EasyChair Preprint

№ 10418

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June 19, 2023

The Dynamics among Absorptive Capacity, Change Trigger and Related Practice in the Blockchain Enabled Traceability Network Alignment

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Abstract. Food supply chains are arguably one of the most complex and challenging systems to manage. Clearly, they played a major role in all human societies for thousands of years, but they still face some fundamental challenges around storing, sharing, and accessing data along the network. Blockchain is a promising data management technology as various actors are connected through the network with efficiency, feasibility, and trust. However, like other new technologies, it has many hidden challenges related to timely information sharing, managing dynamic contexts, and scaling that require urgent attention. This study adopts the concept of absorptive capacity, as the theoretical lens, to investigate a blockchain based traceability network from a longitudinal perspective. This study contributes to the information system study by uncovered the loose connected relationship in traceability network, underpins the dynamics among the contextual changes, absorptive capacity evolvement, practices, and improves the understanding about absorptive capacity from the network perspective.

Keywords: Absorptive Capacity; Blockchain; Food Supply Chain; Traceability; Trustworthy Systems.

1 Introduction

Food supply chains are complex networks due to the involvement and cooperation of numerous actors involved, from farmers to logistic companies, distributors, and retailers. They are fundamental to a functioning and healthy human society through underpinning quality food. Safety and trust have become two topics of conversation in public health in the last twenty years, mainly due to disease outbreaks. Recent examples include foot-and-mouth Disease in Europe in 2001, the Escherichia Coli outbreak in Spinach in 2006 in USA, the South African listeriosis outbreak in 2017, the African swine fever spread at pig farm in China in 2019 and even the Co-vid spread in 2020. Those incidents highlighted lack of traceability among supply chain actors as a major challenge for controlling these incidents and maintaining trust and transparency (Iftekhar and Cui, 2021, Wu et al., 2022, Alkahtani et al., 2021).

In response to these growing concerns, blockchain technology offers a promising solution to create reliable traceability systems and increase transparency (Demestichas et al., 2020a). It underpinned the success of cryptocurrencies in providing transparency and fault tolerance. The blockchain technology has shown great promise in supply chain food traceability (Kouhizadeh et al., 2021, Mann et al., 2018). In order to do this, we conducted a broad case study on a traceability system network in the longitudinal method. This study started from the initiation of the system its breakdown in a four years' period, which demonstrate how blockchain based traceability network acts as the 'loose connected network' linked the various actors from different industries, what is the dynamics among contextual triggers, absorptive capacity and the related practices, and how absorptive capacity acts on the network perspective.

In both farm and industry applications, Blockchain is used for providing the 'Farm to Fork' traceability service. Blockchain embeds a trust mechanism; If anyone attempts to tamper or corrupt the data in one specific block, it is only possible if they alter the subsequent actor of the chain. For constantly added blocks, it is practically impossible to change a single actor in the chain (Demestichas et al., 2020b). Blockchain technology is recognized as a reliable tracking solution, especially for the food supply chain tracking system (Esmaeilian et al., 2020a, Qian et al., 2020). Still, its broader adoption is affected by a set of challenges related to the interaction among the chain linked nodes (actors), and the nodes' collaborative respondence to the contextual changes (Esmaeilian et al., 2020a, Demestichas et al., 2020b)

To scrutinize the deployment barriers of this innovative technology, absorptive capacity (AC) gives us a solid theoretical support (Wu et al., 2021, Dolmark et al., 2021). Scholars adopt AC to explain how organizations learn from external source of knowledge (e.g. other firms, systems, and technology), how to integrate this knowledge within the organization and turn it into internal capability (Van Den Bosch et al., 1999, Mariano and Walter, 2015, Todorova and Durisin, 2007), how to respond to the contextual changes with proper activities (Zahra and Hayton, 2008, Marttila et al., 2017), and how to create a concomitant competitive advantage (Patterson and Ambrosini, 2015, Zou et al., 2016). Harnessing external knowledge is fundamental for modern organizations to maintain know-how knowledge, maintaining alliances, and collaboration (Tzokas et al., 2015, Saad et al., 2017). This inspires the use of AC to investigate how blockchain enabled traceability network might enhance interactions among the loosely connected actors in food supply chain. This is a challenging task as AC is contextually sensitive and changes in context could lead to further changes in it (Marabelli and Newell, 2019, Zahra and Hayton, 2008).

Indeed, how AC itself develops in a loose connected context, such as the blockchain context, is yet to be examined. This paper presents an empirical study to investigate the collective activities among the blockchain connected actors for responding to the contextual changes. Our methodological approach to AC analysis in the context of food traceability network is qualitative. Compared to quantitative method frequently used in AC analysis (Gao et al., 2017), a qualitative method allows an in-depth analysis of learning and practice over time (Neuman, 2010, Denicolai et al., 2016). This network enabled us to investigate the AC, beyond the individual, group, or organization level, but from a network perspective. This is the first research to study the AC from the network perspective. This paper is structured as follows: Section 2 shows the literature review and highlights critical gaps. Section 3 demonstrates the chosen case study and offers some in-depth insights about the role of AC in the deployment of food traceability in full system cycle. A longitudinal view is adopted to show the interplay and syntheses between contextual change, AC and work practice. Section 4 demonstrates and analyses the ensuing dynamics among the blockchain connected nodes in a traceability network and inspects the AC development from a network level. Conclusion and avenues for future research are presented in Section 5.

