Challenges of Value Cocreation in the Digital Era: A Study of Supply Chain Partners

—MEICHUN LIN
Department of Finance and International Business, Fu Jen Catholic University, New Taipei City 242062, Taiwan

The review of this article was arranged by Department Editor Soila Lemmetty.

IEEE DOI 10.1109/EMR.2023.3345262

***Abstract*—*Because of rapid advances in information technology, firms are facing challenges in providing value to their customers and are struggling to cocreate value in their supply chains. The purpose of this study, which was theoretically based on value cocreation, was to investigate the key explicit and implicit drivers of value cocreation by supply chain partners. Semistructured interviews and a case study of a supply chain comprising five companies were used to gather the primary data. This study discovered strategies that can help firms cultivate internal and external linkages, particularly as they relate to information sharing. This study contributes to the value cocreation theory in digital transformation in the context of linkages among supply chain partners. This study highlights the role and importance of customer and supplier engagement in value cocreation. The findings reveal the operational strategy, functional resources, and digital transformation that give rise to value cocreation between supply chain partners. This study contributes to the value cocreation theory regarding digital transformation in the context of linkages between supply chain partners.*

Key words: Customer and supplier engagement, digital transformation, functional resources, operational strategy, value cocreation.

1. INTRODUCTION

THE rapid advancements in information technology (IT) have greatly accelerated and simplified the flow of information. A company's ability to create value and establish its position in the market relies on its understanding of globalization and market demographics. Digital transformation has become a crucial driver of change, impacting the strategies, and operations. Developments have facilitated easier access to data concerning the value creation process, leading to the formation of a value information cycle. Companies actively embrace digital transformation by leveraging cutting-edge IT. This empowers them to deliver products and services based on evidence and collaborate with external partners to foster value cocreation. The global competition and rapid market shifts have significantly transformed industrial ecosystems (Kagermann, 2015). In response to these transformative challenges, enterprises are striving to streamline their value chains, diversify their product offerings, and enhance the flexibility of their production lines to cater to the unique needs of individual customers (Kiel et al., 2017).

Hess et al. (2016) define digital transformation as the changes that digital technologies can bring to a company's business model, resulting in modifications to products, organizational structures, or the automation of processes. It involves adapting technology and creating novel business models to

enhance connectivity with digital customers at each touchpoint of the customer experience life cycle (Schuchmann and Seufert, 2015). Digital transformation necessitates substantial flexibility as it involves a complex process and encompasses three shifts in enterprise strategy: 1) transitioning from resource domination to resource sharing, 2) moving from optimizing internal operations to engaging with external actors, and 3) shifting focus from adding value for customers to enhancing value chain performance (Van Alstyne et al., 2016). Jain et al. (2021) proposed that digital technologies offer firms the opportunity to develop new or improved ways of creating value, thereby enhancing customer experiences. Through digitalization, value can be created through ecosystem orchestration or collaboration (Parida et al., 2019). Moreover, digital transformation can enhance a company's internal processes, leading to increased cost efficiency, ultimately impacting performance positively (Rantala and Karjaluoto, 2018). With inspiration from the private sector, where companies have begun to extend their digital transformation efforts beyond organizational boundaries, there is a growing interest in value cocreation among academics, policymakers, and practitioners in public administration.

Value cocreation is gaining popularity among organizations seeking a competitive advantage. Effective management of value cocreation allows firms to improve operational performance, cultivate stronger stakeholder relationships, increase productivity and efficiency, reduce costs, and minimize the risk of failure (Greenhalgh et al., 2016). The concept of customer engagement refers to the cognitive process that occurs when a customer interacts with a brand, and it is closely linked to value cocreation between the firm and the customer. As relationships become more intense, interdependent, and globally distributed, researchers acknowledge that a company's external business ecosystems influence value cocreation (Clarysse et al., 2014). Industry boundaries are becoming increasingly blurred. Consequently, enterprises must rely on flexible production processes. The key to establishing such processes lies in the company's ability to engage in cooperation and, consequently, value cocreation (Amit and Zott, 2012; Agrifoglio et al., 2017). While scholars and practitioners have studied digital transformation for more than a decade, with many studies explaining its impact on enterprise innovation, competitiveness, and profitability, its implementation remains challenging due to the need for active involvement not only from senior management but also from line employees (Dery et al., 2017).

A recent study on digital transformation explored the challenges encountered during the transformation process, the motivating factors driving the transformation, and the failures of previous transformation initiatives (Haffke et al., 2017). Enterprise managers are particularly concerned about the willingness of employees to participate in digital transformation. Indeed, human factors present the most complex issues in management, as individuals vary in their psychology, education, and socioeconomic status. While scholars acknowledge the importance of professional strategy, digital transformation as a concept is still in its early stages, requiring further research to fully explain how such transformation can be effectively achieved. Therefore, investigating digital transformation from a strategic perspective should provide valuable insights and assist executives in understanding the trends and strategic frameworks they are attempting to establish.

Although many scholars have theorized about the essence of digital transformation, few have delved into how digital transformation is practically implemented within a company, particularly concerning the organizational structure and systems (such as incentive systems). Additionally, studies have overlooked how companies establish value cocreation during digital transformation, thereby impacting operational performance. Consequently, this study investigated how the operational strategy and functional resources within an organization influence operational performance from the perspective of value cocreation between customers and suppliers during digital transformation.

This study emphasizes the importance of bringing together internal resources, customers, and suppliers to effectively address the challenges of the digital age and gain a deep understanding of the internal structure and external environment of the enterprise (whether it's the market or society as a whole). Through such integration, companies can establish meaningful connections, engage in value cocreation, and ultimately trigger adjustments in business models and organizational structures (Fu et al., 2004). To explore the value cocreation process involving internal and external resources in digital transformation, this research conducted a case study of a supply chain involving five firms. The primary objective was to uncover the key drivers, both explicit and implicit, of value cocreation among supply chain partners, providing valuable insights into the value cocreation processes in supply chain management.

