Article

Exploring the Sustainability of the Intermediary Role in Blockchain

Cheng-Te Tseng * and **Shari S. C. Shang**

Department of Management Information Systems, National Chengchi University, Taipei 11605, Taiwan; sshang@nccu.edu.tw
* Correspondence: tsenga168@gmail.com; Tel.: +886-2-937512923

Abstract: Traditional business models involve cost, market development, distribution channels, business partnerships, and supply chain management. The development of the digital economy and digital network technology has engendered a shift away from the traditional model of operation. Intermediaries have long played an essential role in promoting the benefits of economic activities, but new technology is increasingly replacing intermediaries in their roles of connecting players, such as, involving, committing, and mobilizing players. Potential conflicts of interest must therefore be further resolved, avoided, or mitigated. Blockchain technology, as a tool for keeping immutable and digital records, can address increasingly complex issues in global value chains to pursue sustainable development. It attempts to realize the trust mechanism and has been redefining the function of intermediaries. This study used a multiple-case study approach to examine how blockchain technology affects intermediate functionality. We evaluated the industry's use of blockchains to assess how the processes were reshaped and how the intermediary roles were refined. On the basis of the findings, we propose three potential changes for the roles of intermediaries to improve operational efficiency.

Keywords: intermediary; blockchain; value chain

1. Introduction

Sustainability is an attempt to bridge social science with environmental science and civic engineering through technologies. Overall, sustainability aims to protect our natural environment and human health while promoting ecosystem balance and innovation.

For the sustainability of humans and the environment, economic behavior must be improved; to this end, technological innovation is a supporting tool. Market functions in transaction design, such as matching, dispute resolution, and transaction settlement, were traditionally performed by intermediaries. This process led to significant changes in the market, which further provided intermediaries with ample strategic opportunities to add value to both buyers and sellers.

Since the advent of blockchain technology, the role of intermediaries has been severely challenged. Blockchain technology has been reshaping information security and trust mechanisms. A survey by the World Economic Forum showed that by 2027, 10% of the global gross domestic product will be stored on the blockchain [1]. The governments of many countries have published reports on the potential impact of blockchains. Over the past two years, there have been more than 500,000 new publications on blockchain technology and 3.7 million related messages from Google search results [2]. Despite the media hype, blockchain technology is still developing, with no clear route for success. Without a value-at-risk assessment or a viable blockchain solution, many companies will be unable to measure their return on investment and determine whether blockchains have strategic value to justify a major investment.

The adoption of blockchain technology is a driving force for change. It has been adopted by many legacy organizations to redefine old business models. With the digitiza-

tion of the global economy, new business models have emerged, thus changing the future of the global economy.

This study intends to help organizations understand the state of the blockchain environment and scrutinize the value of the intermediary in the process. We investigated multiple cases to analyze the changes in the role of intermediaries and then conducted interviews to explore the benefits and challenges of blockchain technology. Finally, we present our findings and conclusions, discuss study limitations, and provide suggestions for future studies.

2. Literature Review

2.1. Sustainability

From the earliest civilizations, the concept of sustainability has been related to human-led ecosystems. Sustainable development stands on three pillars: environment, economics, and society [3]. Figure 1. shows the relationship among the three pillars [3].
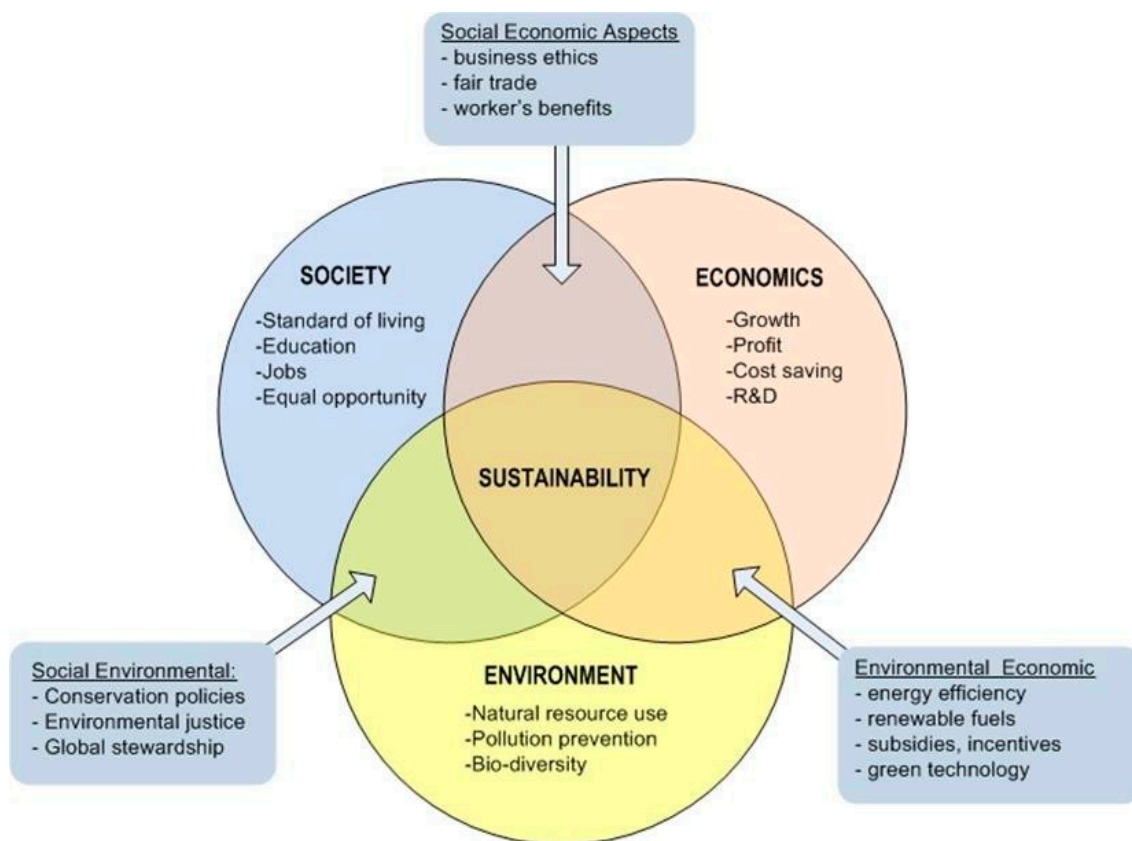

Figure 1. The interplay of the environmental, economic, and social aspects of sustainable development.

The three pillars of sustainable development described above are common terminology in literature, media, and communication. In fact, these terms can embody different ways of thinking and intersect with each other. Over the past two decades, several approaches have emerged for using communication technology for sustainability in academia and industries. Strategies for improving efficiency and scalability are the most effective way to realize using technology to support sustainability [4].

