

Mastering customer lock-in by servitization innovation strategies of asset specificity

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Abstract

Purpose – This study aims to explore how manufacturing firms master customer lock-in through value creation by servitization innovation strategies from the perspective of asset specificity.

Design/methodology/approach – A multiple case study with triangulation fashion is adopted to identify servitization innovation strategies. Several manufacturing firms were investigated, which are distributed in different positions of the value chain. Content analysis and abductive approaches are adopted to analyze the data. Moreover, an in-depth interview and participatory observation were conducted to refine the analysis results.

Findings – This study identified four different focusing points of servitization operations. Based on these, the paper further induces an innovative servitization strategy matrix of customer lock-in, concerning communion, intellectual, existential and insubstantial strategies. Furthermore, a conceptual model of customer lock-in by servitization innovation from the perspective of asset specificity is elaborated. It is suggested that companies can use tangible or intangible resources by sharing or storing operations to create servitization value.

Originality/value – This study theoretically proposes a conceptual model to extend servitization innovation as an intangible asset and adopt the new perspective of asset specificity to illustrate the value creation in servitization to generate customer lock-in.

Keywords Servitization innovation, Asset specificity, Value creation, Customer lock-in, Organizational performance

Paper type Research paper

1. Introduction

As the global economy transforms from material-intensive activities to information-intensive services, servitization is gaining significant attention (Karmarkar *et al.*, 2015). To counter potential competitors, servitization can create barriers for manufacturing organizations as well as provide innovative products and new services in the market (Kamal *et al.*, 2020). Servitization subjects introduced by resource-based theory include valuable, rare, unparalleled or organized assets (Eloranta and Turunen, 2015). Furthermore, how to increase customer loyalty in industrial marketing is critical for manufacturing industry (Troisi *et al.*, 2021). There are many ways to increase customer loyalty, including high-quality services (Ma *et al.*, 2020) and asset specificity (Polese *et al.*, 2018; Troisi *et al.*, 2021).

Kohtamäki *et al.* (2020) provided the concept that servitization in manufacturing is a process of transition from standardized products and additional services to customized and advanced services. Previous research on business-to-business (B2B) servitization mainly revealed the servitization framework from a comprehensive perspective (Baines *et al.*,

2017; Raddats *et al.*, 2019; Zhang *et al.*, 2021). It is a continuous transformation for manufacturers, who increasingly integrate services into their business landscape (Forkmann *et al.*, 2017; Niu *et al.*, 2020). Besides, servitization is a critical topic that has become an important trend in the B2B market (Hakanen *et al.*, 2017; Vargo and Lusch, 2007). The focus of servitization is to determine the activity of manufacturers, which may greatly challenge the way manufacturers organize global B2B distribution in the future, and change the role of related companies (Hakanen *et al.*, 2017). Moreover, B2B servitization can enhance the company's connection to its customers, increase customers' switching costs and build strategic partnerships (Hakanen *et al.*, 2017; Wirtz and Kowalkowski, 2022). Furthermore, it is particularly important to address service innovation to systematically establish the

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company's core service positioning (Alfert and Baaken, 2017). Although service innovation plays a leading role in creating new markets and new business opportunities, the issue of B2B service innovation is not yet fully developed and implemented (Alfert and Baaken, 2017; Hakanen *et al.*, 2017; Wirtz and Kowalkowski, 2022). Thus, the study frames the research issue of servitization innovation from a B2B perspective. In addition, exploring the mechanism behind actor engagement will help to examine the antecedents for B2B servitization in the business ecosystem (Zhang *et al.*, 2021). That is, by examining possible antecedents and mechanisms, it helps to consolidate the understanding of B2B servitization.

The "lock-in" effect occurs when owners invest in specific transactional assets, reducing their value when they are used for other purposes (Williamson, 1985; Shi *et al.*, 2018). To master customer lock-in, many manufacturing firms have adopted strategies of capital-intensive investments (Petrov *et al.*, 2020), such as specific production lines, to serve customers according to their specific needs. However, this may incur high sunk costs and greater subsequent operational risk. In this study, servitization can be considered as an asset-light operational strategy to generate customer lock-in. The management of intellectual capital and other intangible assets is critical to the creation of business value in organizations as contributors to sustainable competitive advantage (Lin and Huang, 2011; Khan *et al.*, 2018; Gallardo-Vázquez *et al.*, 2019). Asset-light ownership (Ba and Yang, 2016) significantly reduces operating costs and enables a rapid transition to new businesses compared to asset-heavy companies, which are traditionally considered as successful organizations (Field *et al.*, 2018). In previous theories of asset-light strategy, one of the assumptions of the resource-based perspective is that firms gain competitive advantages by having specific assets that other firms may lack (Barney, 1991; Wang *et al.*, 2017). Moreover, sharing economy services are unique in terms of value creation in asset-light operations (Field *et al.*, 2018).

This study summarizes three research gaps based on previous research. First, few studies have focused on how asset specificity affects servitization, especially when servitization is defined as an asset-light resource. Previous studies on asset specificity have focused on the explanation of transaction cost economics (TCE) (Colm *et al.*, 2019), aspects of buyer-supplier relationship (Gölgeci *et al.*, 2021), and its impact on organizational performance (Yen and Hung, 2013). Most of these studies have focused on asset transactions in a particular industry, but further research on the value effects of asset specificity is needed (Kim, 2018). Second, there is a lack of in-depth investigation and research on the complete mechanism of servitization innovation. Previous studies on servitization innovation have focused on improvement and competitiveness issues (Freije *et al.*, 2021; Khanra *et al.*, 2021; Lee *et al.*, 2016), archetypes (Kamalaldin *et al.*, 2020; Reim *et al.*, 2018), capabilities (Green *et al.*, 2017; Wang *et al.*, 2021) and value creation process (Kastalli and Van Looy, 2013; Lenka *et al.*, 2017). Furthermore, the impact of servitization on manufacturer performance has been extensively studied, but how servitization operates for customers is understudied (Hakanen *et al.*, 2017; Ruiz-Alba *et al.*, 2019). Third, it lacks a complete conceptual mechanism for how asset specificity acts as a bridge between servitization and organizational performance to generate customer lock-in. Asset specificity has little direct impact on performance outcomes, and a

comprehensive analysis of the phenomenon is required (Wang *et al.*, 2014; Delbufalo, 2021). Although previous studies have focused on the impact of supplier asset specificity on product development performance, the complete mechanism by which asset specificity affects servitization performance needs to be further explored (Yen and Hung, 2013).

Based on the above research gaps, the objectives of this study are as follows. First, this study investigates how asset specificity affects servitization, especially when servitization is defined as an asset-light resource. Second, the study explores the value creation and organizational performance of servitization innovation. Finally, this study proposes a comprehensive mechanism on how asset specificity links servitization and organizational performance to generate customer lock-in. In sum, the research purpose is to explore the servitization innovation strategies for customer lock-in and further construct a systematic mechanism for servitization innovation from an asset specificity perspective.

Mustak *et al.* (2021) investigate how industrial firms can convert existing free services into fee-based services. On the other hand, this study focuses more on how to create value and generate customer lock-in through servitization rather than earning profits. The theoretical implications of this study are as follows. It explores how B2B servitization affects organizational performance from a perspective of asset specificity. In addition, it enriches the literature on customer lock-in and proposes the concepts of unilaterality and bilaterality. Moreover, this study fills in the gaps in organizational perspectives on B2B servitization by providing a new concept of customer lock-in to strengthen the buyer-supplier relationship. The practical implications mainly focus on the fact that, compared with the high-cost of heavy assets, the asset-light B2B servitization operation of sharing and storing proposed in this study is important for manufacturers in terms of locking customers, creating value and maintaining sustainable buyer-supplier relationships.

The theoretical framework is based on the literature on servitization innovation, servitization performance and asset specificity in Section 2. This is an exploratory case study that adopts triangulation approach to investigate 57 manufacturers in the Taiwan region. The database is well developed by collecting secondary data. Four strategies for customer lock-in are established in the servitization innovation matrix. Then, a conceptual model of customer lock-in is further proposed.

2. Literature review

To construct a conceptual model to increase customer loyalty and lock-in effect, performance will be discussed in the context of the mechanism. Service innovation, in terms of asset specificity, is not always about creating financial performance. Organizational performance can be divided into financial and nonfinancial performance, where nonfinancial performance is closely related to asset specificity, which can be used to lock-in customers, and assets do not necessarily generate financial results. Therefore, this study provides an insightful literature review to illustrate the concepts of servitization innovation, performance of servitization and asset specificity. Section 2.2 can be divided into two subsections. In Section 2.2.1, it will discuss the nonfinancial nature of servitization. In Section 2.2.2, it focuses on the financial performance of servitization.

2.1 Servitization innovation

Servitization is receiving increasing attention in research areas such as industrial marketing management, operations, supply chain management and strategic management (Rabetino *et al.*, 2021). Servitization was originally defined by Vandermerwe and Rada (1988) as market packages or customer-centric bundles of goods, services, support, self-service and knowledge, supporting the entire life cycle of products (Kastalli and Van Looy, 2013; Kreye and van Donk, 2021). With the research development, servitization is now a well-established research area, defined by Baines *et al.* (2009) as “it is the innovation in organizational capabilities and processes to better create shared value through the transformation from selling products to selling product-service systems” (Green *et al.*, 2017). Servitization is a form of service innovation, which is the ability to deliver specific solutions for customers based on the close relationships between manufacturers and customers (Cusumano *et al.*, 2014; Shin *et al.*, 2022).

Broadly speaking, servitization has become an integral part of manufacturers, which are all service concepts, system services, processes and related service activities of manufacturing companies (Roos, 2015). To transform servitization, manufacturers are required to change the way of value delivering (Robinson *et al.*, 2016; Xu *et al.*, 2021). However, manufacturers may encounter barriers to the transformation of servitization, thereby affecting the value creation of servitization, and service-oriented business model innovation is an important way to achieve servitization success (Robinson *et al.*, 2016; Xu *et al.*, 2021).

Based on the main boundaries of enterprise theory (resource-based view, game theory and TCE) and organizational boundaries (contingency theory and resource dependence theory), Ruiz-Martín and Díaz-Garrido (2021) summarized the themes of servitization, including performance, capability, supply chain management, business model, strategy and sustainability. From the resource-based view, there is a need for manufacturers to find high-quality resources and gain competitive advantages (Barney, 1991), but many of them may lack the resources or experience to conduct servitization (Kowalkowski *et al.*, 2013; Xu *et al.*, 2021). Few companies have all the resources to confer competitive advantages, so a resource-based view may not be entirely appropriate for manufacturers (Kindström and Kowalkowski, 2014; Raddats *et al.*, 2015). Therefore, according to resource-advantage theory, the lower-level resource allocation required for successful servitization includes financial, human, information and organizational (Raddats *et al.*, 2015).

