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THESIS

The emerging need to integrate the supply chain industry with a future-proof
blockchain model; explorative study into food supply chain and container
logistics

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1. INTRODUCTION

Supply chain management is a complex process that compromises many parties, including manufacturers, distributors, and retailers. Multiple touch points across geographies and time zones make it difficult to keep track of inventory levels and other details. As the supply chain's scope and network grows, there is a need for a large number of simultaneous transactions between different stakeholders. It is no secret that humans are prone to error, fraud, bias, and corruption. For that, each transaction requires trust and verification, leading to a delay in the processing time. Global supply chains have witnessed disruptions in the last few years due to the covid-19 pandemic and regional conflicts. Global boundaries that were disappearing due to globalisation saw a pause and orders were delayed for several weeks and there were constraints on all levels of the supply chain.

The use of blockchain technology can help eliminate these issues as it ensures complete transparency between the different participants of the chain, within every step along the process. In fact, Blockchain helps to eliminate this uncertainty from the system by providing a single, shared record of all transactions across the supply chain network, enabling direct communication between trading partners through self-executable contracts and reducing the overall turnaround time for completing transactions. Today, Blockchain technology is actively changing how businesses manage their supply chains, not only by helping companies reduce costs and improve efficiency but also in its important role in fraud and theft prevention by ensuring visibility and traceability and increasing trust.

However, the current adoption of this technology remains insignificant and is limited to big corporations, whilst the need for this technology is inevitable in certain industries that require full transparency. These industries are mainly the ones that have a direct or indirect impact on public human health or environmental health. Blockchain technologies provide real time tracing of their goods for different stakeholders in the supply chain and the value they add to them is analysed. In this paper, the supply chain industries, specifically of food supply chain and container logistics are analysed and the need for future proof blockchain technology is ascertained. The ease at which such technologies can be rolled out and their significant advantages and challenges specific to the industry are studied. The stage of blockchain technology in supply chain relevant to the diffusion of Innovation theory is studied along with the key factors that affect the diffusion of the blockchain technology.

Innovative and early adopter businesses are identified in the food supply and container logistics industry and the key advantages and drawbacks of the technology are identified.

Research Objectives

The primary objective of the proposed research is to underline the contemporary problems and risks of supply chains in certain industries within the current economic models, and how it is important to switch to a new model that offers complete transparency and traceability as a collective responsibility, thus blockchain technology comes into the picture with companies such as IBM, having the infrastructure to adapt the technologies already and try emerging stronger in times of uncertainty.

The research is aimed to find some of the most important uses for blockchain in the areas of supply chain transparency, traceability, and commercial processes in food supply and container logistics. The research will also look to identify the main risks of implying blockchain technology into supply chain management while suggesting ways to mitigate those risks. In conclusion, the paper will mention some key success factors that will promote the widespread adoption of the technology while mentioning the risks and drawbacks in implementation of the technology and suggesting ways of eliminating them if possible or mitigate them.

1. Understand the risks of the existing problematic economic models of supply chain management in highly delicate industries such as container logistics and food supply chain.
2. Highlight the importance of switching to an efficient and transparent model to meet today's needs and prevail over contemporary human problems and expected Return on Investment on adoption of Blockchain technologies.
3. Examine the risks of blockchain technology if applied to supply chain management and look for ways to mitigate those risks.

Research Methodology

A thorough understanding of the subject is required to analyse how blockchain technology is adapted to today's dynamic supply chain industries. For that purpose, qualitative exploratory research is conducted by extensive literature review about blockchain technology related to supply chains. Global supply chain providing companies such as IBM have placed

implementing blockchain as a priority and key quantitative metrics such as the expected Return on Investment and avenues to monetize on that are explored. Conclusions are arrived at based on the subject's understanding after analysing the complexities and challenges associated with implementing blockchain technology and the benefits to different stakeholders are discussed. Emphasis is on the food supply and container logistics industry. In-depth semi-structured interview is conducted with a potential industry participant in the food supply industry and exploratory analysis with the help of secondary research is conducted. The key factors affecting the diffusion of innovation and its adoption are studied with the help of an integrated Technology acceptance and diffusion of innovation theory relevant for the case of blockchain technology in supply chain (Lou & Li, 2017).

Research questions

- What are the shortcomings and disruptions of traditional supply chains and how can blockchain technology be harnessed into the food supply and container logistics?
- What are the factors affecting the diffusion of blockchain technology and the advantage of being innovators and early adopters in industries such as container logistics and food supply?
- What are the risks associated with applying blockchain in supply chain management? How can they be mitigated?

2. LITERATURE REVIEW

To understand the effect of blockchain technologies on the supply chain, the traditional flow of supply chain and different stakeholders need to be identified.

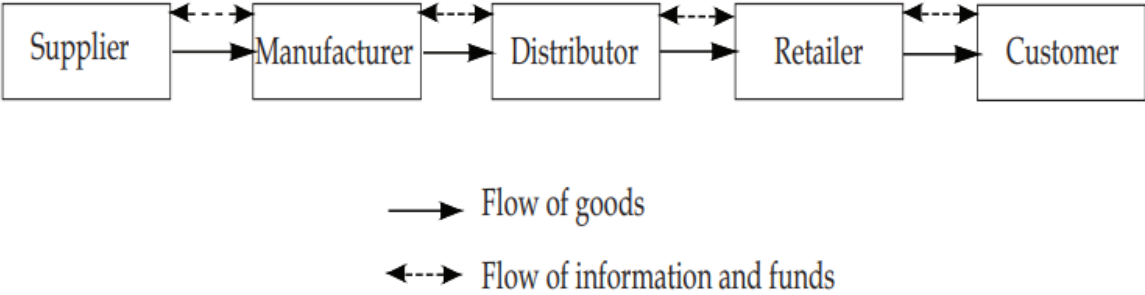


Figure 1 THE BASIC SUPPLY CHAIN (CHOPRA & MEINDL, 2001, P. 6)

Supply Chain Management (SCM) was traditionally associated with inventory management, but it is now widened and includes various touch points and stages within a supply chain.

SCM comprises management of flows of information, products and finances upstream and downstream (Habib, 2011) with the intention of minimising total costs. The benefits of an advanced SCM include high customer responsiveness, improved customer satisfaction, flexibility for changing market conditions, improved retention of customers and effective marketing of goods (Horvath, 2001). Supply chain has to be treated as an integrated process and disruptions in the supply chain can occur due to pandemics, price & currency fluctuations too (Forrester, 2020). Such issues result in increased cost, product release delay and increased delay. Data integrity and automation of business processes are key factors for different shareholders which blockchain technology helps in tackling.

Few issues in the supply chain are recognised where blockchain technologies can improve upon. There is ambiguity regarding the origin of raw materials and product, trust issues between buyers and sellers and the inefficiency in the execution of the traditional supply chain (Fernandez, 2022).

Shortcomings in the current supply chain

1) Raw material or product origin:

Participants throughout the supply chain are interested in knowing the source or origin of their product and raw materials as it is an important consideration for end consumers. Consumers of the products such as bio or organic food prefer to buy products with traceability which helps in building trust. Customers are wary of unethical means of production and appreciate transparency from their buyers in terms of origin of the product and traceability in their supply chain.

2) Distrust between buyer and seller of products:

There may be distrust between buyers and sellers especially in their initial transactions where trust has not been established. There would be doubts regarding the fulfilment of payment on the buyer's part and delivery of product from the seller's part. It has been a long-standing issue and the process of acquiring a letter of credit is expensive and lengthy. Certificates providing authenticity of the sellers help build trust amongst the consumers (Fernandez, 2022).

3) Supply chain execution efficiency:

Contracts between buyers and sellers have some conditions to be met that trigger further actions. In instances where one party has executed their end of transactions the other may fail to do so manually. There would be distrust between two parties who enter a transaction. In addition to the mistrust amongst the parties, entering into trade agreements may be a lengthy process and the mechanisms are old and require cumbersome paperwork.

2.1 Blockchain technology and SCM

Blockchain technology is primarily a layer on the internet where several “blocks” are put together in a chain and each block contains sets of data. Each block has its individual hash which is called the fingerprint of the data and each hash contains the hash of the previous block forming a blockchain. There is additional transparency and security as peer-to-peer network is used and Distributed ledger technology is used. Using the blockchain technology participants can enter smart contracts. As an example, in the logistics industry, if the buyer has his shipment ready and the documents submitted by buyer to blockchain are correct, the transaction would be executed, and the efficiency and transparency of the transaction builds trust between them with the blockchain technology (Fernandez, 2022).

Based on several studies and research papers, we learn that it is a very prominent vision of aspiring global companies to do away with the complexity with which global supply chains work through blockchain technology. The early stages of the research process will put more emphasis on the information needs including relevant secondary data provided from previous studies which can save the researcher a great deal of time and exertion in the initial phase of research through thorough mining of information provided online around the maturity of.

Blockchain technology may still be in its infancy state, and it is crucial for companies to analyse the factors that affect the adoption of the same before trying to roll out an industry wide framework with all the different stakeholders involved (Dahiya, 2015).

However, what we should be focusing on as consumers is not just the efficiency it brings to the system but rather, the transparency. In fact, as consumers, it is becoming almost mandatory for us to question every partition of the end-product from the origin of the product, to how it was conceived, manufactured, and distributed.

To be able to identify companies that follow an ethical production framework we should be able to track back the manufacturing parties, their working culture, and employment models- the implementation of the blockchain technology into the industry is one way of doing that.

The collective motive of consuming clothing from ethical brands that promote renewable energy, reducing water and chemical usage, using sustainable materials, and treating workers right, push us to think of constantly questioning every part of the chain, which can be made easier if we had access to those parts and empirically make a conscious decision of buying or boycotting (Habib, 2011).

