On the road to digital servitization – The (dis)continuous interplay between business model and digital technology

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Abstract

Purpose – The authors seek to understand the process of digital servitization as a shift of manufacturing companies from the provision of standard products and services to smart solutions. Specifically, the authors focus on changes in the business model (i.e. the value proposition, the value delivery system and the value capture mechanism) for digital servitization.

Design/methodology/approach – The authors examine a Chinese air conditioner manufacturer, Gree, who became the global leader with their smart solutions. These solutions included performance-based contracts underpinned by artificial intelligence (AI)-powered air conditioners that automatically adjust to environmental changes and are capable of remote monitoring and servicing thanks to its Internet of things (IoT) technology.

Findings – To successfully offer smart solution value propositions, a manufacturer needs an ecosystem value delivery system composed of suppliers, distributors, partners and customers. Once the ecosystem relationships are well aligned, the manufacturer gains value with multiple value capture mechanisms (i.e. efficiency, accountability, shared customer value and novelty). To arrive at this point, a manufacturer has to pass through different stages that are characterized by both discontinuous and continuous interplay between business

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models and digital technologies. At the beginning of each stage, new value propositions and value delivery systems are first discontinuously created and then enabled with digital technology. As a result, new value capture mechanisms are activated. Meanwhile, the elements of the existing business model are continuously improved.

Research limitations/implications – By combining process-perspective and business-model lenses, the authors offer nuanced insights into how digital servitization unfolds.

Practical implications – Executives can obtain insights into the business model elements, they need to change over the course of digital servitization and how to manage the process.

Originality/value – A longitudinal case study of a traditional manufacturer that has achieved stellar success through digital servitization business models development.

Keywords Digital servitization, Business model innovation, Digital business model, Value creation, Value driver, Servitization, Digitalization

Paper type Research paper

1. Introduction

Over the past two decades, more and more manufacturers have begun to pursue servitization by adding customer-oriented services (e.g. customized solutions) to their existing product offerings (Rajala *et al.*, 2019; Visnjic *et al.*, 2016; Cusumano *et al.*, 2015; Neely, 2008). In parallel, manufacturers have been increasingly pursuing digitalization, using digital technology to better manage their product and service operations as well as develop new value propositions, the so-called smart products, services and solutions (Porter and Heppelmann, 2014; Bustinza *et al.*, 2017). Owing to the high level of interdependencies, academics have recently dubbed the convergence of these transformations as "digital servitization" and have started to explore them jointly (Vendrell-Herrero *et al.*, 2017; Kohtamäki *et al.*, 2019).

While a significant amount of knowledge has already been amassed, we know little about the nature of the digital servitization process as it unfolds. This is a notable gap, considering the attention that this transformation has received in academia and given its prevalence in practice (Jovanovic *et al.*, 2021; Paschou *et al.*, 2020). Moreover, there is a reason to believe that this journey is a complex one, deserving of our attention. For instance, servitization and digitalization seem to unfold differently – servitization follows more of a continuous, evolutionary trajectory (Baines *et al.*, 2017; Bustinza *et al.*, 2017; Martinez *et al.*, 2017), whereas digitalization is known for disruptive and discontinuous changes (Christensen *et al.*, 2013; Markides and Oyon, 2010; Paiola and Gebauer, 2020). Furthermore, considering that each of these two transformations is underpinned by complex business model changes (Hsuan *et al.*, 2021; Rabetino *et al.*, 2017; Sousa and da Silveira, 2017; Kowalkowski *et al.*, 2015), it is unrealistic to expect that the convergence of the two transformation would be simple.

Indeed, recent anecdotal evidence also suggests that the process of digital servitization is highly complex (Sjödin *et al.*, 2020; Kohtamäki *et al.*, 2019). Reports published by McKinsey & Company suggest that the majority of manufacturers are lagging behind their digital aspirations (Bradley *et al.*, 2019). On the other hand, the brave few that make bold moves toward digital servitization – such as general electric (GE) – fall prey to the business model complexities that digital servitization creates, such as conflicts between digital and physical service offerings, clashes between new ecosystem partnerships and traditional supply chain relationships or digital revenue models and product sale models (Jovanovic *et al.*, 2021; Moazed, 2018).

As the GE example illustrates, digital servitization may introduce substantial challenges and contradictions to business model design (Kohtamäki *et al.*, 2020a; Lenka *et al.*, 2018; Snihur and Tarzijan, 2018; Kowalkowski *et al.*, 2015). The current literature lacks understanding of how the business model changes as digital servitization unfolds and what complexity and interdependencies emerge over the digital servitization trajectory. Thus, our research question asks: *How does the business model change as a traditional product manufacturer pursues digital servitization?*

To answer this question and shed light on what the journey to the successful digital servitization business model looks like, we investigate the longitudinal case of “Gree”, a traditional manufacturer that has achieved noteworthy success thanks to its ability to manage business model change along the digital servitization trajectory. Gree is also interesting in that it has emerged in the Chinese context. Previously considered service and innovation laggards, various Chinese manufacturers have recently achieved success through digitalization and servitization initiatives that have delivered both financial performance and resilience (Tan *et al.*, 2019).

Our study has uncovered that Gree designs and provides smart solutions together with its ecosystem composed of suppliers, distributors, partners and customers. Thanks to the well-functioning ecosystem, Gree captures value through several mechanisms (i.e. efficiency, accountability, shared customer value and novelty). Yet, Gree did not follow a purely continuous and evolutionary path to arrive at a higher level of digital servitization maturity. Instead, the process was punctuated by three different stages. The first stage was characterized by the provision of standard products-services, delivered with an internal activity system where Gree captured value through efficiency gains. The second stage was the provision of customized solutions with a supply and distribution chain, where Gree captured efficiency as well as accountability and shared customer value. The third stage is the provision of smart solutions with an ecosystem where Gree captures efficiency, accountability and novel customer value. How did Gree move from one stage to another? To shift from the first to the second and from the second to the third stage, Gree added new value propositions (customized solutions followed by smart solutions). This, in turn, initiated an expansion in the value delivery system (e.g. to the supply and distribution chain and then to the ecosystem). Given the discontinuous nature of these changes, the resulting business model was ineffective at first, and Gree had to improve it through the use of digital technology. As the functioning of the value proposition and value delivery improved, Gree could then capture value through new mechanisms and reach even higher performance than in the previous stage.

These findings allow us to inform the discussion in the literature in several ways. First, we find that servitization does not precede digitalization but that the two evolve in parallel from the beginning (i.e. the use of digital technology enables even the delivery of the most basic service value propositions) (Srivastava and Shainesh, 2015; Vendrell-Herrero *et al.*, 2017; Rajala *et al.*, 2019). Furthermore, the interplay between the business model and digital technology is present within each stage as well as across the stages (e.g. without the adoption of digital technology at the previous stage, the new business model would not emerge). Second, we find that the process of digital servitization has both continuous and discontinuous process features (Martinez *et al.*, 2017; Gersick, 1991; Romanelli and Tushman, 1994; Tushman and Anderson, 1986). More specifically, we identify the continuous development of the elements of the existing business model and the discontinuous addition of new business model elements along the digital servitization trajectory. Third, while the majority of the digital servitization literature focuses either on the value proposition development (Rajala *et al.*, 2019; Cenamor *et al.*, 2017) or on the value delivery system configuration (Kohtamäki *et al.*, 2019; Reim *et al.*, 2019; Sjödin *et al.*, 2019; Sklyar *et al.*, 2019b), we focus on both, and in addition explicitly consider the value capture mechanisms. Furthermore, we show that the interplay of all three elements is necessary to explain the process of digital servitization. Finally, our study contributes to the prior literature by describing the steps that the firm goes through as it reconfigures (and opens) its boundaries to ecosystem partnerships for digital servitization (Huikkola *et al.*, 2020).

2. Theory

Digital servitization is defined as a transition from pure products and add-on services to smart solutions/product-service systems, which possess the capabilities of connectivity, monitoring, control, optimization and autonomy (Porter and Heppelmann, 2014; Lenka *et al.*, 2017; Kohtamäki *et al.*, 2020b). Digital servitization involves "the transformation in processes, capabilities, and offerings within industrial firms and their associate ecosystems to progressively create, deliver, and capture increased service value arising from a broad range of enabling digital technologies" (Sjödin *et al.*, 2020, p. 478).

Two observations can be made in analyzing this definition of digital servitization. First, digital servitization appears to be underpinned by a change in the entire business model or "the architecture of the value creation, delivery, and capture mechanisms" (Teece, 2010). Indeed, value creation or the value proposition change from pure products and add-on services to smart solutions and product-service systems, while value delivery undergoes a transformation in the processes and capabilities of industrial firms and their ecosystems. Finally, authors expect companies that pursue digital servitization to offer new value capture mechanisms or, in their terms, "capture increased service value".