Additionally, this study deeply analyzes value cocreation in the context of digital transformation and its impact on supply chain management, including operational strategies and the influence of

functional resources in the digital era. It aims to understand the effects on organizational performance. Section 2 provides a literature review of relevant research, including digital transformation, value cocreation by supply chain partners, customers, and suppliers, as well as functional resource linkages. It also examines how these factors impact the effectiveness of digital transformation through value cocreation. Section 3 describes the research design used to examine the specific functions of external and internal linkages across various supply chain levels. Section 4 presents the research findings and relates them to the research objectives. Section 5 provides a detailed discussion of the existing research. Section 6 highlights the contributions of this study to theory and practice, explaining how the research findings can be applied to enhance the efficiency of digital transformation in the supply chain. Finally, Section 7 suggests future research directions to further deepen the understanding of value cocreation in digital transformation, especially in the context of supply chain management.

2. Literature Review

2.1 Value Cocreation Grönroos (2012) stated that value cocreation is "direct interaction in a joint cooperation activity, and the goal is to contribute value to customer and service provider during their direct interactions." In a business relationship, extended service offering is an interactive process; by supporting the practices of clients in a reciprocal manner, a company helps clients create value (operational efficiency), which improves business effectiveness. Thus, value cocreation helps a company become more competitive. According to Aarikka-Stenroos and Jaakkola (2012), value cocreation can occur in multiple respects, such as in the digital transformation process and can involve multiple actors, which calls for "restructuring the role of customers and suppliers within the value co-creation process." In particular, customer participation in the processes of digital transformation and value cocreation underscores the importance of interactivity. Toffer (1980) noted that consumers can also function as producers; this entails closer interaction between a business and its customers, particularly through the Internet. For example, customers often leave online reviews and comments, which improve the business and are the result of consumers contributing their time and knowledge (Prahalad and Ramaswamy, 2004). Consequently, both parties, consumers and companies, benefit from this process. The theoretical framework of service-dominant logic posits that consumers, companies, and any actor that benefits from the companies' operations are resource integrators, and only through the interaction between these resources' integrators can value creation occur (Vargo et al., 2008).

2.2 Digital Transformation Companies have recognized the need for digital transformation—alongside taking traditional steps to lower production costs, improve product quality, and streamline manufacturing—in response to rapid changes in markets, particularly with regard to their competition (Matt et al., 2015). As noted by Vial (2019), digital transformation enables companies to master large quantities of information and communicate more efficiently, resulting in changes to their business model, product lineup, production processes, organizational structure, and corporate strategy (Lenka et al., 2016; Zangiacomi et al., 2020). Thus, firms must establish a practical management approach to handle these complex changes to establish value cocreation. Hönigsberg et al. (2020) noted that network value cocreation requires firms to establish 1) a service customization system, 2) a centralized database, 3) an analytics system, and 4) a shared IT platform. During the digital transformation process, various factors—such as collaboration with supply chain partners, the innovativeness of the business model, and the unique capabilities of the organization—affect the effectiveness of value creation. According to Schwab (2016), the success of digital transformation hinges on four factors: customer experience, the analysis of digital products, partner relationships, and teamwork and group learning. In this era of the experience economy, many services require the participation of consumers (Lovelock and Wirtz, 2004), particularly when companies offer highly customized products or services.

2.3 Digital Transformation and Value Cocreation Digital transformation has become a key topic in research on information strategy (Piccinini et al., 2015). Companies must implement digital transformation to innovate (Hess et al., 2016), and digital transformation enables greater participation by customers and suppliers, who then become cocreators. The preferences, interests, and behavior of these cocreators are directly reflected in their use of the digital transformation system; subsequently, companies can make immediate adjustments based on user responses. More explicitly, the end customer lies at the center of value cocreation. To maximize the benefits of value cocreation, end customers take the lead in every action in the value cocreation network (Basole and Rouse, 2008). Activities in value cocreation are, thus, intended to enable the end customer to create value (Zeithaml et al., 2001). The products or services received by customers are a culmination of the collaboration between companies and customers. The business objective of companies

is no longer restricted to creating value for customers; they also want to encourage customers to create value for not only the company but also other stakeholders.

Furthermore, digital transformation achieving its goal of satisfying customer needs must be considered. Digital transformation necessarily involves complex interrelationships between internal and external activities and processes, and these interrelationships must be managed if the implementation of digital transformation is to proceed smoothly. A supportive attitude toward digital transformation by senior management trickles down to line employees, leading to every member of the organization being motivated to confront challenges during digital transformation. Companies should provide training, which can also strengthen teamwork and general problem-solving skills. Digital transformation, by making information more readily available, aids strategic decision-making. Studies on digital transformation, value creation, and value cocreation have provided preliminary findings on how companies have realized these concepts. Findings from these studies also reveal how internal and external relationships in value cocreation give rise to greater engagement, stronger interaction, and collaboration cycles.

The value provided by companies to customers has objective and subjective facets (i.e., how much value the company actually adds versus how much value the customer perceives the company as adding; Ding et al., 2011). However, companies fail despite their efforts primarily because they do not understand their customers and, by consequence, the (often rapid) changes in market demand (Christensen and Bower, 1996). A service customization system is akin to a process configuration because some functions may be equally important to every actor, and the digital transformation system—by sharing information between supply chain partners—depends on the complexities of the role a company plays in value cocreation. A centralized database is one that can be accessed by all relevant actors. An analytics system provides useful information regarding every phase of the value cocreation process. Finally, a shared IT platform enables every participant to join in the process of value cocreation by sharing information and synchronizing network activity in a mutually transparent manner. In other words, digital transformation drives industrial restructuring and subsequently affects innovation, upgrading, transformation, and succession in a company, which are critical to a business' sustainability.

3. Research Design

On the basis of our theoretical understanding, this explored 1) what policies and incentive systems a company should establish to support its digital transformation and 2) how companies can integrate internal and external resources so that every potential cocreator can participate in value cocreation during the digital transformation. Using a case study strategy, this study collected data between March 2022 and October 2022. The operations of five companies were observed, and each interview lasted from 1 to 3 hours. Data triangulation was employed in this research, with interviewees asked to respond to the same questions. To ensure data consistency, relevant documents related to the target companies were also collected. This study investigated the unique linkages between three dimensions of value cocreation between suppliers and customers during digital transformation (Barratt and Barratt, 2010). The case study method was suitable for our research questions, allowing us to conduct an in-depth examination of this phenomenon (Yin, 2003; Eisenhardt and Graebner, 2007). The cases in this study involved both suppliers and customers. The selection of cases from three different levels was made to provide theoretical insights into the digitization transformation of value cocreation among supply chain partners.