2.2. Transaction Cost Economics

Since the proposal of transactional cost theory in the 1970s and 1980s, many changes have occurred in the real world. Transaction cost theory reveals that the costs of running an economic system of companies are unlike production costs. Transaction costs are the costs of making a transaction, including the cost of planning, deciding, changing plans, resolving

disputes, and after-sales. Therefore, the transaction cost is one of the most significant factors in business operation and management [5].

Enterprises should make greater efforts to coexist with society. Businesses are required to minimize impacts on the communities and environment where they operate through regulation, financial conditions, and demand [6]. According to The Economic Institutions of Capitalism by Oliver E. Williamson, contracts and organizational safeguards are created to support transactions [7]. For most transactions, these safeguards are not required and are a source of avoidable costs. Therefore, transactions are conducted in the market where faceless buyers and sellers meet at a balanced price for standardized goods. During the transaction process, many protection and management costs are unnecessary and can be eliminated [7].

In the context of transaction costs, intermediaries perform the following tasks: (i) provide liquidity risk sharing, (ii) address inefficiencies caused by asymmetric information, (iii) coordinate incentives through proactive monitoring, and (iv) conduct transactions and handle the logistics of economies of scale [8].

Blockchains can undermine many assumptions regarding market transactions, causing different forces to come into play. Reducing transaction costs by eliminating the need for an intermediary's help to build trust as a prerequisite reveals a potential cost savings from blockchain in various industries [9]. Market agents are now confronted with opportunities and challenges that force them to redefine how they interact with each other. Because of its novelty, the discussion has focused on technology. In terms of technology, it is crucial to recognize the upcoming blockchain proliferation, which will challenge the accepted theories of transaction cost theory and agency theory.

2.3. Blockchain Technology

2.3.1. Background

In 2008, a white paper written by Satoshi Nakamoto described a new digital currency based on the idea of cryptographically linked data blocks, which were designed to rely on a consensus mechanism of a group of computers, removing any intermediary agencies. Over the years, the popularity and value of Bitcoin have grown, and the underlying technology, called blockchain technology, has also attracted considerable attention. Today, blockchain technology has evolved from supporting Bitcoin to potentially revolutionizing payments, data storage, audit record verification, digital asset registration, and transaction execution. The World Economic Forum regards blockchain technology as one of its six major trends, and it is helping the evolution toward a digital and connected world [10].

Blockchain shows that technology of trust allows different people and organizations to cooperate and create shared values. The application of blockchain opens up a new era where the nature of business will need to be changed within the framework of cooperation to coexist [11].

2.3.2. The Characteristics of Blockchain

Blockchain is a decentralized network. According to the design mechanism, the blockchain prevents data modification. Once a change in any given block is recorded, it is treated as a new block before the change can be retroactively made. For distributed ledgers, blockchain is typically managed by a peer-to-peer network that adheres to protocols for inter-node communication and validation of new blocks. Its main advantage is the ability to allow two or more participants who do not know each other to safely exchange new forms of value and assets in the digital environment. In essence, a blockchain has the following key features [12]:

Security and Immutability

Each new block of the blockchain is encrypted and protected by a hash function. When a new blockchain is being mined, the blockchain is immediately synchronized with other nodes in the network. Because of its decentralized nature, cracking or tampering with the

blockchain requires cooperation with most participants. Thus, the likelihood of fraudulent transactions in the blockchain is negligible.

Resiliency

The elasticity of the blockchain keeps the system from being damaged. If a node fails or decides to exit the blockchain, then other nodes continue to perform all functions to keep the network running normally. A blockchain is a decentralized peer-to-peer network, which also means that the computers behind the nodes may be located all over the world.

Transparency

Transactions on the blockchain transfer value between public keys. It is the combination of transparency and public key identity that ensures that users maintain "trust" in transactions recorded on the blockchain system.

Auditability

Verifying the occurrence of transactions is the basis for auditing financial statements. The verification involves the evaluation of records as relevant, reliable, objective, accurate, and verifiable [13]. Blockchain technology improves the traceability and transparency of data recorded in shared ledgers. Keeping transactions recorded in a reliable blockchain is sufficient to offer the appropriate evidence to support the transaction facts [14].

Permissibility

Permissibility is essentially a protection mechanism to regulate the access rights to the shared ledger. Permissionless blockchain allows anyone to participate as is the case with Bitcoin.

The range of permissioned blockchains is limited to more trusted or semi-trusted participants. Enterprise blockchains are described as "private" blockchains and are considered "permitted" blockchains because the range of nodes is a known and approved set of participants.

2.3.3. Blockchain Applications

Healthcare

In the medical process, various participants (e.g., therapists, medical experts, general practitioners, hospitals) and patients have different medical records and experiences, such as changes in communication media, multiple medical records, and incompatible interfaces. Thus, to obtain a comprehensive overview of a patient's history, relevant medical personnel may need to spend a considerable amount of time on communication, including intensive processing of identity and information verification [15].

Blockchain technology has been applied to health care information management as well, focusing thus far on auditing, authorization, and data verification. However, the scalability and cost-effectiveness of this technology require serious consideration. The nature of decentralized disintermediation already has great potential for innovative health care [16].

Finance

An existing capital market infrastructure usually requires multiparty cooperation during a transaction, and the transmission of information is expensive and slow. Blockchain technology can realize the ownership of digital goods based on the characteristics of transparency and non-tampering. This is why blockchain technology is suitable for the development of the financial field [17]. Commercial transaction applications can use distributed ledgers to store data in immutable and auditable blockchains. In addition, blockchain has some advantages for financial services, such as clearing, remittance, real-time asset settlement, cross-border payment, and currency exchange. Blockchains also

promote the establishment of a secure and reliable P2P financial market in the financial industry [11].

Supply Chain Management

A supply chain can be defined as a set of three or more entities, organizations or individuals, that directly participate in the flow of products, services, finances, and information from the source to the customer [18], thus highlighting the role of information exchange between businesses. Therefore, effective integration between participants must be achieved by integrating processes and information in the supply chain.

The supply chain route, origin, raw materials, and final destination of the product and its respective distance, is not clear in most cases. Lack of information truly hinders the customer's confidence in security. Therefore, a trust mechanism can support the choice of a product by considering its whole life cycle and its impact on sustainability [19].

During supply chain transactions, organizations often let trusted third parties perform process and data integration. However, the introduction and application of technology may minimize the use of unnecessary third-party intermediaries and change the status quo [20].