In B2B servitization, it depends on the availability of the supplier's internal capabilities and those outsourced to the network service provider, and different performance results are generated along the service continuum (Kohtamäki *et al.*, 2013; Bustinza *et al.*, 2019). In addition, relational capabilities enable firms to work with actors, which have been discussed in specific servitization studies (Baines and Lightfoot, 2014; Raddats *et al.*, 2017). While some studies concerned the servitization relationship between tactical-level capabilities and performance, some have focused on the adoption of manufacturing strategies in operations (Sousa and da Silveira, 2019).

Besides, research on servitization has mainly focused on the internal organization of firms (Gebauer and Kowalkowski, 2012), and previous research concluded that manufacturing

firms should focus on how to absorb key capabilities and infuse existing service knowledge in collaborative networks (Kowalkowski *et al.*, 2013). In addition, there is insufficient research on the process of organizational change related to servitization, especially how to interact with the contextual factors (Baines *et al.*, 2017; Baines *et al.*, 2020). Although previous research has provided some theoretical foundations for explaining organizational change, conceptual models for studying the changes brought by servitization are lacking (Martinez *et al.*, 2010; Baines *et al.*, 2017).

Previous servitization literature has analyzed the challenges from various perspectives and suggested some relevant factors, such as mismatches between strategies, structures and various features of the business environment (Kohtamäki *et al.*, 2019, 2020). Although few studies have used industrial organization or transaction cost approaches, there is still lack of analytical studies on the transaction costs of servitization (Kohtamäki *et al.*, 2019). Moreover, it lacks discussion on the process of organizational change through servitization and how this change is influenced by the environment (Lütjen *et al.*, 2017; Baines *et al.*, 2020). While previous literature has summarized the phenomenon of servitization affecting customer value, there is still a need for more in-depth research on how servitization creates customers lock-in and its mechanism.

2.2 Performance of servitization

2.2.1 Value creation of servitization

Servitization strategies can create value as companies redesign the services, products and entire organization (Pawar *et al.*, 2009; Martín-Peña *et al.*, 2019). Although value creation has never been clearly defined, the fact that both the customer and the company are creating value together makes value creation an all-encompassing process (Grönroos, 2008; Grönroos and Voima, 2013). The sources of value creation are increasingly dependent on intangible assets, which are increasingly seen as a key driver of knowledge creation, innovation and subsequent economic growth (Kramer *et al.*, 2011). By elucidating the value creation process of servitization from a manufacturer-to-service provider perspective, servitization can be an engine for generating revenue streams and profitability (Kastalli and Van Looy, 2013; Visnjic *et al.*, 2016; Xing *et al.*, 2017).

Niu *et al.* (2020) concluded two perspectives regarding the value creation of servitization, namely, business model and firm strategy, both of which can create positive outcomes. From the business model perspective, actual increments of financial performance, organizational efficiency and customer value are used to measure positive results (Ambroise *et al.*, 2018; Niu *et al.*, 2020). In the firm-strategy perspective, servitization is a transformation process to create long-term value and the comparative advantages in terms of cost, product and customer base have emerged (Pereira *et al.*, 2019; Niu *et al.*, 2020).

Servitization helps manufacturing manufacturers break the current competitive landscape and enhance enterprise value while meeting customer needs (Rosa *et al.*, 2018; Li *et al.*, 2022). Factors affecting transaction costs include asset specificity, uncertainty and frequency (Lietke and Boslau, 2007; Ruiz-Martín and Díaz-Garrido, 2021). Transaction cost theory initially identified asset specificity and uncertainty as key exchange attributes that increase the potential for opportunism and lock-in risk (Colm *et al.*, 2019). The lock-in effect allows

investors to commit to capitalizing on their previous asset specificity investments (Selnes and Sallis, 2003; Liu *et al.*, 2021). Previous literature discussed how servitization create value and generate customer lock-in mainly focused on how servitization enables manufacturers to respond more effectively to customer needs, preventing competitors from gaining a foothold in their market (Baines, 2015).

Most servitization studies examine value processes in isolation, without considering their interactions and interdependencies, and previous research only proposed three different levels of resource, value creation and value-gain analysis: organizational, network and geographic (Garcia Martin *et al.*, 2019; Delgadillo *et al.*, 2021). Servitization can create value for all network participants and companies must anticipate and manage tensions to build partnerships with value chain partners (Burton *et al.*, 2016; Story *et al.*, 2016). Previous research lacks a deeper exploration of the role of value processes and their importance in understanding servitization value creation. Although existing research often shows outcome-based value servitization, it remains unclear whether it is typical of the service innovation developed by most manufacturers (Raddats *et al.*, 2022). Therefore, this study takes asset specificity as a new perspective to investigate the value creation of servitization.

2.2.2 Organizational performance of servitization

From the perspective of financial performance of servitization (Sousa and da Silveira, 2017), it mainly discusses the specific performance, such as competitive advantages, company performance and profitability. Comparing with other traditional manufacturers, manufacturing companies that successfully operate servitization achieve positive financial performance (Wang *et al.*, 2018; Martín-Peña *et al.*, 2019). Servitization represents a transformation of business models and organizations, thus creating competitive advantages for manufacturers (Bustinza *et al.*, 2015; Lee *et al.*, 2016). There are two core dimensions of servitization, including service investments and service market approach, which affect organizational performance (Visnjic *et al.*, 2012; Moreno *et al.*, 2019). Moreover, servitized companies strive to satisfy customers; create and deliver customer value; and improve company performance and profitability (Lee *et al.*, 2016).

Improving differentiation and customer satisfaction is essential to gain competitive advantage and superior performance through servitization (Bustinza *et al.*, 2015; Shin *et al.*, 2022). There are four determinants of inter-organizational competitive advantage, including complementary of resources and capabilities, relationship-asset specificity, conventional knowledge sharing and effective governance (Kamalaldin *et al.*, 2020; Raddats *et al.*, 2022). Based on a resource perspective, competitive advantage also emerges as a combination of resources and processes in servitization (Lenka *et al.*, 2017; Kohtamäki *et al.*, 2019). As a source of competitive advantage, internal advantages include various social and technological resources (e.g. assets, capabilities and relationships) and their complementary attributes to explain firm performance (Rouse and Daellenbach, 2002; Chisholm and Nielsen, 2009; Kapoor *et al.*, 2021).

In the relationship between servitization and firm performance, it has a direct positive effect on the performance of manufacturing enterprises, whereas the service perspective has an indirect effect on organizational performance through service innovation capabilities (Lin *et al.*, 2019). Many

researchers have found a positive relational effect of servitization on firm performance (Lee *et al.*, 2016; Wang *et al.*, 2018). Some studies indicate that advanced services have a positive effect on profitability, whereas basic services have a negative effect on the company's profitability (Sousa and da Silveira, 2017; Tenucci and Supino, 2019). Furthermore, customer engagement is a core moderator between servitization and performance (Ruiz-Alba *et al.*, 2019).

Therefore, more studies are needed to explore the relationships between servitization and firm performance, and it is important to discuss the contextual conditions of such relationships (Tian *et al.*, 2012; Kowalkowski *et al.*, 2016; Moreno *et al.*, 2019). Previous studies have provided mixed evidence on the performance outcomes of servitization, suggesting that the link between servitization and performance can be linear, nonlinear or even nonexistent (Kohtamäki *et al.*, 2013). In sum, this study mainly focuses on the impact of servitization innovation strategies on the performance of nonfinancial organizations.

2.3 Asset specificity

Services primarily require intangible operational resources or assets such as “applications of specialized competences,” which have an impact on the infrastructure of the business model (Vargo and Lusch, 2004; Helms, 2016). Identifying key assets and strategic processes can create strategic capabilities and competitive advantages for service providers (Huikkola and Kohtamäki, 2017; Kohtamäki *et al.*, 2019). Since Williamson (1985) first defined asset specificity, several researchers have attempted to highlight the redefinition of the concept through their own interpretations. Firms maintain higher asset specificity to maximize the efficiency of knowledge flows, which helps them improve their innovation capabilities and market performance (Zheng *et al.*, 2021).

Asset specificity is a central concept in the study of interorganizational relationships and strategic alliances (Wang *et al.*, 2019; Delbufalo, 2021; Lumineau *et al.*, 2022). Williamson (1985) summarized three types of asset specificity, including site particularity, physical asset specificity and human asset specificity (Lamminmaki, 2005). There are seven dimensions of asset specificity, including human asset specificity, physical asset specificity, site specificity, dedicated asset specificity, temporal specificity, brand capital specificity and procedural asset specificity (Delbufalo, 2021). Key themes in the definition include the uniqueness of the asset to task/activity (Espino-Rodríguez and Gil-Padilla, 2005), transferability of assets/investments needed for supporting a particular transaction (Brown and Potoski, 2005), the value of the asset outside a specific transactional relationship (Brouthers and Brouthers, 2003) and value embedded in the continuance of a transactional relationship (Lamminmaki, 2005).

In this study, the previous literature can be summarized according to transactional cost economics and relational exchange theory (RET). First, TCE suggests that high levels of investment in asset specificity formed in buyer-supported interpersonal relationships will provide lock-in hazards for investors and then increase the risk of opportunism for the other party (Delbufalo, 2021; Wagner and Bode, 2013).

However, RET highlights the bright side of asset specificity, which indicates that the special investment levels increase cooperation as they demonstrate partner intent and commitment, which may positively impact relationship performance (Lai *et al.*, 2013; Lumineau *et al.*, 2022). In addition, based on the RET, the supplier's investment in buyer asset specificity can improve the buyer's perceived relationship quality and make the buyer willing to share knowledge with the supplier (Yen and Hung, 2013; Yen and Hung, 2017). It is worth noting that how asset specificity affects servitization innovation, especially when services are defined as asset-light, still requires more in-depth understanding.

3. Methodology

3.1 Research method

The methods of case study can be divided into three types, including exploratory case study, descriptive case study and explanatory case study (Yin, 2018). Yin further pointed out that “how” and “why” questions are more explanatory and likely to lead to the use of explanatory case study. As this study focuses on how to lock-in customers, therefore, such “How” questions are suitable for adopting an exploratory research method. In addition, many of the previous studies related to B2B servitization on how servitization can create value and how servitisation affects performance have adopted the exploratory research method, e.g. Kanninen *et al.* (2017), Kohtamäki *et al.* (2020) and Grandinetti *et al.* (2020). Therefore, an exploratory case study method was used in this study. A multicase study with triangulation was used to determine the nature of the constraints on asset specificity in servitization. Specifically, in-depth interviews were conducted, followed by participant observation.