3.1 Case Description The case study firm investigated in this study is called *CaseCo*; it is a machinery manufacturer founded in 1996 that mainly produces enterprise-level equipment for corrugated containers. At the time of the study, it had 150 employees. Because of the increase in people staying at home due to the COVID-19 pandemic, carton manufacturing companies worldwide have been expanding their production infrastructure. *CaseCo* now has a presence in Taiwan, China, Japan, Central America, Southeast Asia, Europe, and the Middle East because of the success of its internal restructuring and global marketing. Many large paper companies in Taiwan, use *CaseCo*'s machinery to produce cartons. *CaseCo* has become globally competitive due to innovation and research and development (R&D). Due to a recent need to expand its infrastructure, *CaseCo* has implemented digital transformation to optimize both its internal manufacturing processes and integration with external actors in the supply chain. This has resulted in 200% higher efficiency. *CaseCo* is now, by market share, the largest and second-largest manufacturer of equipment used for corrugated container printing in Asia and worldwide, respectively.

3.2 Data Sources and Collection This study gathered both primary and secondary data. Before visiting the company to collect primary data through semi-structured interviews, this study reviewed company documents (e.g., seasonal reports,

the company's annual report, and news articles) to better understand the company's background and competitive environment. Data triangulation was performed to confirm the accuracy of the data because this study used data from various sources (Merriam, 1998; Yin, 2003). The interview technique employed was that developed by LeCompte et al. (1993); it involved research-related questions selected on the basis of the background of the interviewee—specifically, their department, position, and duties within the organization.

To guarantee a smooth transition in product inventory management, especially regarding the replenishment of promoted products, both suppliers and customers worked together to develop a collaborative digital transformation process and system. After this study established contact with the supply firm (referred to as "*SupplyCo*" hereafter), this study learned that although they had received industry accreditation, they had no information-sharing system for part of their supply chain network. Thus, this study decided to focus on such as information-sharing saturation versus information-sharing shortage within digital system platform linkages. Table 1 details the characteristics of the companies investigated: two customer companies (*CustomerCo1*, an industrial paper and corrugated container manufacturer, and *CustomerCo2*, a Kraft paper and packaging manufacturer) and two supply companies (*SupplyCo3*, a testing equipment and integrated software provider, and *SupplyCo4*, an ink manufacturer). This study did not focus on raw material suppliers because information sharing is unlikely to improve linkages between them.

3.3 Semistructured Interviews

The questions used to guide our semistructured interviews were formulated after a literature review. The inquiries posed in the interviews were aimed at exploring different dimensions of information sharing and visibility. These included the existing and potential modes of information sharing, the advantages associated with information sharing, and the extent level of visibility across different linkages. Subsequently, interview transcripts were given to the interviewees to ensure recorded their responses accurately, thus ensuring construct validity. To ensure that the data collection was comprehensive, this study conducted interviews until no new information surfaced (Eisenhardt, 1989).

In the initial interviews, this study discussed issues that went beyond the interviewees' job scope. For example, this study asked employees in the IT department about the relationships between supply chain partners, specifically how these relationships came to be and what benefits they bring. This enabled us to understand how the departments in a case company worked with their counterparts in the other case companies. The perspective then shifted from the linkages between firms to those within firms, such as that between the purchasing and logistics departments. Furthermore, after gathering data on the impact of composite (external) linkages on operational performance, after gathering information on the general characteristics of the relationships between supply chain partners. Subsequently, this study identified each external and internal linkage to determine how each of them affected operational performance.

Table 1. Overview of the Companies Visited

Firm	Annual sales	Employees	Product
CustomerCo1	$500m	3000	Industrial paper, corrugated container
CustomerCo2	$70m	1600	Kraft paper, packaging,
CaseCo	$5m	150	Manufacture
SupplyCo3	$2m	75	Integrated software solution
SupplyCo4	$5m	100	Printed inks

4. Results

The analysis and interpretation of our interview data helped us understand how *CaseCo* has employed collaboration to cocreate value through digital transformation.

4.1 CaseCo Analysis

Table 2 displays the findings of the within-case analysis conducted on both the internal and external linkages. Specifically, this section covers what the assignment and objective of every linkage are, how customer or supplier value cocreation unfolds, how much customers or suppliers interact with each other, and how linkages interact with each other in terms of operational performance and functional resources. This study identified three sets of linkages: one set of internal linkages within *CaseCo* and two sets of external linkages that *CaseCo* has with customers and supply chain partners (i.e., *CaseCo, CaseCo* ↔ *Customer*, and *CaseCo* ↔ *Supplier*).

CaseCo has been focused on increasing sales. *CaseCo, CustomerCo1*, and *CustomerCo2* have established joint efforts in continuing product maintenance, upgrading their product lineup, and conducting training, which has led to continued positive interactions between partners. Nonetheless, these efforts (and their resulting benefits) have come at a cost in terms of personnel or money. For example, some customers requested to train their employee in a different country, some wanted expensive software upgrades, and others required

shortened lead times. Furthermore, the usual means of information sharing (through telephone, email, and memos) across traditionally structured functional departments were rigid and had low capacity. An interviewee noted the following:

> *"We communicate to our customers the value our company can bring to them. From the customer's perspective, we consider how to deliver higher value through the product, creating benefits for the customer while generating high-profit margins for us. The customer [CustomerCo1] provides information to us when they want us to understand their needs. They tell us their unique requests, and it is our responsibility to fulfill them. This is the norm within the industry." (CaseCo, Production director)*

Its outdated organizational culture, where information failed to flow freely, together with *CaseCo*'s structure of functional departments had led to weak visibility of internal communications. For example, when the sales department shared forecasting information with their colleagues in the production department, they omitted information regarding product requirements or specifications, which led to the production process being halted. This happened because *CaseCo*'s production line had to be adapted to produce a custom-made order where it is most needed for the production process. Additionally, despite sharing monthly product forecasts with the R&D department, the sales department failed to provide specifications regarding base demand and demand driven by customized requirements, resulting in the production department placing orders with *SupplierCo* with no clear instruction on whether assembly parts were required. The purchasing department was concerned about the limited perceived level of visibility that resulted from sharing information digitally, prompting them to place orders with *SupplierCo* that were later questioned.