The second observation is that digital servitization is *a process, a "shift", a "transition"* or a "*transformation*" (Paiola and Gebauer, 2020; Kohtamäki *et al.*, 2019; Sjödin *et al.*, 2020). While the processual character of digital servitization is rarely contested, the literature lacks clarity on the characteristics of this process. As we will argue in the following section, it remains unclear whether this process is continuous, discontinuous or whether it follows an entirely new pattern.

2.1 How does digital servitization unfold?

It has been established in the prior literature that "physical" servitization follows a continuous evolutionary process. This process is argued to start from offering products and then unfolds by adding layer on layer of services that complement these products (Vandermerwe and Rada, 1988). This evolutionary process shows incremental advancement of the value proposition from products to products/basic services, and then to more advanced product-service offerings (Bustinza *et al.*, 2017; Martinez *et al.*, 2017; Visnjic *et al.*, 2016; Neely, 2008). Moreover, servitization seems to be characterized by incremental evolution in value delivery as well (Jovanovic *et al.*, 2019). Continuous improvements are needed to align strategy and the new business model (Rabetino *et al.*, 2017; Sousa and da Silveira, 2019), add service capabilities to manufacturing capabilities (Rajala *et al.*, 2019; Sousa and da Silveira, 2017), fine tune risk management (Reim *et al.*, 2016), improve inter-firm relationships (Kohtamäki *et al.*, 2019) and generally balance different elements of the service business model along the service journey (Martinez *et al.*, 2017). This, of course, does not make servitization less challenging or monotonous. While servitization may be a continuous process, evidence shows that firms can reduce the pace, stop along the trajectory or even engage in deservitization (Kowalkowski *et al.*, 2017).

In contrast to the servitization literature, the digitalization literature seems to suggest that digitalization and digital transformation are characterized by nonlinear or discontinuous changes. For incumbent firms, the adoption of digital technology creates opportunities for radically new business models (Teece, 2018). This may mean the creation of an entirely new value proposition, the need for new organizational capabilities, and distinct revenue and cost structures that potentially conflict with the previous ones (Warner and Wäger, 2019; Vendrell-Herrero *et al.*, 2017; Paiola and Gebauer, 2020). Given this level of business model novelty plus the complexity of its relationship to the existing business model, a firm may need to create an entirely new and separate business unit to host digitalization (Christensen *et al.*, 2013). Thus, "as a move towards digitalization is equal to a move towards more dynamics, there might not be a new phase of stability or equilibrium" (Hanelt *et al.*, 2020, p. 25).

If digital servitization represents a convergence of servitization and digitalization, what does the digital servitization process look like? Is the revolutionary and discontinuous digitalization process managed in parallel with the continuous evolutionary servitization process? Do they appear in sequence – that is to say, does the manufacturer go through (continuous) servitization and then (discontinuous) digitalization? Or are the two actually interwoven, producing an entirely new process pattern? The digital servitization literature does not yet offer an answer to this question.

2.2 What business model changes can we observe?

Considering that digital servitization requires a change in the entire business model, we proceeded to explore what the literature can teach us about the changes in the business model elements of the value proposition, the value delivery system and value capture (Teece, 2010).

On the *value proposition side*, we note the transformation from standard products and add-on services to smart solutions (Rajala *et al.*, 2019). This transformation seems to be underpinned by the adoption of a modular approach. For instance, Rajala *et al.* (2019) elaborate on various capabilities that are required to achieve this, such as ad hoc integration capabilities, modular design and through-chain modularity.

On the *value delivery system* side, we noted the general shift from a closed to an open value delivery (Nambisan *et al.*, 2019; Thomas *et al.*, 2014; Saadatmand *et al.*, 2019; Kohtamäki *et al.*, 2019), where both internal and external value delivery is changed by the use of digital technology. On the internal side of value delivery, digital servitization requires the use of digital resources and platforms to support internal centralized decision-making (Sklyar *et al.*, 2019b), product and service processes optimization (Frank *et al.*, 2019), and the coordination and integration of back-end and front-end units (Cenamor *et al.*, 2017; Rabetino *et al.*, 2017). Furthermore, we found evidence of the use of Industry 4.0 and other digital technologies for the digitalization of supply chain and distribution networks. For example, digital technology is used to achieve scalability and reinforce resilience and coordination (Choi *et al.*, 2018), flexibility and visibility (Srinivasan and Swink, 2018), and integration (Rai *et al.*, 2006). Finally, authors suggest that the value delivery system that supports smart solutions may go beyond the supply chain to encompass an entire ecosystem (Sklyar *et al.*, 2019b). A digital service ecosystem is considered a structure where there are interdependences and alignment between actors (Kohtamäki *et al.*, 2019; Adner, 2017), and where actors aggregate around the focal value propositions (Sklyar *et al.*, 2019a).

On the *value capture mechanism* side, the findings are less clear. Colleagues have found that combining digitalization and servitization holds the potential to capture value by integrating service offerings and digital technologies (Frank *et al.*, 2019; Kohtamäki *et al.*, 2020b) and to accelerate the pace of service innovation through ecosystem integration (Goduscheit and Faullant, 2018; Sklyar *et al.*, 2019a; Brax *et al.*, 2017). Moreover, digital servitization promises to deliver both customization and operational efficiency (Cenamor *et al.*, 2017; Kohtamäki *et al.*, 2019; Rabetino *et al.*, 2017), increase cost effectiveness (Benner and Tushman, 2015; Frank *et al.*, 2019), and fashion opportunities to expand revenue streams through product-service-software systems (Porter and Heppelmann, 2014; Sousa and da Silveira, 2017).

The complex change in value creation that underpins digital servitization requires the development of a simpler framework to understand the *value capture mechanisms*. For instance, the business model literature proposes five "value drivers" that can simplify this enquiry: efficiency, novelty, complementarities, lock-in and accountability (Amit and Zott, 2001; Visnjic *et al.*, 2017). An efficiency value driver concerns transaction efficiency, transaction costs and economies of scale, information asymmetry reduction and eliminating waste (Amit and Zott, 2001; Visnjic *et al.*, 2017). A novelty value driver features the creation of value from changes and enhancements in elements and links in the structure of transactions, as well as introducing new customer offerings (Amit and Zott, 2001; Visnjic *et al.*, 2017). A complementarity value driver involves promoting greater aggregate value by integrating disparate assets that may include external assets that the firm depends on (Amit and Zott, 2001) such as complementary innovations (Visnjic *et al.*, 2017; Zott and Amit, 2007) and assets of other network participants (Amit and Zott, 2001). Lock-in effects are characterized by loyalty, dominant design (or follow-up), high transfer costs, path dependence, and recurring transactions between organizations and customers (Amit and Zott, 2001; Visnjic *et al.*, 2017). The accountability value driver emphasizes the management and elimination of risk and the internalization of "unmanageable risk" that crosses the organizational boundary (Visnjic *et al.*, 2017).

Furthermore, the literature has hinted at the important *interplay among these business model elements*. For instance, companies use digital technology to collaborate with customers and a variety of partners and ecosystem complementors through the digital platform architecture (Jovanovic *et al.*, 2021), which in turn may allow them to develop customized solutions based on modularity, cocreate digital service innovations, and integrate digital modules and smart solutions (Brax *et al.*, 2017; Cenamor *et al.*, 2017; Rajala *et al.*, 2019; Sjödin *et al.*, 2020). At the same time, we know that this interplay can result in complexity, inefficiency and confusion (Eloranta and Turunen, 2016; Lightfoot *et al.*, 2013). Multiple business models can offer greater diversity in value drivers (Aversa *et al.*, 2020) but that may lead to business model contestations (Lenka *et al.*, 2018) and business model portfolio complexity (Snihur and Tarzijan, 2018).

3. Methods

To summarize, the extant literature left us with a lack of understanding of how digital servitization unfolds. At the same time, we have found valuable insights that helped us understand the changes occurring on the level of business model elements – namely – the value-creation proposition, the value delivery system and the value capture mechanism. We proceeded with empirical research intending to study these changes, focusing particularly on their relationships and interplay, with the objective of better understanding the overall process.

Given this aim, we chose an inductive, longitudinal, single-case research design to explore the dynamic unfolding of phenomena over time (Cloutier and Langley, 2020), answer "how" questions, disentangle complex processes (Yin, 2017; Eisenhardt and Graebner, 2007) and build theory (Edmondson and McManus, 2007; Gioia *et al.*, 2013).

