval.

- ◯ Marketing
- ◯ Finance
- ◯ Production
- ◯ Purchasing
- ◯ HRM
- ◯ Other: ______________________

3. **Please choose your *sector***

Mark only one oval.

- ◯ Fashion
- ◯ Food Production
- ◯ Automotive
- ◯ IT
- ◯ Education
- ◯ Finance
- ◯ Food Retails
- ◯ Other: ______________________

Untitled Section

4. **How long are you in this function**

Mark only one oval.

- 0-1 Year
- 2-5 Year
- 6-10 Year
- Other: ____________________

5. **Please encircle the department that, in general, has more status in the hierarchy of decision making in your company:**

Scenario 1: Marketing vs. Finance

Mark only one oval.

- Marketing < Finance
- Marketing = Finance
- Marketing > Finance

6. **Scenario 2: Marketing vs. Production**

Mark only one oval.

- Marketing < Production
- Marketing = Production
- Marketing > Production

7. **Scenario 3: Marketing vs. Purchasing**

Mark only one oval.

- Marketing < Purchasing
- Marketing = Purchasing
- Marketing > Purchasing

8. **Scenario 4: Marketing vs. HRM**

Mark only one oval.

- Marketing < HRM
- Marketing = HRM
- Marketing > HRM

9. **Scenario 5: Finance vs. Production**

Mark only one oval.

- Finance < Production
- Finance = Production
- Finance > Production

10. **Scenario 6: Finance vs. Purchasing**

Mark only one oval.

- Finance < Purchasing
- Finance = Purchasing
- Finance > Purchasing

11. **Scenario 7: Finance vs. HRM**

Mark only one oval.

- Finance < HRM
- Finance = HRM
- Finance > HRM

12. **Scenario 8: Production vs. Purchasing**

Mark only one oval

- Production < Purchasing
- Production = Purchasing
- Production > Purchasing

13. **Scenario 9: Production vs. HRM**

Mark only one oval.

- Production < HRM
- Production = HRM
- Production > HRM

14. **Scenario 10: Purchasing vs. HRM**

Mark only one oval.

- Purchasing < HRM
- Purchasing = HRM
- Purchasing > HRM

15. Please share with us if you have an idea or comment related to this research:

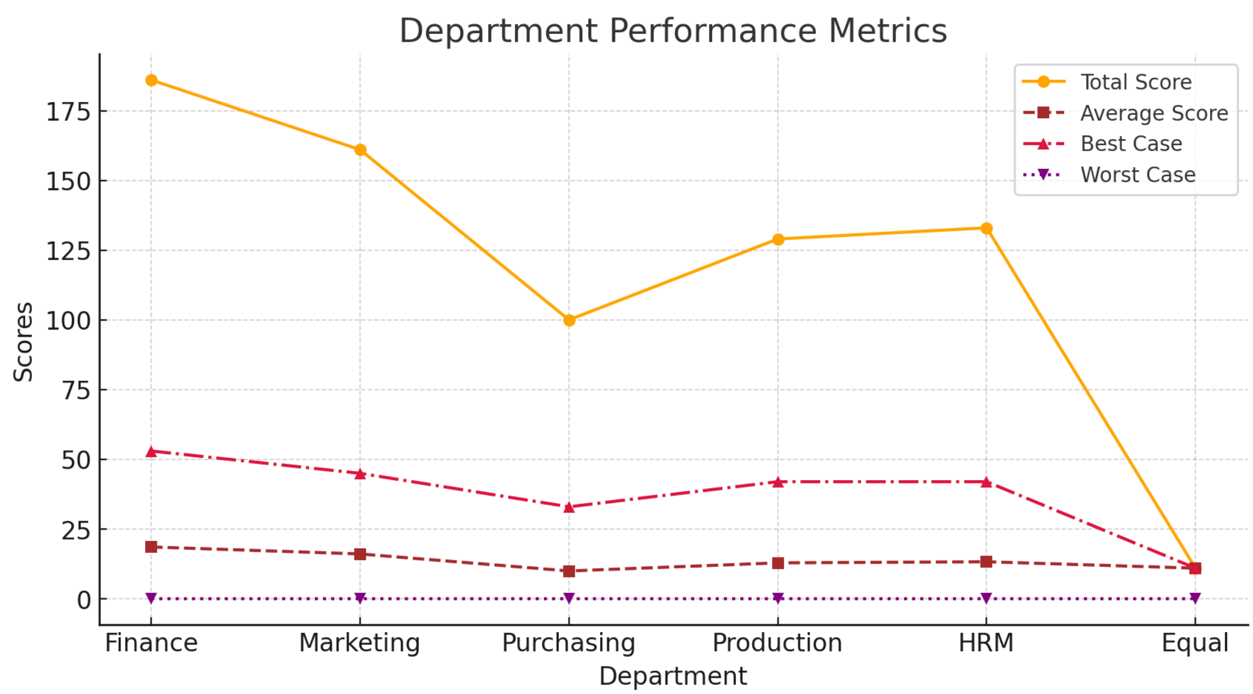


Figure 9: Department Performance Analysis: Scores & Variations

Arena 3, Interview Questions *(Qualitative)*:

Focus group discussion Design:

1. Introduction (2 minutes)

- Briefly introduce the topic and participants.