Advantages of blockchain technology include the use of public key infrastructure to inform counterparties of executable transactions and smart contracts through a public transaction ledger. Participants can be allowed to enter the supply chain on the basis of trust to maximize the benefits of information exchange.

2.4. Role of the Intermediary

2.4.1. Definition of Intermediary

Cambridge dictionary defines an "intermediary" as "a person or an organization that makes business or financial arrangements between companies or organizations that do not deal with each other directly" [21]. Value exchange in socioeconomic activities requires a regulatory and intermediary agency as a bridge to ensure transparency and trustworthiness. Blockchain's proponents call it the "internet of values" which is better able to provide reliable infrastructure without any intermediates [22].

According to Bakos (1998), the market has three primary functions and eight sub-functions [23] (Table 1). In modern economic and commercial activities, intermediaries provide the first two primary functions, whereas institutional infrastructure is usually the government's responsibility. Electronic markets use information technology to improve efficiency and reduce transaction costs, thereby performing these functions and establishing a more efficient market.

Table 1. Functions of a market (Bakos 1998).

Primary Market Function	Sub-Functions
Matching Buyers and Sellers	➢ Determination of Product Offerings ➢ Searching ➢ Price Discovery
Facilitation of Transactions	➢ Logistics ➢ Settlement ➢ Trust
Institutional Infrastructure	➢ Legal ➢ Regulatory

2.4.2. Disintermediation in a Digital World

Interorganizational information systems [24] are systems where automated information is shared by two or more companies. The operating system is built around computers and communications to help create, store, convert, and transfer information. The Internet has led to previously unimaginable means of conducting business, such as e-commerce and e-markets, allowing the continuous transformation of an organization's value chain and value system [25,26]. When these advancements are beyond the scope of the organization, the efficiency of industrial operations involves bypassing traditional market intermediaries such as retailers and wholesalers and directly interacting with end-users. Early research has indicated that information systems tend to assist producers and consumers who are in direct interaction. This trend will cause the intermediaries to gradually disappear from the value system [27].

The term "disintermediation" describes the electronic market's evolution into a shorter value chain. Both producers and consumers seem to have strong economic incentives to drive intermediaries out of the value chain [28]. Intermediaries increase the cost of the value chain, suppress the profitability of producers, and bring higher final prices to consumers [29]. The use of information technology is thought to potentially reduce transaction costs between markets. The resulting redistribution of profits in the value chain can be said to promote the exclusion of intermediaries.

2.4.3. New Role of Intermediaries

Early studies of the market indicated that reducing market transaction costs reduces or even obviates the need for traditional intermediaries in the value chain. Moreover, advances in network technology and the maturity of the information infrastructure can provide new online opportunities for intermediaries.

According to Giaglis' description, new intermediation methods, including re-intermediation and cyber-mediation, will emerge to support transactions [30]. Traditional market activities formerly needed to be completed through a traditional intermediary because the information was asymmetric and opaque. Traditional intermediaries overcame obstacles to the delivery of messages. However, in the traditional logistics structure, almost no interchangeability of data exists between various systems used by stakeholders in the supply chain. Most communication and planning is achieved by phone. This method is highly ineffective and costly. The role of r**e-**intermediary shows that existing organizations can recreate missions and responsibilities according to their professional knowledge, background, and market position for survival. In this case, intermediaries also attempt to innovate existing business models to expand revenue by transforming themselves. The advanced role of cyber-intermediary is strongly related to network technology. A cyber-intermediary focuses on the operation of applications and automatically provides new services to mediate communication between data providers and end-users to maintain information symmetry and provide a timely messaging experience.

Intermediaries are institutions that support a company's external economic activities. They are often used to bridge the gap between different industries. The intermediaries must successfully initiate innovation and achieve mutual benefit across industries [31].

According to an examination of different bridging agencies and their impact on cross-field cooperation, bridging agencies are conceptualized as a process of integration involving internal partners and external intermediaries. The participation of external intermediaries simplifies the formation of individual products or services and long-term alliances [32].

2.4.4. Value of Intermediaries

The nonintermediate argument mainly focuses on the cost of intermediaries, without considering the added value of intermediaries [33]. It is generally believed that value is not limited to the exchange of value embedded in the products or services delivered to customers, but rather includes use-value, defined as the customer's perspective in process, or goals achieved through the service [34].

The service provider uses its own resources for the benefit of customers. In other words, the value is not only "generated" by the supplier but mainly provided by the network actors participating in the process, and the customer's experience using the service [35].

A cooperative relationship among service-providing companies with an intermediary role can reveal the co-creation value that arises in service business relationships. The tripartite relationship reveals the key role of intermediaries by enabling the relevant activities of each participant to be determined [36]. When co-creation activities occur, each participant must target all stakeholders, and changes in value creation occur.

Intermediaries provide solutions by playing a conciliatory role that covers service maintenance, external resource collection, communication acceleration, and the event of force majeure [36].

3. Method

3.1. Research Process

A case study is an empirical study that investigates contemporary phenomena, especially when the line between the phenomenon and context is unclear [37]. The purpose of a case study is to try to clarify the process of a decision: why the decision was made, how to implement the decision, and what the result was [38].

This research is an exploratory study in which interviews were conducted to investigate professional understanding and concerns regarding blockchains and to explore how blockchain affects the role of intermediaries in sustainable development. Questionnaires were adopted in this study because they are often used to determine the factors that influence event occurrence. Structured qualitative interviews were the main data collection methods used in this study and enable us to understand the statements presented by participants in a social environment. Consequently, we can understand the participants' ideas, experiences, and concerns. The questions in the interview are classified as follows.

Open question: pre-requirement

➢ Demonstrate knowledge regarding the concept of blockchain technology
➢ Provide an "intermediary" description and examples

The Intentions of Deploying Blockchain Technology

➢ Reason for using blockchain technology
➢ Benefits provided by the blockchain
➢ The application selected for implementing blockchain technology

Before Deploying Blockchain Technology

➢ The function of an intermediary in the original process
➢ The essential responsibilities of these key intermediaries in the process
➢ On the basis of the value proposition, whether the function of intermediaries is eliminated or transformed

After Deploying Blockchain Technology

➢ Applications and usage contexts after blockchain technology is implemented
➢ Given the definition of "cyber-intermediation process", "semi-intermediation process", "re-intermediation process", and "disintermediation process", revisit the current process
➢ A new intermediary role
➢ Expand to other applications or organizational processes in the future

This study uses a multiple-case study approach to explore whether adopting blockchain technology can change the role of the intermediary and affect the process architecture. We accumulated evidence that is either in support or against the value of an intermediary. Four industries were selected for in-depth interviews. Qualitative data was then collected to confirm the research objective. After completion of all the interviews, the results were

organized and cross-analyzed to provide recommendations for process transformation. Finally, the conclusion provides insight for future studies and related applications. The detailed research steps are presented in Table 2.