3.2 Sample selection

This study conducted exploratory research using the logic of replicated sampling. Based on corporate revenue, 57 companies were selected as the study sample, including 30 Top 100 Benchmark Companies, 18 Backbone Companies issued by the government of Taiwan region and 9 certified companies of the innovative Information Technology Application and Service (ITAS) Program. The criteria for sample selection were companies with international competitiveness, unique products and services, commitment to industry and technology development, long establishment, rich data and media attention. The unit of analysis is each servitized innovation program (project) with asset specificity in the collected data. Table 1 summarizes sources of the cases, number of the cases from different sources and names of the cases.

3.3 Data collection

Based on three data collection sources, a database was created to collect serviced items for the sample from 2003 to 2021, including secondary data and semi-structured interviews (face-to-face, online meetings and phone calls). Secondary data were mainly collected from the UDNDATA database (including news, magazines and industry reports), public information from government agencies, analytical industry reports and the servitization projects certified by relevant government agencies in the Taiwan region. Other data sources concern participant

observation and additional secondary data, including internal documents (paper and electronic data), social media posts about the selected cases and popular media articles. In addition, in-depth interviews were conducted with interviewees who had to have at least 10 years of experience in manufacturing industry and who were anonymous in the interview reports. Four senior executives and four board members from eight manufacturing companies were selected as interviewees. Specific interview information is summarized in Table 2. Furthermore, the interview protocols used during the interviews are presented in the Appendix. It is worth to note that the points of the interviews are to make sure that no significant servitization innovations are missed and explore how their implementation can lock in customers. In the second stage, the main point of the interview is to ascertain whether the results of the conceptual model can be matched with the reality in practice. The interviews consist of the following two stages:

Stage 1: The main interview questions are described as follows:

【Interview question #1】 whether there are any significant innovations that are perceived to lock-in the customer (to ascertain that the data is compared so that no significant innovations are missed).

【Interview question #2】 whether the service innovations summarized can lock-in customers, and for representative companies, whether some of the innovations are uncertain (whether their implementation has locked customers).

Stage 2: The main interview questions are described as follows:

【Interview question #1】 whether the results of the conceptual model can be matched with the reality in practice (Is it helpful? Do you agree with this approach?).

Furthermore, the process of the data collection and data clean is shown in Figure 1. Specifically, observing Figure 1, there were 5,872 events initially obtained from secondary data through searching by using the keywords such as “case name” and “service”. Then, the 5,872 events are extracted as 948 documents according to the following data clean rules. The events are deleted, including those that are not lock-in suppliers and company marketing activities, which are not lock-in customers and cannot be categorized to specific services, e.g. Taiwan Semiconductor Manufacturing Company (TSMC) aids suburban villages with books, etc. Moreover, the primary data includes 56 documents consisting of interviews and observations. Thus, after continuous data clean, a total of 1,004 documents were obtained. Then, they are extracted as 199 servitization projects (summarized in Table 3), where eight projects are from the primary data and the rest 191 projects are from the secondary data. Table 3 shows data sources, number of data and document abbreviations. In the second round of data cleaning, the 199 projects have been further organized into 111 projects by removing duplicate projects and the projects that are unrelated to B2B servitization of customer lock-in.

3.4 Data analysis

Sample cases are classified according to upstream, midstream and downstream of the value chain. The detailed classification steps include the following:

- determine the industry classification of the sample;

Table 1 Samples

Source of the cases	Name of the cases
Benchmark manufacturers (30 enterprises)	Foxconn, Pegatroncorp, Quanta Computer, Compal Electronics, Wistron, TSMC, Delta Electronics, United Microelectronics, Tatung, Calcomp, Chicony Electronics, Micro-Star International, Teco Electric, Simplo Technology, Canon (TWC), Wistron NeWeb, Powerchip, Askey Computer, Sampo, Advantech, Acer, Asus, China Steel, Formosa Plastics, Taiwan Tobacco and Liquor, Yuen Foong Yu Group, Far Eastern New Century, Pou Chen Corporation, Cheng Shin Rubber, CPC Corporation
Backbone manufacturers (18 enterprises)	San Shing Fastech, Hiwin, Einkgroup, Central Tooling, Chung Hsin Electric, Solartech, Syscom Group, Polytronics Technology, TRI, Galaxy Software, Giant manufacturing, Merida, Pacific Cycles, Eclat Textile, ACS, Ever-tools, Gain How Printing, WeMo
Innovative IT applications and service manufacturers (ITAS) (9 enterprises)	Federal corporation, Lealeagroup, Makalot Industrial, Ruentex Industries, Fortune Electric. Victor Taichung, Twoway, Asogroup, New Wide Enterprise

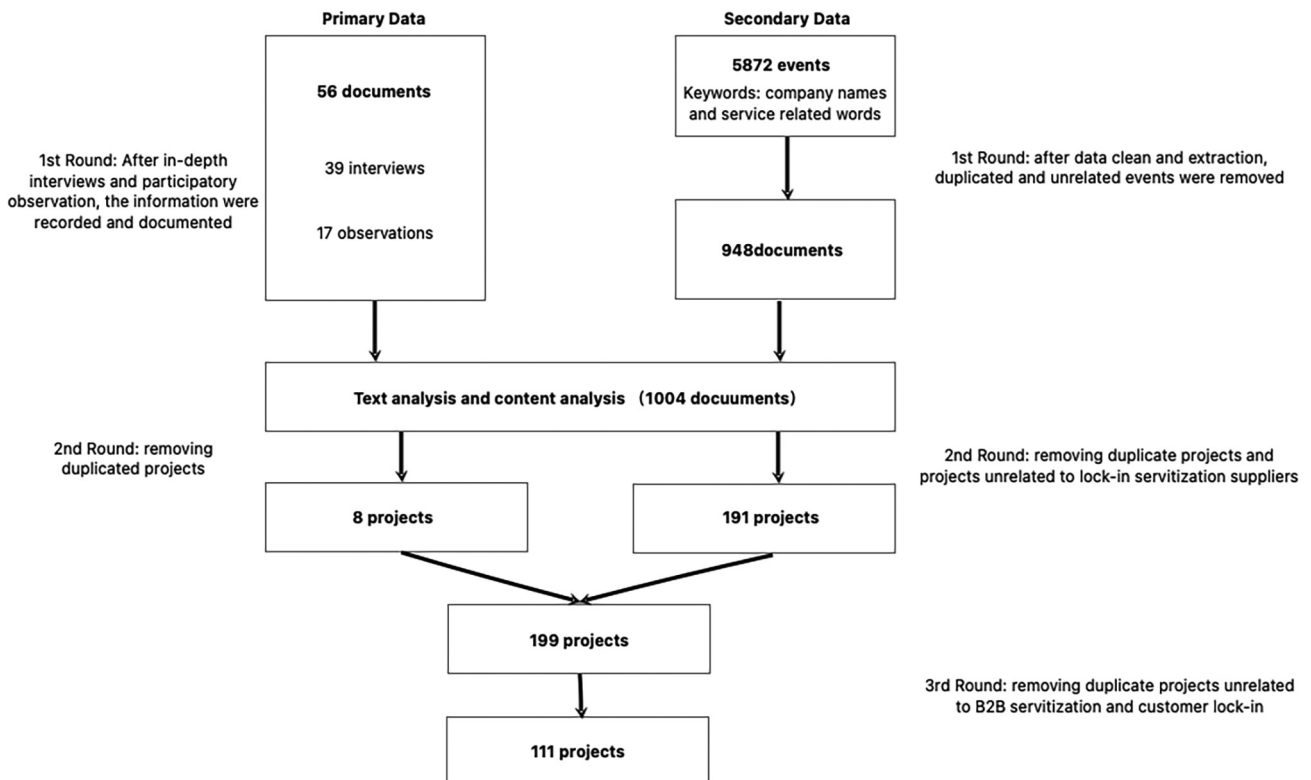
Source: Authors' own work

Table 2 Interviewee information

Case firms	Service offering	Interviewees	Seniority	Times of interview	Interview lasting time (h)
Case A	Supplier platform	Project manager	25	Once	2
Case B	Rental service	Senior VP	16	Once	2
Case C	Consultant	Staff to COO	14	Twice	3
Case D	Big data	President	29	Twice	3
Case E	Internet of things	Former CEO	22	Once	1.5
Case F	Industrial automation	Manager	10	Twice	3
Case G	Liquor storing	Director	28	Twice	3.5
Case H	Digital Fabric Library	Vice GM	20	Twice	2.5

Source: Authors' own work

Figure 1 The process of data collection and data cleaning



Source: Authors' own work

Table 3 Overview of data sources, sample cases and document codes

Data sources	No.	Abbreviations
1. Principal data sources		
UDNDATA database (News, magazines, industrial reports, etc.)	26	UDT 1–26
Public information of government authorities (January 2003 to December 2020)	35	PID 1–35
Small Business Innovation Research (SBIR) program (including datasheet, statistical table, relevant attached file, briefing documents, etc., from January 2003 to December 2020)	18	SRD 1–33
2. In-depth interviews		
Interviews with four senior executives of top manufacturing companies in Taiwan (June 2020 to August 2020; average interview length 120 min)	4	IDE 1–4
Interviews with four board members of top manufacturing companies in Taiwan (September 2020 to December 2020; average interview length 180 min)	4	IDB 1–4
3. Archival and secondary data sources		
Internal documents (including paper data and electronic data) (January 2003 to October 2020)	23	ID-D 1–67
Social Media posts about the manufacturing servitization (December 2020)	26	SP-M 1–26
Popular press articles (Jan 2011 to October 2020)	51	PP-A 1–51
Manufacturing industry analysis report (November 2020)	12	MI-R 1–12
Total	199	

Source: Authors' own work

- determine the location of the sample value chain (downstream or upstream/midstream); and
- determine the classification of the sample companies (benchmark, backbone or ITAS vendors).

After that, the focus of B2B servitization is summarized to illustrate the resource location attributes of the sample cases. Specifically, the data analysis procedure is as follows. First, the textual analysis is performed for each servitization case to explain the existence of servitization from the perspective of asset specificity. Second, based on the results of the textual analysis of each servitization case, the initial categories were modified and constructed using content analysis and the themes were summarized. Third, this study provides a deeper understanding of the practical implications of the servitization cases through the analysis of the interview data. The coding of servitized cases includes open-ended coding and axial coding. The coding must be continuously modified and adjusted to finally obtain the extracted dimensions. Finally, the incorporated data architecture is shown in Figure 2, and the dimensions of servitization lock-in from an asset specificity perspective are summarized in Table 4 with the number of servitization samples selected. After filtering the 1,004 documents and removing duplicates and some nonproprietary cases of asset specificity and customer lock-in, 111 valid servitizations remained.