> *"After placing orders for several minutes, we immediately received a call from them telling us [SupplierCo2] that the lead time would be 12 weeks due to them not having these special parts in stock. It is somewhat annoying but, at the very least, they helped us make better decisions." (Employee of CaseCo and purchasing director of SupplierCo2)*

SupplierCo1's production department tried to establish a closer connection with *CaseCo*'s purchasing department through scheduled weekly meetings and the exchange of information regarding production schedules and net monthly requirements. However, *CaseCo*'s purchasing department, on the other hand, only exchanged order-related information with S*upplierCo1*'s logistic department, offering little to no appreciable visibility, consequently failing to make any improvement in operational strategy.

> *"If they were more capable with the planning and internal system operation, we might consider providing more information that would help enhance their performance, but they have to improve first for us to consider that." (Employee of CaseCo and purchasing director of SupplierCo1)*

Table 2. Linkages in Value Cocreation in Digital Transformation

Linkage	Functional resources	Customer/supplier engagement	Operational performance
CaseCo	Sales R&D Production Finance HR IT Logistics	Forecast and plans Production plans Maintenance plans Delivery plan Training plan Custom orders Net monthly requirement for various parts	Increased forecast accuracy Flexibility Reduced inventory Quality assurance Customer service
CaseCo- Customer	Sales Production R&D	Promotional uplift information New product information Production schedule Future and order plans Quality KPIs Delivery requirements	Improved responsiveness Quality issues Customer service
CaseCo-Supplier	Production Purchasing R&D	Supplier requirements Net monthly requirement of inventory Production plans Annual usage Consignment stock Stock levels Cost reduction	Reduced inventory levels

Notably, *SupplyCo1* reported they had tried multiple times to contact *CaseCo* to discuss problems in product development, but *CaseCo*'s purchasing department rejected these invitations and informed top management of these overtures. *SupplyCo1*'s actions were recognized by CaseCo to have established loyalty between them.

4.2 Linkage Between CaseCo and CustomerCo Through Value Cocreation The sales department exchanged net monthly order information with the R&D and purchasing departments to aid in customized product planning and balancing the production schedule. However, the customized information was not shared with the *CaseCo* production department. The order process status with customer-perceived interaction was identified as being almost invisible. Furthermore, uncertainty in raw material deliveries had frequently halted *CaseCo*'s production schedules. Despite *SupplierCo*'s active efforts at resolving these problems by exchanging information with the sales and purchasing departments in *CaseCo*, it failed to improve operational performance. The interaction, and thus reduced uncertainty, stemmed from the linkage that shortened production lead time from 6 to 4 months while drastically boosting purchasing-related forecast accuracy through a new joint production process implemented within the digital information system. Additionally, the interaction led to higher product availability because the sharing of information through interactions between partners led to cohesive relationships and an effective production process:

> *"By combining our suppliers' knowledge together with CaseCo device specification knowledge and subsequently establishing joint efforts in the monitoring of weekly and even daily production progress, greater insight and certainty were obtained in terms of what the device was meant to be—this made forecasting easier." (CustomerCo1, purchasing director)*

To improve communication and joint problem-solving between the functional departments of *CaseCo* and *CustomerCo, CaseCo* implemented a strategy that involved hiring a customer service coordinator. The coordinator utilized a digital information system platform to facilitate communication and interaction between the two firms. This solution was implemented to address the issue of inadequate collaboration between the departments of both companies.

The customer service coordinator played a vital role in enabling *CustomerCo2* to rely heavily on *CaseCo* for the flow of information related to customer service activities. The resulting high level of interaction between the two companies enabled *CaseCo* to be more flexible and responsive. Specifically, the enhanced interaction reduced the level of uncertainty, allowing for better coordination control of the production schedule.

> *"The service numbers indicate we are now able to better cooperate and meet customer demand. The data they provide are helpful but being involved in customer decision-making certainly helps decrease the guessing on our part." (CaseCo, Customer service manager)*

The sales department of *CaseCo* and the production department of *CustomerCo2* engaged in an exchange of information pertaining to promotional plans and product orders, which included device data and status. This reciprocal sharing of knowledge resulted in a discernible increase in interaction, thereby reducing uncertainty and enabling more informed decision-making on the part of both parties.

> *"They [CaseCo] simply do not know what to do with the information we provide. When they do, we will proceed to exchange more information with one another, and their performance should improve." (CustomerCo2, purchasing director)*

4.3 Linkage Between CaseCo and SupplyCo Through Value Cocreation Internally communicated data were distrusted and interaction was weak because much real-time information relevant to *CaseCo* and its suppliers (i.e., the inhouse inventory levels of material parts across its distributors) was withheld and because its rigid organizational culture stymied the flow of information. Before developing a collaborative digital transformation system, *CaseCo* had encountered issues with satisfying the demand for its products from *SupplyCo*, causing *SupplyCo* to hold significant inventory levels (i.e. 12 weeks) of key parts. SupplyCo's logistics director came to realize that the root cause of the issues was insufficient visibility and coordination of promotional activities; thus, the digital system was designed to expand visibility and information sharing by *CaseCo* and to promote closer interaction in planning and inventory replenishment.

> *"We had hoped to receive more information from the customer, however, I'm thinking they do not believe we have ability to effectively utilize the provided information." (Supplier 1, R&D)*

CaseCo recognized that to further improve suppliers' responsiveness to

meet the demands of end customers and to instill awareness within *CaseCo* regarding the knock-on effects of last-minute decisions on production activities for not only *CaseCo* but also its suppliers within the value chain, *CaseCo* had to deepen and widen interactions in purchasing and inventory management with *SupplyCo2*.

Due to persistent quality problems with its various ink product suppliers, *CaseCo* decided to focus on a single supplier instead. That supplier was *SupplyCo2*, and they were most receptive to collaboration, especially in addressing quality problems. *SupplyCo2* then announced a 2-week delay that stemmed from *CaseCo*'s sudden changes to the product artwork on its cardboard trays. *CaseCo* soon became aware that it was more dependent on *SupplyCo2* than it had originally thought; thus, delays would lead to customer complaints because they would increase the lead time of finished products.

> *"CaseCo business is important to us, but they only provide roughly one-seventh of our total monthly volume. Their business is certainly important, but not that important." (SupplierCo2, Customer Account Manager)*

CaseCo and *SupplierCo2* regularly communicated production-related information, including weekly and monthly production plans and schedules, through both face-to-face meetings and email. This resulted in increased flexibility for *CaseCo*, as *SupplierCo2* was able to reduce lead times in response to *CaseCo's* adaptable production schedule.