Table 2. Description of the Research Process.

Phases	Why	How
Literature review	➢ The impact of technology on sustainability. ➢ The influence of intermediaries in the market. ➢ The impact of the blockchain on the role of intermediaries.	➢ Review existing industry reports and research. ➢ Explore the key features of the intermediary. ➢ Summarize the characteristics of the intermediaries being affected.
Case selection	➢ The intermediary's value in the selected organizations is influenced due to the implementation of the blockchain.	➢ Select the case where the intermediary plays a crucial role in the organization and the blockchain is in progress.
Multiple-case study	➢ The implementation of the blockchain application will affect the intermediary role and business model.	➢ Conduct an in-depth interview with selected companies.
Cross-case analysis	➢ The similarities and differences between cases.	➢ Compile and summarize through cross-analysis. ➢ Explore case differences and similarities.
Conclusion	➢ The functions of the intermediary will exist. ➢ The change of the intermediary role transforms business process and operation.	➢ Consolidate the functionalities of intermediation. ➢ Compile the results of findings.

3.2. Data Collection

3.2.1. Selection Criteria

An intermediary must be the provider of value in a market or process. This research selects four entities as research targets in different industries that are committed to transforming business processes through blockchain technology to explore the differences between before and after the blockchain deployment. In the process, intermediaries can perform certain functions through blockchain construction to provide an effective value service.

3.2.2. Case Description

Data were collected through interviews with participants who use blockchain to solve problems. We interviewed each participant regarding the impact of blockchain construction. Table 3 summarizes the characteristics of the four participants.

Table 3. Description of selected cases.

	Case 1	Case 2	Case 3	Case 4
Business Sector	Medical Care	Accounting	Farming	Supply Chain
Application	Data management	Information confirmation	Information transparency	Information traceability
Interviewee	Manager	Manager	Deputy of director	CEO
Interview Date	2019/1	2020/3	2019/6	2020/9
Location	National Health Insurance Agency (NHIA)	Financial Information Service Company (FISC)	Agriculture Council	Formosa Technologies Corporation (FTC)
Interview Time	150 min	120 min	180 min	120 min

4. Results

4.1. Case Study

4.1.1. Case 1: Medical Care

Background

Approximately 99% of the population in Taiwan is enrolled in Taiwan's National Health Insurance program. Patients can choose the hospital and doctor/specialist instead of waiting for general practitioners to act as intermediaries for referrals.

The National Health Insurance Agency (NHIA) established the National Medical Referral (NMR) system, which is designed for doctors to refer patients to different medical institutions as required. This can avoid unnecessary repeated visits and reduce unnecessary waste of medical resources. However, the NMR system is based on the government's electronic medical recommendation service. Recommendation data can only be obtained and exchanged through NHIA's private network to authorized clinical experts only. Data held by other private hospitals or clinics remain isolated as a matter of privacy and trust. Other hospitals or clinics do not have direct access to patient-related information. Patients must apply for relevant medical records (paper copies) before the records can be transferred to another hospital which requires time. Figure 2 illustrates this data transfer process between hospitals.

Consequently, the system lacks scalability and cannot build trust relationships between patients, doctors, and hospitals.
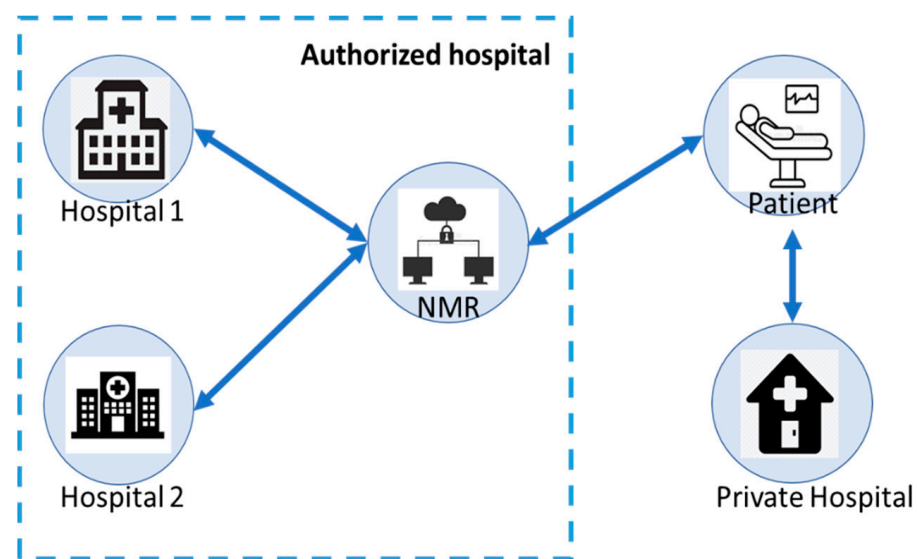

Figure 2. The original National Medical Referral (NMR) process.

Blockchain Implementation

To solve the existing limitations of the NMR system, Taiwan's National Development Council (NDC) announced the launch of the government-backed Taiwan Blockchain Alliance in July 2019. NHIA developed a blockchain function framework to increase scalability and flexibility. The framework uses NMR recommendation data to establish a medical recommendation service alliance across medical institutions.

The NMR development manager described the NMR process as follows:

We exchange data within the framework of blockchain technology to increase scalability. This framework combines patient recommendation data from NMR systems with electronic medical records (EMR) and electronic health records (EHR) from hospitals and clinics. The goal is to establish trust in transaction security for patients, strengthen the relationship between clinics and hospitals, and complete the alliance's medical referral services. Within the blockchain framework, we have also developed a blockchain-based

decentralized application (DApp) for personal health records to enable patients to access their EMR and EHR data. By collecting DApp information, we can assess patient behavior and health status through individual authorization frameworks.

The blockchain framework involves a teaching hospital and four cooperative clinics. Through the automatic execution of the framework, all medical referral processes are paperless. In addition, patients enable blockchain DApp to access and control their EMR and EHR data.