Blockchain technology is still in its early years and its correct application to relevant fields and its limitations need to be specified. Numerous additional applications are being investigated as a result of the growing realisation that blockchain technology can be used for much more than only bitcoin and financial transactions: digital authentication, managing and preserving administrative records, and signature technologies, confirming and tracing intellectual property ownership technologies for allowing smart contracts, property rights, and tracking patient health records, improved charity transparency, seamless electronic voting, the transfer of real estate, and the distribution of locally produced for tracking items and, generally, goods as they pass through production , manufacturing , retail link to end consumers (Tayeb et al., 2018).

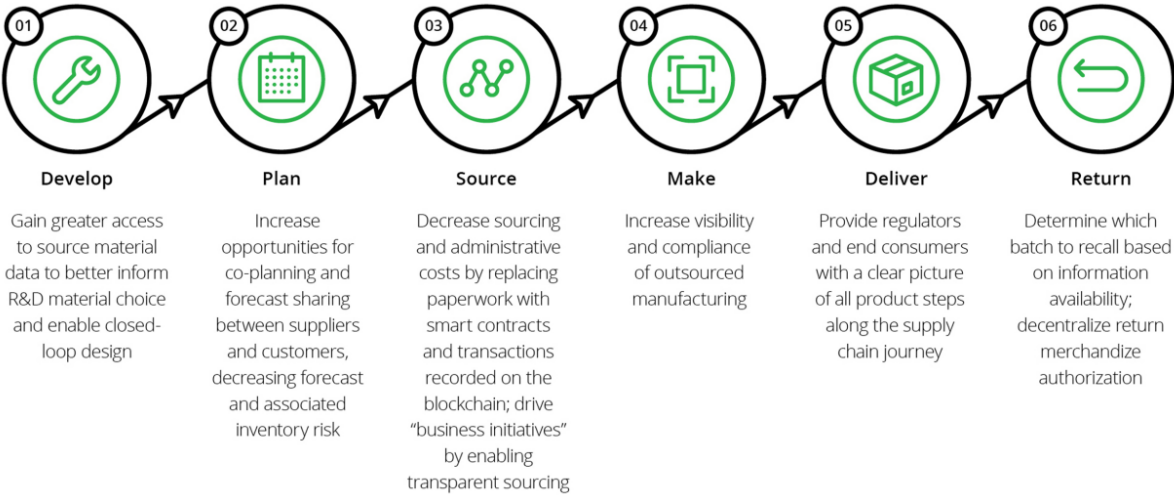


Figure 2 DRIVING VALUE IN THE SUPPLY CHAIN INFOGRAPHIC (ANON., 2019, P. 1)

Deloitte has developed this infographic which provides a roadmap on how blockchain technology can be used from the start to the final phase of supply chain management and can increase transparency, minimise risks and costs throughout the value chain. Primary benefits with adoption of this technology are identified as improved transparency in raw material sourcing, lower duplicate products, agreed compliance across various activities and decrease in cost and paperwork (Anon., 2019). Whereas the secondary benefits can be strengthening relationships between stakeholders and promoting trust while engaging with them.

In recent years, several studies have been conducted to analyse how blockchain technologies can be integrated in the supply chain of different fields. In this paper, we analyse the uses of blockchain technologies in the container logistics and food supply chain. The benefits of real time tracking and tracing that different companies can use while implementing these technologies is analysed where tools like Radio Frequency Identification (RFID) and Internet of things provide real time information to suppliers, the blockchain technologies provides immutable transactions (Helo & Shamsuzzoha, 2020). Many sectors of commerce, government, and community are already being transformed by these developments, but they may also bring with them new difficulties and threats that must be anticipated. Many of these innovative applications in blockchain technology combine decentralised applications, distributed ledger technology (DLTs), and smart contracts, making it nearly impossible for third parties to censor or interfere with data.

The Blockchain Technology environment has factors that can prove to be the drivers and drawbacks and can be studied with a PEST analysis. The political, economic, social and technical factors have a bearing on the technology's adoption and diffusion too (Woodside, et al., 2017).

2.1.1 Blockchain technology for food supply chain

Blockchain can be implemented in the information security side of the food supply chain and provide accurate traceability for food stuff (Tse et al., 2017). Acquiring food certification needs supply chain tracking. Blockchain technology provides a permanent record for individual transactions stored in individual blocks that can't be toyed or destroyed with and can replace ancient methods of paper tracking, food and monitoring. Blockchain technology can be implemented well in the food supply chain to strengthen the traceability of the product and promote transparency of the products. Several food certificates such as Vegan, Fair-trade certificates require traceability of the raw materials and blockchain technology provides an innovative solution for the same.

Food safety is an important responsibility for governments across the globe and improving the efficiency of the supply chain can have long lasting and far-reaching benefits. The Chinese government has launched a research project on blockchain technology's application and development and are investing into the technology to integrate in the next generation of their supply chain (Tse, et al., 2017).

Global food supply chain contains a lot of different players right from the farmers, producers, food manufacturers, shipping companies, wholesalers, retailers. The key stages of a standard agri-food supply chain are outlined below (Fonts, et al., 2019).

1. Production: Agricultural activities that take place on the farm are represented by the production phase. To grow grains and food stock, the farmer uses unprocessed, organic materials. Farmers may have different production and harvest times around the year. Consumers are interested in the ways the food is manufactured and the working conditions of farmers involved and demand transparency in tracing of raw materials.
2. Processing: In this stage, a primary product is completely or partially converted to near finished goods. Large companies have mechanised this process already but there is a need to do batch tagging which helps in source food contamination. A packaging step is then anticipated, during which each package may be individually identifiable by a production batch code that contains details similar to the production time and a list of the raw ingredients utilised.

3. Distribution: Following packaging and labelling, the item is made available for the phase of dispersion. Delivery timing will vary depending on the item., the geographies, their storage specifications, whether it should be refrigerated or not before being stored.

4. Retailing: The products are distributed to stores after the distribution is complete. Retailers who carry out the goods sale (Retailers). The consumers are usually at the end of this chain.

5. Consumption: The consumer is the chain's final customer; he or she makes purchases. The goods and wants verifiable details about its production processes, country of origin, and quality requirements.

AgriBlockIoT System Architecture

AgriBlockIoT aims to provide consumers with the entire history of the food stuff being purchased. The requirement is that all members in the food supply chain are registered users of the blockchains with their unique public/private key-pairs to digitally sign each step of the operation on the distributed ledger with the blockchain. The following are the requirements that each participant needs to fulfil for the effectiveness of the AgriBlockIoT (Pincheira, et al., 2018, p. 3).

Raw Material Purchasing: Producers and suppliers keep the specifics of sales and acquisitions of raw materials in the blockchain, together with technical facts about the goods and quantities.

Planting: Producers store data about the planting process (such as the number of seeds utilised) on the blockchain. The sensors can automate this data entry procedure while smart contracts are activated on their own and create records when there are instances where the process does not meet required specifications.

Growing: Sensors automatically record information about the surroundings and developing plants in the blockchain from time to time. As smart contracts could asynchronously fire, if an anomaly is found (for example, when sensor values are outside of predetermined thresholds), records are created.

Agriculture: Farmers store data on every stage of the process (such as irrigation, pest control, fertiliser usage, etc.), including the quantities of seeds, fertilisers and pesticides used, in the blockchain. Blockchain has the potential to automate certain data entering procedures, limiting the paperwork.

Harvests: Farmers record information about their harvesting in the blockchain. Note that sensors can automate this data entry process (e.g., linked weight scales), and smart contracts can unanimously execute, guaranteeing that the entire seed-to-harvest process complies with laws.

Delivery to processor: Farmers are capable of transferring product ownership to distributors via the blockchain. The instilled smart contracts and sensors can automate this procedure and generate records anytime about anomalies that are found during the delivery phase.

Processing: Taking the most basic example of a packaging processor, the latter stores in blockchain information about the quantity of product received from distributors, the quantity packaged, and eventually the quantity of product lost during the processing step in the blockchain. Note that sensors can automate this data entry process (for example, connected scales for weights), and smart contracts can fire on their own and create records whenever an anomaly is discovered (for example, the packaged amount is lower or higher than the amount received).

Delivery to retailers: After food is processed, it is delivered to retailers with the help of an integrated blockchain platform. Smart contracts may eliminate the need for delivery notes and even in this process the GPS sensors and other tools work and may trigger warning when the procedure laid out in agreement is not followed.

Retailing: Retailers get information about the products and the quantity received on the blockchain and they are further displayed on the shelves. The blockchain stores information regarding the in-store conditions. In respect to refrigerated products, the temperature can be checked if it has been in the provided threshold or there were fluctuations during the process.

Consuming: Retailers store information about the sold products in the blockchain, while customers can trace the product journey and learn about the raw material sourcing of the product, the growing conditions and other related information which helps build reputation of the brand by bringing transparency and traceability to their consumers.

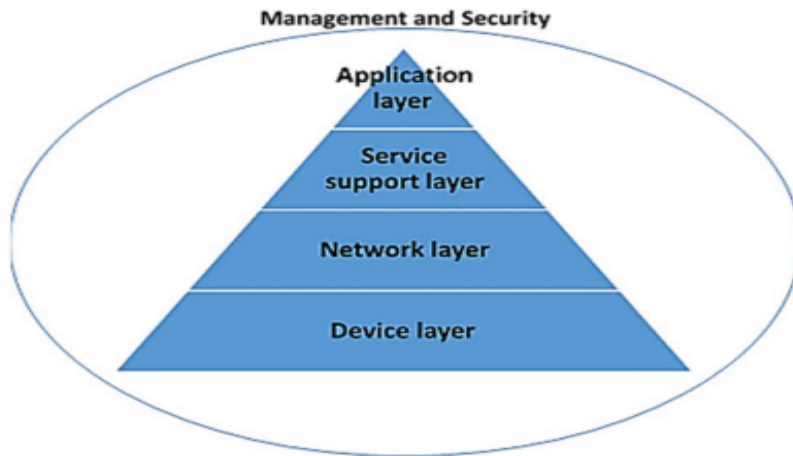


Figure 3 IOT ARCHITECTURE (BOUZEMBRAK, ET AL., 2019, P. 3)

The Iot architecture was designed keeping the food supply chain and specifies the four different layers that a business must implement to harness this technology.