5. Discussion

In this section, this study summarizes the benefits that established companies acquire when shifting to value cocreation. The findings are summarized in Table 2. This study identified all 1) internal linkages within the case company and 2) all external interactions between supply chain partners regarding operational strategy, supply chain engagement, functional resources, and digital transformation in value cocreation. These created linkages that enabled broader interaction across both internal and external firms. Two key sets of external interactions were identified: first, interactions of customer and supplier engagement, operational strategy, and digital transformation with value cocreation, and second, interactions of customer and supplier engagement, functional strategy, and digital transformation with value cocreation.

Despite increasing engagement with supply chain partners, CaseCo experienced a higher external flow of information among partners than within its internal departments. Possible explanations for this phenomenon could include a harmonious relationship among departments, with the exception of the previously mentioned conflict between sales and production, or the presence of established communication protocols. Furthermore, the purchasing department lacked access to inventory level information available to its production colleagues, leading to excessive reliance on the R&D department for purchasing decisions. To enhance coordination with

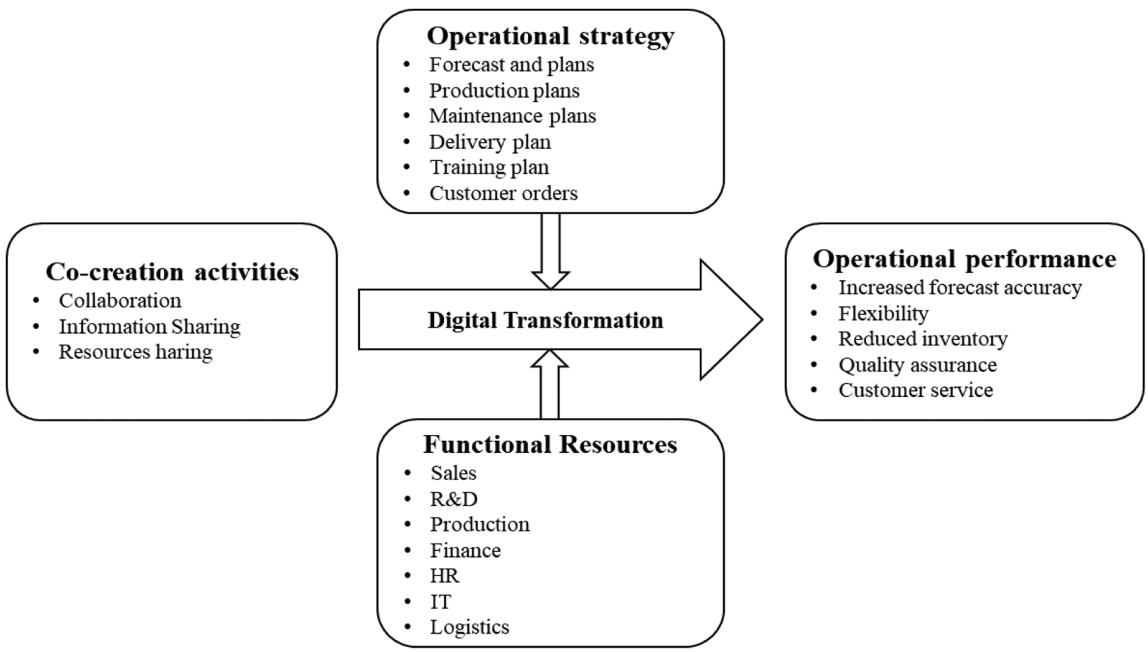

Figure 1. Model of value co-creati on for supply chain partners.

supply chain partners, CaseCo encouraged internal and external interactions with key suppliers, particularly in custom order fulfillment, resulting in increased flexibility and responsiveness for suppliers such as SupplierCo. The reason for the disconnectedness between procurement and production was identified as the absence of a connection between the sales and production units., highlighting the importance of developing interaction and information-based sharing channels to bridge functional gaps in the value cocreation process of organizations (Tiwana, 2008; Burt, 1992; Zaheer and Bell, 2005).

5.1 Role of Operational Strategy and Functional Resources in Cocreation

5.1.1 Effect of Operational Strategy on Digital Transformation in Value Cocreation The operational strategy of *CaseCo* and *Customer*/*SupplierCo* improved because of information sharing on the digital system between supply chain partners. This was due to the interaction of customer/supplier engagement and digital transformation with value cocreation, which derived from the application of digital information to value cocreation. Although organizations seek to establish extended interaction with their supply chain partners can sometimes impede the flow of information due to preexisting relationships. For *CaseCo*, a conflicted relationship between the sales and production departments prompted employees in the logistics department to create a "bridging" linkage to directly communicate with the purchasing department. *CaseCo's* sales department wished to enhance its internal planning capabilities, but it was hindered by its managing director who wanted to participate in every meeting with *CustomerCo* to increase forecast accuracy and reduce inventory levels. Regarding *CaseCo*, its purchases comprised approximately 10% of *SupplierCo1*'s total business volume. This helped the motivation of SupplierCo to encourage their customers to provide information that is relevant for determining the total volume. It was observed that information related to production and inventory was limited to the upstream tier between CaseCo and SupplierCo, whereas promotion-related information flowed from distributors to the end customer. Consequently, promotion-related information was subject to changes in the nature and volume of the recipient's product. To enhance operational performance through internal and external linkages, the influence of interaction was adjusted by sharing information and resources within CaseCo functional resources on the digital transformation platform. This indicates the importance of effective information sharing and resource allocation in improving overall operational performance in supply chain management.

In the realm of supply chain management, the transmission of information to partners is often subject to the sender's perception of the receiver's ability to make use of the information effectively. This perception can influence the level and extent of information flow between partners, thereby affecting the operational performance of the entire supply chain. For instance, between *CaseCo* and *SupplierCo1*, custom software, based on customer requirements, was employed. Thus, the purchasing and production departments agreed that exchanging information on the specifications of downstream products with *SupplierCo1* would not yield improved lead times. In addition, the functional departments within a company may not continue sharing information beyond their immediate circle if they lack the necessary knowledge and skills to utilize it appropriately. This is exemplified by *CaseCo's* sales department, which may struggle to make use of the information obtained from *CustomerCo's* purchasing department due to a lack of understanding of how to leverage this information effectively. Furthermore, in situations where a firm is located downstream from its suppliers, the level of uncertainty regarding customer demand is typically higher. As a result, information shared internally between departments is often perceived as being more useful than information received from customers. Therefore, this study proposed the following propositions:

Proposition 1: Operational strategy in coworking activities increases the ability of supply chain partners to engage in digital transformation and value cocreation.