The scalability of the blockchain-based framework effectively enables the deployment of a blockchain environment for medical institutions. Blockchain DApps can be used with patient-centric applications to promote other applications. In the future, the project plans to pass personal health information to insurance companies according to their preferences as the basis for insurance claims. Figure 3 presents the directness of data sharing in the blockchain-based framework. Thus, the speed and error rate of data transmission can be improved.
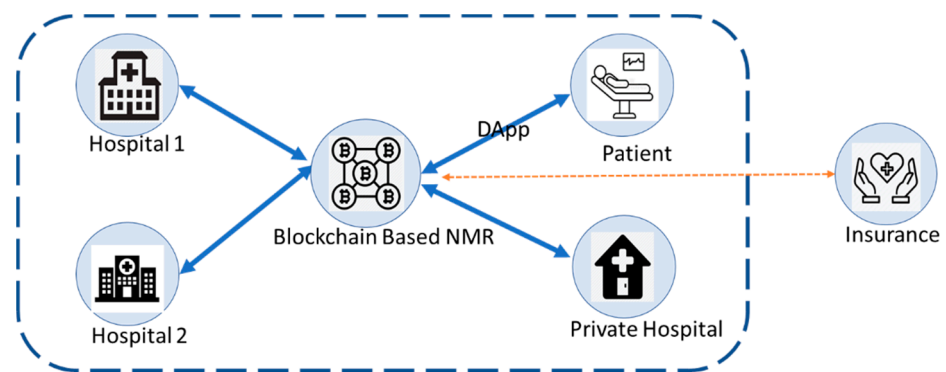

Figure 3. Process of blockchain-based NMR.

4.1.2. Case 2: Accounting Industry

Background

Accountants perform various types of annual or quarterly financial audits or other auditing requirements for enterprises. Manual delivery processes such as mailing can be intercepted by humans. Moreover, all banks manually fill out letters of credit, leading to many cases of incorrect information or clerical errors. Filling out a letter of credit is an auditing process that an accountant must perform when obtaining audit evidence from a bank and upstream and downstream manufacturers.

Financial Information Service Company (FISC) led 20 banks to establish a blockchain-based letter of credit for financial statements and signed contracts with four major accounting firms: Ernst & Young, Deloitte Taiwan, PwC Taiwan, and KPMG Taiwan [39,40]. It also selected several well-known listed companies taking the lead in piloting a blockchain-based letter of credit.

People in the financial sector said that approximately 1.5 million bank-related letters are created in Taiwan annually. Thus, a considerable amount of time is spent in creating and exchanging correspondences between accountants, banks, and companies. Figure 4 illustrates that accountants must play the role of intermediary to track data accuracy between banks and enterprises.
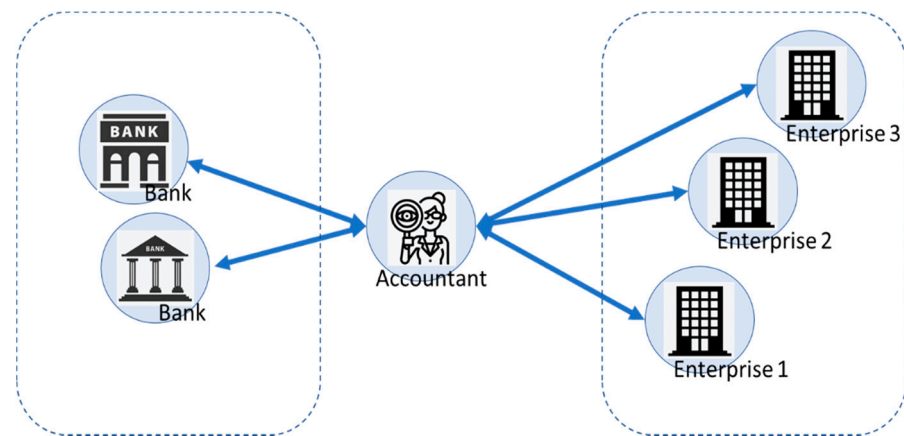
Figure 4. The original bank auditing process.

Blockchain Implementation

Large-scale bank executives say that after completing the bank's blockchain-based letter of credit, accountants can save a great deal of time spent conducting various types of annual or quarterly financial audits. The digitization of letters of credit with blockchain technology has several advantages over manual delivery processes, such as postal mailing. It can also avoid the risk of intermediate human interception. Figure 5 illustrates that accountants can perform audits in the blockchain framework. Trust and antitampering increase audit effectiveness.
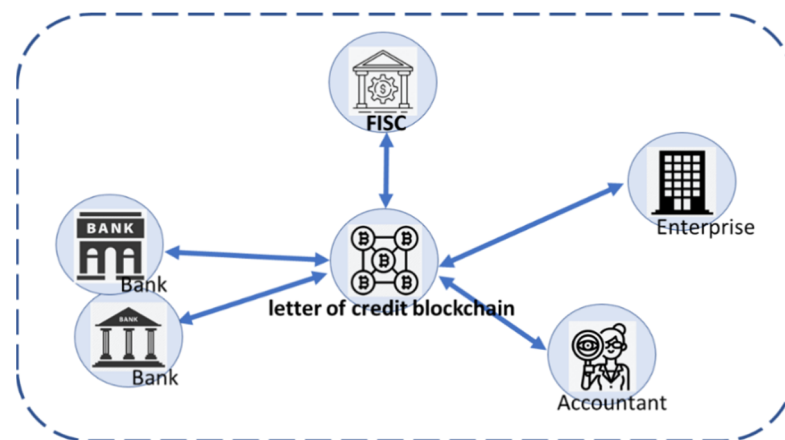

Figure 5. Process of blockchain-based banking audit.

4.1.3. Case 3: Farming Logistics

Background

Former logistical difficulties in the production and marketing processes of high-quality agricultural products included the following:

1. No trust mechanism to integrate different information systems
2. Lack of timely and transparent information on temperature/goods
3. Too many manually processed paper documents
4. High cost of communication checks

In 2017, the International Division of the Agricultural Committee (IDAC) promoted the construction of agricultural blockchain programs by employing experts equipped with blockchain skills to strengthen the competitiveness of Taiwan's agricultural products. The key motivation of using a blockchain-based food traceability system is to connect participants and related stakeholders and avoid incomplete/untraceable information and data tampering.

The IDAC's deputy director said that "In the process of promoting Taiwan's agricultural products to the world, the most difficult point is that we cannot effectively prove our quality".