3.5 Reliability and validity

To explain the validity, the research strategy proposed by Yin (2018) states that replication logic can be adopted as a case study strategy during the research and design phase of external validity testing. Triangulation has long been considered to achieve a certain level of validity or reliability in research results (Eisenhardt and Eisenhardt, 1989; Fusch et al., 2018; Yin, 2018; Farquhar et al., 2020). In this study, methodological triangulation is adopted to measure the collection of various data, which could enhance the reliability and validity of the multiple case study. In addition, this study follows the replication sample logic, which can increase external validity by replicating sample cases. The higher the number of replications, the higher the validity of the data. A

database containing 57 companies and 111 B2B servitization innovation projects were established for this study. Furthermore, a case study protocol was designed in this study to improve the reliability of the multicase study with the purpose of guiding the researcher to collect data from each case.

4. Finding and discussion

4.1 Servitization operation models with resource orientation focusing points

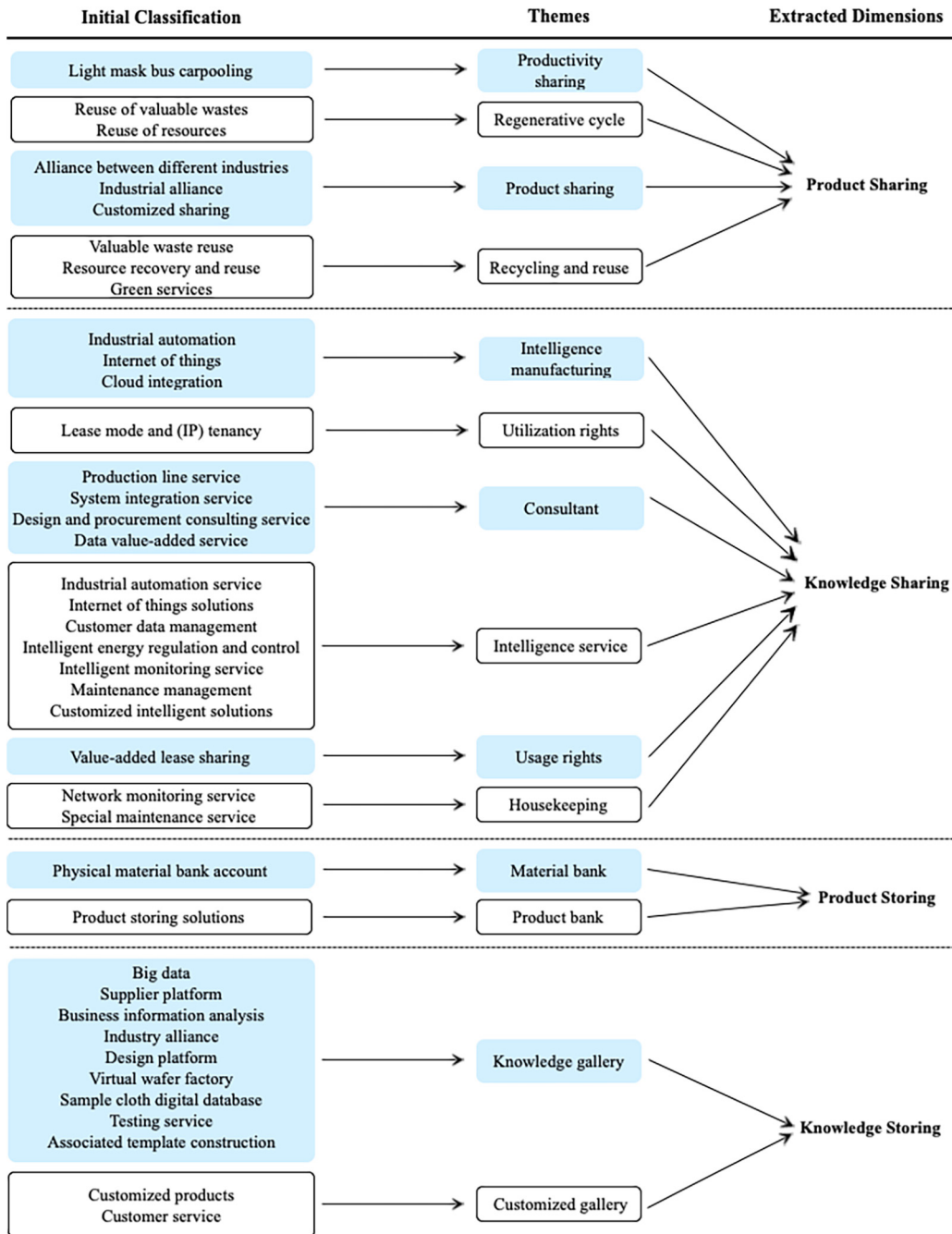
Based on the analysis of multiple cases of the B2B servitization samples selected in the previous chapters, this section summarizes the servitization operation models with different resource-oriented focuses from the perspective of asset specificity in the upstream, midstream and downstream of the value chain. Servitization operation can be classified into two directions, namely, sharing and storing.

As servitized assets can be divided into tangible assets and intangible assets, this section further summarizes four resource orientation focusing points and fourteen servitization operation models. Specifically, in the upstream and midstream of value chain, seven servitization operation models have been optimized, including “regenerative cycle model,” “productivity sharing model,” “intelligence manufacturing model,” “utilization rights model,” “consultant model,” “material bank model” and “knowledge gallery model.” Under the downstream of value chain, it proposed another seven models, including “recycling and reuse model,” “product sharing model,” “intelligence service model,” “usage rights model,” “housekeeping model,” “product bank model” and “customized gallery model.” Different resource orientation focus points concerning different servitization operation models and case examples are shown in Figure 3.

4.2 The innovative strategic matrix for customer lock-in

This section further summarizes and proposes an innovative B2B servitization strategic matrix, which contains four strategies to create customer lock-in, as shown in Figure 4. The servitization strategic matrix adopts two dimensions of

Figure 2 Dataset structure



Source: Authors' own work

servitization operation and resource orientation to evaluate the four strategies. Each strategy is explained by several submodels, in which detailed examples are given to illustrate how the companies generate customer lock-in. The following paragraphs discuss each strategy of the matrix in detail.

4.2.1 Communion strategy

The communion strategy illustrates that for product-oriented tangible resources, enterprises conduct servitization

operations of sharing to create customers lock-in. In the upstream and midstream of value chain, the substrategy includes productivity sharing model and regenerative cycle model. In the downstream of value chain, the submodel includes product sharing model and recycling and reuse model. These are explained as follows:

- *Productivity sharing model (upstream and midstream).* TSMC introduces the concept of “mask bus,” which divides the mask process into several blocks. It will let the

Table 4 Dimensions of asset specificity lock-in of servitization

Extraction dimensions	Themes	Initial classifications	Total data 111 Coding
Product sharing (17)	Productivity sharing (1)	Light mask bus carpooling (1)	1
	Regenerative cycle (4)	Reuse of valuable wastes (2) and reuse of resources (2)	1
	Product sharing (7)	Alliance between different industries (2), industrial alliance (1), customized sharing (4)	3
	Recycling and reuse (5)	Valuable waste reuse (1), resource recovery and reuse (3), green services (1)	2
Knowledge sharing (50)	Intelligence manufacturing (15)	Industrial automation (5), Internet of things (6), cloud integration (4)	3
	Utilization rights (3)	Lease mode and (IP) tenancy (3)	1
	Consultant (8)	Production line service (3), system integration service (3), design and procurement consulting service (1), data value-added service (1)	3
	Intelligence service (19)	Industrial automation service (3), Internet of Things solutions (11), customer data management (1), Intelligent energy regulation and control (1), intelligent monitoring service (1), maintenance management (1), customized intelligent solutions (1)	4
	Usage rights (1)	Value-added lease sharing (1)	1
	Housekeeping (4)	Network monitoring service (3), special maintenance service (1)	2
Product storing (2)	Material bank (1)	Physical material bank account (1)	1
	Product bank (1)	Product storing solutions (1)	1
Knowledge storing (42)	Knowledge gallery (36)	Big data (5), supplier platform (3), Business information analysis (6), industry alliance (1), design platform (12), virtual wafer factory (1), sample cloth digital database (2), testing service (4), associated template construction (2)	8
	Customized gallery (6)	Customized products (3) and customer service (3)	2

Source: Authors' own work

customers get a tenth of the original price of open mask costs to create customers lock-in.























- *Regenerative cycle model (upstream and midstream)*. In 2009, the Chinese Petroleum Corporation (CPC) bought surplus steam from China Steel Corporation, after the purchase the surplus steam will converted into hot coal for use. In this way, the use of boilers can be controlled, thus reducing carbon dioxide emissions.
- *Product sharing model (downstream)*. Cheng Shin Rubber Company invested in Maxxis Technology Company to launch the “E-road rage” racing video game. Through the continuous emergence of Maxxis ad boards in video games, it enhanced the players’ impression of Maxxis brand, and even the product of virtual ad boards in video games can also be sold to Kymco, CPC Corp. and other manufacturers.
- *Recycling and reuse model (downstream)*. Wistron used the plastic parts of electrical waste and electronic products in 2006 as raw materials, which were used in three-level processes, classifications, categories and purification. Then, customized plastic particles are prepared to produce “green plastics” that comply with EU regulations according to customer needs.

4.2.2 Intellectual strategy

The intellectual strategy illustrates that for knowledge-oriented intangible resources, manufacturing enterprises adopts the servitization operation of sharing to create customers lock-in. In the upstream and midstream of value chain, the submodel includes intelligence manufacturing model, utilization rights model and consultant model. In the downstream of value chain, the substrategy includes intelligence service model, usage rights model and housekeeping model. These are explained as follows:

- *Intelligence manufacturing model (upstream and midstream)*. Everest Textile Co. Ltd. sets up various sensing devices on the machines, connecting all machines in a network connection to continuously collect the production data. It integrates and shares the production system with upstream, procurement system and downstream customer system so that manufacturers can respond quickly according to the supply of raw materials and changes in customer needs.
- *Utilization rights model (upstream and midstream)*. Giant acquired the bot bid of the Taipei smile bicycle (U-bike) and built 163 bicycle rental stations in downtown Taipei, with 5,000 giant bikes for public rental. By sharing the utilization rights to business cooperators and customers, it can create customer lock-in and contribute to the benefit at the same time.
- *Consultant model (upstream and midstream)*. New Wide Enterprise began to collect hot raw material and process application information in 2009, providing customers with raw material products and share process technology information in line with the trend of the times and collaborated with vendors. By this way, it can create customer lock-in.
- *Intelligence service model (downstream)*. The maintenance management platform launched by Formosa Technologies Corporation allows inspectors to upload the on-site inspection data directly to the database in the form of text or photos with smart devices such as mobile phones or tablets. It can be the best way to satisfy customers with sufficient soft power.
- *Usage rights model (downstream)*. WeMo Scooter provides 24-h rents with a shared motor vehicle platform service, as the mobile app can open innovative transportation mode, creating a new experience of renting. The big data collected can be applied to urban traffic reforms, which

Figure 3 Servitization innovation models with different resource orientation focuses

Focus:	Upstream & midstream		Downstream	Value Chain
Sharing tangible resource	Regenerative cycle model	Productivity sharing model	Recycling and reuse model	Product sharing model
	 CPC Corp.	 Taiwan Semiconductor Manufacturing Company	 Wistron Corp.	 Cheng Shin Rubber Ind. Co., Ltd.
Sharing intangible resource	Intelligence manufacturing model		Intelligence service model	
	 Evermore Machine Co., Ltd.	 Powerchip Technology Corp.	 Wistron ITS Corp.	 E Ink Holdings Inc.
	 Tatung Company	 Victor Taichung Machinery Works Co., Ltd.	 Canon Marketing Taiwan Co., Ltd.	 Chung-hsin Electric & Machinery Mfg. Corp.
Storing tangible resource	Utilization rights model	Consultant model	Usage rights model	Housekeeping model
	 Giant Manufacturing Co., Ltd.	 Central Tooling Design Corp.	 New Wide Group	 Merida Industry Co., Ltd.
Storing intangible resource	Material bank model		Product bank model	
	 Solar Applied Materials Technology Corp.		 Taiwan Tobacco & Liquor Corp.	
Storing intangible resource	Knowledge gallery model		Customized gallery model	
	 Ruentex Group	 Yong Feng Yu Group	 Li Peng Enterprise Co., Ltd.	 SHUI-MU International Co., Ltd.