2 Literature Review

2.1 Traceability system in food industry

Traceability is the ability to view the history, application, or location of that is under consideration (Mann et al., 2018). Recent disruptions of food supply chains further highlighted the demand of this traceability, which embodies all food information identified throughout the entire food production lifecycle with trust and access. The particular importance in this is the ability to track along the supply chain (downstream path) to trace the origins of food products (Maouchi et al., 2019). This traceability network can include information about food ingredients, sources, processing, transportation, storage and so on. With this ensuring the safety in food supply chains, five major outcomes can become possible: 1) information management for transparency and interpretability, 2) quality management for food quality and safety requirements, 3) production management for in-house production and outsourcing, and 4) logistics management for food supply chain complexity, and 5) new services with novel technology adopted (Wu et al., 2022, Demestichas et al., 2020b, Fisher et al., 2008). Combining interconnecting process with a re-constructing production path of food adequate and food traceability (Aung and Chang, 2014). For having the trustworthy outcome of traceability, all actors in the food supply chain must coordinate with others.

Blockchain technology was initially introduced by Stuart Haber and W.Scott Stornetta 1991 in their article " How to Time-Stamp a Digital Document". Satoshi Nakamoto (a name used by an unknown person or group of people) has operationalized it cryptocurrency way, developed the first blockchain database well recognized since 2008 (Huang and Chen, 2020). In general, blockchain is accepted as " digital transaction ledger, maintained by a network of multiple computing machines that has never relaying on any trusted third party" (Kamilaris et al., 2019). Its essential character is the ability to keep consistent and tractable agreement among the connected nodes. Motivated by the need to guarantee the food safety and quality through entire supply chain, the blockchain network is recognized as a promising mechanism and is further developed in this area (Iftekhar and Cui, 2021, Baralla et al., 2019).

An agriculture traceability network contains the food information from "farm to fork" with security, transparency, and stability, in which the blockchain is suggested in HACCP (Hazard Analysis Critical Control Point) system to produce, transport, and preserve food (Tian, 2017). There is one Chinse company developed the blockchain-based food supply chain system for improve food safety by providing the information and transaction security among all the involved parties (Tse et al., 2017). In the following years, use of blockchain has become more prevalent in Agri-food industry since 2018. For example, the Food Trading System with Consortium blockchain (FTSCON) aims to upgrade transaction security and privacy (Mao et al., 2018); integrating the blockchain technology in the existing ERP project (enterprise resource planning) for promoting the traditional agri-food supply chain (Lin et al., 2018) and developed the new services of with blockchain for achieving the new business (Esmaeilian et al., 2020b). There is still a lack of research on traceability network, as less understanding about dynamics among the connected nodes, impacts from continuous contextual changes (Demestichas et al., 2020a), longitudinal network dynamics (Saad et al., 2017, Ranjan et al., 2016). Therefore, it is necessary for scholars to conduct research on the longitudinal traceability network dynamics, constantly changing context and interactions among the connected actors.

2.2 Absorptive capacity and organizational learning

IS scholars have recognized absorptive capacity (AC) as a significant construction to uncover how to capture and learn external knowledge and integrate into the business environment to generate the new knowledge. In early 90's, Cohen and Levinthal (1990) introduced AC as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends." Later, AC is defined as a substantive organizational capability (a high-level routine or set of routines) that gains and releases resources (Zou et al., 2016). In IS domain, AC is an important theory to understand the knowledge processes in organization. Focusing on the construct of AC, a method is proposed by Dyer and Singh (1998) who viewed AC as an iterative process of exchange (modifying assumptions), which contrasts with the single loop learning process described by Cohen and Levinthal. Lane and Lubatkin (1998) developed the idea of "relative absorptive capacity" and assessed AC as a learning dyad –in which a firm's ability to learn from another firm depends on similarities in their knowledge bases, organizational structures, and dominant logics. Zahra and George (2002a) defined AC as a dynamic capability and indicate that the construct has potentially two general states—firms acquire and assimilate new knowledge and firms transform and exploit new knowledge. The construct of AC has been widely adopted in IS study for understanding organization capability for processing knowledge and responding to contextual change (Grandinetti, 2016, Mariano and Walter, 2015, Liu et al., 2013). This study adopts AC to uncover the mystery of blockchain based traceability network from a longitudinal perspective. Moreover, it looks at the AC from network level, which has never been studied.

3 Research Setting and Method

In line with Walsham (1993), this study adopts an approach assuming the organizational actor domain, is a social construct. This approach is consistent with our aims which regard AC as an essential dynamic capacity of an organization and realized it in an empirical context. This research moves beyond the traditional view that treats AC as an objective reality with predictable outcomes, but from network level and contributing to inter-organizational learning. We believe that observing the blockchain traceability system network from the longitudinal and network view provides an insightful way to understand the role of AC in the loose connected inter-organizational context, such as traceability network and underpins the co-evolving between AC and system use in a dynamic context.