The IDAC started to use blockchain technology in agriculture in cooperation with related stakeholders to upload production information of agricultural products. The safety and security of traceable agricultural products may further open the export market for Taiwan's agricultural products. Figure 6 illustrates that the food supply chain—from production through logistic processing and finally to the market—requires multiple independent operation and communication systems.
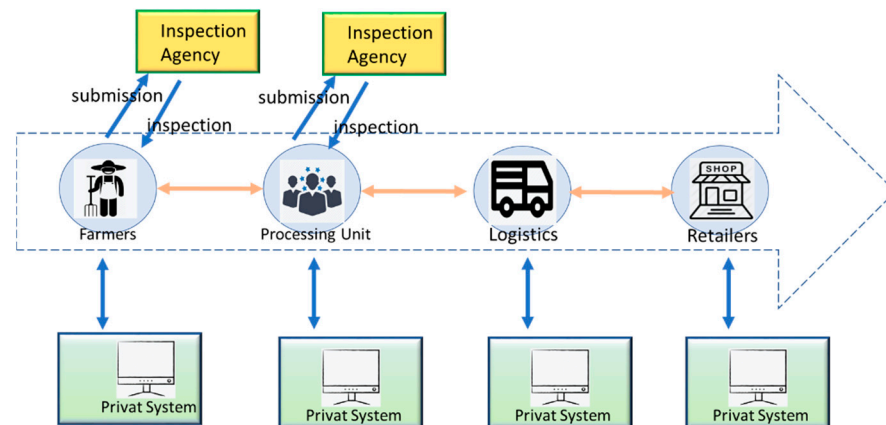

Figure 6. The original process of the food supply chain.

Blockchain Implementation

Considering the full traceability of the food produced, the IDAC also actively assists farmers to deploy "Internet of Things" sensors, such as for measuring temperature and humidity, to automatically evaluate the growth environment of crops, accompanied by pesticide residue and heavy metal inspection reports during production.

Before sale, the final product is certified by the inspection agency, and the inspection report is uploaded. A QR code is created for each product, enabling consumers to scan and easily view the production process through the traceability system. All information is always recorded on the blockchain, reducing the likelihood of human manipulation during the generation of food information. Trust and immutability-modifying elements allow Taiwan's fine-quality food to be witnessed through the government-approved blockchain mechanism and exported to the world. Figure 7 illustrates the blockchain-based logistics process to make information transparent and reduce the cost of intermediary communication.
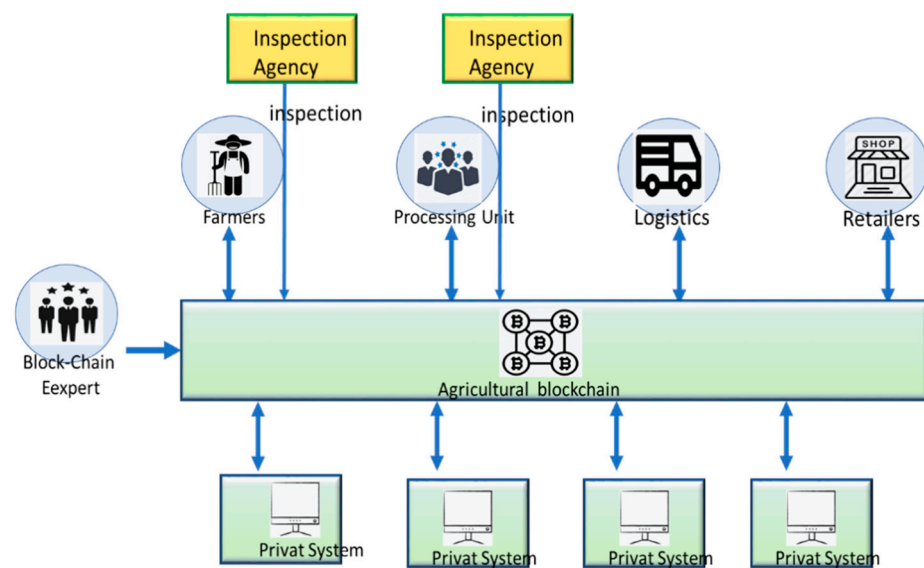
Figure 7. The process of the agricultural blockchain.

4.1.4. Case 4: Supply Chain Financing Service
Background

Formosa Technologies Corporation (FTC) was established in April 2000 as a professional information services company owned by Formosa Plastics Group (FPG), which operates in the petrochemical, textile, plastics-processing, electronics, biotechnology, medical, education, and information industries, with more than 100 subsidiaries worldwide. To effectively manage the diversified cross-sector business, the company began building an e-management structure in 1967 and successfully received management benefits by creating a reputable one-day settlement, checking fraud prevention, and satisfying other indicators of excellent management.

The vice president of Formosa Technologies Corporation stated that when a bank approves corporate financing credit, conducting an internal audit to ensure the correctness of information such as paper orders takes a long time. Corporate customers are required to fax or provide authentication of the paper order to the bank. For example, in the case of a query to the supplier's central plant requesting financing to confirm the authenticity of the transaction, many unnecessary resources are wasted. Suppliers are unable to get the money they need for production orders immediately.

DBS Bank (Taiwan) collaborated with FTC to launch a supply chain financing service platform using blockchain technology, thereby improving the financing efficiency of downstream suppliers of Formosa Plastics Group and ensuring the authenticity of transaction information. Figure 8 illustrates the supply chain which requires a bank to act as an agent to bridge and check the correctness and consistency of information.
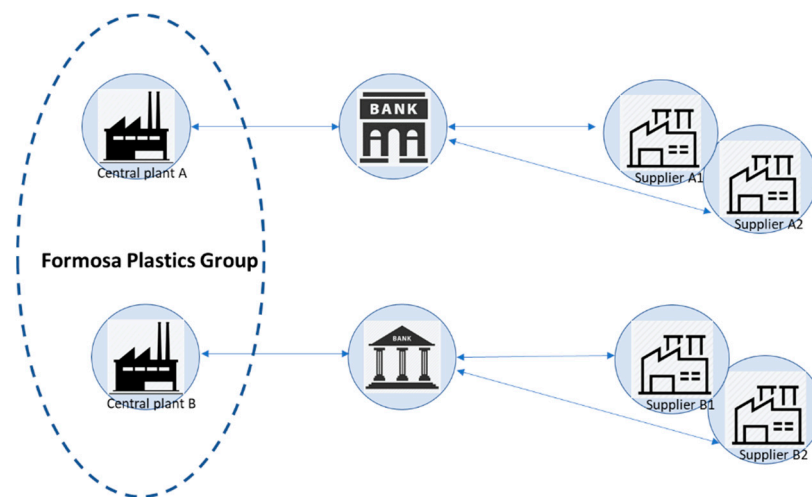
Figure 8. The original supply chain financing service process.

Blockchain Implementation

　　To enable banks to quickly grasp and review the actual transaction status of suppliers for credit assessment, thereby reducing bank financing risk and meeting supplier financing needs while maintaining the supply chain, paper orders from suppliers to banks are traditionally converted for financing, whereas a blockchain-based platform enables the bank and FTC to access the information flow of orders. The suppliers of Formosa Plastic Group can apply to the bank for purchase order financing directly according to their capital needs and order status through the supply chain financing service platform. Using the tamper-proof technical features of a blockchain, the central plant can, with the supplier's authorization, simultaneously upload orders to DBS Bank through the platform and provide electronic orders to the supplier. In addition, banks can speed up lending when they receive authentic and reliable trading information.