- Device layer includes sensors, receptors and devices which help in communication such as Wi-Fi, Lan cable etc.
- Network Layer contains the main functions of the network based on the connectivity, mobility, authorization, accounting and authentication and it also contains the transport layers (Bouzembrak, et al., 2019).
- Service layer includes different services that help the IoT application and is useful in storing and processing data.
- Application layer contains the application and various services required
- Management and Security refers to the configuration of security and management for the resources, performances and the account.

IoT use in the food supply chain aims to increase safe, efficient and sustainable sourcing of foods in the near future. In their research, (Bouzembrak, et al., 2019) it was found that IoT in food supply was used for tracing food products, food safety and overall monitoring of the food safety and quality.

Food Security: The Food and Agriculture Organization (FAO) is a global organisation which lays emphasis on food security where there is enough food for people to feed themselves without facing malnutrition. As a result of violent political and ethnic wars, natural disasters, and other humanitarian crises, achieving this goal has proven to be incredibly difficult. Blockchain is seen as a chance to deliver foreign help transparently, remove middlemen from the distribution process, make data and assets verifiable and accessible, and, eventually, respond more quickly and effectively to humanitarian situations.

Food Safety: Food safety is the state of handling, controlling, and storing food in a hygienic environment to stop infections from spreading among humans. Increasing global trade flows have made it more difficult to ensure food safety and quality. Blockchain technology may be able to effectively address the pressing need for increased food traceability in terms of transparency and safety. Storing data about the products throughout the supply chain enables good hygienic conditions, early detection of tainted goods, fraud, and dangers.

Recently, the integration of blockchain with Internet of Things (IoT) has been proposed for real-time monitoring and tracing of physical data based on the hazard analysis and critical control points system (HACCP) (Feng, 2017).

A) link to production: Crop plants that have been harvested are bundled and RFID-labelled. New products are tagged and added to the database and key product information may be saved in their profiles. These essential details are: 1. background setting such as the soil, water, air, and sunlight quality. 2. cultivating a plant including: seed quality, operational procedures, variety, and item number, area used for production, growth status, planting time, time for picking, responsible businesses, even personnel etc. 3. Data regarding the application of pesticides and fertilisers is recorded.

B) Processing Link: Following product delivery, processing businesses could read and update the product's profile with new information by scanning its tags using scanners that are wirelessly connected to a network. The following details: 1. environment for processing, such as managing the temperature, cleaning, and processing equipment. 2. context of appropriate additive use. 3. Basic information on the processing company and the appropriate people (Feng, 2017).

This is especially important for the upkeep of the cold chain in the logistics of the delivery of perishable food items. Real-time problem identification allows for prompt notification of all parties and quick action. Utilising smart contracts will improve the security of product transactions and deliveries.

C) Warehouse management link: By deploying appropriate Internet of Things technology in storage facilities, the details of received goods can be acquired automatically. In the meanwhile, wireless sensors and monitoring tools, the real-time information store product's attributes, such as its size, category, and temperature. It is possible to examine and update humidity and storage time in Product profile and Tag (Feng, 2017).

D) Retail Link: When merchants receive the goods, they very immediately find out everything about the supply chain that led to products. Customers can therefore use the RFID reader to find out the fundamental details about things when they are shopping. Additionally, due to blockchain technology, all of the food supply chain's information may be properly audited which implies that users could get more specific information.

E) Inspection by Authorities: Authorities from different links in the food supply chain will periodically visit the working area to examine compliance with rules and regulations and, more importantly, whether the pertinent data has been altered before being updated by the participant. These organisations include certifications, audits, third-party authorities, and government departments. The outcomes of the inspection can then be saved to both parties' digital profiles (Feng, 2017).

Food Integrity: Food exchange in the supply chain must be trustworthy if there is to be food integrity. Each participant must provide full information regarding the products' origin.

Downstream beer in Ireland is one of the first to use blockchain technology by making all its data public where consumers seek information on beer, such as its ingredients and brewing processes. This craft beer's every detail is being noted and added to the Authenticity and transparency are ensured by blockchain. Consumers can scan the QR code on the bottle's front with their smartphones. and then directed to a website where consumers can get pertinent information about everything from the raw materials to the bottling.

The Grass Roots Farmers' Co-operative has a subscription service for meat products, and it harnesses blockchain technology to inform consumers about the growing conditions of the animals and the products contain a QR code in their labelling which contains the story of the meat that they purchase. Moreover, the consumer behaviour of the consideration of rapid development in technology has changed. Consumers are demanding more information about various aspects of the products and a genuine method regarding the traceability of products is desired.

Small Farmers Support

Small farmer cooperatives are a means for them becoming more competitive. Individual farmers can increase their volume of the crops they grow by joining cooperatives. FarmShare strives to establish new models of community cooperation, land ownership, and local economic independence. It is an advancement of the model of community-supported agriculture by utilising the distributed consensus capabilities of the blockchain, they can connect with each other better while setting standards for the whole cooperation to meet in their business practices.

Decrease spoilage and environmental awareness

Blockchain can contribute to increasing public knowledge of the environmental aspects of food production. Land, soil and water pollution are the important considerations for companies. Consumers are informed about the carbon emissions and footprint of different processes and demand more sustainable practices from their businesses. The achievement of the Sustainable Development Goals (SDG) of the United Nations depends particularly on the condition of the soil. In this setting, it is crucial to prioritise sustainable development, goods management, and judicious usage of agricultural fields, water resources, and soils. Improving transparency with the public and following it through the supply chain is crucial for applying pressure to producers and decision-makers on the issue of how the food is produced sustainably.

Supervision and management

The food supply chain can gain huge benefits from the use of blockchain technology by implementing it as a credit evaluation system and improving oversight and management efficiency. Additionally, it can be used to strengthen the oversight of agriculturally related international agreements. Food regulatory authorities such as FDA and HACCP can integrate the blockchain technology to monitor food manufacturers and ensure standards are met. Additionally, food contamination and product recall can be administered with the help of blockchain technology too.

2.1.2 Blockchain technology for Logistics

Blockchain technology in terms of logistics can provide great operational benefits such as cost efficiency, auditability and guaranteed continuity (Badzar, 2016).

A modular program containing six aspects can be implemented for the logistics industry using blockchain (Steiner & Baker, 2015). They are independently controlled and broadcasted on the same blockchain and co-exist in the system. The six modular programs are:

Registering: During registration, the real-world identity of the participant is linked to the digital identity of the blockchain, and they are enabled to interact. Access is provided to a profile with an individual key by the user.

Standards: Certain standards for production of goods need to be complied with to gain access to the blockchain and inspection of the product is required. When the standards are met, the participant is given a digital token (Steiner & Baker, 2015).

Production and manufacturing programs: They are deployed once successful certification is achieved and the program specifies the parameters for individual production facilities. The production parameters can be changed by certifiers following inspection. Producer programs are key for the traceability of finished goods. Manufacturing programs implement the transformation of input goods from the production programs to output goods and help in reducing waste (Steiner & Baker, 2015).

Tagging: tagging the product helps in linking the physical goods to digital counterparts and aids informed purchases along the supply chain.

Linking: The technology involved in linking the two participants on blockchain are RFID and NFC tags, QR and -bar codes and serial numbers. Right technology should be chosen for individual products for identification on the blockchain. Identities are assigned in the production and manufacturing programs; serial numbers or bar codes are chosen form of tagging where each tag contains a hash that links them to the blockchain (Steiner & Baker, 2015).

The product journey can be traced in the supply chain by the auditability and security of the blockchain. Product authenticity check and screening of supply chains can be done via phone applications to scan and gain access to information using RFID tags or other conspicuous holographic tags.

IBM and Maersk have adopted Blockchain technology through the platform of 'tradelens' and are considered pioneers in doing so in the shipping industry. Which has made competitors investigate adoption of such technology in their supply chain as well. Where the focus of the participants is to reduce paperwork, promote digitisation and use smart contracts to maintain transparency and trust between the parties.

Tradelens was claimed to be the world's first blockchain network in the industry of global supply chain (Scott, 2018) where digitisation and implementation of blockchain technology was meant to go hand in hand. Companies such as Dow Chemical, Tetra Pak forming the early participants in the tradelens platform.

The process of international shipping is long with various stakeholders. Tradelens aims to provide safe transport and signing of smart contracts which would reduce cumbersome paperwork and inefficiencies and human errors (Jović, et al., 2019).

CargoX is another company which uses blockchain technology with its BDTS platform (Blockchain Documentation Transaction System) which aims to provide a fast and efficient way to process shipping documents globally. CargoX removes the need for physical ownership of paperwork, and it transfers to digital proof of ownership. Bill of lading is one such document which is digitised and is faster and efficient. The CargoX platform aims to execute transactions in less than 20 seconds (Anon., 2017).

Ship Chain is another technology established with the use of blockchain technology which helps in monitoring cargo touch points globally by various stakeholders. The features of Shipchain include Visibility, Trust and Control (Jović, et al., 2019).