Source: Authors' own work

helps multi-valuable social applications to build a smart city together with customers.

- *Delegation model (downstream)*. Chung Hsin Electric provided the innovative after-sales service model through remote automation. In addition, it established equipment and network service systems to monitor and sharing all device status in time. And if the exception of the device, it can enter the auto recovery program according to the actual situation to complete the repair and give the correct record return.

4.2.3 Existential strategy

The existential strategy illustrates that for product-oriented tangible resources, enterprises conduct the servitization operation of storing to create customer lock-in. In the upstream and midstream of value chain, the submodel includes material bank model. In the downstream of value chain, the submodel includes product bank model. These are explained as follows:

- *Material bank model (upstream and midstream)*. Solar Applied Materials Technology Corp. improved the problem of the waste of ruthenium materials. Because it uses only 30% with 70% residue, the residue is converted into stable quality and reusable ruthenium powder, and then the first application of the trading platform is created using the concept of account management of ruthenium powder bank.

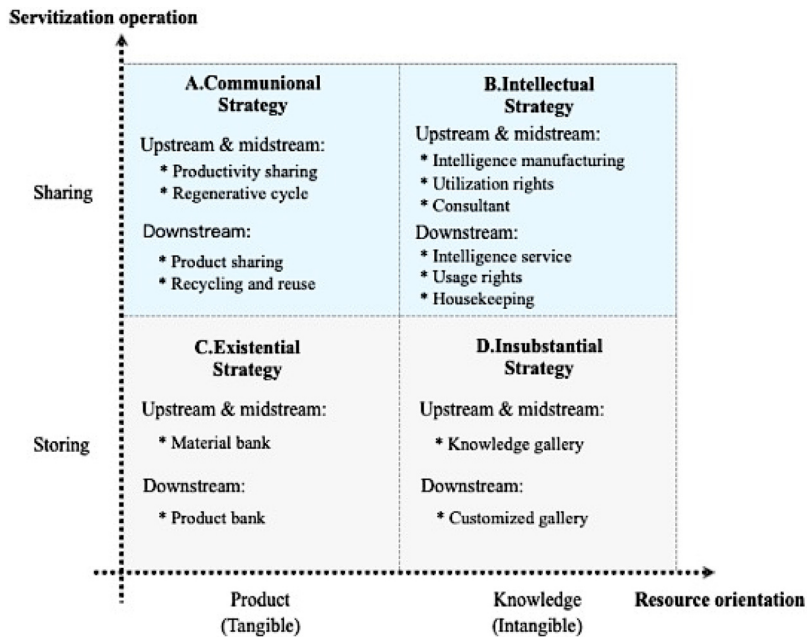
- *Product bank model (downstream)*. Winery of Tobacco and Liquor Company (in Taiwan region) initiated the “liquor bank” in 2007. The “liquor bank” allows consumers to drink more fragrant and better sorghum wine, it has a fixed annual value-added space of 5% to attract consumers in droves. Consumers can open their accounts in the branches of Taiwan region so they can deposit or withdraw their wine. Online banking can also see wines saved in the liquor bank.

4.2.4 Insubstantial strategy

The insubstantial strategy illustrates that for knowledge-oriented intangible resources, enterprises adopt the servitization operation of storing to create customer lock-in and achieve value. In the upstream and midstream of value chain, the submodel includes knowledge gallery model. In the downstream of value chain, the submodel includes customized gallery model. These are explained as follows:

- *Knowledge gallery model (upstream and midstream)*. Ruentex global established automatic classification of fabric images in 2009 to develop multiple value-added applications. This service allows users to find similar fabrics images. Then, it will not only stimulate the imagination of designer space but can also be more efficient and rapid response to customer demands.

Figure 4 The strategic servitization innovation matrix of asset specificity



Source: Authors' own work

- *Customized gallery model (downstream)*. In 2014, Advantech provided customized services through the electronic platform “E-store,” which provided customers with jet lag-free service. By doing this, it can provide more value-added services to customers.

4.3 Evolutionary logic of unilaterality and bilaterality ambidexterity

This study further explains how the four B2B servitization innovation strategies are linked with asset-specificity servitization operations and their underlying logic (Figure 5). There are two dimensions in servitization operation of asset specificity, including sharing dimension (extracted from the communion strategy and the intellectual strategy) and storing dimension (extracted from the existential strategy and the insubstantial strategy). Behind the two dimensions of sharing and storing, there exists an ambidexterity of unilaterality and bilaterality, which are defined as follows. On the one hand, unilaterality can be defined as that suppliers unidirectionally invest resources, such as servitization resources and specific asset resources, to lock-in customers with sharing services. However, in this case, the customers do not conduct any resource investment, only the suppliers' unilateral investment, so it is called “unilaterality.” On the other hand, the bilaterality is defined as both suppliers and customers invest resources, and the suppliers provide storing services after the customers purchasing their products or services.

The evolutionary logic and ambidexterity of unilaterality and bilaterality are consistent with previous studies to some extent. It indicated that there are three types of buyer-supplier relationships including unilateral and bilateral governance mechanisms and market, which suggested that bilateral

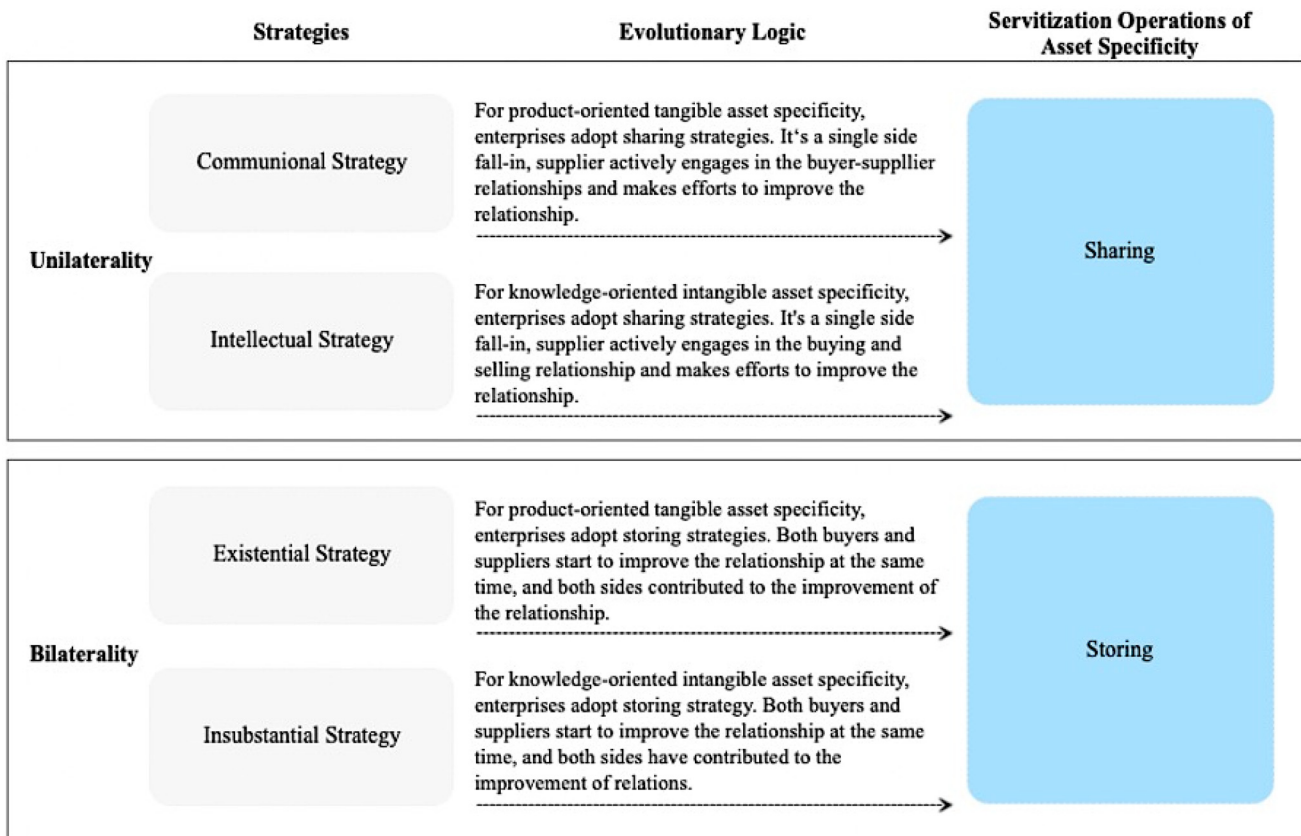
dependence increase the flexibility of buyer-supplier relationships (Heide, 1994; Tangpong et al., 2015). In the buyer-supplier relationships, companies may find unilaterally investing in high-level assets dedicated to specific transactions (Wagner and Bode, 2013; Delbufalo, 2021). In addition, specific investment in unilateral supplier transactions encourages buyers' opportunism by increasing their dependence on suppliers (Wang et al., 2020).

4.4 Construct development

This study mainly aims to explore and further propose a conceptual model for B2B servitization innovation based on the perspective of asset specificity. In the section, the construct development is elaborated as follows. Definitions of different constructs including the strategic resource orientation, servitization operation orientation, value creation, superior outcome and customer lock-in dimensions, as well as relevant evidence and supporting literature are summarized in Table 5.