The case study data was collected through the full life cycle of a food traceability network in four years' time. Between September 2019 and December 2022, project data was collected from four organizations, Alpha, Beta, Omega, and Delta, which all have been connected into one food traceability network. Alpha is an IT company and provides a service in the food supply chain. In September 2019, it released a blockchain based food traceability system (named ETS in this study), and in December 2022, the ETS network breakdown. Beta is a local supermarket company with about 3,000 employees, ten supermarkets and about 100 mini supermarkets in one city. Omega is a farm with about 2,000 pigs, 3,000 ducks and 1,500 chickens, and most of its animals are supplied to Beta. Delta is agriculture company the produces vegetables, feed for the pigs, and Chinese medicine. Moreover, it has about 500 contracted farmers for supplying vegetables and pig food.

Since the ETS has been rolled out on market, it continuously updated with the new functionalities added. These new functions are designed for meeting the system requirements from the system customers. In order to meet research purposes, we considered the network with four actors as a single case and have the close observation of daily practice. Also, we adopt the interpretive approach for data collection and analysis (Walsham, 1993, Walsham, 2006).

This case is appropriate and relevant for this research, as it provides us with a unique opportunity to access the data from 'farm to fork' to uncover the food supply chain. The data are collected qualitative way from several sources: interview, non-participant observations, official documents, meeting minutes, and steering committee presentations. During our two years retrospective data collection, judgment and snowball sampling method were mainly employed to select interviewees (Marshall, 1996, Taherdoost, 2016), while the interviews guided by the research objectives and questions were semi-structured (Wright and Wright, 2002, MacLean et al., 2004, Doherty et al., 2010). The structured questions with prompts to guide the semi-structed interviewee were adopted.

4 Data interpretation

This section provides a narrative of the blockchain food traceability system deployment, upgrade and close involving various actors at different time of period. In September 2019, Alpha rolled out its ETS system to market. This ETS system adopted blockchain technology and provided the traceability service for tracking the food from its origin, logistics, distribution, into retail store. At end of 2019 Alpha connected Beta and Omega into the ETS blockchain network. Although Alpha had the experience of connecting vegetables, chicken, and online shops into the traceability system. It was the first time for them to connect the pig and supermarket data.

Alpha reconfigured the chain for Omega uploading its pig data, including the ID (bar code on ear tag), specs, days, weight, and movement into the system. However, at that moment, Omega did not use any farming software and all this data has been recorded on Office Excel. Therefore, its staff had to manually copy and paste the data into ETS daily. Compared with Omega, Beta was better, as it has a small IT team running an ERP system. It took Alpha three months to collaborate with the ERP system vendor to access the database and share certain data with the blockchain. In June 2020 Alpha released its smart e-tag for pig. This smart e-tag is an innovative product, which can record the pig temperature and movement in 24 hours for 6 months and help them to monitor and predict pig's health condition. This technology received a great welcome from Omega, as the plague has become a severe issue. Using the e-tag added some new data into the chain. At the end of 2020, local government also provided the financial support for the firm to adopt the new technology in the business. With this financial support, the ETS was further adopted by these three actors, and Delta was connected into the network. Finally, due to the Co-vid extending in China, local government control on people movement and financial shrinking, Alpha did not receive any 'new' financial investment. Since early 2022 Alpha has gradually stopped system support and the entire blockchain traceability network was bankrupted at the end of 2022.

From the project documentation, interview with key actors, and on-site observation, four adoption phases were identified. These four phases are not strictly sequential but overlap in certain times of the period as shown in Figure 1.

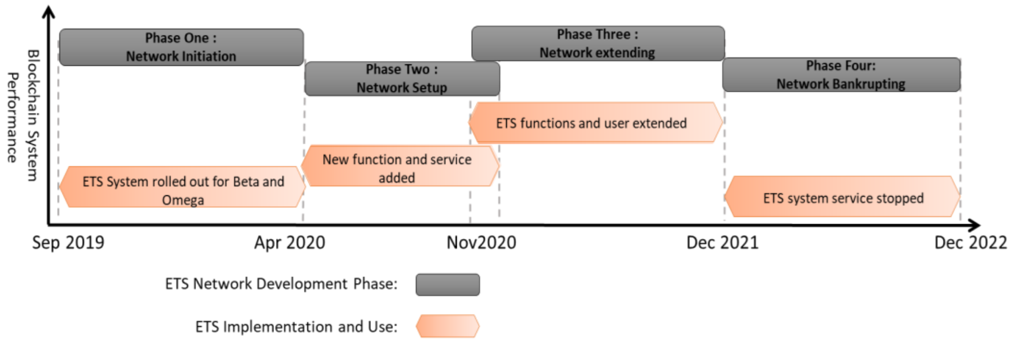

Figure 1. The Four Phases of ETS Blockchain Traceability System Project

In Figure 1, the grey rectangle demonstrates the project phases, and the orange hexagon presents the ETS system practices. The system implementation and use are in sequence with some overlaps. For example, when Alpha developed e-tag applied at Beta and system expansion is not fully updated, the local government already provided the financial support for these three companies to upgrade their blockchain system. Hence, phase two and three have overlaps during a certain period. This study took another look at the four phases under the theoretical lenses of AC to discover the interactions between the blockchain nodes (actors) and the related practices for responding to the contextual changes.