3.1 Research setting: case method and selection

Following the principles of theoretical sampling (Eisenhardt and Graebner, 2007), we sought a typical manufacturing *context* where digital technology would offer the potential we anticipated (Kohtamäki *et al.*, 2019; Ardolino *et al.*, 2018). But, additionally, we required a company that was especially successful in managing digital servitization (Siggelkow, 2007). Considering that successful digital servitization is expected to create multiple sources of value and contribute to overall performance, we looked for a manufacturing company with stellar profitability and growth performance, which could be attributed to digital servitization.

The selected firm, Gree Electric Appliances, Inc. of Zhuhai (Gree for short), is a China-based provider of air conditioners. At the beginning of the observation period in 1994, Gree was a manufacturer of low-cost residential air conditioners operating from a single plant in China. At the end of the observation period in 2018, Gree's suite of residential and commercial air conditioners, small household electrical appliances and comprehensive air-conditioning solutions was sold in over 160 countries to more than 400 million users. Their residential air conditioners ranked first globally by market share, while their commercial air-conditioning solutions ranked first in China. Overall, Gree reached \$30.24bn in revenue and a profit margin of 13.31%, compared to \$43m in revenue and a profit margin of 7% at the beginning of the observation period in 1994.

The use of digital technology played a major role in this success. For instance, Gree has invested more than $700m in digital transformation since 2013 alone. In 2015, its "New Model of Collaborative Intelligent Manufacturing of Whole Processes in the Air Conditioner Industry" project won the Chinese Ministry of Industry and Information Technology's award. In 2017, Gree won recognition for its National Pilot Demonstration Project of Intelligent Manufacturing. In addition to stellar financial performance and digital awards, Gree ranked first in the household appliance industry in the "2018 top 100 Chinese brand value list" issued by the China Council for Brand Development (the organization responsible for the formulation of national standards for brand evaluation).

3.2 Data collection

Our data collection approach employed the typical methodology of combining archives, interviews and observation (Eisenhardt, 1989). Considering that digital servitization impacts the company as a whole, we started by interviewing top management, including the president of the board, the executive president, the assistant president, and six vice presidents and president assistants. Using the snowballing informant sampling technique, we asked top management to recommend experts that we should interview (Andriopoulos and Lewis, 2009). This led to interviews with the directors, managers and experts across 50 departments.

Over the course of six years (2014–2019), we interviewed over 80 informants from Gree. Each interview lasted 90–150 min, amounting to 200 h of recording. Interviews typically started with open questions: *How did the company's service portfolio evolve? How did the company's (department's) digitalization evolve? What were the strategies and outcomes of the company's (department's) digital transformation at each stage?* To mitigate respondent bias, we solicited several opinions on the same questions (Eisenhardt and Graebner, 2007). To help mitigate retrospective bias in interviews, we paid specific attention to identifying and interviewing the informants with over 20 years of experience at Gree. In general, we asked informants to offer relevant archives that could validate their accounts (Miller *et al.*, 1997).

In parallel with the interviews, we collected and analyzed internal archival data. We started with introductory documents on the overall layout of digitalization, supply chain information flow, smart manufacturing and smart solutions as well as a summarized historical record of Gree's digital transformation (1994–2016). Then, we analyzed strategic and departmental archival data such as the president's annual reports, annual reports of senior executives, annual development plans, the departmental reports (e.g. annual report of the IT center) and internal magazines. In these documents, we were able to identify events related to the changes in the value proposition (e.g. through new product and service introductions), changes in the value delivery system (e.g. through departmental activity updates, lists of supply chain collaborations and partnerships) and investments in digital technology (e.g. introduction of the enterprise resource planning (ERP) system). In the strategic reports, we were able to observe the company's assessment of the returns and the value created as well as the challenges they identified along the way. For instance, we inquired specifically about the ecosystem partnerships to come to an understanding of how the nature of these partnerships differs from existing supply chain relationships. These archival data were of crucial importance in overcoming retrospective bias, especially for the earlier years.

Finally, we performed continuous observations over the 2014–2018 period. We visited key automated manufacturing workshops, smart logistics centers, research and development (R&D) departments, the exhibition hall and the customer experience center at headquarters. We also analyzed their digital tools to understand how they functioned, the type of data that was collected, and we were also able to gain useful knowledge by analyzing the databases. Furthermore, we were afforded the use of Gree's smart home solutions, smart business solutions and photovoltaic house solutions.

We triangulated the interview data, observational data and archives to mitigate data source biases, such as retrospective sensemaking and impression management (Eisenhardt and Graebner, 2007). For instance, we double checked our interview data with archival records, and we relied on follow-up interviews with our informants to verify our understanding of the archival records. We wrote a detailed case narrative of digitalization at Gree to make sure that we had captured all the relevant events and activities, and we then asked several key informants to validate it. When we encountered inconsistency between an informant's account and the archival record, we sought further clarification from additional informants, through which means our queries were resolved. The inconsistencies we encountered between archival and interview data were rarely interesting; occasionally, an interviewee forgot a particular event that was recorded in the archival dataset, which another informant could confirm. Aside from increasing the reliability of our data, the follow-up interviews proved to be a valuable source of illustrative quotations that we were able to use in the manuscript to illustrate the observations.

3.3 Data analysis

We followed the recommendations of the inductive approach for data analysis and grounded theory building (Corbin and Strauss, 1990). We recursively iterated between data and theory to closely fit our theoretical perspective to the empirical data, with the goal of enhancing the likelihood of accurate and reliable theory (Eisenhardt and Graebner, 2007; Eisenhardt, 1989). As mentioned earlier, we began by writing a longitudinal case study that integrated our various sources of data and provided a thorough description of how events unfolded over time (Langley, 1999). This case study included the timeline of main events and activities concerning the use of digital technologies, the business model changes and the results that were accomplished. To analyze these (unstructured) data, we open coded them, creating first-order codes. We then compared the codes, deriving common empirical themes that emerged from the data (Eisenhardt, 1989). Next, a comparison of these empirical themes and those that existed in the relevant literature helped us move from first-order codes to second-order conceptual categories (Eisenhardt, 1989; Gioia *et al.*, 2013). Witness the data structure in Figure 1.

With minor adaptations, we were able to match most second-order conceptual categories with constructs from the prior literature. All the first-order codes related to the value proposition aggregate dimension–standard product-services, integrated solutions and smart solutions – could be traced to constructs from prior digital servitization literature – (Kohtamäki *et al.*, 2019; Rajala *et al.*, 2019). We noticed some duplication of the constructs in the literature. For instance, the label "product–service system" was often used interchangeably with the label "solution"; we opted for "solution" on the grounds of simplicity and brevity (Reim *et al.*, 2016; Rabetino *et al.*, 2018). All the first-order codes related to the value delivery system aggregate dimension could be traced to constructs from the digital servitization literature – the internal activity system, the supply and distribution chain, and the ecosystem (Sklyar *et al.*, 2019b; Vendrell-Herrero *et al.*, 2017). Among these aggregate categories, we noticed that "value chain" and "internal activity system" were used interchangeably in the prior literature; we opted for "internal activity system" (Kohtamäki *et al.*, 2019). Conversely, "supply chain" and "distribution network" were often used separately but, for the purpose of our analysis, we merged them into "supply and distribution chain" (Beamon Benita, 1999). Finally, the label "ecosystem" was used in the prior literature to denote a loose collective of diverse actors (Adner, 2017). For the purpose of our analysis, we use the term "ecosystem" to represent the collection of diverse partners and customers in addition to "suppliers" and "distributors".