5.1.2 Effect of Functional Resources on Digital Transformation in Value Cocreation In terms of functional resources, despite the importance of information sharing and the visibility provided by internal and external linkages, each interaction linkage served significantly different purposes. Studies have shown that information sharing through supply chain linkages can enhance service quality and responsiveness (Cao and Zhang, 2011). On the other hand, information sharing through functional resource linkages can improve inventory flexibility and the usefulness of digital information (Zhang et al., 2021). Additionally, internal functional linkages within a supplier can enhance awareness of internal operations and minimize disruptions to the production line. The interaction established through information sharing with the means of supply chain linkages had higher chances of improving performance in terms of, for example, service quality and responsiveness. Furthermore, the interaction established by information sharing through

functional resources linkages was likely to improve performance in terms of, for example, a more flexible inventory, greatly affecting how timely and useful digital information was. Furthermore, functional linkages within a supplier (such as CaseCo) for information sharing can increase awareness of internal operations, enabling all functionally based departments to remain aligned, minimizing disruptions to the production line. Internal interactions within functional resource strategy and operational performance can play a critical role in connecting organizations. For instance, *CaseCo* utilized internal linkages across its sales, R&D, production, and purchasing departments to extend the interaction derived from information sharing via external linkages with supply chain partners. The functional linkage interaction across sales, R&D, production, and purchasing departments allowed CaseCo to coordinate with supply chain partners. However, a more efficient execution could have been possible if the production department was better prepared to directly exchange information with the logistics department to prepare for shipments. Subsequently, functional resource linkages with *CaseCo* promoted information sharing across firms, which led to greater visibility and a better digital transformation in value cocreation.

Had there been greater information sharing between these departments, the production department could have directly shared information with the purchasing department, benefiting downstream customers (Lee et al., 2010). Consequently, the following proposition was proposed:

Proposition 2: Greater engagement between supply chain partners leads to greater functional resources being available in support of digital transformation regarding the provision of supply chain-related information.

5.2 Using Digital Transformation in Value Cocreation Operational Performance

In the pursuit of customer satisfaction, organizations seek to minimize uncertainty, and digital transformation is seen as a means of achieving this by facilitating information sharing. Despite its importance, few studies have explored the roles that information-based linkages play in this regard. This study investigated multiple tiers within the supply chain and identified four types of information being shared, namely, demand-related information, inventory-related information, custom order-related information, and manufacturing-related information. By increasing the functional linkages of *CaseCo,* the company can enhance its internal visibility of functional resources, thereby streamlining production and purchasing processes between the purchasing and production departments, leading to improved flexibility and efficiency. Ultimately, digital transformation can facilitate the promotion of information sharing across firms through the amplification of these linkages.

Customers engage in cocreation because they wish to, for example, share their ideas, learn from others, or (in some cases) receive a monetary reward; they are happy to use the latest communications, services, and learning mechanisms to create value (Brunink, 2014). Value cocreation is established between a firm and its customers when the customers can personalize their experience through the firm's products or services; this not only strengthens their loyalty but also benefits the company in the form of increased revenue or productivity (Shrivastava et al., 2017). Customers use various online channels (e.g., social media, the company's website, and email) to exchange information and provide suggestions regarding promotions, branding, packaging, and corporate social responsibility (Barbu and Militaru, 2019). A competitive advantage can be gained when a company is capable of creating value and improving its production process. Furthermore, the influences of cocreation value and the performance of manufacturers are partially mediated by IT competence (Shrivastava et al., 2017). Digital interactions enable supply partners to be closely integrated with an organization and engaged with the organization's operational strategy and functional resources. Engagement with supply chain partners and their experiences aid in digital transformation for value cocreation (Agrifoglio et al., 2017). Therefore, this study proposed the following:

Proposition 3: Strong supply chain engagement can boost digital transformation in value cocreation activities. Subsequently, digital transformation in value cocreation can enhance the engagement of supply chain partners in a digital transformation platform.

6. Contribution to Theory and Practice

This research aims to contribute to the current knowledge on value cocreation among firms engaged in complex R&D competition. Specifically, the study investigates the internal interactions within four organizations, as well as the interactions of CaseCo with its customer and supplier firms, where digital transformation plays a critical role in facilitating value cocreation. The theoretical underpinning of the research is based on two main concepts: value cocreation and digital information flow in a supply chain, which is achieved through a combination of external and internal value cocreation processes.

Furthermore, the study employs a case study approach with semi-structured interviews to explore the impact of operational strategy and functional resources as key drivers of value cocreation. By doing so, the study aims to deepen our understanding of the complex dynamics of value cocreation in the context of R&D competition.

Useful information was shared more effectively and in larger quantities through external linkages with supply chain partners in the digital information platform of CaseCo; the information shared was selected on the basis of how able the recipients were to properly utilize the information. For instance, the customer service and quality assurance strategy of CaseCo led to CustomerCo1 being able to share more information with CaseCo. However, we noted that CaseCo lacked the ability to properly use the information provided. By identifying the results of information sharing by CustomerCo1's linkages, such as those in product development and production plans, this study noted various forms of visibility. Internal exchange of information among supply chain partners increased the visibility of the internal operational strategy. However, when both internally held and externally derived information was shared through a digital information platform, it resulted in greater visibility of supply chain information among partners. This enhanced the process of digital transformation and value cocreation.

The study findings indicate that when supply chain partners' experiences become the primary source of digital transformation in value cocreation, the cocreation process becomes more visible and efficient (Nguyen et al., 2015). Previous research has suggested that interaction linkage externalities exist in a firm's adoption of new technologies or practices (Fabiani et al., 2005; Frambach and Schillewaert, 2002). In the context of value cocreation, interaction linkage externalities refer to the phenomenon in which product utility is obtained by supply chain partners, and this utility increases as more supply chain partners use digital information. Consequently, the interaction linkage externality of growth partners can enhance value creation in digital transformation platforms. The linkage helped address gaps in interactive flow across the supply chain, which can compromise coordination and information sharing (Gligor, 2015). Supply chain partners could provide their feedback regarding forecasts and custom specifications. This enhanced coordination in the digital platform for coproduction and replenishment, which led to higher lead time accuracy. Correspondingly, improvements were noted in functional resources and operational performance, where the composite interaction linkage between CaseCo and SupplyCo developed to seal the "gaps" in interactive flow across linkages realized that these gaps would compromise coordination and information sharing. While the digital information system has successfully sealed some of these gaps, operational performance has not improved as much as originally anticipated. This lack of improvement can be attributed to the limited information sharing between CaseCo's sales and production departments.