Phase one: network initiation

In May 2019, Alpha decided to extend its product line from the production of vegetables and fish to pig and cattle. Based on the existing blockchain traceability system, it took Alpha three months to extend the system into pig and cattle farm. This new system was released in September 2019 as ETS, which triggered a set of changes in their practices and relationships. Alpha's existing client, Beta, was the first network user of ETS, as it was connected into ETS existing system. Beta had its own ERP system for managing the supermarket and connecting Alpha's traceability system into the existing ERP system was not easy, which required a series of implementation actions for integrating new node into the chain, as Alpha Engineer Vincent explained:

> *"This blockchain based network is not just a software system to actually implied it into the actual work, we need to set up the new business policy for managing the system and controlling the data security for the other actors in the blockchain network."*

Rather than joining the chain itself, Beta also introduced its meat supplier Omega into the chain. Omega owns a pig farm, and most pigs are supplied to Beta's supermarket. At that time, as Omega had low IT capacity, this blockchain system did not really bring any benefits, but added extra working load. As its accountant explained:

> *"My manager asked me to put a large amount of data into the system daily. I had to manually copy and paste the data from excel document into the system, which was only adding my workload, but not bringing any benefits to my work. Also, were any mistakes I made on data entry, which taken us lots of time to correct it. Whatever, Beta is our major customer, we must do it."*

Beside interviewing with key personals, we collected the project documents and conducted the onsite observation for a deeper understanding of the application of blockchain systems in these companies. In this project, the ETS system acted as the Contextual trigger (Zahra and George, 2002) leaded to a series of related practices to adopt the contextual changes. These practices caused changes to the AC in all nodes. Moreover, the changing practice on various nodes impacts the ETS performance. Table 1 offers synthesis of the ETS practice from these three actors through the AC perspective in phase one.

Table 1. Phase one contextual trigger, AC and related practice analysis.

Node (Actor)	*Contextual Trigger(s)*	*Absorptive Capacity*	*Related Practice Analysis*
Alpha	Emerged marketing demands livestock farming.	Alpha CEO realized the market of the blockchain system in pig and cattle industry; Added the blockchain knowledge into the new industry.	The ETS was developed; Alpha started to market this blockchain system.
Beta		Beta management team recognized the benefits of joining the blockchain network; Staff learned the basic system knowledge from ETS.	Beta agreed to join the blockchain and became one actor in the network; The ETS started to provide data service for ETS customers.
Omega		Only one staff in Omega learn to input data into the system.	ETS added working load to Omega; Omega did not need to access the ETS.

The above discussion systematically analyzes the dynamics among the contextual changes, absorptive capacities and blockchain network adaptation. Due to the contextual changes, the blockchain traceability system connected various actors into the network and impacted actors differently. From AC perspective, each actor took a different role in the chain, the differences in capacity for acquiring, assimilating, transforming, and exploiting knowledge leaded to the performance and benefit variations on joining the chain. In this time of period, though Alpha and Beta benefit from joining the network, Omega did not receive any benefits yet.

Phase two: network setup

In 2019, almost eight million pigs, about half of China's pig population, were killed because of the re-emerging African swine fever (Mighell and Ward, 2021). The prior study has indicated the accurate adoption of the IoT technology, such as the accelerometer, temperature, GPS, in tagging pigs to judge their health condition (Kamminga et al., 2018). By combining the Neural Network and online activity recognition system, it will be practical to monitor human and animal health condition in the real-time (Tran et al., 2021, Sharma et al., 2022). To monitor the pig health condition, Alpha has extended its research focus from the blockchain traceability to the IoT based solution. In May 2020, Alpha released a new product, the electrical pig ear tag sensor with temperature and movement monitoring for 15 grams with IP67 waterproof.

Through this e-tag and ETS, the pig farmer could monitor their pig health conditions in the real time. Also, each e-tag has a blockchain ID for the following supply chain activities. This e-tag could bring great contribution to Omega, as it could reduce their risk dramatically for the swine fever and similar diseases. For testing purpose, Omega tapped the e-tag on the sow for two weeks and was satisfied about the test results. Therefore, Omega put the e-tag on each of its pig. Beta's sale team noticed that these pig health data could strengthen its market competition. Beta collaborated with Alpha expanded the ETS system to share the pig health data with the supermarket customers. Moreover, for certain pig cuts, the customer can know the pig health data by scanning the bar code on the meat box. These practices can help Omega to build trust with their customer and develop their competitive advantage.

Table 2. Phase two contextual trigger, AC and related practice analysis.

Node (Actor)	***Contextual Trigger(s)***	***Absorptive Capacity***	***Related Practice Analysis***
Alpha	African swine fever spread at pig farm in China; The new technology development enabled the electrical tag application from human to ananym.	Alpha management team noticed the blockchain traceability system cannot meeting the customer requirements; ear-tag was developed for monitoring the pig and cattle temperature and movement.	The blockchain data and network extended with the pig and cattle health data added.
Beta		Beta's marketing team noticed the value of the e-tag data; E-tag data was applied in the blockchain network.	The real-time pig health data displayed on the screen in the supermarket;
Omega		Omega management team noticed the importance of IT technology in farming industry; realized the value of monitoring the pig health condition in the real time.	The pig health data was shared with the meat customers.

Table 2 summarized that African swine fever on pig and wearable device develop cause the demanding on the trigger (e-tag) which led to the sequenced changes on these three nodes' AC and blockchain related practice. This e-tag requirement first changed the blockchain practice in Alpha, as it added the function of recording movement and temperature data into the ETS; then, Omega applied the e-tag and uploaded the health data into the blockchain, finally Beta shared these data with the customers for improving its reputation. As a result, their ACs were all developed sequentially.