We relied on the business model and servitization literatures to identify all the relevant constructs related to the value capture mechanisms. Efficiency and accountability value drivers

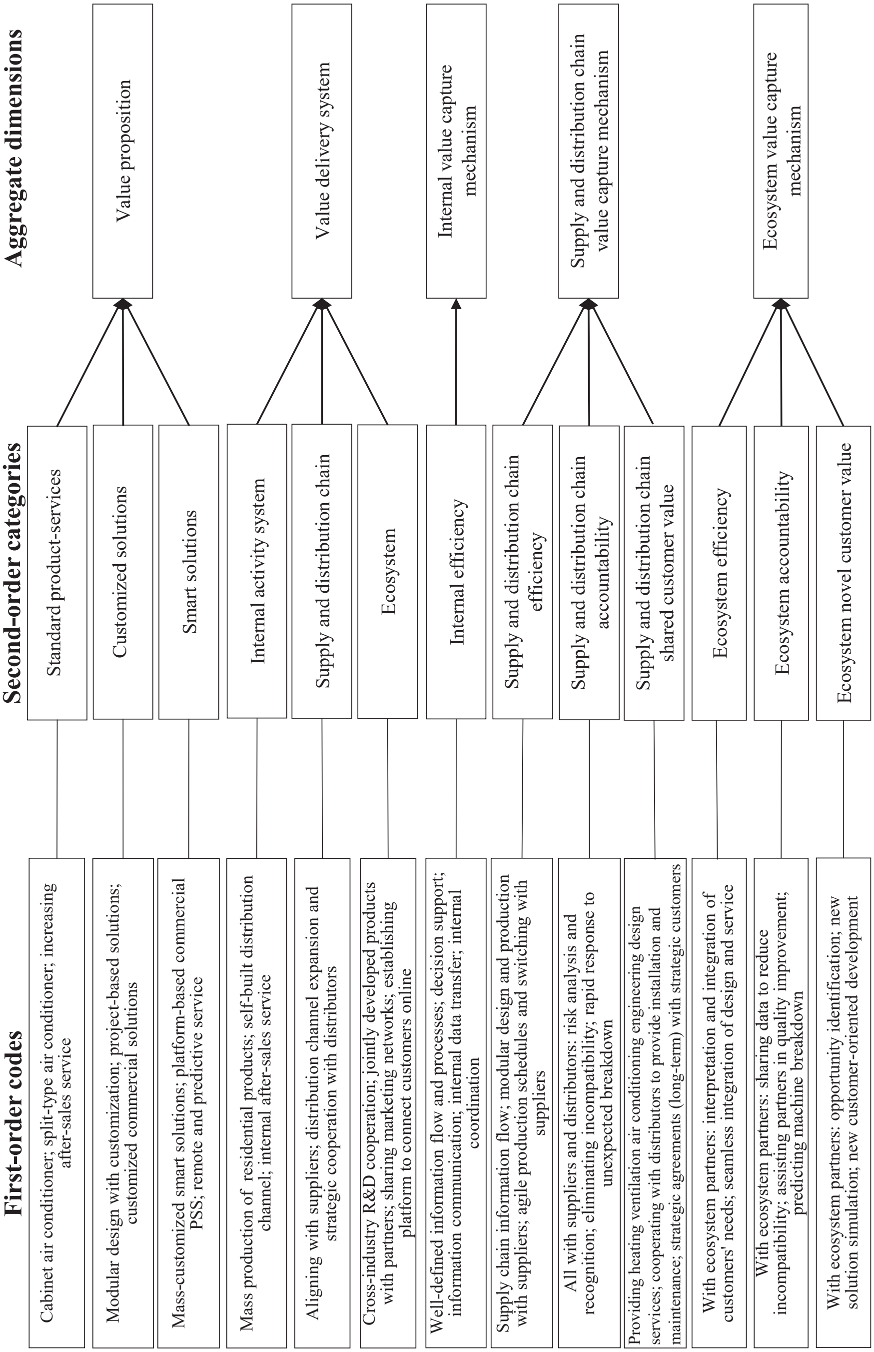

Figure 1.
Data structure

were traceable in both the digital servitization literature and the business model literature. We used the construct "novelty" from the business model literature to represent the value (e.g. new revenue streams) that manufacturers reap by providing new, innovative services to their customers. Finally, we developed a new label "shared customer value" to denote the value that the manufacturer captures as a portion of the value generated on the customer side, such as demand-side economies of scope (Adner and Zemsky, 2006; Priem, 2007; Ye *et al.*, 2012; Aversa *et al.*, 2020), complementarities in use and interoperability (Tanriverdi, 2005; Tanriverdİ and Lee, 2008; Lee *et al.*, 2010; Ranganathan *et al.*, 2018), and/or reduction in the information asymmetries related to product and service quality (Nayyar, 1993).

Finally, we noted some duplication in the literature in terms of labels for the aggregate categories. The labels of "value creation", "value proposition" and "product-market strategy" were used almost interchangeably to group the same constructs, so we used the term "value proposition" as a better suit for our data structure (Zott and Amit, 2008; Zott *et al.*, 2011). "Value delivery", "value delivery system" and "activity system" were also used interchangeably, so we opted for "value delivery system" (Kam-Chuen Yung and Ting-Hong Chan, 2003; Oh and Teo, 2010; Visnjic *et al.*, 2018). Finally, among "value capture mechanism", "sources of value" and "value drivers", we opted for "value capture mechanism" (Amit and Zott, 2001; Visnjic *et al.*, 2017; O'Kane *et al.*, 2020).

Having classified all the data into the second-order categories, we constructed a temporal sequence on the level of the conceptual categories, and we were able to infer causal relationships from one construct to another. Moreover, the sequence analysis on the level of the constructs revealed a particular process pattern, and at that point we performed "temporal bracketing" (Cloutier and Langley, 2020; Langley, 1999) to structure the process into three distinct stages that emerged from the data analysis: Stage 1 (1994–2005), Stage 2 (2006–2012) and Stage 3 (2013–2019). In the following section, we present this visually and explain the process findings, step by step.

Finally, throughout the data collection and analysis process, we worked to increase the validity and reliability of our findings in several ways. First, we triangulated the interview, archival and observation data to construct an accurate and exhaustive case database. Second, two authors were involved in the process of data coding to ensure that the data were properly translated to the first-order codes and then to the second-order categories. Third, all the data and the conceptual representations, including the final framework, were regularly shared and finally approved by Gree's management.

4. Findings

As mentioned in the methodology section, Gree's digital servitization process unfolded over three distinct business model stages. At each of these stages, we noted significant changes in terms of the value proposition, value delivery and value capture mechanisms. Figure 2 illustrates these stages, with changes in the value proposition on the y-axis and changes in the value delivery system on the x-axis. In the body of the figure, we place the value capture mechanisms resulting from changes in the value proposition, the value delivery system and the application of the digital technology. Finally, the figure provides information on the value that Gree captured at the end of each stage, in terms of revenues and profits.

In the following section, we explain the value creation process that Gree underwent and how this process unfolded over the various stages. For each stage, we provide observations regarding how the stage was initiated, how it unfolded and how it ended, including the challenges that the company faced and how they overcome them. We pay particular attention to the role that the changes in the value proposition, the value delivery and the application of digital technology played in this regard, and we explain the mechanisms by which the interplay of these changes led to change in the value capture mechanism.