First, strategic resource orientation refers to assets developed by manufacturing enterprises to achieve servitization operations, which can be divided into tangible assets (products) and intangible assets (knowledge). There exist similar arguments in previous studies to provide evidence for the construct, which are illustrated below. In addition to the development of new resources, the servitization companies re-allocate existing resources in the new environment and based on existing resources to start its reorientation to services (Danneels, 2011; Huikkola et al., 2016). The concept of servitization is related to the combination of services and intangible assets to create value and gain competitive advantages (Vandermerwe and Rada, 1988; Freije et al., 2021). Intangible assets such as knowledge assets are the combination of cognitive process, context

Figure 5 The parallelism between the servitization innovation strategies and the servitization operations of asset specificity



Source: Authors' own work

understanding and experience, which is the wisdom resource continuously accumulated by the company (Li and Tsai, 2009).

Second, the strategic servitization operation construct can be defined as the strategic service action of the company from the perspective of asset specificity, which can be divided into two types: sharing and storing. The evolutionary logic linking to ambidexterity of unilaterality and bilaterality for the two servitization operations is referred to the previous section. Sharing can be defined as transferring assets between suppliers and buyers, which is a double-side interaction. Storing can be defined as reserve assets after the consumption, which is a single-side interaction between suppliers and buyers. Contrary to the resource-based view, many resources are dynamic and can be shared and developed on the entire enterprise network (Kraaijenbrink *et al.*, 2010; Haim Faridian and Neubaum, 2021). According to Oliva and Kallenberg (2003), due to the indivisibility, companies can store customers and services involved in the production process after consumption. In addition, to overcome the resource constraints of pursuing win-win situation, enterprises can jointly create and share assets.

Third, value creation construct is defined as servitization operations with different characteristics that can create different types of value, including green value creation, knowledge value creation, intelligence value creation and customization value creation. Green value creation can be defined as the value created through servitization operation, which is sustainable and

environmentally friendly. Knowledge value creation can be defined as the value of innovative knowledge created by servitization operations. Intelligence value creation can be defined as the value brought by intellectual strategy in conducting servitization operations. Customization value creation refers to the value generated in the servitization operation of providing customized and exclusive services to customers. To illustrate the arguments about the construct, this study used similar arguments or discussions from previous research. In green servitization, business models are designed not only to achieve value creation but also to consider and address some environmental issues (Agrawal and Bellos, 2017; Paiola *et al.*, 2021). Knowledge value achievements refer to the innovation opportunities generated by servitization (Garcia Martin *et al.*, 2019). With greater opportunities for optimization, the potential to connect a variety of intelligent products at the network level opens new value-creation scenarios (Lenka *et al.*, 2017). The customer value proposition of servitization is mainly related to the availability and performance of the product, as well as the sharing of risks and returns (Baines and Lightfoot, 2014; Rabetino *et al.*, 2017). And one of the manufacturers' potential value propositions is based on service innovation and customer relationship differentiation.

Fourth, superior outcomes can be defined as better performance results obtained by servitization strategies, including corporate social reputation, cost reduction, R&D capability promotion and customized professional solution.

Table 5 The constructs of the conceptual model of customer lock-in

Constructs	Definition/subconstruct	Sample data	Relevant literature
Strategic resource orientation	Assets in manufacturing companies can be strategically categorized into tangible and intangible: <ul style="list-style-type: none"> • Product (Tangible) • Knowledge (Intangible) 	<ul style="list-style-type: none"> • Product (Tangible) <ul style="list-style-type: none"> ➢ Winery of Taiwanese Tobacco and Liquor Company initiated the “Liquor bank” in 2007 to store the wine. (TIBW 8, 15–19) ➢ “Customers open an account in liquor banks . . . The innovative Winery of Taiwanese Tobacco and Liquor Company meet the needs of consumers and strategically launch more services” (NBW 2, 13–20) • Knowledge (Intangible) <ul style="list-style-type: none"> ➢ After Yuen Foong Yu established the collaborative design platform in 2003, their design team communicate directly with customers online. (SIPW 3, 28–30) ➢ He Shouchuan believes: “Yuen Foong Yu integrates the knowledge resources from industry, research and actively playing the role of cooperation” (NEY 4, 15–24) 	Huikkola et al. (2016), Freije et al. (2021), Li and Tsai (2009)
Strategic servitization operation	The servitization operations can be strategically categorized into sharing and storing based on the aspect of resource orientation: <ul style="list-style-type: none"> • Sharing • Storing 	<ul style="list-style-type: none"> • Sharing <ul style="list-style-type: none"> ➢ Evermore provides a series of industrial robot products, as well as the design and production of automated end finger jaws. (INQE 5, 33–47) ➢ “This intelligent system can save robotic localization time and collect more data. Through analyzing QR CODE, it will enhance the operational performance of enterprise” (NHE 8, 18–26) • Storing <ul style="list-style-type: none"> ➢ Foxconn has made strategic investments in the field of data center construction, and the virtualization data center. (TIBW 6, 14–17) ➢ Foxconn will continue to develop ‘Cloud, transfer, things, big, wisdom, network + robot’, and in manufacturing parts, through large data analysis. . .” (NBF 3, 45–53) 	Haim Faridian and Neubaum, (2021), Oliva and Kallenberg, (2003)
Value creation	Servitization with different characteristics can create different types of value: <ul style="list-style-type: none"> • Green value creation • Knowledge value creation • Intelligence value creation • Customization value creation 	<ul style="list-style-type: none"> • Green value creation <ul style="list-style-type: none"> ➢ Wistron used the customized plastic waste as raw materials to produce ‘green plastics’ that comply with EU regulations. (EFX - A 2, 4–7) ➢ “Wistron . . . implementing daily operations in environmental protection, social participation, corporate governance and innovation” (NBW 9, 11–35) • Knowledge value creation <ul style="list-style-type: none"> ➢ Ruentex started to collect the information coming from brands, clothing collections . . . which form a “knowledge base” of cloth blocks. (EDX - B 7, 23–32) ➢ The president said: “. . .The vertical integration shows brand value and knowledge value” (NAR 7 21–34) • Intelligence value creation <ul style="list-style-type: none"> ➢ The smart ball screw of Hiwin is the world’s first, and the industry 4.0 links the intelligent with the ball screw. (CF-H 39, 51–63) ➢ Managers of Hiwin said: “In the future, we will move towards the intelligent automation industry” (NEH 6, 23–31) • Customization value creation <ul style="list-style-type: none"> ➢ Fortune Electric launched after-sales service to provide customers with monitoring services of transformer factors. (CF-D 22, 34–42) ➢ The Fortune Electric manager said in the news report: “We have a complete sales system. With customized services, customer needs will be satisfied to the greatest extent” (NEP 5, 9–17) 	Paola et al. (2021), Garcia Martin et al. (2019), Lenka et al. (2017), Rabetino et al. (2017)

(continued)

Table 5

Constructs	Definition/subconstruct	Sample data	Relevant literature
Superior outcome	<p>Servitization strategies may further help companies gain superior outcomes:</p> <ul style="list-style-type: none"> • CSR • Cost reduction • R&D capability Promotion • Customized professional solution 	<ul style="list-style-type: none"> • CSR <ul style="list-style-type: none"> ➢ Chung-Hsin Electric and Machinery ... established network service systems to monitor and share device status, which achieve energy saving and generate CSR (EDX – B 5, 66–93) ➢ "In order to respond to the global climate change, power outages will happen easily. Chung-Hsin Electric has the responsibility to put the green energy effort into electricity support applications" (NAC 1, 17–26) • Cost reduction <ul style="list-style-type: none"> ➢ "It is more cost-effective to purchase steam from China Steel than to invest in equipment to produce it." (SIPW 8, 31–40) ➢ "Now the technologies are available, but if it has not achieved cost reduction, there is no way to implement co-production", director said bluntly (NEP 6, 25-37) • R&D capability promotion <ul style="list-style-type: none"> ➢ New Wide Enterprise ... developed D³ Lab, including cloth research and development, commodity planning, trend sample design (EBD – N 4, 15–27) ➢ Director of New Wide said: "The key point of how to optimize the manufacturing process through digital technology is to combine expert knowledge and further improve R&D efficiency" (NES 11, 9–21) • Customized professional solution <ul style="list-style-type: none"> ➢ By launching the "virtual fab", customers can access the TSMC online information platform and connect with TSMC service units. (EH-T 18, 6–16) ➢ TSMC chairman believes "only customer-centric service, the company can produce a large number of manufacturing models of standard products, and towards the service model of industrial changes at any time" (NET 11, 20–39) 	<p>Doni et al. (2019), Lee et al. (2016), Winkelbach and Walter (2015), Othman and Sheehan (2011)</p>
Customer lock-in	<p>Due to the lock-in effect, customers with specific assets are willing to be dependent on suppliers</p>	<ul style="list-style-type: none"> ➢ Giant manufacturing ... By sharing the utilization rights to business cooperators and customers, it can contribute to the customized professional solution outcome and create customer lock-in (EGPD 15, 21–36) ➢ The executive of Giant said: "Customer satisfaction is the company's business philosophy, by continuously developing innovative products and continuously supplying after-sales repair parts, the consumer rights have been ensured" (NEQ 5, 8–14) 	<p>Oliva and Kallenberg (2003), Wang et al. (2021)</p>

Source: Authors' own work

Previous research shows that manufacturers’ willingness to servitization may have positive impacts on environmental practices and policies, such as obtaining external assurance through independent review of their corporate social responsibility (CSR) activities (Cohen and Simnett, 2014; De Beelde and Tuybens, 2015; Doni *et al.*, 2019). Multiple analyses and empirical studies also found that cost is an important regulating factor that may affect the effectiveness of servitization strategies (Zhen, 2012; Lee *et al.*, 2016). Study on the R&D project database shows that the influence of complex technical knowledge on value creation is enhanced under the high level of prior knowledge and absorption capacity (Winkelbach and Walter, 2015). Value creation logic is to apply expert knowledge to provide customers with customized solutions through the selection and combination of customized professional skills (Othman and Sheehan, 2011).

Finally, customer lock-in is defined as that, by providing services of asset specificity, customers rely on suppliers and are locked-in without changing to other suppliers. Customers are locked-in by establishing long-term relationships with them in servitized companies (Oliva and Kallenberg, 2003; Wang *et al.*, 2021).