Phase three: network extending

In late 2020, the government provided the fund for supporting organization's technology application in agriculture industry. Alpha, Beta and Omega all received government technology funds and used it for different purposes. This fund helped the existing supply chain to bring a new actor 'Delta' to ETS system. Based on the interviews and company documents from these four actors, they have used the fund differently as the followings:

- Alpha developed the mobile app for the providing traceability service, named ETS APP. Project document recorded that Alpha's ETS mobile app provides the extra services on three aspects:
  1. Pig's health data for the customer who purchased the meat;
  2. Traceability data 'from the farm to plate' for covering entire supply chain;
  3 Extra services for the related auditing institutes.
- Beta installed more sensors in their supermarket, warehouse, and delivery trucks to monitor the entire supply chain by IoT devices.
- Omega paid back for the e-tag installation and farming system implementation.
- Delta purchased the ETS system and implemented it in their business.

Beside the system useability for managing day-to-day operations, Omega found new opportunities to sale its meat and vegetables into Beta's supermarket network using it:

> *"This blockchain network enabled us to collect the product data on the growing field and feeding farm from our contracted farmers. This will help us ensure the food quality and reduce the risks. [...] We worked with Beta to sell our products at its supermarkets because we could provide the consistent data on the current premium products, but still working on the payment term. This is good for both parties (CEO, Delta)."*

Based on data, the local Government Technology Funding lead four actor's changes on absorptive capacity and related practices at phase three as summarized in Table 3.

Table 3. Phase Three contextual trigger, AC and related practice analysis.

Node (Actor)	*Contextual Trigger (s)*	*Absorptive Capacity*	*Blockchain Related Practice*
Alpha	Local government technology funding for support local companies on applying the new technology.	Absorbed the external knowledge for adding the supply chain data into the system; Updated the ETS system with more functions and wider accessible;	The blockchain encompasses more data and more service for more actors;
Beta		Acquired blockchain and supply chain knowledge; Added more supply chain data into the blockchain;	The blockchain can access the supply chain data;
Omega		None	None
Delta		Adopting the ETS system knowledge; Required more system solutions. Realizing the system knowledge into the body of the organization.	Adoption of ETS in the organization required the new system solutions; Stepped into the blockchian network and developed the new market.

In this phase, the government technology support funding, act as the contextual trigger, led to a set of actions, such as Alpha upgraded the system with mobile app function, Beta installed more sensors along its food supply chain to extend the data coverage scale and Delta got connected into the network.

These new data and services were available for Beta's customers and extended the availability of the blockchain. Alphas absorbed 'new' knowledge using mobile software. Beta also adds the supply chain data into the blockchain for improving customer service. Although, government funded Omega, the fund has been used for supporting the phase two activity, and this trigger did not lead to the AC change in Omega. This fund partially supported Delta to join this network, adopt the ETS system knowledge, and utilize it in their farm and even the contracted farms. Also, this may bring Delta into Beta's sale market. Therefore, we can see a reciprocal effect, that one trigger may lead to a series of changes in activities and AC.

Phase four: network failure

At the end of 2021, due to the co-vid spreading and restricted government control, technology funding and investment seriously reduced in China. Alpha was still a novel technology company and facing some financial difficulty. Since early 2022, due to the financial difficulty Alpha has stopped developing new system services and upgrading animal electrical tag. In the middle of 2022, some key technicians left the Alpha. Therefore, the system service and technology support have been gradually reduced.

Beta has received network benefits, such as improved quality control, positive feedback from customers on blockchain based traceability services and reduced management costs. As Beta's IT manager Ming said:

> *"We have developed our IT capability as we have extended our IT team …… We were thinking about take over ETS system by ourselves, but it has too many challenges and just give up……. Due to Alpha close down and the network failure, now we were looking for a new supplier to work on the similar system and network."*

During this time of period the system application at Omega remains the same, as the e-tag has been inserted into the pig ear and the system could provide the health data such as the pig temperature and movement data for every 30 minutes. Until the system closed, all the e-tag services were stopped. The pig farming went back to the prior practice.

Delta system practice remains the same, as in early 2022 the ETS system implementation has not been fully conducted. Due to the implementation and payment conflicts, until the system close and network failure at the end of 2022, Delta was starting to look for a new similar system supplier. The contextual triggers, absorptive capacity changes and the related practices have been summarized at Table 4 as the following:

Table 4. Phase Four contextual trigger, AC and related practice analysis.

Node (Actor)	*Contextual Trigger(s)*	*Absorptive Capacity*	*Blockchain Related Practice*
Alpha	Co-vid spreading related IT investment shrinking; financial support from the system clients was not enough for supporting Alpha business; Alpha closed on December 2022.	AC reduced constantly due to the key technicians lost, and finally the AC went back to 'zero' as the business closed.	Stopped new system service and e-tag research; system support reduced; key technicians lost; system and network close down.
Beta		The AC was slightly increased as the more system practice and more IT staffs worked at the Beta	Less IT support from Alpha made Beta try to take over the ETS, team; The system was too complex for Beta IT team; The system close caused Beta to look for new IT solution in early 2023.
Omega		None	The system application at Omega remains the same, until the system closed down and Omega back to the prior practice.
Delta		None	Due to Alpha AC reduction,

			the ETS system implementation has not been fully conducted; Until Alpha closed, Delta started to look for another similar IT solution.