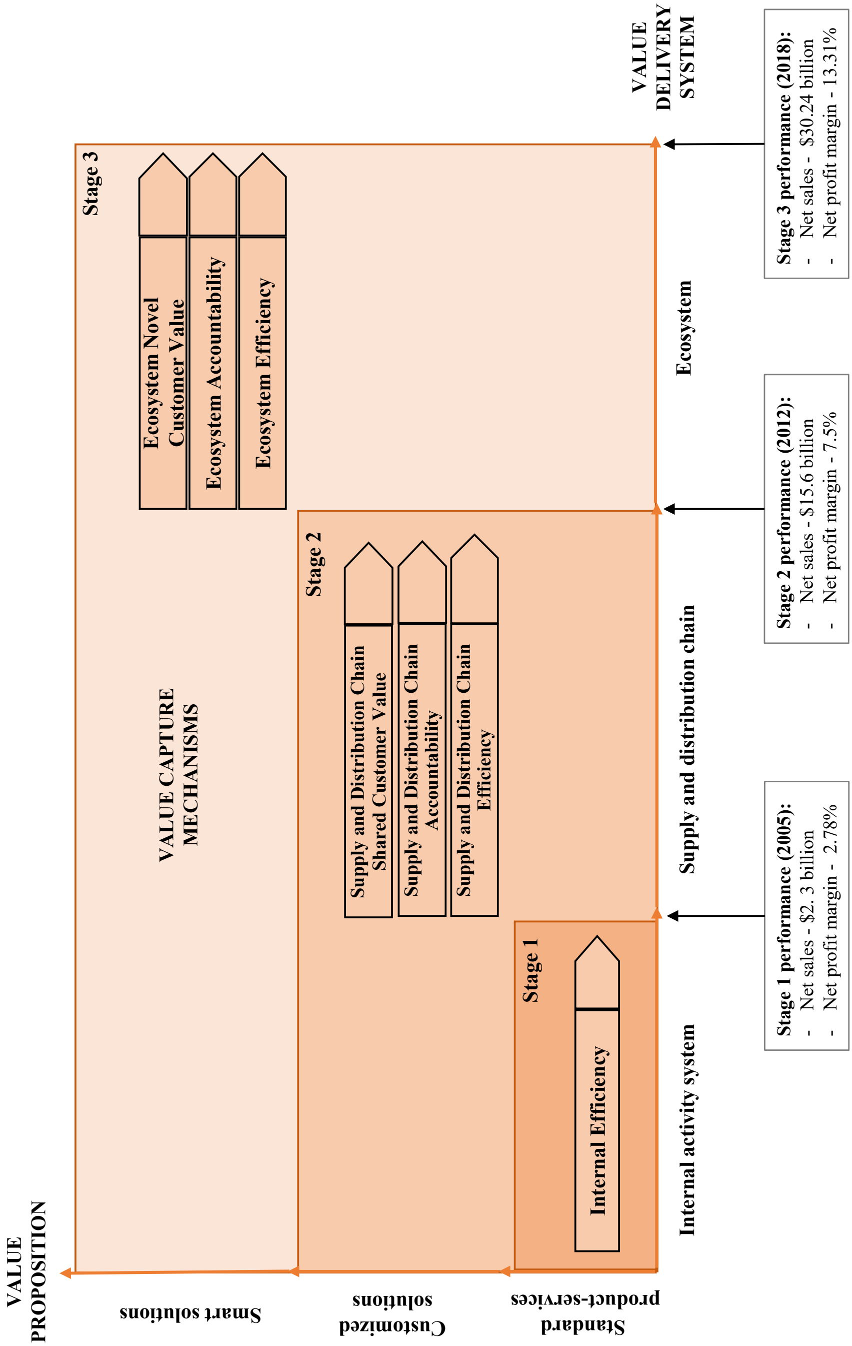

Figure 2.
Three stages of digital servitization

4.1 Digital servitization business model – Stage 1

In 1991, Gree entered the residential air-conditioning market as a fledgling and latecomer. Gree had neither sophisticated technical capabilities nor service experience, and they focused on the low-end residential market, competing on price to satisfy the growing demand for low-end air conditioners.

> In the 1990s, developing commercial air conditioners (integrated solution) was only a fantasy for Gree. We had no core technologies and no experience in operating commercial air conditioners. The greatest effort was to develop the residential (standard products), and mass production was the foundation of success. (Executive President)

Thanks to growing demand, Gree's business expanded, and more labor was required to satisfy rising production needs. Increased use of labor had a detrimental effect on efficiency and costs, putting downward pressure on productivity. The labor challenge was further complicated by Gree's lack of preparedness and unplanned growth. Sales orders were anticipated despite inadequate capacity, and unrealistic promises were made on product functionality. Increased service requests coupled with inefficient service responses caused the departments responsible for sales, after sales and marketing to be overwhelmed. To quell the fires in the after-sales department, it was necessary to draft staff from other departments to support service activities.

> The impact of mass production, first of all, caused the management and process problems within the firm…it led to low communication efficiency, and many difficulties in the management of accounting, numerous sales and after-sale service orders and financial data, together with the inability to accurately monitor processes and results of business activities… At that time, to overcome the internal obstacles to industrialization, Gree had to resort to information systems. (Director of IT Department)

Observation 1a. A sudden increase in demand for standard product-services contributes to inefficiencies (e.g. production holdups, after-sales service delays) in the internal activity system.

The need for process definition to optimize mass production and servicing became increasingly pressing, and Gree decided to optimize internal processes by digitalizing them. In 1994, Gree adopted management information system (MIS) to digitally execute finance, sales and after-sales service analysis, moving away from the traditional reliance on paper documents and manual data calculation. In 1998, Gree introduced an ERP to enable integrated analysis of production, sales and after-sales service. ERP improved the accuracy of production planning by analyzing the integrated MIS data from various internal units. The digitalization progress in the 1990s was slow as the IT team lacked relevant business knowledge and the organizational structure necessary to promote adoption of digital technology. In 2000, Gree management facilitated progress when they set up a standalone IT center headed by a manager responsible for digital transformation.

By 2004, a product data management (PDM) system was adopted to manage product and component data. By leveraging PDM, designers could efficiently query the required data and maximize their potential in design work. Furthermore, managers could monitor drawings and structural changes online, based on the defined processes and technical standards, to enhance the efficiency and quality of R&D. Finally, PDM proved its worth in standardized component development, product structure modification, design concept tracking, and data management of products, bills of materials and design.

> Our goal was to improve production capacity and efficiency, otherwise we could not quickly expand the scale and become bigger and stronger. Therefore, the problem of low efficiency must be solved by

informatization. For example, a lot of work that depended on manual input, manual calculation, and statistics made our workload quite huge and seriously affected efficiency. (President)

Observation 1b. Investments in digital technology are made to increase efficiency in the internal activity system that supports standard product-services (e.g. by eliminating communication gaps across departments).

At the end of Stage 1 (2005), Gree had some modest success by achieving net sales of \$2. 27 billion and a net profit margin of 2.8%, compared to net sales of \$750m and a profit margin of 4% in 2000, and net sales of \$43m and a profit margin of 7% at the beginning of this stage (1994). Indeed, while Gree managed to secure growth, its margin was in decline. Our interviewees clarified that, as one of the standard air-conditioning manufacturers, Gree had been in stiff price competition with other low-cost manufacturers since 1995. While the efficiency gains helped the company survive in these circumstances, it was not possible for Gree to retain a significant portion of the value.

4.2 Digital servitization business model – Stage 2

By 2005, having digitally enabled product design functionality and a successful residential air-conditioner business, Gree's management felt ready to focus on the more sophisticated and lucrative market of commercial air-conditioner solutions. The market opportunity in the commercial segment was long known to Gree, yet it required a very different value proposition than the standard products and services that Gree was used to providing. Indeed, sophisticated commercial customers were demanding customized solutions (e.g. office building and industrial project-based solutions) and more sophisticated air-conditioner technology. In 2012, Gree's technology was ready to support this value proposition. Furthermore, the recent success in ensuring the efficiency of internal operations for its standardized air conditioners laid the foundation for creating the value delivery system required. For instance, Gree's leadership was confident its recently installed PDM System could be extended to manage more sophisticated R&D data across the supply chain that would be needed if customized solutions were to be delivered.

> The market position of residential air conditioning was leading, and we had rich experience in design and technology. It can be said that we have obvious advantages in residential air conditioning market. So, we hoped to expand this advantage to the field of commercial air conditioning (Quotation from the President in 2004 provided by Gree)

> In recent years, we turn to the research and development of commercial air conditioning. Relying on our strength in residential air conditioning, we have made great progress in the development of commercial air conditioning technology. (Quotation from the Chief Engineer and President Assistant in 2006 provided by Gree)

Observation 2a. Success with standard product-services and efficiency increase across the internal value delivery system (Stage 1) lays the foundation to pursue customized solutions.

The growth in customized solutions required changes in the value delivery. A new production system was added to the mass production system for residential air conditioners. This new production system was more complex, as customized air conditioners were based on greater variety in components delivered through a growing network of suppliers. Considering that the PDM system did not yet contain supplier data, nor data on customer requirements, designers had to spend considerable time searching for the right components. They also needed to repeatedly coordinate customized development through offline communication with suppliers and customers.

The complexity of customized solution production and delivery created challenges in control and oversight of the supply and distribution chain actors. Due to customization, the design cycle and the cost of commercial air conditioning operated in conditions of greater uncertainty (e.g. lead times range from 35 days to half a year), which further complicated the sourcing planning with suppliers and led to a high-volatility supply chain. Additionally, running commercial and residential production systems in parallel introduced severe supply-chain process uncertainties and complexities.

In addition, more specific customer data became necessary. As the customized solutions required more complex maintenance, service technicians needed specific technical data on components and accurate data on customer use of the equipment in order to maintain the customized unit. During the maintenance period, upfront visibility on the type of components that may need to be replaced was limited. This meant that technicians had to visit customers several times; first, to understand what was needed and, then, to fix it.

> The decentralized systems and inconsistent data standards continue to increase the cost of internal and external communications. The data of product module design cannot be directly distributed to the workshop and outsourcing suppliers. Establishing supply chain data flow was also an important direction for digitalization at that time. (IT Center Director)

Observation 2b. The pursuit of customized solutions reveals inefficiencies, complexity and customer information gaps across the supply and distribution chain.

Efficiently developing and delivering customized solutions with suppliers became a strategic priority for digitalization. For instance, achieving a shorter supply chain and production cycle became critical to deliver the customized solutions. In 2006, Gree introduced supply chain management (SCM) to build interfaces between the product design and production systems for residential and commercial businesses and, in doing so, to increase the supply chain efficiency of both systems. Furthermore, building on the application of PDM technology in the first stage, Gree adopted the product lifecycle management (PLM) tool in 2006, which helped to integrate the product life cycle data with the module suppliers and, as a result, support cooperation on R&D.

As a result of the SCM and PLM implementation, Gree was now in a position to standardize its product platform and create shared product blueprints for both residential and commercial air conditioners. Nevertheless, it faced some resistance from R&D managers as it attempted to initiate this change. In order to overcome these obstacles to standardization and modularity, Gree established the Standard Management Department headed by the President in 2007, empowering the department to implement through-chain standardization and modularization.