2. Discussion Topics (16 minutes)

Topic 1: Compelled Terms (5 minutes)

- “Have you experienced situations where suppliers or buyers felt compelled to accept specific terms or relinquish demands? Why do you think this happened?”
- “What factors—like financial dependency or market conditions—caused this dynamic?”
- “How did this affect the long-term relationship?”

Topic 2: Arrogance in Interactions (5 minutes)

- "Have you encountered buyers or suppliers exhibiting arrogance? How did it manifest in your interactions?"
- "Was it through tone, demands, or other behaviors?"
- "How did this impact the negotiation or relationship?"

Topic 3: Power Dynamics and Relationships (6 minutes)

- "Does the exercise of power influence negotiations or relationships? Could you share an example?"
- "In what ways can power be used constructively?"
- "Have you seen relationships damaged due to power misuse?"

3. Conclusion (2 minutes)

- "What is the key takeaway from this discussion about managing power dynamics?"

Responses: Three Examples Derived from Interview Responses Prior to Analysis

Supply Chain Purchasing Sector

- Yes, in the purchasing sector, I've often been 'forced' by suppliers to accept higher prices or longer lead times, especially during peak seasons. There have been times when suppliers-imposed changes in terms and conditions, like changes in payment terms or minimum order quantities, and I had no choice but to agree to maintain the supply flow. On the buyer side, sometimes buyers push for lower prices or higher delivery speeds, which forces us to adapt our processes.
- Yes, sometimes we encounter suppliers who are quite arrogant because they have exclusive products or a dominant market position. They know we need their goods, and they can set terms that benefit them without much negotiation. Similarly, some buyers in retail chains can be arrogant, expecting deep discounts or pushing for last-minute changes without considering the challenges we face in the supply chain.
- Absolutely, power plays a huge role in this industry. For instance, large suppliers with high-volume production capabilities can dictate terms because they know they control the product that my company depends on. In contrast, when we're a smaller player and dealing with huge retail buyers, they tend to use their market size as leverage, demanding lower prices or faster delivery times, knowing we need their shelf space.
-

2. **Fashion Brand Owner**
    - Yes, as a fashion brand owner, suppliers sometimes have the upper hand, especially when they are exclusive fabric producers or manufacturers with limited capacity. There have been times when suppliers raised prices or reduced times, forcing me to accept their terms, even though it wasn't ideal for my margins. On the buyer side, large department stores and online retailers often impose strict terms, like demanding promotional discounts or extra inventory, and we had no choice but to comply to keep the relationships strong.
    - Definitely. Suppliers, particularly those who provide high-demand fabrics or trendy items, sometimes come across as arrogant because they know that fashion brands are dependent on the latest trends. They may limit the quantities they offer, raise prices, or impose higher minimum orders. Buyers, on the other hand, often expect deep discounts or demand quick turnarounds for seasonal collections, knowing they control whether we get placed in major retail chains or not.
    - Yes, power plays a massive role in fashion. For example, if I'm dealing with a supplier who controls a unique fabric or a production method, they hold all the cards. A major department store chain that has the ability to showcase my collection in high-profile locations can demand discounts, faster shipping, and special deals because they know that their visibility can drive sales. I have to comply with their terms because their size and market presence outweigh my individual power as a smaller brand.
3. **Marketing Person**
    - In marketing, it's a bit different, but we do feel the pressure from both suppliers and buyers. Suppliers often push for specific promotional strategies, especially when they're offering products with high demand. For instance, some suppliers might want us to emphasize certain product features or use particular imagery in our campaigns, even if it doesn't align perfectly with our brand identity. From the buyers' side, they sometimes demand a specific type of marketing campaign or even dictate how much of a discount should be included in promotional efforts to increase sales volume.
    - "Arrogance can show up in both suppliers and buyers. Some suppliers, especially those representing large corporations, believe they can dictate how the brand markets their products, often without understanding the brand's voice or audience. This can feel like a forceful attempt to control the narrative. Buyers can be equally arrogant, especially those from large retail chains or platforms. They may insist on promotional deals that are difficult to accommodate, but since they have purchasing power, we often need to bend to their demands.
    - Power is crucial in the marketing sector as well. A big retailer with high foot traffic or a dominant online platform can demand specific marketing activities or discounts because they know they control the customer's attention. For example, if a retailer like a major department store is pushing a seasonal sale, we have to cooperate because they drive traffic to our brand. On the other hand, a supplier with exclusive access to high-demand products can dictate the terms of how those products are marketed, knowing that without them, we would lose out on consumer interest.