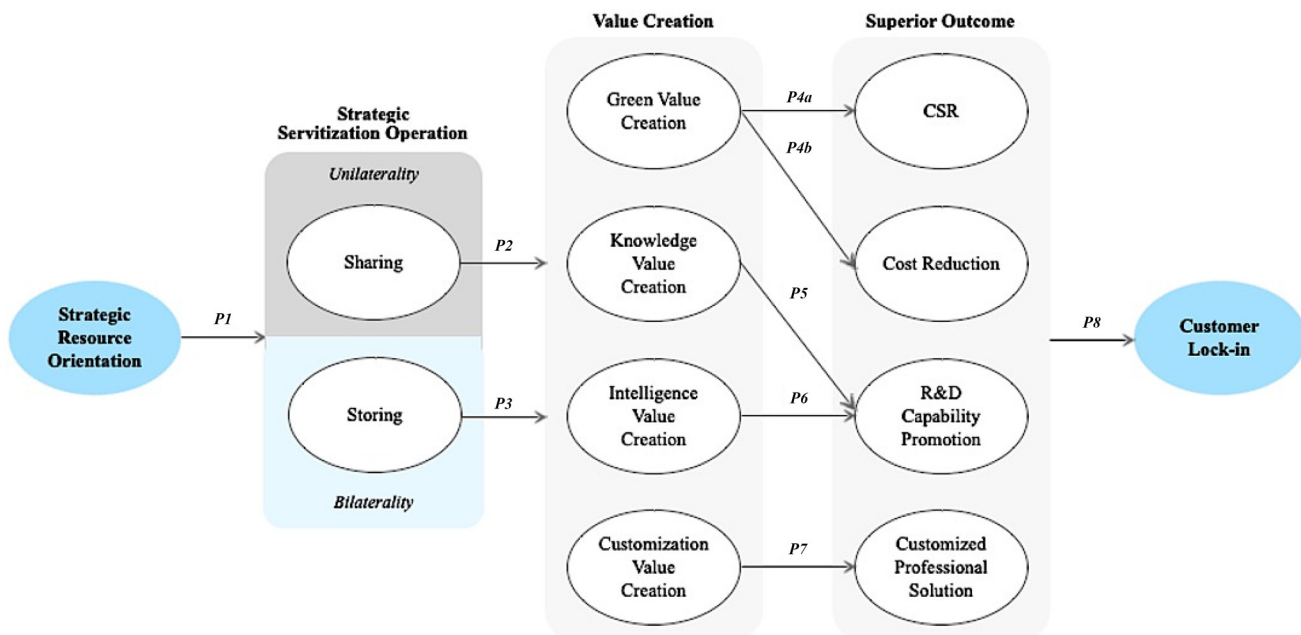
4.5 The conceptual model of customer lock-in

Based on Figures 3–5, this study further develops a conceptual model (Figure 6) to elaborate a clear picture of how to generate customer lock-in based on B2B servitization innovation from the perspective of asset specificity. Through sharing and storing the tangible and intangible resources, specific services are provided to create value. Value creation shows a mediation effect between strategic servitization operations of enterprises and superior outcomes for customers. In addition, servitization with different characteristics can create different types of value. Four types of

value creation are concluded in this paper, including green value creation, knowledge value creation, intelligent value creation and customization value creation. These strategic servitization operations not only create value for customers but also bring superior benefits for them and further bind customers. These superior benefits are named as CSR, cost reduction, R&D capability promotion and customized professional solution. The definition and relevant evidence and literature for each construct of the model have been summarized in Table 5. Furthermore, there are eight main propositions illustrating the relationships in Figure 6. Propositions are named from “P1” to “P8” to show the relationship among the constructs.

Here, the research context has become very clear, which will be illustrated in detail to better explain the logic between these propositions and constructs. All the propositions are supported by enterprise servitization examples, in-depth interviews, secondary data (such as enterprise news reports), theoretical derivation and evidence from previous research. First, the Winery of Tobacco and Liquor Company (in the Taiwan region) initiated the “Liquor bank” in 2007 to store the wine, which is from the resource orientation of tangible product to the strategic servitization operation of storing (PID 8,15–19). Based on the interview evidence, it has been pointed out by the interviewee that: “Customers open an account in liquor banks, which will provide them with more value. The innovative service meets the needs of consumers and strategically launch more services” (IDB 2, 13–20). Another example is that Yuen Foong Yu reported the establishment of their collaborative design platform, which can help its design team contacting customers directly and customers can also see design portfolios of products and provide their feedback to design teams, which create knowledge value for the company (UDT 3, 28–30). In-depth interview evidence shows that: “Yuen Foong Yu integrates the

Figure 6 The conceptual model of customer lock-in by asset-specificity servitization innovation



Source: Authors’ own work

knowledge resources from industry, research and actively playing the role of cooperation” (IDE 4, 15–24). Previous literature shows that the implementation of servitization may require support from different antecedents, including different dimensions of resource allocation (Tseng *et al.*, 2019; Shah *et al.*, 2020). The greater the incentive of the platform resources integration mechanism, the greater the availability of the gradual integration and sharing assets themselves (Akbar and Tracogna, 2018). Therefore, the paper makes the following proposition:

P1. Strategic resource orientation has positive impact on strategic servitization operation.

Through independent R&D, external cooperation and information sharing, The Evermore company provides a series of industrial robot products, as well as the design and production of automated end finger jaws and parts clamps, which can satisfy the needs of different customers (UDT 5, 33–47). Senior executives pointed out that: “this intelligent system can save robotic localization time and collect more data. Through analyzing QR CODE, it will enhance the operational performance of enterprise” (IDE 1, 18–26). Another example is that New Wide Enterprise began to provide customers a platform with raw material products and process technology information in line with the trend of the time and collaborated with vendors (PID 11, 19–25). “According to the ‘raw material demand list’, people can enter the product and technical document management center to supplement the required raw material products and uploaded documents,” said a board member (IDB 3, 26–34). Previous studies provide supporting evidence that increased customer satisfaction may contribute to asset sharing (Chen and Ching, 2007), and intellectual property sharing has positive impacts on value creation (Belderbos *et al.*, 2014). Through innovative asset-light business model (Michelman, 2016), knowledge can be accumulated and shared, thus generating value creation (Alberti-Alhtaybat *et al.*, 2019). Therefore, the paper makes the following proposition:

P2. Sharing servitization operation has positive impact on value creation.

As a global technology leader, Foxconn has made strategic investments in the field of data center construction, and the virtualization data center has made the flexible configuration and quick configuration of information technology (IT) resources, bringing significant value for data center operators and users (PID 6, 14–17). A manager said in the interview that:

Foxconn will continue to develop “Cloud, transfer, things, big, wisdom, network + robot”, and in manufacturing parts, through large data analysis, deepen existing precise manufacturing advantages, refine production efficiency, and enhance Value Creation (IDE 3, 45–53).

Another example is that Advantech cooperates with the shoe manufacturer Tien Kang to establish a smart machine management solution for integrated intelligent software and hardware technology. In terms of hardware, Tien Kang uses I-factory real-time monitoring gateway of Advantech to collect and share machine data, providing exception call function (ID-D 6, 12–22). Evidence from article shows that:

Advantech’s recently proposed business model for the Internet of Things era sharing economy and cross-industry integration, with a view to building a complete industrial ecosystem and linking technology partners to jointly develop and introduce industrial smart manufacturing (PP-A 2, 28–43).

The study of Lin *et al.* (2017) illustrates that the ability to integrate new organizational information into the creation, storing, access and retrieval of new service systems and to create asset specificity value for both parties is a key factor in building long-term robustness. In addition, training and organization of intangible capital have the greatest positive impact on value appropriation (Corrado *et al.*, 2017; Jonas-Lasinio *et al.*, 2019). Therefore, the paper makes the following proposition:

P3. Storing servitization operation has positive impact on value creation.

Wistron used the customized plastic waste as raw materials to produce “green plastics” that comply with EU regulations (PID 2, 4–7). In this way, it provides a proposition from green value to CSR. A board member answered in the interview that: “Wistron understands the necessity of social responsibility, actively planning and implementing daily operations in environmental protection, social participation, corporate governance and innovation” (IDB 1, 11–35). Another example is that Chung-Hsin Electric and Machinery Manufacturing provided innovative after-sales service models through remote automation, and established network service systems to monitor and share device status, which achieve energy saving and generate CSR (SRD 5, 66–93). A board member provided interview evidence that: “in order to respond to the global climate change, power outages will happen easily, Chung-Hsin Electric has the responsibility to put the green energy effort into electricity support applications” (IDB 4, 17–26). In the current environment, there is a huge demand for sustainability, but this can only be embedded in the core business through the CSR leadership with value creation concepts through the CSR culture (Phillips *et al.*, 2019). Therefore, the paper makes the following proposition:

P4a. Green value creation has positive impact on CSR.

The two leading factories of CPC and China Steel launched the integration of regional energy resources earlier. China Steel produces steam during the steel-making process, and CPC just needs steam as fuel. It is more cost-effective to purchase steam from China Steel than to invest in equipment to produce it (UDT 18, 2–29). Other evidence shows that “now the technologies are available, but if it has not achieved cost reduction, there is no way to implement co-production” (SP-M 8, 31–40). Another example is that TSMC, the leading foundry company, pointed out in its report that last year, it effectively saved 500 million kWh of electricity, which exceeded the original target by 25% and greatly reduced the company’s production costs (MI-R 5, 11–18). The green technology utilization can not only save costs and increase energy efficiency but also open new research opportunities (Fernando *et al.*, 2019; Park, 2022). Therefore, the paper makes the following proposition:

P4b. Green value creation has positive impact on cost reduction.

Ruentex started to collect the information coming from brands’ clothing collections, which form a knowledge base of cloth

blocks (UDT 7, 23–32). Secondary data evidence suggests that: “Ruentex uses technology to provide auxiliary service for customers and achieve destructive innovation. The vertical integration shows brand value and knowledge value” (PP-A 7, 21–34). Another example is New Wide Enterprise, which developed D3 Lab, including cloth research and development, commodity planning and trend sample design. With the information of global trends and market brands as R&D cornerstones, combined with big data and innovative technology, integrated professional fabrics development, commodity planning and sample design team, Products have strengthened customer satisfaction and improve R&D efficiency during this process (PID 11, 27–40). Based on the interview evidence, the interviewee replied: “The key point of how to optimize the manufacturing process through digital technology is to combine expert knowledge and further improve R&D efficiency” (IDB 3, 4–25). Previous research shows that when the company’s internal knowledge creation process is powerful, the external R&D team will improve new product performance (Kogut and Zander, 1992; Adomako *et al.*, 2021). Therefore, the paper makes the following proposition:

P5. Knowledge value creation has positive impact on R&D capability.

Haier’s Intelligent Ball Screws utilize Industry 4.0 to link intelligence with Ball Screws, providing customers with innovative services and intelligent value, and creating more dynamism in the smart machinery industry (ID-D 39, 51–63). Managers of Hiwin said: “In the future, we will move towards the intelligent automation industry” (IDE 2, 15–31). Another example is Formosa Technologies Corporation. For production performance, the inspectors allow the on-site inspection data to be uploaded directly to the database, and the intelligent monitoring system was established many years ago, which will omit the intermediate steps and improve R&D efficiency (UDT 21, 31–45). Evidence from press articles pointed out that: “We apply our own experience to build the FPG intelligent monitoring system, which is an example of optimization experience in the R&D process” (PP-A 46, 67–79). Previous studies have shown that innovation can create value, and artificial intelligence can accelerate knowledge creation and technology spillover as well as increase R&D investment to promote technological innovation (Liu *et al.*, 2020). Moreover, the concept of value drivers has been applied to a series of related fields to that of intellectual capital such as R&D (Pike *et al.*, 2005; Dane-Nielsen and Nielsen, 2017). Therefore, the paper makes the following proposition:

P6. Intelligence value creation has positive impact on R&D capability.