> Only by eliminating the "information island" can we achieve an interaction from the supplier to the market. Only with integrated interaction can we directly manage the production process and greatly improve design and manufacturing efficiency. Through integration of the supply chain, the product development cycle was shortened by more than 30%, and production efficiency was increased by more than 20%. (Vice President, Production)

Observation 2c. Investments in digital technology are made to increase the efficiency of the customized solution (e.g. by reducing communication challenges across the supply and distribution chain).

Digital technology became important to increase supply and distribution chain transparency and accountability. A large number of monitoring technologies and processes were utilized in the supply chain to collect logistics data and workshop data, test the quality of modules and relevant architecture, and monitor supply chain processes, along with early warning and rapid responses to unexpected breakdown. For example, Gree established supervisory control and data acquisition (SCADA) systems in its main warehouses and workshops. In production, from 2009, Gree required its main suppliers to digitize supplied materials with bar codes and to share their data. Before the components entered the intra-firm environment, the first step was to leverage the bar codes, radio frequency identification and sensors so that materials identities were matched to suppliers. In 2012, Gree created data warehouses to integrate the data of all business activities and developed business intelligence applications to comprehensively analyze business operations, assess and monitor key indicators related to supply chain risk (e.g. efficiency, effectiveness, assets and expenses), and explore management vulnerabilities.

> The ability to control every detail of operation management and realize data sharing in the vertical field of business and the value chain ensure the traceability of each link and continuous feedback and improvement. If quality problems occur in the procurement, warehousing, and any components in workshops, we can quickly find the relevant suppliers and then punish the suppliers. (Assistant President, Quality Management)

Observation 2d. Investments in digital technology are made to increase accountability with the customized solution (e.g. by monitoring supply and distribution chain).

To satisfy the need for timely data on customer needs and requirements and ensure that customer data flow seamlessly from the customer to the service operation and the production of integrated solutions and its specialized components, Gree integrated horizontal information systems, such as the service management system, the channel management system, the outsourcing platform and the distribution channels management system, achieving horizontal integration in the supply chain to support the coordination of upstream module suppliers, downstream distributors and specialty stores. In 2009, Gree introduced customer relationship management (CRM), which connected customers, distributors and specialty stores, making possible the sharing of customer data between Gree, the distributors and the specialty stores in both residential and commercial markets, and providing timely guidance to the sales activities of downstream partners to achieve consistent cross-regional cooperation.

> CRM and its internal commercial air conditioning order management module assisted in connecting with our distributors. . .It also helped us understand customer needs, analyze the demand order parameters that can help product development, and thus shorten the lead time. (Manager of Commercial Air Conditioning Market Operations)

> Based on CRM, we had established a special sub-information system for commercial air-conditioning after-sales service. Through this service system, we can provide distributors with installation service specifications, process standards, after-sales service maintenance knowledge including previous successful maintenance solutions and on-line training. (Manager of Commercial Air Conditioning Technical Service Department)

Observation 2e. Investments in digital technology are made to increase the shared customer value of the customized solution (e.g. by identifying customer needs and sharing these data across the supply and distribution chain).

At the end of Stage 2 (2012), Gree achieved notable success. Net sales exceeded $15.6bn, compared to $ 2.27bn at the end of Stage 1 (2005). Net profit margin reached 7.5%, compared to a net profit margin of 2.78% in 2005.

4.3 Stage 3: digital servitization in the ecosystem

By 2012, Gree began to be perceived as a market leader in customized solutions. Moreover, Gree's management was confident in Gree's ability to deliver customer solutions that create shared customer value and were also reliable and efficient, thanks to the application of digital technology across the supply and distribution chain. Finally, digital technology also increased knowledge of customer needs that Gree was *not* able to meet with customized solutions. For instance, there were opportunities to pursue new digital services (e.g. remote monitoring of air conditioners) or create more customer value (e.g. energy efficiency) through broader solutions (e.g. solar-panel-powered air conditioners). At the same time, an emerging trend for digitalized and smart solutions applied by companies in other industries was to demonstrate how digital technology could be used to create shared customer value in new ways.

> In recent years, we have been creating the information flow that allows us to leverage data to support the entire process (procurement, design, logistics, production, sales, and service, etc.). At present, we realized an end-to-end closed loop to meet any specific customer needs or business objectives. It can be said that we paved a way for the next step – smart products and services. When a product is smart, it needs to transfer the operation and usage data back to the service department and then to the R&D department, so as to improve the product and service quality and form a virtuous circle. (IT Center Director)

Observation 3a. Success with customized solutions, the value captured in collaboration with the supply and distribution chain and the insights on customer needs gained in Stage 2, lays the foundation to pursue smart solutions.

The vision to pursue smart solutions that go beyond "simple" air conditioners exposed significant capability gaps at Gree and its supply and distribution chain. To delivery smart solutions, Gree needed to procure a diverse set of products, services and digital modules for smart homes, office buildings, specific projects, cold chain logistics and automotive air conditioners. The diversity coupled with technical sophistication of these modules made it impractical for Gree to consider developing all these modules on their own. Instead, Gree started to look for partners from other industries that would have the competencies to develop relevant modules. As Gree aimed to progress from simple air conditioners to smart air conditioners, it partnered with Insur Group and several other IT solution providers. Later on, as it progressed beyond smart air conditioners and began to develop broader smart solutions, such as the smart home, it expanded its ecosystem of partnerships to companies from those industries as well.

> We are working closely with JD.COM (largest retailer in China), WM Motor (connected car manufacturer), CRRC (rail transit equipment manufacturer and solution provider) and other companies in other fields to jointly develop refrigeration technology and products. The use of the necessary complementary resources has effectively helped us expand commercial product platforms. . . (Chief Engineer, Vice President, R&D)

Gree quickly realized that the collaboration with these new partners unfolded differently than the traditional collaborations with suppliers that they were used to. Gree collaborated with traditional suppliers by providing them with the specification for a particular component that it needed suppliers to design, whereas collaboration with the new partners was hard to manage by setting standards and specifications. Consequently, more back-and-forth conversations between the R&D teams on both sides were required. The reason for this was that Gree did not have the knowledge to specify exact standards for the partners' modules. They were also in the position of a partner rather than the position of a client. A new collaborative approach was needed where Gree would not "set the rules and standards" but work jointly and in parallel with the partner in a process of cocreation.

As Gree started to collaborate with new partners, it was confronted with several inefficiencies. The development of sophisticated smart solutions with cross-industry partners required IoT-related interfaces, which were lacking in the early stages of cooperation. Meanwhile, sophisticated smart solutions complicate testing and commissioning and field debugging, requiring both sides to exchange more digital resources and utilize more complex digital tools. Moreover, new risks started to emerge. With an increase in technical depth and greater complexity in the smart solutions, some actors lacked sufficient digital capabilities to achieve the goals that Gree required for the complements and subsystems. For example, some of Gree's smaller partners were unable to invest in essential digital technologies and capabilities due to lack of funds and smallness of scale. They simply could not stand the financial risk. When they needed to develop more complex components that required powerful simulation and analysis technology, they had to rely on external digital technology support – which meant that they exposed themselves to partner risks. This partner risk was also passed on to Gree.

> In the collaboration with partners in multi-industries, the most important thing is to develop good interfaces, and use these interfaces to communicate with the external parties (i.e. using interfaces to connect Gree's modules with partners' modules) . . . We have to continue to study the interface together with our partners, to ensure that the interface is stable, easy to use, and scalable. Continuous efforts on compatibility will bring good alignment and compatibility among the modules. (Director of New Energy Research Institute)

> We try to use existing digital resources to support this cooperation, including providing automated production solutions, simulation and test platforms, and related standard data, and also serving the development and operation and maintenance of common solutions. (Chief Engineer, Vice President, R&D)

Observation 3b. The pursuit of the smart solutions creates a need for new partners. In turn, this opened the opportunity for novel customer value, but it also triggered new inefficiencies and accountability gaps in the ecosystem.

From 2013, Gree leveraged IoT technologies and data analysis technologies with its partners, to access and analyze their module data. These data were used to gain an in-depth understanding of how to develop successful smart solutions with sufficient compatibility, reliability and performance. For example, in 2015, Gree entered into partnership with Yingli Solar, a manufacturer of solar panels, with the objective of jointly developing solar-powered air conditioning solutions. This solution labeled "Zero Carbon Health Home", was based on Yingli's solar panel, Gree's solar-panel-compatible air conditioner and the digital management module specific to photovoltaic air-conditioning solutions, called "Integrated Management System", which was developed jointly by Yingli and Gree. Integrated Management System is a smart control system and integrates multiple functional modules, including smart subsystems for solar-panel, air conditioner and power management. The smart management subsystems for air conditioners are developed by Gree; they can automatically control the central air-conditioning units according to the environment and the state of the central air-conditioning unit (temperature, humidity, power supply, shake, nose, and other parameters of the apparatus and its components) to adjust operational performance. The energy management subsystem developed by Yingli can automatically distribute and allocate the power generated by the Photovoltaic Power Generation System.