　　In the past, intermediary banks financed suppliers, and this function is now performed by blockchain financing platforms. With such platforms, various information transferred between the central plant and its suppliers, such as that related to production, manufacturing, and orders, is uploaded. In addition, the data encryption method prevents the information of one central plant from being arbitrarily revealed to other central plants. Mutual authentication of information flow and payment flow can effectively meet needs regarding capital and the supply chain. Figure 9 illustrates how blockchain-based platforms make information transparent and simplifies the cost of intermediary communication.
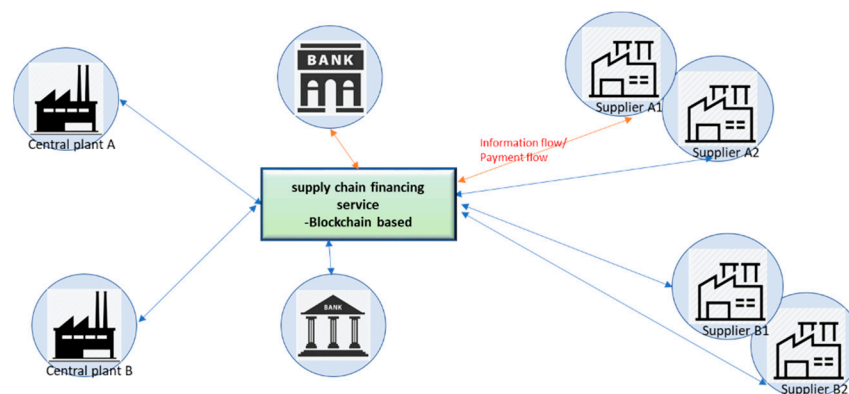

Figure 9. Process of blockchain-based supply chain financing service.

4.2. Cross-Analysis

4.2.1. Adoption of a Blockchain as an Intermediary

This study reveals the following reasons why organizations consider using blockchains to complete intermediary activities:

(1) Achieving data transparency: the characteristics of blockchain technology enable different organizations to share information and avoid unnecessary intermediate procedures. Increased transparency of data management helps solve social or operational problems. For example, the use of an authorization mechanism between hospitals allows a real-time understanding of a patient's health status.

(2) Realizing the trust mechanism: data are transmitted automatically from point to point, thus avoiding human error or tampering; accurate presentation of information is paramount, especially for the transfer of money between businesses. Audit activities can only be performed correctly under safe conditions. Interviewees also stated that "Most intermediaries still handle the same work through the blockchain system, and blockchain applications can achieve data transmission correctly and reduce the processing time".

(3) Realizing digital transformation: More and more information is being digitized. The consensus mechanism in blockchain systems allows industry information to be digitized without intervention. Because the operation of existing companies is based on the old system, the blockchain system still coexists with legacy systems to handle some processes. Therefore, the scope of blockchain applications must be expanded.

4.2.2. Findings of Companies After Blockchain Implementation

The interview results indicate that the intermediaries can be classified as follows: "traditional intermediary", "semi-intermediary", "re-intermediary", "cyber-intermediary", "co-intermediary", and "cross-sector intermediary". Intermediaries of "traditional intermediary", "re-intermediary", and "cyber-intermediary" have been previously addressed in an existing literature review. In this study, we focused on the roles of "semi-intermediary", "co-intermediary", and "cross-sector intermediary".

Semi-intermediary: The company's usual operating procedures cannot be changed immediately, and the blockchain application is not yet used universally in the industry. The company may maintain a traditional centralized database managing the legacy system and gradually import the related information into the blockchain system. For example, it is difficult for hospitals to comprehensively manage all medical data through the blockchain platform; in particular, doctors are used to making medical decisions using traditional systems and frequently add, modify, and delete data during the diagnosis process. Therefore, hospitals still use a centralized system.

Co-intermediary: Because of the transparency of blockchains, participants can directly access data and focus more on the business's value without wasting time. As blockchain technology matures, participants are expected to expand their professional value through data ledger management and maximize their economic impact. All participants can gain new business benefits from the data ledger in their industry business. For example, by using an inter-hospital blockchain-based medical ecosystem, surgeons can access patients' medical data from other hospitals in a timely manner.

Cross-sector intermediary: Through cross-domain integration, science and technology applications can be thoroughly integrated to drive industrial transformation and service innovation. For example, data related to a patient's health information, under authorization, can be transmitted to the patient's insurance company as well as other hospitals as a basis for applying for insurance coverage or claims settlement.

Humans are currently faced with complex and challenging issues, such as those pertaining to health, food, energy, and water resources. They must integrate ideas, methods, and technologies from all life domains to stimulate innovation. Blockchain's trusted mechanisms have the potential to change sustainability and assurance to help companies manage, demonstrate, and improve performance. It also enables consumers and investors

to make better decisions. This could lead to a new era of accountability and action as this information is filtered to provide more information on risk management. Thus, "cross-domain" cooperation, including the integration of knowledge, methods, and expertise in different fields, is necessary to solve complex problems pertaining to social needs and to form a new framework for scientific exploration.

The entire digital transformation process can be divided into digitalization, digital optimization, and digital transformation. Intermediary roles are critical in the transition process. Trust mechanisms are established with the participation of intermediates through blockchains. Consolidation of our interview data reveals the status of different intermediaries in Table 4.

Table 4. Status of different intermediaries.

Business Sector	Case 1 Medical Care		Case 2 Accounting		Case 3 Farming		Case 4 Supply Chain	
Semi-intermediary	√	New and old systems coexist	x		√	Internal jobs maintain privacy and external contacts provide transparent sharing	√	Some of the suppliers keep the existing process and migrate data gradually in a blockchain system
Re-intermediary	√	DApp serves personal health information	√	Through "letter of proof blockchain", traceability can be improved without sending hard copies	x		√	FTC utilizes a blockchain-based system to string information between FPG and suppliers
Cyber- intermediary	√	Information of NMR and EMR aggregation	√	Auto-detect consistency of documents uploaded	√	Information compilation to streamline the process	√	Information between FPG and suppliers can be transparent in the supply chain
Co-intermediary	√	Other clinics and hospitals join	√	New accounting firm can join the accounting ecosystem to serve	√	New participants join the ecosystem to provide services	√	New suppliers and banks can join blockchain to share co-value
Cross-sector intermediary	√	Information exchange with the insurance sector	x		x		√	Concatenate financial service with supply chain