The study also highlights the role of supply chain partners and functional resources in driving digital transformation in value cocreation (Nog et al., 2023). Supply chain partners bring new functional resources that the company can use to improve the informational quality of the digital information platform. Moreover, when supply chain partners engage in interaction linkage sharing and cowork with more product demand forecast, production, and delivery plans, the performance of the operation of the digital information platform improves, leading to a virtuous cycle of value cocreation.

Regarding practical implications, managers interacting with a supply chain must consider whether information sharing is necessary to improve visibility and minimize uncertainty. Managers must also note how different stages of integration between company departments affect operational performance. As demonstrated in previous studies, the use of innovative IT increases perceived service value and customer loyalty. A digital information platform is required for innovative value cocreation (Lee et al., 2010, Yang et al., 2008).

7. Future Research

Future studies can test our findings by using survey data. These studies can focus on a variety of industries or on companies across a large supply chain to increase the generalizability of the findings. Furthermore, this study found that the medium of communication matters, with direct digital communication yielding better linkage benefits (in, for example, the *CaseCo–CustomerCo* linkage and *CaseCo–SupplierCo* linkage), and future studies can analyze the influence of the medium of communication. Scholars should also investigate the effects of an actor choosing not to send information upon perceiving the receiver as being unable to make use of it. During this study, the focus of research moved further upstream from *CaseCo*, and it became clear that the two packaging suppliers were positioned at different stages given their differing levels of operational capabilities in their supply chain operations.

During this study, the research focus expanded upstream from *CaseCo*, revealing that the two packaging

suppliers were positioned at different stages due to differences in their operational capabilities. In addition, certain internal interactions within *CaseCo* failed to develop, such as between the sales and production departments, and critical information was withheld, such as the lack of an interaction platform for *SupplierCo's* purchasing department to obtain information on inventory levels. These issues with information flow were attributed to organizational culture, providing an avenue for future studies to explore.

ACKNOWLEDGMENT

This work was supported by the Ministry of Science and Technology, Taiwan under Grant MOST 103-2410-H-006-043 and Grant FJCU-TaiwanTech-111-05. The authors thank the Editor, the Associate Editor, and the anonymous reviewers for their valuable feedback on this paper. The authors also thank the five companies for their support and providing valuable data.

REFERENCES

Aarikka-Stenroos, L. and Jaakkola, E. 2012. "Value co-creation in knowledge intensive business services: A dyadic perspective on the joint problem-solving process," *Industrial Marketing Management*, 41(1):15–26.

Agrifoglio, R., Cannavale, C., Laurenza, E., and Metall, C. 2017. "How emerging digital technologies affect operations management through co-creation. Empirical evidence from the maritime industry," *Production Planning & Control*, 28(16):1298–1306.

Amit, R. and Zott, C. 2012. "Creating value through business model innovation," *MIT Sloan Management Review*, 53(3):41–49.

Barbu, A. and Militaru, G. 2019. "Value co-creation between manufacturing companies and customers. The role of information technology competency," *Procedia Manufacturing*, 32:1069–1076.

Barratt, M. and Barratt, R. 2010. "Exploring internal and external supply chain linkages: Evidence from the field," *Journal of Operations Management*, 29(5):514–528.

Basole, R.C. and Rouse, W.B. 2008. "Complexity of service value networks: Conceptualization and empirical investigation," *IBM Systems Journal*, 47:53–68.

Brünink, L.A. 2014. "Co-creation: Customer integration in social media based product and service development," *Procedia - Social and Behavioral Sciences*, 148:383–396.

Burt, R.S. 1992. *Structural Holes. In Structural Holes*, Harvard University Press.

Cao, M. and Zhang, Q. 2011. "Supply chain collaboration: Impact on collaborative advantage and firm performance," *Journal of Operations Management*, 29(3):163–180.

Christensen, C. and Bower, J. 1996. "Customer power, strategic investment, and the failure of leading firms," *Strategic Management Journal*, 17(3):197–218.

Clarysse, B., Wright, M. Bruneel, J., and Mahajan, A. 2014. "Creating value in ecosystems: Crossing the chasm between knowledge and business ecosystems," *Research Policy*, 43(7):1164–1176.

Dery, K., Sebastian, I.M., and van der Meulen, N. 2017. "The digital workplace is key to digital innovation," *MIS Quarterly Executive*, 16(2):135–152.

Ding, J.-H., Chen, P.-S., and Lyu, J. 2011. "Evolutionary strategy to apply information and communication technology: A case study in the apparel industry," *Production Planning & Control*, 22(3):282–297.

Eisenhardt, K.M. 1989. "Building theories from case study research," *The Academy of Management Review*, 14(4), Art. no. 532.

Eisenhardt, K.M. and Graebner, M.E. 2007. "Theory building from cases: Opportunities and challenges," *Academy of Management Journal*, 50(1):25–32.

Fabiani, S., Schivardi, F., and Trento, S. 2005. "ICT adoption in Italian manufacturing: Firm-level evidence," *Industrial and Corporate Change*, 14(2):225–249.