In their study (Jabbar & Bjørn, 2018), three different domains where blockchain technology could be applied in shipping were identified:

Port to port shipping – Maritime sector forms most of the global shipment trade and the underlying structures and paperwork required in the supply chain proves to be cumbersome. Which has been built on lasting negotiations and international policies. Currently, export consignments may consist of four major steps – export sales, finance, carriage and insurance (Jabbar & Bjørn, 2018). Apart from these contracts several other documents are required as well. The paper trail of the shipping industry is strained, and IBM and Maersk invested in implementing blockchain technology in port-to-port shipping which is the most structured part of shipping supply. They proved that this technological innovation may be used to simplify the process.

Bill of lading – It is the most important document while shipping. It is often traded when the goods are in shipment. The physical owner of the bill of lading is entitled to the shipment throughout different touch points of the supply chain. Oftentimes, the traders wish to remain anonymous to not reveal their trade positions to competitors. This problem may be solved with a credit note provided by the bank but there is a degree of mistrust involved between the parties. The introduction of blockchain technology can increase trust and transparency amongst the stakeholders.

Container weight rules – Container-weight rules are implemented to improve the safety on board for proper transportation of the shipment and for the safety of the personnel on board. The existing IT infrastructure across ports may not be integrated and this provides an opportunity for the blockchain technology to enter and provide a blockchain backed system (Jabbar & Bjørn, 2018).

Blockchain technology has relevance to governmental bodies and societies as they can promote social and environmental sustainability by monitoring their trade practices and keeping their carbon emissions in check

2.2 Diffusion of blockchain technology

Blockchain technology is a popular topic in the technology sphere and the implementations of it are hotly debated. The diffusion of innovations theory (Rogers , 1995) can be applied in the blockchain technology adoption and the category of adopters can be identified.

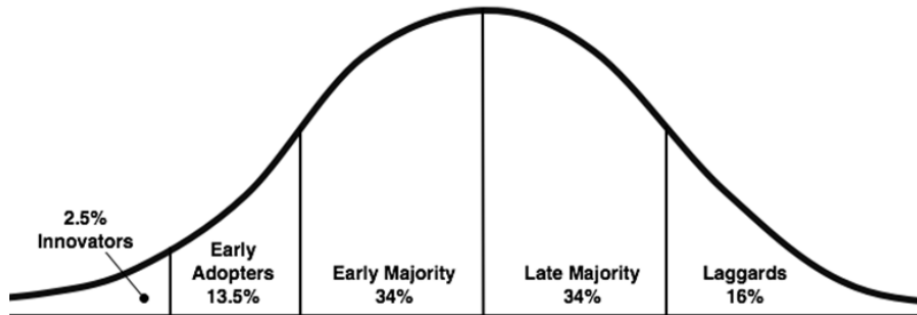


Figure 4 DIFFUSION OF INNOVATION ADOPTER CATEGORIES (ROGERS , 1995, P. 3)

Innovators: Innovators in the diffusion stage are the firsts to adopt a technology and are willing to set the trend for others to follow.

Early adopters: They are the second category on users who pass the knowledge stage and adopt a technology after the innovators

Early majority: The technology has started to become mainstream, and the majority of the consumers are aware of the technology and its uses.

Late majority: Economies of scale kick in, and the technology is available to the vast majority of consumer markets and those who were reluctant to participate initially are attracted to it and they participate as well.

Laggards: The last stage of the adopter's category who adopt a technology when it is out of fashion or it is at the end of its cycle.

Along with the five main adopter categories in the diffusion of innovation theory, five factors influencing adoption of an innovation are mentioned (Rogers , 1995).

Relative Advantage – What are the benefits of the current technology compared to the pre-existing technology that it aims to replace. Blockchain technology aims to disrupt the supply chain industry which has been in place for decades or even centuries and it is important to assess the relative advantage that blockchain can offer compared to traditional supply chain methods.

Compatibility – The adopters in each category have their innate values and expectations and compatibility of blockchain technology with them is an important factor for the diffusion of blockchain technology in the food supply and container logistic industry. Various stakeholders usually demand transparency and trust while dealing with different entities and blockchain aims to ensure the same.

Complexity – Is blockchain technology implementation going to be smooth and are the current IT infrastructures of different companies compatible with the needs of blockchain integration? The complexity of the proposed blockchain model along with its feasibility can have an important bearing on the adoption of the technology.

Trialability – Trial and testing of a new technology is crucial in the implementation of it on a longer scale. Companies would like to trial the implementation of blockchain on a smaller batch of shipment before wide scale application of the same.

Observability – The innovative technology should have tangible results which can be measured by organisations so the investments can be justified for the same.

Blockchain technology application in supply chain seems to be in its earlier stages and these factors can be further analysed to understand the diffusion of blockchain technology in food supply and container logistics industries.

Strategic	Tactical	Operational
1. Necessary collaboration	8. Knowledge deficit	12. Technical shortcomings
2. Necessary paradigm shift	9. Viable use cases	13. Process maturity
3. Market position adoption	10. Implementation method	
4. Compliance	11. Change readiness	
5. Sector pressure		
6. Organizational size		
7. Investment hesitation		

Table 1. Factors affecting blockchain technology diffusion (Post, et al., 2018, p. 5)

In their study, the identifying factors of blockchain diffusion were researched and grouped into strategic, tactical and operational (Post, et al., 2018). The strategic factors that could affect the diffusion of blockchain technology were – collaboration, compliance, sector pressure, organisational size and investment hesitation. Different stakeholders are not completely convinced to shift to blockchain technology-backed shipping supply chain and its implementations are being analysed. The knowledge deficit, implementation methods and change readiness from the tactical factors are affecting blockchain technology’s diffusion. Operational factors could be technical difficulties and the immaturity of the process stage (Post, et al., 2018).

2.3 Technology Acceptance Model (TAM)

Technology acceptance model (Davis, 1989) was developed with the perceived usefulness and perceived ease of use of a new technology in mind which affects the behaviour of the stakeholders.

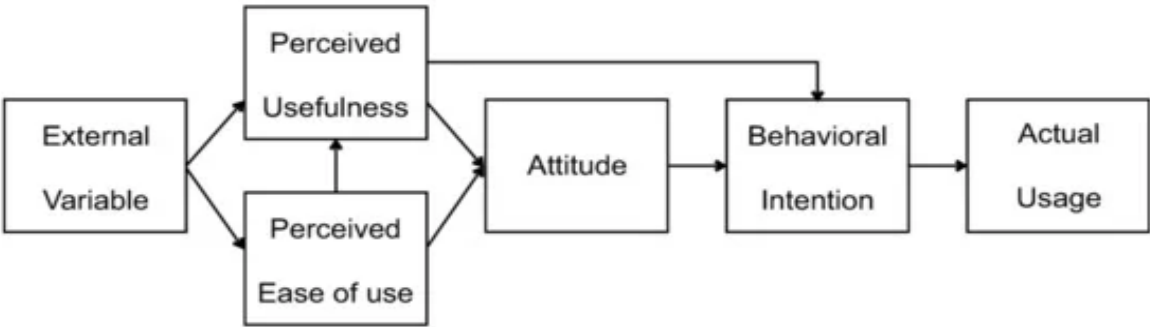


Figure 5 TECHNOLOGY ACCEPTANCE MODEL (TAM) (DAVIS, 1989, P. 2)

Perceived usefulness may be described as the potential benefits that a user may achieve in adoption or usage of a new technology and it affects the user’s attitude and his behavioural intention which may result in usage of the technology.

Perceived ease of use may be described as the potential ease at which new technology may be implemented. If a technology has a steep learning curve, and complex systems, it may negatively affect the user’s attitude and may not result in the adoption of the technology.

In respect to our study, external variables may be government regulations regarding safety and compliance or the competitors’ actions. In their comprehensive study (Kamble, et al., 2108) about blockchain technology adoption in India, it was found that perceived ease of use has an influence on the perceived usefulness of blockchain technology in the context of supply chain and the effect of perceived ease of use is insignificant on the attitude. Although, the perceived usefulness has a positive effect on the attitudes. The perceived usefulness merely forms a mediating variable between perceived ease of usage and the attitudes of the user. Peer pressure and compliance issues were significant external variables that may influence the attitudes of the user towards the adoption of the technology.

Based on the implementation of blockchain technology in food supply and Container logistics by industry leaders and pioneers we can analyse the adoption stage of the technology and the relevant factors.

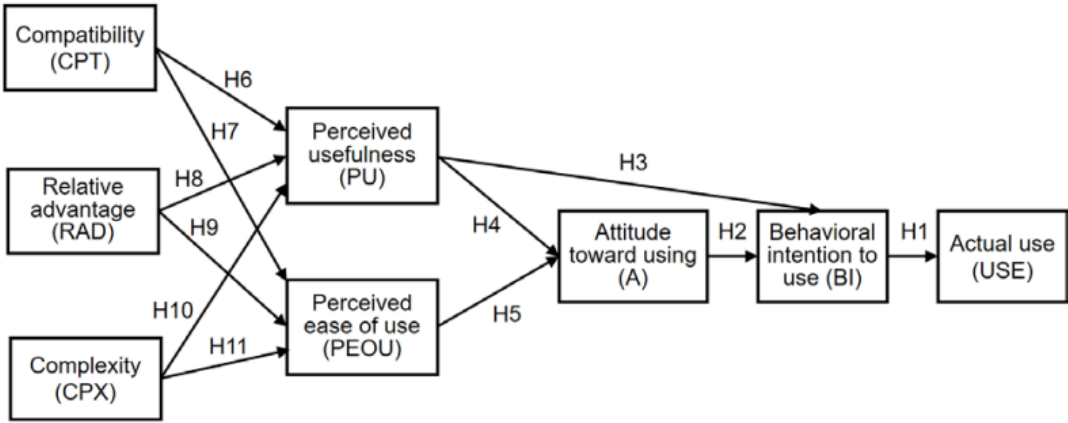


Figure 6 RESEARCH MODEL FOR INTEGRATING DIFFUSION THEORY AND TECHNOLOGY ACCEPTANCE MODEL IN ADOPTION OF BLOCKCHAIN TECHNOLOGY (LOU & LI, 2017, P. 4)

The research model is relevant to our study of blockchain technology acceptance in food supply and container logistics. In technological innovation, compatibility, relative advantage and complexity are the important factors affecting the diffusion which along with other external factors, affect the perceived usefulness and perceived ease of use. For industries such as the shipping industry, perceived usefulness has an important bearing in the attitude towards the technology and perceived ease of use acts as an auxiliary for the perceived usefulness. The research model will be analysed with the help of exploratory analysis and the factors affecting the acceptance of the technology for the shipping industry and the diffusion of technology in the food supply industry will be explored.