The transformation process can be broadly categorized as follows. Figure 10 shows that with the advancement of network technology, if traditional intermediaries cannot contribute substantial value to an operation system, cyber intermediaries will gradually replace their functions.
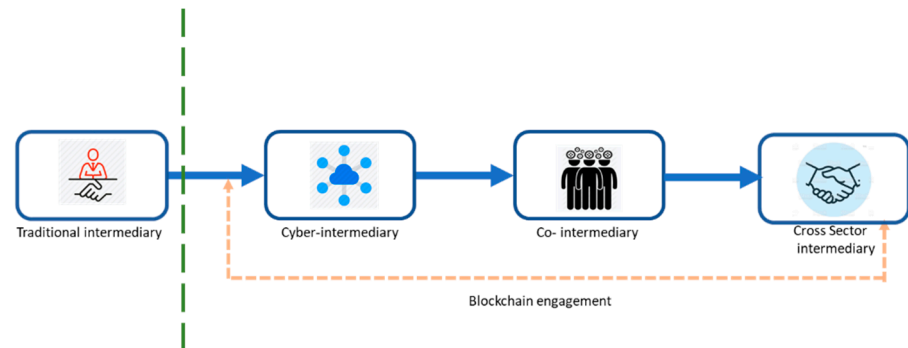

Figure 10. The generalized process.

Figure 11 illustrates that blockchain technology empowers stakeholders to reverse traditional processes in data management, but cannot be fully substituted for legacy systems. Therefore, semi-intermediary coupling with cyber-intermediary facilitates business transactions and gradually transforms operation processes.
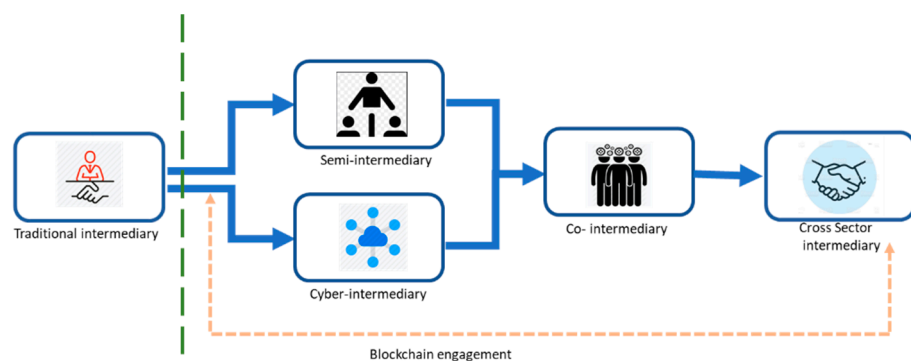

Figure 11. Process 1 for existing industries.

Figure 12 illustrates that existing intermediaries in processes may relocate themselves to find solutions to maintain their advantages in industries. With the support of the blockchain, the cooperation between cyber-intermediary and re-intermediary will eventually transform and strengthen business value.
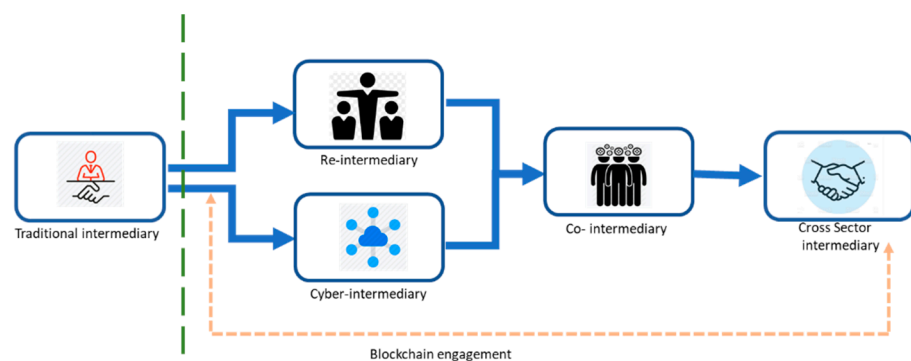

Figure 12. Process 2 for existing industries.

This study reveals that cross-sector intermediaries have major advantages in terms of being able to attract more participants and design a better transaction experience. Therefore, the ultimate goal of cross-sector intermediaries is to develop blockchain applications in a social ecosystem.

5. Discussion

Many scholars have commented on the future of blockchains, but the actual functions and contributions of stakeholders must be considered in practical business operations and social activities. This study reveals the changes in the role of intermediaries in current blockchains in Taiwan and provides insight into blockchain implementation.

However, our study has some limitations resulting from resource constraints. First, not many companies have implemented blockchains in Taiwan, making it difficult to estimate the number of companies in different industries that will employ blockchain technology. Moreover, evaluating the scalability of a blockchain and the value it will bring is challenging. Second, because blockchain development requires time, the participants should be followed up for a long time to elucidate the development of the intermediary's role. Third, every mature company has a fixed operation model. The conversion value of the intermediary role must be examined. The company may conditionally adopt blockchain technology, so more application models may be developed.

The role of intermediaries in various industries must be scrutinized. Smart contracts based on blockchain technology may be a critical factor affecting blockchain operations without intermediary participation. Future studies should focus on the flexible application and availability of smart contracts to investigate how the advantages of intermediaries can add to industry value.

While blockchain can support intermediation function to transform almost every business around the world, it requires regulatory oversight. Governments need to develop a wide range of regulations to keep pace with blockchain development. Therefore, how to formulate regulations and policies is a matter of concern to the government and a subject for further research in the future.

6. Conclusions

Although information technology facilitates and simplifies communication between customers and suppliers, traditional intermediaries have become less important in this process. However, the demand for intermediaries is unlikely to dissipate entirely in the future, as they may play vital roles, including helping to filter information, providing domain knowledge, and ensuring market integrity. Thus, their intermediary function will allow them to serve as facilitators of the interoperability between a network and user community. In brief, they are expected to provide a complementary rather than competitive infrastructure.

Sustainable development is the concept of a circular economy. Products and services are exchanged in a circular manner, which means that nothing is wasted, thus protecting and allowing better use of Earth's natural resources. Blockchain technology ensures transparency and traceability which enables the quick and convenient attainment of benefits, allowing the value chain in economic society to go through an immutable, time-based network to increase productivity. As blockchain technology advances and an increasing number of operations are performed using this technology, different industries will form a cross-industry alliance for cooperation to create large-scale business value. Furthermore, the aggregation effect will enable blockchain applications to trigger more business development.

Overall, this research outlines the changes in the intermediary process that the industry may experience while continuing its increasing implementation of blockchains. The new roles and responsibilities will be related to managing the blockchain system.

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