Frambach, R.T., and Schillewaert, N. 2002. "Organizational innovation adoption: A multi-level framework of determinants and opportunities for future research," *Journal of Business Research*, 55(2):163–176.
Fu, H.P., Chang, T.H., and Wu, W.H. 2004. "An implementation model of an e-procurement system for auto parts: A case study," *Production Planning and Control*, 15(7):662–670.
Gligor, D.M., Esmark, C.L., and Holcomb, M.C. 2015, "Performance outcomes of supply chain agility: When should you be agile?," *Journal of Operations Management*, 33-34(1):71–82.
Greenhalgh, T., Jackson, C., Shaw, S., and Janamian, T. 2016. "Achieving research impact through co-creation in community-based health services: Literature review and case study," *The Milbank Quarterly*, 94(2):392–429.
Grönroos, C. 2012. "Conceptualising value co-creation: A journey to the 1970s and back to the future," *Journal of Marketing Management*, 28(13–14):1520–1534.
Haffke, I., Kalgovas, B., and Benlian, A. 2017. "Options for transforming the IT function using bimodal IT," *MIS Quarterly Executive*, 16(2):101–120.
Hess, T., Matt, C., Benlian, A., and Wiesboeck, F. 2016. "Options for formulating a digital transformation strategy," *MIS Quarterly Executive,* 15(2):123–139.
Hönigsberg, S., Dinter, B., and Wache, H. 2020. "The impact of digital technology on network value co-creation," in *Proc. 53rd Hawaii International Conference on System Sciences*, 5233–5242.
Jain, G., Paul, J., and Shrivastava, A. 2021. "Hyper-personalization, co-creation, digital clienteling and transformation," *Journal of Business Research*, 124:12–23.
Kagermann, H. 2015. "Change through digitization – Value creation in the Age of Industry 4.0," in *Management of Permanent Change*. Berlin, Germany: Springer, 23–45.
Kiel, D., Muller, J., Arnold, C., and Voight, K. 2017. "Sustainable industrial value creation: Benefit and challenges of Industry 4.0," *International Journal of Innovation Management*, 21(8):1740015.
LeCompte, M.D., Preissle, J., and Tesch, R. 1993. *Ethnography and Qualitative Design in Educational Research*, 2nd ed. Orlando, FL, USA: Academic Press.
Lee, M.S., Hsiao, H.D., and Yang, M.F. 2010. "The study of the relationship among experiential marketing, service quality, customer satisfaction and loyalty," *International Journal of Organizational Innovation*, 3(2):352–378.
Lenka, S., Parida, V., and Wincent, J. 2016. "Digitalization capabilities as enablers of value co-creation in servitizing firms," *Psychology & Marketing*, 34(1):92–100.
Lovelock, C., and Wirtz, J. 2004. *Services Marketing: People, Technology, Strategy*, 5th ed. Englewood Cliffs, NJ, USA: Prentice-Hall.
Matt, C., Hess, T., and Benlian, A. 2015. "Digital transformation strategies," *Business & Information Systems Engineering*, 57(5):339–343.
Merriam, S.B. 1988. *Case Study Research in Education: A Qualitative Approach*. San Francisco, CA, USA: Jossey-Bass.
Nog, V.M. et al., 2023. "Digital supply chain transformation: Effect of firm's knowledge creation capabilities under COVID-19 supply chain disruption risk," *Operations Management Research*, 16:1003–1018.
Nguyen, T.H., Newby, M., and Macaulay, M.J. 2015. "Information technology adoption in small business: Confirmation of a proposed framework," *Journal of Small Business Management*, 53(1):207–227.
Parida, V., Sjödin, D., and Reim, W. 2019. "Reviewing literature on digitalization, business model innovation, and sustainable industry: Past achievements and future promises," *Sustainability*, 11(2):1–18.
Piccinini, E., Hanelt, A., Gregory, R.W., and Kolbe, L.M. 2015. "Transforming industrial business: The impact of digital transformation on automotive organizations," in *Proc. International Conference on Information Systems*, USA, 1–20.
Prahalad, C.K. and Ramaswamy, V. 2004. "Co-creation experiences: The next practice in value creation," *Journal of Interactive Marketing*, 18(3):5–14.

Rantala, K. and Karjaluoto, H. 2018. "Value co-creation opportunities: Managerial transformation of digitisation risks into success factors," in *Management and Technological Challenges in the Digital Age*. Boca Raton, FL, USA: CRC Press, pp. 31–52.
Schuchmann, D. and Seufert, S. 2015, "Corporate learning in times of digital transformation: A conceptual framework and service portfolio for the learning function in banking organisations," *International Journal of Corporate Learning*, 8(1):31–39.
Schwab, K. 2016. "Summary for policymakers," in *Climate Change 2013: The Physical Science Basis*. Cambridge, UK: Cambridge Univ. Press, pp. 1–30.
Shrivastava, A., Anupam, K., Sharma, P., and Sharma, S. 2017. "Lean co-creation: Effective way to enhance productivity," *International Journal of Science and Technology*, 1:96–107.
Tiwana, A. 2008. "Do bridging ties complement strong ties? An empirical examination of alliance ambidexterity," *Strategic Management Journal*, 29(3):251–272.
Toffler, A. 1980. *The Third Wave*. New York, NY, USA: William Morrow & Company, Inc.
Van Alstyne, M.W., Parker, G.G., and Choudary, S.P. 2016. "Pipelines, platforms, and the new rules of strategy," *Harvard Business Review*, 94(4):54–62.
Vargo, S.L., Maglio, P.P., and Akaka, M. 2008. "On value and value co-creation: A service systems and service logic perspective," *European Management Journal*, 26(3):145–152.
Vial, G. 2019. "Understanding digital transformation: A review and a research agenda," *The Journal of Strategic Information Systems*, 28(2):118–144.
Yang, H.E., Wu, C.C., and Wang, K.C. 2008. "An empirical analysis of online game service satisfaction and loyalty," *Expert Systems With Applications*, 36(2):1816–1825.
Yin, R.K. 2003. *Case Study Research Design and Methods*, 3rd ed. Newbury Park, CA, USA: Sage.
Zaheer, A., and Bell, G.G. 2005. "Benefiting from network position: Firm capabilities, structural holes, and performance," *Strategic Management Journal*, 26(9):809–825.
Zangiacomi, A., Pessot, E., Fornasiero, R., Bertetti, M., and Sacco, M. 2020. "Moving towards digitalization: A multiple case study in manufacturing," *Production Planning and Control*, 31(2–3):143–157.
Zeithaml, V., Rust, R., and Lemon, K. 2001. "The customer pyramid: Creating and serving profitable customers," *California Management Review*, 43(4):118–142.
Zhang, J., Qi, L., and Tong, S. 2021. "Dynamic contract under quick response in a supply chain with information asymmetry," *Production and Operations Management*, 30(5):1273–1289.

Meichun Lin received the Ph.D. degree in industrial and information management from the National Cheng Kung University, Tainan City, Taiwan, in 2019. She is an Assistant Professor with the Department of Finance and International Business, Fu Jen Catholic University, Taipei, Taiwan (ROC). Her works have been published in *Industrial Management & Data Systems*, *Journal of Business & Industrial Marketing*, and other journals. Her current research interests include digital technology management, strategy management, supply chain management and AI application in industry.