Technical adoption and diffusion of blockchain in supply chain are considered in previous studies to understand the potential benefits and drawbacks of adopting them in their digital architecture. It was noted that blockchain has the potential to disrupt the supply chain and provide better governance, system automation and efficient performance (Chang & Chen, 2020).

3. METHODOLOGY

In analogy to the research questions, the objective of this study is to expound on the potential of using blockchain technology in supply chain management while establishing a set of benefits it can bring to the container logistics and food supply industry.

A semi structured expert interview is conducted with a business owner in the food manufacturing industry where the potential implementation and uses of blockchain technology are discussed.

Additionally, exploratory analysis will be conducted with recent publications in journal articles, interviews from company executives and tech-enthusiasts. The different participants in the adopter stage of blockchain technology's diffusion are identified with the help of the research.

Therefore, this paper would include primary research based on the interview and secondary research based on literature reviews, blog posts and interviews of relevant personnel. Based on this research, the data is collected and analysed in accordance with the research questions and observations and conclusions are arrived at. The managerial implications of blockchain technology in food supply chain and container logistics are also discussed.

Qualitative research is suitable for this study as the blockchain technology usage in supply chain is yet in its initial stage and the acceptance and resistance factors for various stakeholders are not entirely determined yet. In depth interview provides a flexible approach and as a primary research lays foundation for qualitative research across adopter categories. In depth interviews help in acquiring detailed information than data gathering methods and provides a more comfortable environment for respondents (Boyce & Palena, 2006).

Technology acceptance model and Diffusion of Innovation theories are applied to the case of blockchain technology usage in the Food supply and Shipping industry. These theoretical frameworks will help to identify the underlying factors for the technologies' acceptance and diffusion across industries.

3.1 Data Gathering

The data-gathering process consists of semi-structured, face-to-face in-depth interview and exploratory analysis based on secondary research.

The interview was conducted based on the framework of predefined questions regarding the implementation of blockchain technology in the food supply industry and it was semi-structured based on the answers. The interview was conducted for 50 minutes and took place in November 2022, in Budapest, Hungary. Previous research on the adoption of blockchain technology was kept in mind while framing the questions.

The interviewee was informed about the nature and purpose of the study beforehand and how they shall contribute to the same. The interviewee willingly and fully participated in the interview and was informed about the duration of the interview.

The interview was divided into two phases where initially the respondent introduced himself and his business and was informed about the topic and the second part focused on the research questions.

For the purpose of secondary research, various sources are identified, and the collected data is compiled and compared and finally analysed in context of the research questions. The research questions specific to this study are analysed for food supply chain and container logistics.

4. RESEARCH ANALYSIS

With the help of the theoretical framework and data collected in the research, an exploratory analysis is conducted along with findings from in depth interview. The factors affecting diffusion of innovation and acceptance of blockchain are studied.

4.1 Blockchain technology integration in Food Supply Industry

Primary research: In-depth interview was conducted with Dilip Purohit, the owner of Gaia foods kft established in 2022 in Budapest, Hungary. Dilip Purohit is a post-graduate with an Economist in Marketing Management degree from Corvinus University and is educated and aware about blockchain technology and its application related to the food supply industry. Gaia foods aims to penetrate the Hungarian market in the category of store bought and refrigerated hummus section and bottled Tahini. The product offerings are vegan, and the raw materials are currently purchased from local vendors most of which are sourced internationally by its vendors. Gaia foods does not use the blockchain technology in its current proceedings but the potential application of the same in the food supply industry especially in the fast moving consumer goods sector, refrigerated sectors are discussed and the potential benefits and challenges associated with the implementation of such technologies for small businesses are analysed.

4.1.1 In-depth Interview Findings and exploration

Questions in the interview were asked with the research objectives and questions in mind and based on the pre-existing literature. It is important to note that the Interviewee was aware of the mechanisms of blockchain technology and its potential uses in the food supply chain industry.

Limitations of traditional supply chain and how blockchain technology can be used to overcome them – Shortcomings in their current supply chain for Gaia Foods were identified as follows.

The origin of the raw materials is not transparent and the degree of traceability of the components is low. “Food manufacturing businesses in Hungary have to follow Hazard analysis and critical control points guidelines regarding sourcing of raw materials and the customers are more information seeking therefore traceability of raw materials for these purposes and potential allergen is important information” Dilip, Gaia Foods. The guidelines for food manufacturing are set by HACCP which form the compliance part of businesses (Feng, 2017) and there are restrictions on the raw material items that can be sourced for further processing. There are import duties that need to be paid and certificates of origin and standards that need to be met while importing goods from outside the European Union.

The following implications based on the interview were identified for food supply chain specific to Gaia Foods - Customers are information seekers and appreciate traceability and complete specification of products while making purchases and brand adoption. Apart from the customer's perspective, traceability of raw materials is required. Batch traceability is required to identify if there is a specific fault in a batch of production and helps in deciding if a product batch needs to be called back if it does not meet the food safety standard. Therefore, the traditional supply chain offers less transparency for Gaia foods while purchasing raw materials and in turn offers limited traceability to its end customers who are curious about the product journey. Compliance with food safety and standards can also be cumbersome and tracking stamps are used for different batches and their records are kept till the products are on the shelves.

“I am aware of the potential application of blockchain in Gaia foods and have gone through blockchain applications such as Vechain, although I am not keen on implementing the same right away” Dilip. The respondent is aware of the application of such technologies in the food supply industry and its potential benefits but is not convinced about exerting resources to implement the same right away. “These are turbulent times to do business and I am wary of spending on such technologies and increasing my expenditure although I know the benefits, I can reap from it” Dilip. Barriers to entry for this technology does seem to exist while it is easier for companies with large resources at disposal to try, test and implement blockchain in the supply chain. This is specifically true for container logistics where firms like IBM and Maersk invested in Tradelens and convinced various stakeholders involved to participate in the same. Based on the interview it can be identified that Gaia foods has not adopted blockchain technology yet and there is an amount of knowledge inadequacy regarding the same. Therefore, they do not participate in the innovator or early adopter phase of diffusion in blockchain technology in food supply. The respondent was open to implementation of the technology if their business grows to a larger scale covering the markets of other countries and an increase in the number of stock keeping units.

Integration of the technology is required from farm to plate for full efficiency and traceability of products and since their suppliers do not use blockchain technology, the usage can be limited for Gaia Foods alone. This raises important questions about integration of the technologies and the complexity of the necessary collaboration required by various stakeholders for the implementation of such technology in their business (Post, et al., 2018).

“I believe this technology is not mature enough and my customers are not necessarily demanding this from me but I’m aware of its benefits and will look into it again once the technology matures and given all is well with my business in the near future” Dilip.

Therefore, limitations such as financial costs, integration issues are the main challenges of Gaia foods that hinder their adoption of blockchain tools in the supply chain. It can also be ascertained that they do not belong to the innovator category and may adopt the technology later not due to knowledge deficit but due to feasibility concerns. Based on the competition and the factors affecting blockchain technology diffusion, the respondent may adopt the technology in the later stages of its diffusion.

4.1.2 Secondary Research in food supply industry

Consumers have started demanding more from their businesses and the case for the food supply industry is important for its traceability and trust building.

It is important to identify the companies that have already implemented blockchain technologies in their food supply chain.

-Bumble Bee Foods uses blockchain technology in its tuna operations and is using the SAP Cloud Platform Blockchain (SAP, 2019) where customers can see the journey of their yellow fish tuna that reaches their table with the aim to improve traceability and the tuna is traced from the time it is caught / farmed to the point of sales (Haskell, 2022).

-Nestlé provides traceability of its coffee brand Zoegas which is Rainforest Alliance certified. This helps build trust amongst the consumers and they enjoy the traceability aspect of the product and there is a higher degree of reliability while making the purchase (Nestlé, 2020).

It was the first time that Nestle entered into a partnership with a third party to provide reliable information to their consumers more than they usually do. Rainforest alliance provides their own certification on the platform and is accessible on the IBM food trust blockchain platform. Customers are able to follow the product journey and get information regarding farmers, harvest conditions and season along with the roasting period. Mousline purée is another product where Nestlé provides customers access to blockchain (Nestlé, 2020).

- Walmart requires suppliers of leafy green vegetables to input their data into a blockchain system platform which helps them in identifying sources of food contamination (Haskell,

2022). Additionally, as early as in 2017, Walmart announced partnerships with suppliers such as Tyson Foods, Unilever, Dole and Kroger to improve traceability of their products for customers to follow the product journey (Sristy, 2021).

- Kraft Heinz is the company that uses blockchain technology in their children's food section to improve traceability (Nutrition insight, 2019).