> We try to use digital resources to support this cooperation, including providing automated production solutions, simulation and test platforms, and related standard data, and also serving the development and operation and maintenance of common solutions. (Chief Engineer, Vice President, R&D)

Observation 3c. Investments in digital technology are made to identify opportunities to create novel customer value and develop new smart solutions (e.g. by supporting cocreation among ecosystem partners).

In parallel with supporting the development of smart solutions through digital technology, further efficiency gains were being pursued. For example, Gree's product lifecycle management tool, which was developed for the purpose of collaborating with suppliers, had to be adapted to collaborate with ecosystem partners. For this task, Gree created a digital tool called PartsLink that allows access to and facilitates the transmission of module data on parts and components between authorized suppliers, partners and workshop manufacturing in real time. In 2014, Gree harnessed the potential of IoT, Big Data analytics and automatics to construct smart factories and accelerate the vertical and horizontal integration of the production system, realizing synchronous development and configurations across various customized orders. Furthermore, Gree used data from the remote control systems (e.g. temperature and humidity, energy consumption, and reliability data on core components) not only to improve remote services and predictive services but also to examine product system and component failures and solve relevant deficiencies in the product-service design, the production processes and even R&D efficiency.

> Gaining more economic returns from the R&D investment in customized solutions lies in the establishment of mass customized production capabilities. . .the key parts in design are common needs integration and the matching of customer parameters with existing modules. We and our partners had jointly built some product platforms based on general modules using shared data analysis. When the customer provides us with its parameters, we can quickly generate a design plan (by using general modules) with the help of the data platform. . . (President Assistant, the intelligent equipment business)

Observation 3d. Investments in digital technology are made to increase efficiency in the delivery of smart solutions (e.g. by automating communication across ecosystem partners).

Aside from the novel customer value and efficiency in ecosystem collaboration, digital technology served to increase accountability of the solutions. Going back to the example of collaboration between Yingli and Gree, the two companies shared digital resources (i.e. data and algorithms) from their respective smart subsystems through the Integrated Management System, in order to avoid incompatibility. This approach of sharing digital resources to avoid incompatibility was extended to other partners. Gree offered standard data and IT consulting and training services to partners in need of its supercomputing, simulation software and robotic equipment solutions. By providing digital resources and technology services, Gree assisted partners in improving the quality and technical compatibility of modules and, therefore, increased the reliability of jointly developed smart solutions. In 2015, Gree initiated the "Smart Product Strategy" by adding risk management and predictive analysis modules to smart solutions, such as Zero Carbon Health Homes. Predictive analysis modules were able to predict technical risks (e.g. equipment failure) as well as risks related to customer error in handling equipment (i.e. mismanagement of the equipment). Moreover, the "Smart Product Strategy" was able to detect contextual conditions (e.g. instability of the power grid) that could lead to equipment failure.

> In cooperation, we conduct a comprehensive demonstration analysis, including some key indicators of feasibility and reliability. We usually ask strategic partners to share some necessary data with us. We are the same, we even share key algorithms. Only by obtaining the key module data as much as possible can we carry out effectively the subsequent simulation and demonstration of the product system. Otherwise, it is difficult to understand the reliability and energy-saving performance of the product system in the development process. (Director of New Energy Research Institute)

> We will also share our computing resources with our partners to help them improve their product design and quality. This is a win-win situation. Only when the quality of their products is improved can the quality of our integrated solutions be guaranteed. (Manager of IT Department)

Observation 3e. Investments in digital technology are made to increase the accountability of the smart solution and its delivery (e.g. by increasing transparency and enabling best practice exchange among ecosystem partners).

At the end of Stage 3 (2018), Gree achieved net sales of \$30.2bn and a net profit margin of 13.3%, compared to net sales of \$15.6bn dollars and a net profit margin of 7.5% achieved at the end of Stage 2 (2012). Moreover, the commercial business ranked first in China's market for seven years, whereas Gree maintained global leadership in the market for residential air conditioners for 14 years.

5. The process of digital servitization through business model – digital technology interplay lens

The empirical observations generated in the previous section enable us to make several inferences about the nature of the digital servitization process. Figure 3 illustrates our framework, which depicts how a traditional manufacturer implements digital servitization through expanding its business model in tandem with the adoption of digital technology. As elaborated below, we note that process patterns/features repeat over the three digital servitization stages. This repetition allows us to make generalizable claims about the nature of the process (Langley *et al.*, 2013).

First, we find evidence for expansion of all the elements of the business model – namely, the value proposition, the value delivery system and the value capture mechanism – at each stage. On the value proposition side, the case firm starts from the standard product-services in Stage 1, adds customized solutions in Stage 2 and, then, adds smart solutions in Stage 3. To support this value proposition expansion, the value delivery system has to expand too. A manufacturer that started from the internal activity system in Stage 1, expands its value delivery system to the supply and distribution chain in Stage 2, and then to the ecosystem in Stage 3. However, for this expanding value delivery system to function properly, the case firm heavily relies on the adoption of digital technology. Thanks to the adoption of digital technology, the value capture mechanisms expand as well. More specifically, the firm starts by capturing value through an increase in efficiency in Stage 1, adding an increase in accountability and shared customer value in Stage 2 and, finally, achieving also an increase in novel customer value in Stage 3.

P1. The process of digital servitization consists of distinct stages, characterized by changes to all the business model elements. At each stage, a new (service) value proposition is introduced, the value delivery system is extended and new value capture mechanisms are added.