In this phase, the co-vid spreading in China, act as the contextual trigger, led to a set of actions, such as reduced IT investment caused Alpha key IT staffs lost and even business close, Beta and Delta started to look for alterative IT solution, and Omega has back to the prior farming practice. Due to the business close on Alpha, its AC has gone back to ‘zero’. Therefore, we can see a reciprocal effect, that one trigger may lead to a series of changes in activities and AC.

This longitudinal case study clearly illustrated the dynamics among the actors in the ‘loose connected’ ETS blockchain network. Moreover, contextual triggers not only lead to the actors join or leave, practices and even cause the network failure The actor’s AC and blockchain related practices are all co-constructed and co-evolved in a turbulent context.

5 Discussion and Implications

The prior data interpretation summarizes the ETS system project development, implementation and use among Alpha, Beta, Omega and Delta from later 2019 to later in 2022. This interpretation is primarily based on Zahra’s concept of absorptive capacity (2002) as well as Marabelli’s research method of applying the absorptive capacity on enterprise system study (2019, 2009). In this section, we further depict the dynamics among contextual trigger, absorptive capacity and related changing working practices in the blockchain traceability network constructed loose connected network.

Figure 2 presented these four actors’ network contextual trigger, absorptive capacity and blockchain related practice from the longitudinal perspective. It highlights the key roles of absorptive capacity in the blockchain based traceability system project and points out the co-constructed and co-evolved of the absorptive capacity among the connected actors in the turbulent context. Also, it underpins the role of the contextual trigger in the traceability network. The ETS system network development is divided into four phases. In each phase the pentagon presents the contextual trigger, which caused the related system and business practices; the cloud shows the actual practices from various actors for responding to the contextual triggers. The rectangle indicates that the actor’s absorptive capacity and the arrow underpins the conditioning and enabling links.

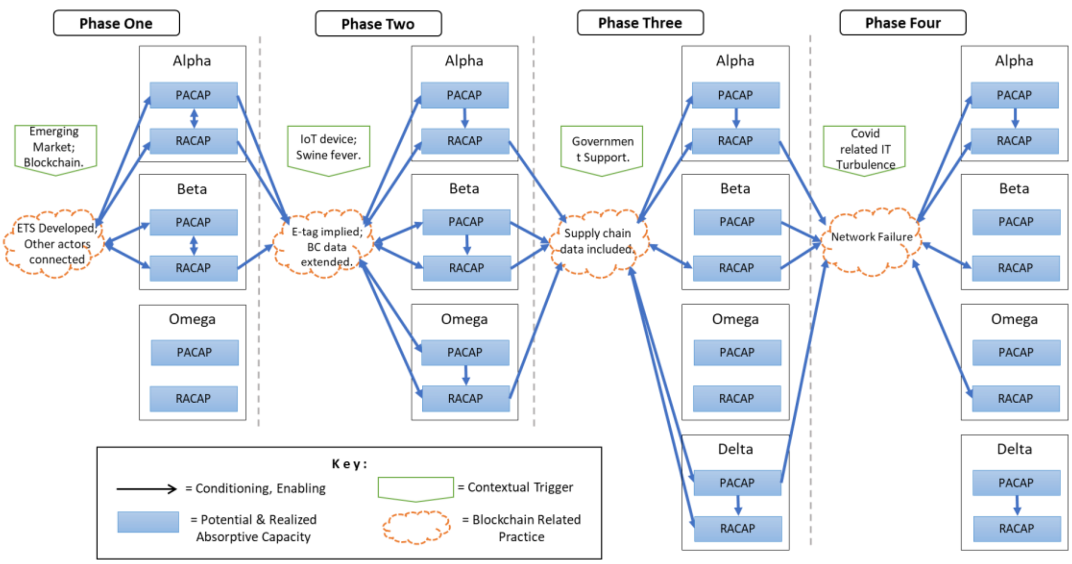

Figure 2. The Dynamics among Contextual Trigger, Related Practice and Absorptive Capacity at ETS Network

1. Blockchain enabled traceability network constructed 'loose connected network' – compared with the traditional network for data sharing and communicate, the blockchain based network brings the transparent and trust (Iftekhar and Cui, 2021), especially on food supply chain has been well recognized for traceability from multiple perspectives (Qian et al., 2020). From this case we notice that the blockchain has been adopted as the essential technology for developing the food traceability network, which triggered a series of actions from various actors. As traceability network, only certain data are shared on the network and the data access right is restricted. In this study, we define this kind of traceability network as the 'loose connected network'.

2. The role of AC in the blockchain based traceability network project- the above vignettes and analysis illustrate the key role of AC in blockchain traceability network adaptation. Compared with the majority study of AC in organization, the group or individual (Omidvar et al., 2017, Gao et al., 2017, Dolmark et al., 2021), The blockchain traceability network provides a unique environment, named loose connected network, for the AC. Under this network, one node's AC may interact with the others. For example, in phase one, Alpha's AC was connected to Beta's AC on the system adaptation, and they worked together to develop ETS. However, this did not contribute to AC of Omega, as their accountant still manually copied the data from Excel and pasted it into the system. Also in phase two, Alpha developed the pig E-Tag for monitoring the pig temperature and movement, which developed the AC at Beta and Omega differently. Beta presented the data at its supermarket for improving the customer reputation and Omega pinned the E-Tag on its pigs. In phase three, Alpha and Beta AC practice developed Omega AC and system practices. Various actors played different roles in the blockchain network; their absorptive capacity interplayed constantly. In this network, the AC still plays the mediating role between the context and practice, but the ACs from various actors collaborated construct the network and determined the network performance.