Important observations can be made regarding the companies that have adopted such technologies, they are global brands in the food sector and have complex supply chains and their customers seek additional information on the products they buy and oftentimes purchase decisions can be based on the traceability of the ingredients.

In addition to corporates, National governments and food safety and regulatory authorities are keen on implementing the blockchain technology in their standards to improve traceability and transparency in the food supply chain. The FDA has analysed the new era of smarter food safety (FDA, 2020) enabled by technology such as blockchain to improve business processes and their four core elements were identified as Tech-Enabled Traceability, better approach to prevent and outbreak response and food safety culture. These issues can be tackled with the help of blockchain technology.

We have found these companies that are willing to be the pioneers in terms of application of the blockchain technology in their food supply chain are innovators in that respect. Due to the complexity and immaturity of the innovation.

Blockchain technology requires the systems to be always connected to the blockchain networks which raise some uncertainties (Antonucci, et al., 2019) regarding:

- Ownership of maintaining the infrastructure
- Complex implementation of infrastructure to enter smart contracts with government or other agencies
- Distributing advantage and defining an economic model which works for the food supply chain
- Different strategies & technical aspects which can be applied to fully harness the potential of blockchain in agri-food industry

Traditionally there are five factors that affect the diffusion of innovation (Rogers , 1995) namely relative advantage, complexity, compatibility, trialability and observability. We need

to analyse these factors with respect to blockchain technology and it has been found that relative advantage, complexity and compatibility are the important factors for diffusion of technical innovations (Lou & Li, 2017). In their paper, the proposed research model, compatibility and relative advantage was hypothesised to have a positive effect on the perceived usefulness and perceived ease of use whereas complexity negatively affected the perceived usefulness and perceived ease of use. These factors alone are not enough to analyse the use of blockchain technologies in the supply chain management and industry specific analysis is required.

Factors affecting blockchain technology diffusion were grouped into three categories namely Strategic, Tactical and Operational (Post, et al., 2018). These factors are analysed with regard to the food supply chain based on our primary and secondary research.

Strategic Factors affecting blockchain technology diffusion in food supply chains:

Necessary collaboration: Implementation of blockchain requires extensive collaboration externally with every touch point and internally as well. Extensive collaboration between different stakeholders is crucial for the exchange of data between the participants of the supply chain. The company's own IT infrastructure should have the necessary alignment to accommodate such technologies. In the example of Gaia foods, the suppliers of raw materials do not use this technology to gain transparency and traceability of their produce therefore they cannot implement it themselves successfully.

Necessary paradigm shifts: The IT infrastructure of participating companies need to shift their way of thinking from introvert to extrovert paradigm and it should aim to include its customers and users (Post, et al., 2018). Food manufacturing companies realise that the consumers need more transparency from them in terms of the sourcing of raw materials and adoption of blockchain technology which enables consumers to seek information and build trust with the sourcing process of the company.

Market Position adoption: Introduction of blockchain technologies may push companies to newer ways of generating revenue and shifting their position in the market but in the case of food supply chain, increases customer's trust in the products and helps getting competitive edge compared to others in the market.

Compliance: In the food supply Industry, companies need to adhere to standards set by the Food Safety and regulatory authorities. FDA in the USA and HACCP in Europe list the required safety and sourcing requirements for companies. The regulatory bodies are aware of the potential benefits of integrating blockchain technology to comply with the sourcing and batch tracing which may also help in identifying contaminated products (FDA, 2020).

Sector Pressure: The diffusion of blockchain technology in the food supply chain is still in its early stages and companies with large resources can introduce it to specific product ranges such as Nestle and Kraft. Market pressure from competitors may push companies to adopt these technologies. Whereas for small business such as Gaia Foods, it is not an important consideration as the local rivals do not harness this technology.

Organisational size and Investment hesitation: Companies with complex food supply chains may not be able to implement such technology as it may be too cumbersome in a turbulent business environment and the existing digital infrastructure does not suit the application. Similarly, small businesses may not have the financial capacity and are risk averse in these turbulent business environments to invest in such technology which is not largely proven yet.

Tactical Factors affecting diffusion of blockchain innovation in Food supply chain:

Knowledge deficit: Organisations may suffer from knowledge deficit about blockchain in general and required domain and technical knowledge (Post, et al., 2018). They may decide to outsource the technology, but small businesses may not have the resources at bay to implement blockchain in their supply chain. In addition to knowledge deficit, the viable use cases may not be clear as the technology is still in its infancy stage and the implementation methods are not clear. Companies with large personnel and complex supply chains may also face resistance from employees while trying to adopt such technologies in the supply chain.

Operational factors affecting diffusion of blockchain technologies can be grouped into technical shortcomings and process maturity where companies may not have the required tools to adopt such technologies in their infrastructure. Gaia foods is a small food manufacturing company and faces such issues where their production process is not mature enough to implement these technologies seamlessly and do not possess the required IT tools to do the same.

By applying the diffusion factors for blockchain technologies into the food supply chain, we can understand that the technology is not mature, and it is accessible to multinational companies such as Nestle, Kraft who have the resources to invest in them. Niche operators also invest in this technology such as The Crafty Pint (Anon., 2022) which is a beer brewery, and it helps them communicate their sustainability message and the traceability of their products too.

4.2 Blockchain Application in Container Logistics Industry

Based on our secondary research and data gathering we can identify companies that have implemented blockchain technologies initially and the scope of its application. Along with identifying such firms, the process by which they are utilised by the firms is described. The factors that affect the technology's diffusion are also explored.

The blockchain technology is still in its initial stages and it is the innovators and early adopters who can utilise their potential. Following are the major blockchain technology developments in the Maritime Industry in 2018 when it was the breakthrough year for blockchain technologies in supply chain industry (Anon., 2019).

- In August 2018, the first bill of lading was issued with blockchain technology at Port of Koper, Slovenia by CargoX Smart bill of lading. The bill of lading was issued electronically and was executed in just minutes instead of the lengthy procedure (Anon., 2017).
- In March 2018, 300 cubits completed the first shipment with smart contract on the Ethereum Blockchain. The shipment went from Malaysia to Brazil and contained two 40-foot-high cube container boxes
- Maersk and IBM introduce TradeLens (IBM, 2018)
- Abu Dhabi Ports Launch Blockchain technology for trade community
- EY and Guardtime announce the world's first blockchain platform for maritime insurance.
- Port of Antwerp Develops Blockchain document workflow based on smart contracts.

The above mentioned are the pioneers in adoption of blockchain technology in container shipping and aim to bring the technology to wider audiences around the world. It may be noted that shipping industry can be a complex industry where the functioning is affected by

decades of negotiations and governmental regulations but the perceived usefulness of the technology in the long run outweigh the barriers and we can see companies paying heed to these technological advancements and implementing the same in their supply chain where smart contracts are entered into and there is transparency throughout the supply chain and transactions can be executed instantly.

Tradelens, a blockchain solution platform built by IBM and Maersk aims to reduce global shipping cost, improve transparency and decrease inefficiencies caused by non-automation of processes (IBM, 2018).

Blockchain technologies can be used in the exchange of information in seaports, information flow and operations (Jović, et al., 2019).

The current container logistics supply chain can be tedious with several licences and paperwork required to ship goods and it may be difficult to get real time information regarding the other parties due to the presence of speculators and traders. Blockchain technology has the potential to streamline the shipping industry and promote trust and transparency amongst the stakeholders and smoother exchange of data and cost reductions.

The technology adoption model (Kamble, et al., 2108) can be used to understand the adoption of blockchain technologies with respect to the Shipping Industry.

The external variables are regulatory authorities and government customs and paperwork which strain the supply chain process and the competitor's innovativeness. We have seen that IBM and Maersk took initial strides in utilising blockchain integrated supply chain platforms with Tradelens (IBM, 2018) and other companies like DHL followed suit.

Similar to the findings of previous study (Kamble, et al., 2108) perceived usefulness has an important bearing on the attitudes and usage decisions amongst companies and the perceived ease of use is an axillary to perceived usefulness to positively affect the attitudes of stakeholders. The benefits of adopting blockchain technology in shipping industries to promote sustainability and increase efficiency are identified in various studies (Badzar, 2016) (Jabbar & Bjørn, 2018) (Steiner & Baker, 2015).

Perceived usefulness of the blockchain technology is affected positively due to factors such as digitalisation of the physical paperwork and improving transparency for all stakeholders.

IBM and Maersk, CargoX, DHL are some companies that have envisioned a better supply chain with the integration of blockchain technology and invested in them with their different platforms. Shipping industry is a complex industry where different parties may change resistance and it is important for collaboration throughout the supply chain to be convinced of the technology. Although, the perceived usefulness outweighs the perceived ease of use when affecting the attitudes of users.

The important factors of the diffusion of blockchain technology in the shipping industry can be identified on the strategic, tactical and Operational factors (Post, et al., 2018).

Strategic factors are crucial considerations for shipping companies as the traditional supply chain is quite complex. The strategic factors include:

Necessary collaboration: Internal and external collaboration are necessary considerations for the diffusion of blockchain technology in the shipping industry. Organisations would need to collaborate externally on their data models, decision structures and business process (Post, et al., 2018). The perceived usefulness of this technology will have a favourable impact on the decision to adapt blockchain integrated platforms. Internally, organisations should not lay much emphasis on the perceived ease of use and align their IT infrastructure.

Paradigm shifts are required in the archaic structure that the shipping supply chain uses traditionally and relies on extensive paperwork. IT infrastructure can be more transparent with different stakeholders and streamlined.

Market position adoption: Blockchain technology can cause disruptions in the existing market structure where intermediaries and speculators may be eliminated and pave way for new revenue streams and market entrants (Post, et al., 2018).