These examples show how power dynamics, communication, and decision-making interact in networks. They present empirical evidence for the study's exploration of blockchain adoption, particularly how power imbalances and negotiation dynamics influence technology integration within supply chains.

16.1. The list of Figures, Charts and Models

16.2. List of the abbreviations

Supply chains	**SCs**
Sustainable Supply Chain	**SSC**
Blockchain	**BC**
Focus Group Discussion	**FGD**
Food/Fashion Supply chain	**FSC**
Analytical Hierarchy Processing	**AHP**
Internet of Things	**IOT**
Artificial intelligence	**AI**
Sustainable Quality Program	**SQP**
Food and Agriculture Organization	**FAO**
Technology Acceptance Model	**TAM**
Unified Theory of Acceptance and Use of Technology	**UTAUT**
Hazard Analysis and Critical Control Points	**HACCP**
European Blockchain Services Infrastructure	**EBSI**
Diligence Guidance for Responsible Supply Chains of Minerals	**OECD**
Linear Structural Equation Modeling	**LISREL**

16.3. List of the Publications

1. Behavioural and Organisational Factors Determining Blockchain Adoption,

   Journal: Current Journal of Applied Science and Technology. Published ,**2022.**

   DOI: 10.9734/cjast/2023/v42i74077

2. Blockchain adoption: the decision flows through three arenas,

   Journal: Journal of Economics, Management and Trade (JEMT). Published ,**2023.**

   DOI: 10.9734/jemt/2024/v30i71221

3. The impact of blockchain on transparency & trust in sustainable agri-food supply chains. **Book**: Springer: Web 3.0 and Metaverse. Published ,**2024.**

4. 3 Arenas Models. **Magazine**: Deal. Business and Economy ,**2024.**

5. Micro-Level Perspective on Blockchain Adoption: A Fuzzy Cognitive Map Analysis of Motivations. **Journal** : Journal of Business Research (JOBR-D-25-00966). Submitted , **2025.**

6. How Finance stages and shapes strategic Blockchain technology adoption decisions

   Journal: Frontiers. Submitted ,**2025**.

7. The role of power in market control in supplier-buyer relations

   Journal: Edelweiss Applied Science and Technology- Published, **2024**.

   DOI: 10.55214/25768484.v8i6.3858

8. How Isomorphism Forces Shape Blockchain Adoption for Sustainability in Supply Chains: A Multi-Level Analysis.

   Journal: European Management Journal-Submitted ,**2025.**

16.4. Conferences presentations

1. Pannon University National Conference

- Year: 2021
- Conference Date: 9th November 2021
- Location: National Conference (in-person)
- Mode: In-person
- Participation: Participated and presented

2. IKSAD INSTITUTE International Conference

- Year: 2021
- Conference Date: 9th October 2021
- Location: Izmir, Turkey
- Mode: Online
- Participation: Participated and presented

3. IPSERA International Conference

- Year: 2022
- Conference Date: 2nd – 5th April 2022
- Location: Jönköping, Sweden
- Mode: In-person
- Participation: Participated and presented

4. IKSAD INSTITUTE International Conference

- Year: 2022

- Conference Date: September 2022
- Location: Online
- Mode: Online
- Participation: Participated and presented

5. IPSERA International Conference

- Year: 2023
- Conference Date: 2nd – 5th April 2023
- Location: Barcelona, Spain
- Mode: In-person
- Participation: Participated and presented

6. MDI International Conference

- Year: 2023
- Conference Date: 5th – 7th January 2023
- Location: Online
- Mode: Online
- Participation: Participated and presented

7. IKSAD INSTITUTE International Conference

- Year: 2023
- Conference Date: 13th – 15th December 2023
- Location: Mardin, Turkey
- Mode: Online
- Participation: Participated and presented

8. UNeECC International Conference

- Year: 2024
- Conference Date: 9th – 11th October 2024
- Location: Timișoara, Romania
- Mode: In-person
- Participation: Participated and presented

9. BBU 1857 National Conference

- Year: 2024
- Conference Date: 14th November 2024
- Location: Budapest, Hungary
- Mode: In-person
- Participation: Participated and presented

10. IPSERA International Conference

- Year: 2024
- Conference Date: 5th – 9th April 2024
- Location: Rio de Janeiro, Brazil
- Mode: Online
- Participation: Participated and presented

11. IKSAD INSTITUTE International Conference

- Year: 2024
- Conference Date: 11th – 13th November 2024
- Location: Antalya, Turkey
- Mode: Online
- Participation: Participated and presented

12. AI-Hungary International Conference

- Year: 2024
- Conference Date: 11th – 13th September 2024
- Location: Berlin Germany
- Mode: In-person
- Participation: Participated and present

13. IPSERA International Conference

- Year: 2025
- Conference Date: 30th March – 4th April 2025
- Location: Eindhoven, Netherlands
- Mode: In-person
- Participation: Participated and present