3. The AC cross-boundary co-evolvement at the loose connected network – In this network, the AC change at one actor may cause the AC change at the other actors. For example, Alpha recognized the market opportunity for adopting blockchain on food traceability which not only improved its AC for developing the ETS system, but also contributed to AC development at Beta for adopting this system; Alpha's e-tag, act as the contextual trigger, brought IT into Beta daily management, in which Beta staffs can monitor their pig health condition through the ETS, rather than visiting the pig farm on daily base. The scale of this blockchain network is flexible, as Delta was connected into the network and its AC involved the network and plays the key role as well. During this process, Alpha's transferred the system knowledge into Delta. Controversially, Delta's business requirement for connecting the contract farmer data into the network lead to the extension of AC at Alpha. We call this blockchain linked absorptive capacity the loose-connected absorptive capacity.

4. The key role of contextual trigger in this loose connected network – Figure 3 demonstrates the contextual triggers play the essential role in this network. It did not merely initiate the action for developing this network, but also terminated this network. These triggers are either predictable or unpredictable, and from both internal and external environment; one actor internal trigger may impact other actor's external trigger; even the same trigger may play different roles for various actors. As we noticed that the emerging blockchain technology and the market demand for traceability system motivated Alpha to develop the ETS system and explore the market. The ETS system use in various actors enabled Omega noticed the emerged pig farming business demand and business opportunity for developing the E-tag to monitor the pig health condition. The re-emergence of African swine fever in 2019 almost killed eight million pigs for about half of China's pig population (Mighell and Ward, 2021), which amplified the need for monitoring the pig health for 24 hours. Omega showed the great interests for adopting the ETS system for their pig farm management. This e-tag also created the 'new' business opportunity for Beta to demonstrate the pig health condition on their supermarket and improving trust in the products for their customer. In 2020, the financial support from the government for the technology development and adaptation also acted as the trigger for Alpha and Omega to move further towards their technology development and adaptation. This trigger also led Delta to join the

network as a new actor and enabled Alpha to transfer its knowledge to this organization through the system use. However, Co-vid led financial crisis on technology development finally caused the entire network interruption. This case uncovered that, in this loose connected network, the contextual trigger may come from quite different backgrounds, and even the same trigger may play different roles for various actors. For example, the same government funding was used by Alpha for developing the mobile app, by Beta to payback for the prior investment, and by Omega to develop the marketing software. This trigger also enabled Delta as a new actor to join this network.
Based on the substantive model and findings above, a generalized model is summarized as below. This model adopts the process and social constructive perspective, and underpins the technology appropriation integrating the constitution of human users, social histories and organizations (Orlikowski, 2010, Gare and Melin, 2013) that is compatible with the loosely connected network such as blockchain based traceability network (Garaus and Treiblmaier, 2021). Figure 3 shows the dynamic interactions among the absorptive capacity, working practice and contextual triggers in the blockchain enabled loose connected network from the longitudinal perspective. Here, the pentagon presents the contextual triggers that change the absorptive capacity and the related working practices; the rectangle indicates each actor's absorptive capacity; the ovals show the related practice, the cloud presents the blockchain enabled loose-connected network; and the arrow indicates the social integration.

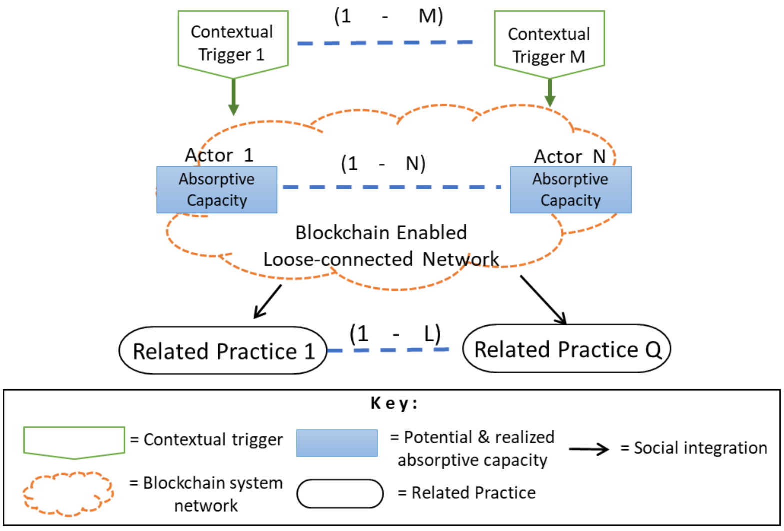

Figure 3. Dynamics of Blockchain Related Practice and Absorptive Capacity.