Compliance and Sector Pressure: Regulations and compliance for shipping companies can be enforced with the help of blockchain technology by digitising the delivery note and handling other port activities and checking shipment weight. IBM and Maersk's tradelens platform may put sectoral pressure on other supply chain companies to roll out blockchain integrated systems if the perceived usefulness is considered high and to not miss out on future revenue streams.

Organisational size and hesitation in Investment: The large financial resources required for introducing this technology by aligning the IT infrastructure may deter companies from

opting for blockchain based shipping supply chain. Complexity of collaborating with different stakeholders may not be possible if all are not on the same page.

Tactical factors include knowledge deficit, viable use cases, change readiness and implementation methods. Large shipping companies have a pool of talent at their disposal and do not face a knowledge deficit, but they can be sceptical about their viable use cases due to uncertain forward outlook for the technology and the extent and speed at which the diffusion occurs (Post, et al., 2018). Government organisations are usually important stakeholders in the shipping industry, and they might be reluctant to change and processing a streamlined implementation method may need extensive negotiations.

Operational factors affecting the diffusion of blockchain technology in the shipping industry include technical challenges and process maturity. Aligning the IT infrastructure to accommodate blockchain technology needs a significant amount of investment and standardisation and companies which have large resources with matured processes may benefit from implementing a blockchain platform with digital contract to reduce cost and increase transparency.

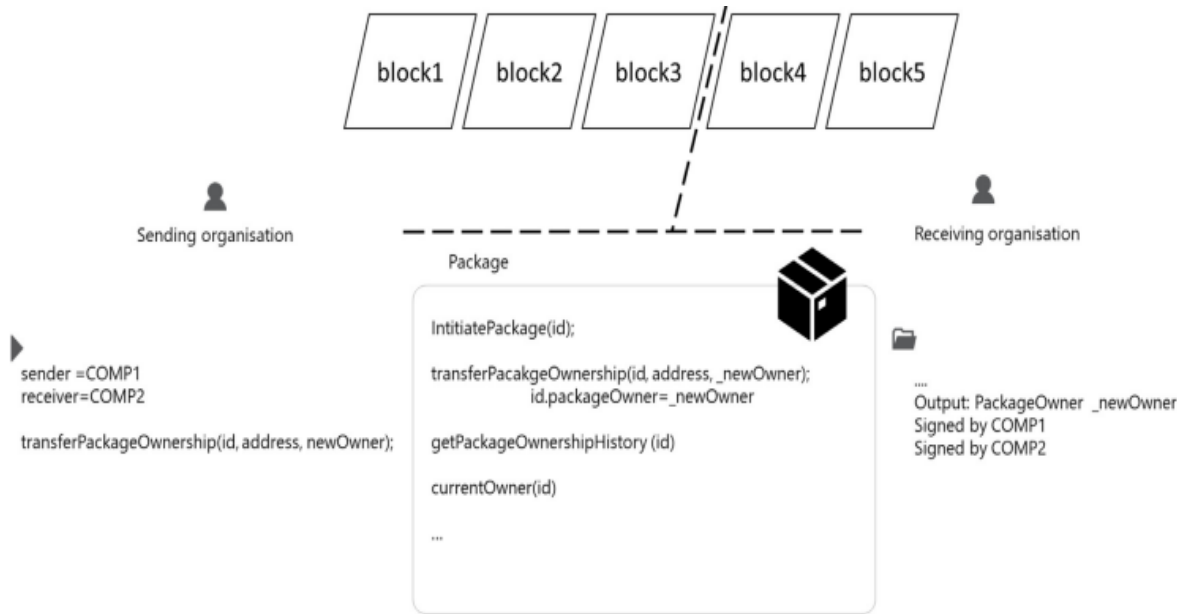


Figure 7 SUPPLY CHAIN VIA BLOCKCHAIN AND SMART CONTRACT ARCHITECTURE (HELO & SHAMSUZZOHA, 2020, P. 8)

Smart contracts help to build trust and transparency amongst the dealing parties and each block is placed after another to form a chain and have traceability. This technology is being

implemented by supply chain logistics companies and at several ports as well. Ocean carriers such as CMA CGM, COSCO SHIPPING Lines, Evergreen Marine, OOCL, and Yang Ming; terminal operators DP World, Hutchison Ports, PSA International Pte Ltd, and Shanghai International Port; and software solutions provider CargoSmart have initiated a blockchain consortium (Anon., 2019). Blockchain technology due to its perceived usefulness has convinced stakeholders through the shipping industry to update their supply chain and integrate an open digital platform powered by distributed ledger technology.

4.3 Research findings

Based on the primary and secondary research and exploratory analysis, our research questions regarding blockchain in the food supply and container logistics industry can be brought to light and analysed.

Research Questions:

- What are the shortcomings and disruptions of traditional supply chains and how can blockchain technology be harnessed into the food supply and container logistics?
- What are the factors affecting the diffusion of blockchain technology and the advantage of being innovators and early adopters in industries such as container logistics and food supply?
- What are the risks associated with applying blockchain in supply chain management? How can they be mitigated?

Based on the literature review, semi structured personal interview and secondary analysis findings particular to this study's research questions can be analysed. The adoption of blockchain is visible in food supply and container Industry but the nature and characteristics may vary and are therefore analysed separately for an in depth understanding.

In their research, an integrated model of Innovation diffusion theory and Technology acceptance model for the case of blockchain technology was formulated and helps in the analysing our research findings as well. The shipping Industry has fewer players than the food supply industry and the characterises are different and therefore an integrated model helps us better understand the factors involving acceptance of the technology and its diffusion.

4.3.1 Blockchain technology for Food supply chains

Shortcomings in the traditional food supply chain are due to non-traceability of origin of raw material and lack of information about the manufacturing or food handling process. Additionally, food regulatory authorities such as FDA and HACCP require food manufacturers to provide certificates of product origin while importing and batch stamping. Food alteration is an important concern for regulatory authorities and implementing a batch stamping for food manufacturers may prove to be a strenuous process. We have seen that customers have started demanding more information about the products that they are buying related to the allergens, or the raw material traceability. There are specific labels assigned to a product which can be displayed in the labelling such as vegan product, but consumers have become more information seeking and companies which promote complete traceability of their product stand to get favourable results from consumers. Nestle's coffee brand Zoegas uses IBM's food trust blockchain platform. Consumers, by scanning the QR code on the product can follow the coffee's journey and get information regarding farmers, harvesting times, roasting time frame etc.

Additionally, integrating blockchain technologies may need collaborative effort internally and externally of the organisation and for companies that do not source their raw materials internally, may find it challenging if their supplier is not focused on the same metrics and transparent in their sourcing and traceability of their raw materials such as Gaia foods. Their local suppliers source raw materials from outside Europe too from countries such as Turkey and Israel. Customers may be interested in seeking information about the product journey, but it requires collaboration from the producer link, manufacturing link and retail link. Internally, maintaining a functional blockchain integrated platform requires educating employees and investment in the IT infrastructure, changing their labelling. Such changes would bring their consumers closer, associate with the brand and increase their reputation. Therefore, it is noticeable that companies that have large financial resources and are in control of producing (farming) food manufacturing and close retail link can roll out these technologies in some of their product range and increase the products backed by blockchain technology once they are feasible for their business. The business process maturity is another important factor which affects the diffusion of blockchain technologies and smaller companies may not have been convinced of the perceived usefulness even if the perceived ease of use is considered high.

Companies such as Nestle, Kraft have integrated blockchain technology, in particular products which give their information seeking consumers an insight of the product journey from ‘farm to folk’ and there is traceability of the raw materials used in the product. FDA has also emphasised on the advantages of using blockchain for regulatory purposes and checking food contamination and product recalls (FDA, 2020).

It is important to determine the factors specific to an industry that have a bearing in the diffusion of innovation. In our analysis, we have noticed that the factors for food supply and container logistics are different. The important factors for food supply are mainly strategic and operational (Post, et al., 2018). The necessary strategic factors are internal and external collaboration, market position adoption, compliance with food safety regulatory authorities, Investment hesitation and Organisational size which are important considerations. Operational factors such as technical shortcoming and process maturity make organisations change resistant as well.

Blockchain Technology in the food supply chain is a relatively new concept where companies with large resources can implement certain product or pilot programs. Additionally, niche products such as craft beers have proven to benefit from blockchain platforms where beer enthusiasts can trace the components that go into their beer with ease. Smaller companies such as Gaia Foods kft may not have a mature enough business process and the capacity to implement blockchain can be harnessed later.

Regulatory authorities such as FDA and HACCP are working on mechanisms to integrate these technologies in their framework and have realised that this may be the future for improving traceability, containment of product contamination and product recalls and promote the use of such practices for businesses (FDA, 2020).

4.3.2 Blockchain technology in Container Logistics Industry

Shipping industry forms a major part of international trade, and it involves a lot of tedious paperwork, and the supply chain has been impacted by decades if not centuries long negotiations. There are constraints while dealing with different government authorities and at times, mistrust between the suppliers and customers about non-payment after receiving the goods (for suppliers) and about not receiving the foods at all or in specification of their order. There is also the presence of third-party interest and speculators who act as middlemen and purchase from large manufacturers and supply to their clients the delivery notes without

getting involved in the shipping process. The process of transferring delivery notes is expensive and there are cases where the receiving party does not have the physical delivery note.

Integrated Blockchain platform has the potential to solve majority of these issues but requires extensive collaborative effort internally in the organisation to align their IT infrastructure and externally along the supply chain and convince all parties involved of the perceived usefulness of adoption of this technology.

The perceived usefulness of adopting blockchain to supply shipping supply chain has been documented well such as updating archaic systems, reducing carbon emissions, cost reductions and efficient transfer of data (medium.com, 2018).