Fortune Electric launched after-sales service to provide customers with monitoring services of transformer factors (SRD 22, 34–42). The Fortune Electric manager said in the interview that: “We have a complete sales system. With customized services, customer needs will be satisfied to the greatest extent” (SP-M 6, 9–17). Another example is TSMC, by launching the “virtual fab,” customers can access the TSMC online information platform and connect with TSMC service units. If customers login to be certified, they can tract the chip

production process and yield analysis online which provides customized professional solutions (SRD 13, 20–39). Industry analysis report pointed out that: “only customer-centric service, the company can produce a large number of manufacturing models of standard products, and towards the service model of industrial changes at any time” (MI-R 6, 3–10). There also exists theoretical basis from previous research. Customer value can also be associated with the description and prediction of the user’s taste and behavior to create a better-customized solution (Elia *et al.*, 2020). Therefore, the paper makes the following proposition:

P7. Customization value creation has positive impact on customized professional solution.

Finally, Ruentex global provided customers with customized professional solution to better generate customer lock-in (UDT 7, 35–46). Secondary evidence shows that: “Ruentex global has the responsibility for fulfilling CSR, and the first is to create customers lock-in, continuously pursue product and service quality, providing customized services” (PP-A 7, 8–20). Another example is Giant manufacturing, which built 163 bicycle rental stations in downtown Taipei with more than 5,000 giant bikes for public rental. By sharing the utilization rights to business cooperators and customers, it can contribute to the customized professional solution outcome and create customer lock-in (UDT 15, 21–36). Industry report shows that: “Customer satisfaction is the company’s business philosophy, by continuously developing innovative products and continuously supplying after-sales repair parts, the consumer rights have been ensured” (MI-R 8, 3–14). The three behavior constructs affecting customer lock-in include satisfaction, trust and loyalty (Chen and Ching, 2007). Previous studies have confirmed the key role of superior outcomes such as CSR in the development of customer loyalty and emphasized the mediating role of customer trust and satisfaction in the impact of CSR on customer loyalty (Martínez and Rodríguez del Bosque, 2013; Ozkan *et al.*, 2022). Therefore, the paper makes the following proposition:

P8. Superior outcomes have positive impact on customer lock-in.

5. Conclusions

5.1 Theoretical contributions

From the perspective of asset specificity, this study proposes a conceptual model for mastering customer lock-in. The model emphasizes value creation through B2B servitization innovation based on strategic servitization operations of sharing and storing. It also summarizes the evolutionary logic behind the strategic matrix to the conceptual model and proposes the concepts of unilaterality and bilaterality. Paths among different constructs of the conceptual model are also concluded.

Based on the previous findings and discussions, the main theoretical contributions can be summarized in the following three aspects. First, this study extends previous literature on B2B servitization and organizational performance by discussing how servitization affects organizational performance from the perspective of asset specificity. This study summarizes the

superior outcomes resulting from value creation in servitization innovation. Studies have shown that B2B service-centered firms are not clearly managed in their innovative practice, with low innovation expectations and preferring gradual innovation (Biemans and Griffin, 2018). It highlights the function of asset specificity in linking servitization and organizational performance and is supported by evidence from previous literature. Specifically, asset specificity predicts the desire to invest in enduring relationships, which can increase partner trust and satisfaction, leading to behaviorally enhanced relationship performance (Lui *et al.*, 2009; Lin *et al.*, 2012). Closer linkages with service providers can enhance the positive impact of servitization on financial performance (Zhou *et al.*, 2020; Li *et al.*, 2021).

Second, it enriches the literature on B2B servitization lock-in from the perspective of asset specificity. In terms of resource orientations of servitization, this study extends the transaction cost theory from the perspective of asset specificity. The viewpoint of strategic resource dimension of sharing extracted in this study coincides with the research of Ayala *et al.* (2019), that is, through the servitization strategy, information sharing can be strengthened through interaction with customers, and customer needs can be responded more quickly. This study finds that asset specificity has a certain impact on the operation of servitization innovation based on the perspective of strategic resources and aims at customer lock-in, which is related to the lock-in of buyer–seller relationship in previous studies. While relationship-specific investments can increase relative dependencies, there are four types of interdependence, including low, unilateral, mutual relationship-specific investments and full lock-in (Wilson, 1995; Ojansivu *et al.*, 2015). This study further extends previous research of B2B to investigate how to create lock-in effect in B2B relationships and build a relatively complete mechanism as how it operates. Suppliers can achieve higher margins, have more stable and predictable cash flows over time and increase competitiveness through buyer lock-in (Schmenner, 2009; Kreye and van Donk, 2021). Although asset specificity creates lock-in conditions, this condition motivates all parties to focus resources on relationship-specific learning (Liu *et al.*, 2021).

In addition, to lock-in customers, this study further extends the concepts of unilaterality and bilaterality on B2B servitization operations, where both tangible and intangible assets can be shared and stored. Previous studies are fragmented and lack sufficient supporting evidence, most of which are related to knowledge management and buyer–supplier relationships. Research related to knowledge management finds that explicit knowledge can be stored in IT-based knowledge-sharing systems to enable the storage and reuse of knowledge assets in organizations (Hirai *et al.*, 2007). In the case of hegemony, the decision on strategic direction is unilateral, limiting the flexibility of suppliers to implement alternatives (Johnsen *et al.*, 2020). Most studies have mostly considered servitization in a unilateral way, with the manufacturer playing a key role (Matthyssens and Johnston, 2006; Ruiz-Alba *et al.*, 2019).

Third, the findings are consistent with previous studies and contribute to the research of B2B servitization and buyer–supplier relationships. Previous research on servitization has shown that the complexity nature of servitization can strengthen the business–supplier relationships, which are more complex than traditional product upstream relationships

(Ambroise *et al.*, 2018; Gölgeci *et al.*, 2021). In addition, some previous studies on B2B perspective pointed out that servitization entails the integration of B2B relationships, often in a dynamic setting (Kreye *et al.*, 2015; Raddats *et al.*, 2017), with benefits and costs for both suppliers and buyers. From an organizational view, while servitization research has begun to acknowledge the importance of customer experience management, more research is needed to understand the relationships and interactions among customer success, key account management, service operations and other concepts (Ulaga and Kowalkowski, 2022). Therefore, this study fills the gaps of organizational view on B2B servitization, providing new concepts of customer lock-in to strengthen the buyer–supplier relationships from the perspective of asset specificity.

5.2 Managerial implications

The managerial implications are summarized below. First, previous studies of buyer–supplier relationships generally suggest that it uses heavy assets to lock-in customers, but sometimes the risk is high. From the perspective of asset specificity, this study adopts the concepts of sharing and storing with asset-light servitization to lock-in customers. The concepts make manufacturers realize that not all servitizations are high-cost, and sometimes customers can be locked-in by sharing knowledge or storing services. For example, Evermore can meet different customer needs by sharing information and automating the design and production of end finger fixtures and component fixtures.

Second, servitization emphasizes the strategic service operations of sharing and storing that deliver value to customers, including green value, knowledge value, intelligence value and customized value and adopts conceptual model to guide the implementation of specific strategies in practical sector. They are represented by the following examples: Chung-Hsin Electric and Machinery Manufacturing provides after-sales service models through remote automation to share equipment status and thus save energy to create green value; Ruentex provides customers with ancillary services that are vertically integrated for knowledge value creation; Hiwin links intelligence with ball screws to provide customers with innovative services and smart value; and TSMC provides specialized solutions to create customized value by launching the “Virtual Factory.”

Moreover, this study explores sharing and storing from a B2B perspective. Once the customers are locked-in, the business connections will be maintained for a long period of time, resulting in solid and sustainable buyer–supplier relationships. For example, Ruentex global offers customized services for better lock-in business customers to create sustainable buyer–supplier relationships.

Finally, to illustrate how the conceptual model operates in practice, a complete storyline and the paths in the conceptual model adopting manufacturing company cases are presented below.

Story Line – Example of P1–P3–P4a–P8

Solar Applied Materials Technology Corp. created the first application of the trading platform using the concept of account management of ruthenium powder bank (P1). It helped the company improving the problem of the waste of ruthenium materials as it uses only 30% with 70% residue, the residue is

converted into stable quality and reusable ruthenium powder (P3). Through adopting this material bank model, it created green value for the customers as well as CSR (P4a) for the company. Furthermore, customer lock-in are created (P8).

5.3 Limitations and suggestions for future research

This study also has some research limitations. First, although the research objects are 57 manufacturing companies in the Taiwan region, the sample size needs to be expanded in future research. In addition, this study only analyzed the cases from the Taiwan region. Therefore, the conceptual model can be extended from companies in the Taiwan region to manufacturing companies in other countries or regions around the world. Future research can further investigate manufacturers around the world to validate the four strategies of asset specificity-based servitization innovation summarized in this study. Furthermore, the strategic servitization matrix and the conceptual model of customer lock-in, as well as each substrategy proposed in this study, can be further optimized in future research based on larger research samples.

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Appendix

Interview Protocol

Section A - Introduction

[Briefly describe Introduction (self-introduction, goals of interview, duration, overview of components, confidentiality, voluntary nature, permissions). Help the interviewee explain from which perspective the questions should be answered. Outline confidentiality and how it will maintain confidentiality.]

Section B - Interview Schedule

Date: _____	Interviewee: _____
Duration: _____ min.	Interview began: _____
Place: _____	Interview finished: _____

Positions	Warm-up questions	Core Questions
<input type="checkbox"/> Senior Executives	1. Do you think servitization is important to the company?	- Tell us more details about servitization process in your company? - How did it switch from product to service?
	2. How is your company using asset specificity to lock-in customers?	- What do you think asset specificity from the perspective of servitization? - Do you think it is necessary, why?
	3. How do you think servitization could effect company performance?	- What do you think is the key to lock-in customers from the perspective of servitization? -Do you feel asset specificity is an efficient way to lock-in customers? why?
<input type="checkbox"/> Board Members	1. What is the aim to conduct servitization?	- How did the effect work? can you evaluate it? - Do you think servitization is necessary? why?
	2. Explain how servitization effects company performance based on your experience	- What do you think asset specificity from the perspective of servitization? - Do you think it is efficient and why?
	3. What do you think is the key to lock-in customers from the perspective of servitization?	- Do you think asset specificity is an efficient way to lock-in customers? why? - Any opition regarding asset specificity from the perspective of servitization based on your experience?

* More questions or additional information can be recorded in the extra pages.

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