Change is the nature of business and regarded as one of the most threatening aspects in information technology implementation and use(Lichtenthaler, 2009). Absorptive capacity is context sensitive phenomenon responsive to change, and it is also developed through changing practices (Omidvar et al., 2017). For absorptive capacity, the contextual triggers have been identified and extended from various aspects, such as the internal prior knowledge, working practices, system structure (Marabelli and Newell, 2019, Martinkenaite and Breunig, 2016), the external market, technology, and supply chain(Golgeci and Kuivalainen, 2020, Omidvar et al., 2017, Saad et al., 2017). Therefore, for understanding the dynamics among the AC and working practices in a connected network like loose connected, we should underpin the key role of contextual changes in our modelling. Moreover, these contextual triggers are further defined as activation triggers, which cause serial dynamic changes in the loose connected network.
Most prior AC studies focused on one unit on organization, group or individual level, but the nodes in this blockchain enabled loose connected come from network level with various background, such as IT, farming, retail, government, and others. activation trigger comes from wider backgrounds internally, externally, predictably, and unpredictably. The contextual trigger leaded practice is conditioned by the actor's AC. Controversially, the only a conditioning agent, but itself is also liable

for change and transformation with the practice. The changing practice as new knowledge is acquired and assimilated by the adopting actor and further develop its AC. This has been identified as the endless process of revisions and enhancements (Markus et al., 2000) in which each process encompasses different degrees of knowledge exploration and exploitation (Marabelli and Newell, 2019).

From the longitudinal perspective, in this case the blockchain based loose connected network, the related practice and the AC overlappingly is developed in multiple actors, because the loosely connected network also provides a data and knowledge sharing channel. The information technologies can develop knowledge management and learning in organization (Iyengar et al., 2015), through implementing knowledge management systems (Wu et al., 2022, Acar et al., 2017) and enterprise system(Wagner et al., 2011, Chadhar and Daneshgar, 2018), but the loose connected network creates an unique environment in which actors come from multiple levels such as organizational, group, or individual. This study has clearly shown that, in this kind of network, one actor's AC interacts with another actor's AC through the network related practice. In this network changing one actor's absorptive capacity could influence other actors' absorptive capacities in different ways, and these absorptive capacities can co-construct and co-corrupted. Compared with the traditional enterprise system network, the blockchain based traceability system provides a unique loose-connected network condition, as only certain data and service are connected with limited access.

6 Conclusion and limitation

Blockchain is an immutable digital ledger which provides a unique mechanism for traceability (Demestichas et al., 2020a). A blockchain enabled traceability network is a quite different and new environment for data transfer and working practices. This study uncovers salient opportunities and challenges in blockchain network deployment in food supply chains in which 1) the blockchain enabled supply chain connected actors are very heterogeneous, as they come from quite different industries (e.g. technology, farming, manufacturing, logistics and even retail); 2) all actors are loosely connected through common data access spanning over the entire network; 3) the network often changes due to new nodes (actors) added or lost; and 4) this network can provide an innovation space for unforeseen actions, in which one actor could introduce new services; 5) the contextual trigger play the key role in this network

This research adopted the AC as the theoretical lens for uncovering the knowledge absorption and development under the conditions afforded by a loosely connected network of actors. It also highlights the importance and complexity of the knowledge processing capacity in this network. Adopting AC as the theoretical lens enlightens the research on blockchain technology application in traceability. From this longitudinal perspective the benefit of blockchain based traceability system emanates from the dynamics among the contextual trigger, system use and AC. In this process, the AC plays a mediator role, as it conditions the interactions between the contextual trigger and the related working practice. The co-construction and co-evolution also provide a unique circumstance for AC, in which it is not developed from PACAP to RACAP, but an actor's AC improvement may also cause the other actors' AC changes in different ways. The development of loose connected network relays on the accumulated knowledge processing capacity of the connected actors. Even the nodes' (actors) AC dynamically determinates the whole blockchain network performance. Therefore, the loose connected network has its own AC waiting for future research.

This study also discussed the complexity and importance of the contextual trigger in this loose connected network. As this study noticed, the blockchain connected nodes come from various backgrounds. Compared with a single unit, this network is more sensible to various contextual changes and responsible for the changes with different actions. In this case, with four actors that have quite different ACs and business backgrounds, the government technology funding led to the various actions, and even continuous changing practices on certain actors. The unpredict Co-vid spreading leaded the technology investment crisis and even caused the network failure. Although previous studies about AC uncovered its context sensitive characteristics (Volberda et al., 2010, Todorova and

Durisin, 2007), our results furthers this finding and suggests that, in the loose connected network, one contextual trigger may play various roles at different actors and these actors may interplay as well.
This study has some inherent limitations, but it indicates some future research possibilities. The data was collected from only one blockchain food traceability network in full life cycle. A broader survey from various blockchains traceability in different backgrounds may provide detailed insights into the dynamics of AC and add more detailed interactions among the actors. Moreover, the research focuses on the high-level network aspect and construct amongst this loosely connected network and related blockchain working practice. More elaborative studies into the details of those constructs and processes are likely to add further value to the applications of this technology in real word problems.

7 Acknowledgments

This paper is supported by Harbin Science and Technology Innovation Talents Research Fund (No. CXRC20221115450); State Grid Heilongjiang Electric Power Co., Ltd. Technology Project (Analysis of Provincial Economic Operation and Policy Effectiveness Evaluation Based on Power Big Data and Blockchain Technology under the Dual Carbon Target)， Key Projects of Education Science Planning in Heilongjiang Province for 2021

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