Using smart contracts, the involved parties can be informed about the real time ownership of the shipment and track it. When data is stored along the blocks and relevant parties have access to them, the execution of transactions can be done in seconds and the cumbersome paperwork is digitalised. Additionally, weight checking of the shipment can also be recorded in the blockchain mechanism and can help them comply with the regulations. Large Ocean carrier fleets have signed a Memorandum of Understanding and are forming a Global Business Network based on distributed ledger technology (Anon., 2019).

The factors affecting the diffusion of blockchain technologies are different in comparison to the food supply industry. Due to the high perceived usefulness of blockchain integrated systems, we have seen that logistics companies have invested heavily in them such as IBM and Maersk and prove to be industry pioneers when it comes to their adoption. It does need extensive collaborative efforts, but emphasis is on the perceived usefulness rather than perceived ease of use therefore the willingness to adopt the technology is high. The presence of blockchain integrated platforms in the shipping industry is also growing and there is sectorial pressure that pushes organisations to innovate and compete with their rivals.

Amongst the Strategic, Tactical and Operational factors affecting diffusion of blockchain technology in shipping industry, the strategic factors have the most important role as shipping industries have large human and financial resources but reaching an industry wide consensus and collaborating internally and externally with trade partners may be faced with resistance. Also, the introduction of blockchain technology in shipping can remove the role of speculators and middlemen and create new market opportunities for innovative companies.

One of the most important factors in implementing this technology is the technical shortcomings that organisations may face which are adequate data models, standardisation needs and the tools to support it. The integrity and quality of data is important for the blockchain technology to work efficiently, for standardisation across the platforms a new software development cycle needs to be rolled out and supporting tooling such as RFID tags, scanners that help in implementing blockchain technologies need to be invested in.

For companies that have not adopted blockchain integrated platforms, face considerations such as organisational size and investment hesitation. If the existing system is working well and the complexity involved may deter new entrants to use this technology even though there is sectoral pressure to do so. Risk Averse organisations who are not entirely convinced of the perceived usefulness of the technology may not invest in blockchain and may wait to roll them out. Also, in the shipping industry, changing the supply chain systems may prove to be a lengthy procedure as the digital infrastructure and legacy systems in place need extensive efforts, research and investment to change.

Despite these drawbacks, their perceived advantages such as reliable and smoother data exchange , reduced time in document processing ,cost efficiency, transparency and secure communication (Jović, et al., 2019) are gaining momentum and we can see widespread use of blockchain integrated platforms in shipping industry where stakeholders such as exporters , importers , carriers and ports are involved in a balanced system and the mistrust is minimised. Companies can gain various primary and secondary benefits with application of blockchain supply transparency (Anon., 2019). Primary benefits include reduction in admin and paperwork costs, and loss from Gray marketing while improving the traceability and visibility of the processes. Secondary potential benefits may be engagement amongst stakeholders, improved reputation and credibility by being transparent in their practices.

The main bottleneck is global rollout of blockchain in the shipping industry may prove to be the non-presence of a single underlying system and knowledge deficit amongst users.

5. CONCLUSION

Extensive literature review and exploratory analysis helps us better understand the hotly debated issue of blockchain in the shipping and food supply industry.

In terms of the shipping industry, the impact that blockchain has had, has been largely positive which is in line with previous studies conducted on the topic where the main advantages of

this platform would be transparency and decentralisation of systems. The need for lengthy paper documents and long execution times may be done away with by integrating blockchain technology and can help in avoiding paper forging and other malpractices.

Numerous pilot projects and trials are conducted by logistics companies, but the technology is yet to reach its maturity and its seamless integration needs involvement across all stakeholders such as ports, manufacturers, government regulatory authorities, insurers etc. Unless an integrated and standardised approach across stakeholders is achieved the benefits of this technology may not be fully exploited. Despite its current limitations, blockchain has the potential to evolve the container logistics industry and World Economic Forum has noticed the same and state that global trade can be increased by more than one trillion US dollars by 2028 by aligning trading processes, removing barriers and managing the risks involved with the usage of the technology (World Economic Forum, 2018).

Innovators started pilot projects in blockchain as early as 2018 and early adopters and entrants have entered the market. The diffusion of the technology with respect to blockchain depends on strategic factors such as seamless internal and external collaboration, along with aligning the IT infrastructure to accommodate the new standards. The three main domains where blockchain technology can be utilised in the shipping industry have been identified as port-to-port shipping, bill of lading and container weight rules (Jabbar & Bjørn, 2018).

In the food supply industry, the introduction of blockchain technologies is still limited to companies with large resources and niche markets where customers appreciate transparency and traceability. For smaller companies, who are not in control of the entire manufacturing process that is farm-fork cannot easily integrate a full proof blockchain technology which may improve the traceability of their raw materials as their suppliers and retail link may not have the capacity or the will to do so. Whereas food regulatory authorities such as FDA and HACCP have realised the potential benefits of harnessing this technology to regulate contamination of food stuffs and trace them back to their origin and recall products if need arises.

Consumers have become more information seekers and demand from the companies they affiliate to that they provide transparency in their business practices where the farmers and factory workers are not exploited. Consumers are also concerned about the sustainability aspect of businesses and have a favourable impression of companies that engage in

sustainable agriculture and manufacturing processes. All this information can be communicated to consumers where the authenticity of the information can be checked by consumers instantly. The important factors affecting diffusion of blockchain innovation in food supply are strategic and operational where small companies cannot adopt them yet due to immaturity of their process, technical shortcoming and investment hesitation.

Blockchain technology may have an integral part to play in the future supply chains with trust being the crucial factor for its adoption and its value lies in improved visibility and traceability, digitalisation and improved data security with the help of smart contracts (Wang, et al., 2019).

6. MANAGERIAL IMPLICATIONS

Benefits of a blockchain integrated system is a hotly debated topic in the tech industry and its applications have been noted by different logistics companies and ports too. From extensive research, it is noted that the potential benefits in the shipping industry are high. It is therefore important for managers in respective companies that integrate the blockchain technology to ensure that the users do not face issues such as knowledge deficit and the digital infrastructure is aligned to accommodate new changes. Employees can change resistance and educating them about new practices and benefits of the technology may be crucial in seamless integration of the technology. Apart from internal collaborative efforts, managers have to join forces with their suppliers and retail link too and there is a need to form one network. We can see it happening with large global food manufactures such as Nestle and Kraft whereas in the case of the shipping Industry, large Ocean carriers are forming a Global Shipping Business Network (GSBN).

Due to covid-19 pandemic and other disruptions in business supply chain such caused by wartime activities, there is additional strain on businesses and a lot of smaller businesses may be hesitant to invest in such technology unless there is sectoral pressure to do so. Therefore, it is crucial for managers to analyse if the perceived usefulness of the technology is enough to mitigate the risks and invest in Blockchain integrated supply chain platforms. Understanding the underlying factors in adoption of blockchain can help managers hold dialogue with different stakeholders to reach collaboration across industry too (Post, et al., 2018).

Future of the technology lies in the active governance and regulatory framework which companies need to adopt in addition to sector wide pressure for collaboration. Entities who are robust in their preparation for a blockchain integration may emerge successful with blockchain innovation.

7. LIMITATIONS OF THE STUDY

This study aims to compile and analyse data along with the in-depth semi structured interview of a food manufacturer in Budapest, Hungary. Major part of the research is done with the help of exploratory analysis on the basis of research done till date and available blog posts, websites of relevant companies and expert interviews. The technology is still in its infancy stage and has not crossed the early majority of the diffusion stage.

Additional qualitative research based on interviews, focus groups with industry participants can provide further insights into the topic of adoption of blockchain technologies along with its mechanisms.

There is also the scope of quantitative research not covered in this study where measures regarding the feasibility of the technology can be studied. This research forms a theoretical framework identifying important factors of adoption of blockchain in the shipping industry and the diffusion of the same in the food supply industry. Additionally, research on the consumer's point of view based on how they view the technology can be learned with the help of questionnaires and other forms of data collection.

Further research needs to be conducted as the diffusion of blockchain technology takes place in various sectors. There is scope for a quantitative analysis and development of an ROI model for companies to be convinced of the potential benefits of an integrated blockchain platform for their supply chain.

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9. APPENDICES

Interview Guideline

The interview was conducted in a neutral environment where the interviewee was relaxed and welcome. The purpose and nature of the interview was explained to and notified about the length of the interview. The interviewee was informed that the interview would be recorded and once the respondent was comfortable, the in-depth interview began.

Introductory questions:

Interviewee and Interviewer introduce themselves and questions regarding name, business name and Industry are asked.

- When did you start your food manufacturing business?
- Do you know about blockchain technology and its uses in the supply chain?
- Do you know of any company implanting this technology in the food supply chain?

Questions based on research questions:

- What do you think are the current shortcomings in the current food supply chain management?
- Is transparency and certificate of origin an important component for your industry for raw materials and products?
- Are you willing to implement blockchain technology in your food supply chain?
- Do you think such technology is only feasible for large companies right now?
- What potential benefits do you think blockchain technology can offer in your supply chain?
- What are the hindrances in the application of this technology in your supply chain?

Based on the interview questions, the interviewee's attitude regarding the blockchain technology was analysed in reference to the food supply industry.

DECLARATION

I, the undersigned*Sandra Mizcea - Florin*..... aware of my criminal responsibility, I declare that the facts and figures contained in my dissertation correspond to reality and that it describes the results of my own independent work.

The data used in the dissertation were applied taking into account the copyright protection.

No part of this dissertation has previously been used in other training at an educational institution during graduation.

I accept that my dissertation is subject to plagiarism control by the institution.

Budapest, 2022 year*11*..... month *29* day

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student's signature