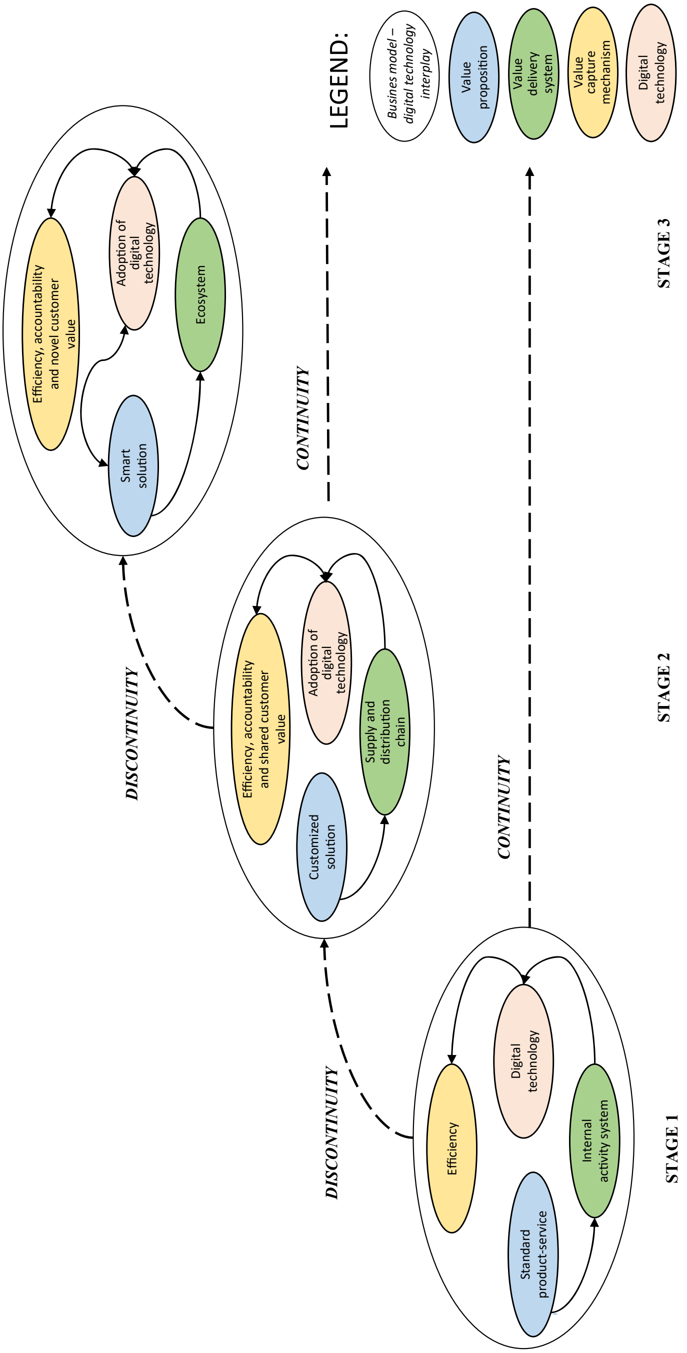

Figure 3.
Process of digital servitization

Second, there is a strong interplay between business model change and the use of digital technology throughout the entire digital servitization trajectory. The shift to services does not precede the use of digital technology or vice versa. At each stage, the two occur in parallel – the adoption of digital technology supports the business model change and this interplay ensures successful digital servitization at that particular stage. In addition to this *concurrent* interplay between the business model change and the digital technology adoption *within* each stage, there is an interplay *across* the stages. More specifically, the successful application of digital technology at any given stage lays the foundations for the development of the new business model at the next stage. This *dynamic* interplay between business model and digital technology across stages occurs through several mechanisms. To start with, a successfully digitalized value delivery system at any given stage lays the foundation for the development of the new value proposition. For instance, data obtained during the delivery of the customized solutions (Stage 2) revealed insights about novel value propositions – namely – smart solutions (Stage 3). Moreover, digital technology deployed at any given stage (e.g. supply chain PLM in Stage 2) provides the basis for the digital technology development in the following stage (ecosystem PLM in Stage 3). Finally, additional value captured at any given stage gives rise to increased investment in the digital technology at the next stage.

P2. The process of digital servitization is characterized by concurrent and dynamic interplay between business model and digital technology. Concurrent interplay occurs when digital technology enables implementation of the focal business model at any particular stage. Dynamic interplay occurs when digital technology enables the inception of the business model at the subsequent stage.

Our third inference concerns the nature of the business model change process that underpins digital servitization. We identify two underlining mechanisms, where one is continuous in nature and the other is discontinuous. On the evolutionary/continuous side, the firm maintains its existing business model elements, such as the existing value proposition and the value delivery system, and it continues to capture value using the same value capture mechanism that operates from one stage to the next. For instance, standard product-services continue to be sold in Stages 2 and 3, and customized solutions continue to be sold in Stage 3. The value delivery system expands from the internal setting to the supply and distribution chain and then on to ecosystem. But, as the expansion takes place, the previous activity system continues to be used (e.g. the internal activity system is present in Stages 2 and 3). Finally, efficiency is an important source of value capture at Stage 1, and it continues to be an important value capture mechanism in Stages 2 and 3 where a firm looks to capture efficiency value by delivering standard product-services, customized solutions and smart solutions using an ecosystem-wide value delivery system.

On the other hand, the discontinuous aspect of the business-model change stems from the addition of a new value proposition at every stage. More specifically, at the beginning of each stage, the addition of a new value proposition distorts the well-functioning value delivery system that was achieved during the previous stage. To remedy value delivery challenges, top management invests in digital technology to resolve the blockages and restore equilibrium to the functioning of the value delivery system. When this equilibrium is achieved in additional (and qualitatively different) value propositions, the new value capture mechanism is added. Thus, the addition of the new value proposition and resulting value delivery challenges introduce discontinuity, while the use of digital technology gradually brings the business model into a state of equilibrium. These discontinuous aspects of change contrast with prior studies that consider both servitization and digital servitization as purely continuous and evolutionary processes (Baines *et al.*, 2017; Martinez *et al.*, 2017).

Thus, there is a need to simultaneously manage continuous and discontinuous business model changes in digital servitization. This is challenging as the two process types represent opposing forces of change. For instance, a manufacturer that pursues digital servitization has to simultaneously improve the efficient delivery of standard product-services while, at the same time, learning how to reap shared customer value in an accountable and efficient manner along its supply and distribution chain. Going forward, a manufacturer must continue to make improvements along these two lines while, at the same time, learning how to reap novel sources of shared customer value in an accountable and efficient manner but, this time, in collaboration with ecosystem partners. This implies that the governance and organization mechanisms (e.g. the use of key performance indicators (KPI), structures, job roles) must be able to ensure simultaneous continuity and to enable discontinuity while, at the same time, having the capacity to manage the attendant complexity.

P3. The process of digital servitization is characterized by continuous as well as discontinuous process features. Elements of the earlier business models are kept and continuously improved along the digital servitization trajectory while, at each new stage, new business model elements are added, producing discontinuity.

6. Discussion and conclusion

The purpose of this study is to advance understanding of the business model change that underpins digital servitization. To accomplish this, we relied on insights from the digital servitization literature (Cenamor *et al.*, 2017; Sjödin *et al.*, 2020; Kohtamäki *et al.*, 2019; Sklyar *et al.*, 2019b; Rajala *et al.*, 2019) and the business model literature (Amit and Zott, 2001; Visnjic *et al.*, 2017). In short, our findings uncover the relationship between the expansion of the value proposition into customized and smart solutions, the opening up of the value delivery system to the supply and distribution chain, and to the ecosystem, and introduction of diverse value capturing mechanisms. Digital technology is crucial in making these shifts viable. The interplay between business model change and digital technology adoption occurs within and across three distinct stages. Moreover, the interplay produces continuous and discontinuous changes that need to be managed simultaneously, making digital servitization a challenging organizational endeavor.

These findings offer several contributions to the literature and also provide useful guidance for practitioners. First, while the majority of the digital servitization literature focuses either on value proposition development (Rajala *et al.*, 2019; Cenamor *et al.*, 2017) or on the value delivery system (Kohtamäki *et al.*, 2019; Reim *et al.*, 2019; Sjödin *et al.*, 2019), we explicitly introduce consideration of the value capture mechanisms and then focus on the interplay of all three business model elements. For instance, we are able to observe that the development of customized solutions is only effective when accompanied with the opening of the value delivery system to the supply and distribution chain. Stated differently, the modular design and platform approach that colleagues observe (Rajala *et al.*, 2019; Cenamor *et al.*, 2017) is a necessary but insufficient condition for a manufacturing company to reap value from digital servitization – it has to be accompanied by the opening of the value delivery system and the use of digital technology to capture new value. The explicit treatment of the value capture mechanisms allows us to identify this relationship. Thus, successful capture of value is a condition sin qua non for the next stage of digital servitization. Considering the importance that the value capture process plays in the sustainability of digital servitization and the recent evidence concerning the number of manufacturers who struggle to identify and implement new value capture mechanisms, we cannot afford to omit this variable from our study.

Second, our study shows that, in order to understand how a large product-centric organization is transformed into offering smart solutions, it is important to consider interdependence between digitalization and servitization efforts that the manufacturer makes before the final step of providing smart solutions. More specifically, while the previous literature focused on the role of technology in creating smart solutions (Reim *et al.*, 2019) and in promoting the value delivery system's evolution into ecosystems (Kohtamäki *et al.*), we focus on untangling the interdependency across the entire digital servitization path. This longitudinal perspective reveals strong interdependencies that cannot be underestimated. For instance, the early stage digitalization efforts on products (e.g. the introduction of PDM) are an indispensable antecedent for the later delivery of smart solutions with ecosystem partners. Thus, we show that, in order to comprehend digital servitization, we need to understand both of the earlier steps of digitalization of products and servitization.

Third, we show that digital servitization follows a process characterized by both continuity and discontinuity. This complements the existing literature stream that establishes that physical servitization is continuous (Martinez *et al.*, 2017), as well as the literature stream that argues that digitalization is discontinuous (Sjödin *et al.*, 2020; Paiola and Gebauer, 2020; Paschou *et al.*, 2020; Sklyar *et al.*, 2019b; Coreynen *et al.*, 2017). These findings have strong implications for the organizational change approach that manufacturers need to take when pursuing digital servitization as well as for the competitive dynamics with the digital entrants or with the incumbents that pursue "pure" product digitalization. As we have elaborated further below, a sophisticated business model based on customized solutions may offer a better vantage point for smart solutions development than pure product digitalization, yet it may also imply some challenges in organizing the interfaces.

Finally, our study contributes to the prior literature by describing the steps that the firm goes through as it reconfigures (and opens) its firm boundaries (Huikkola *et al.*, 2020). We find evidence for the need to utilize and coordinate external partnerships with suppliers, distributors and ecosystem partners as a central element in the evolution of the proposed digital servitization business models. Prior studies have communicated the importance of ecosystem partnerships (Kohtamäki *et al.*, 2019; Lenka *et al.*, 2017; Sklyar *et al.*, 2019b) but have not adopted a process view on how the complex relationships evolve over the digital servitization journey. In particular, we find that when offering smart solution value propositions, the manufacturer becomes largely reliant on having a well-functioning ecosystem value delivery system composed of suppliers, distributors, partners and customers. Through such involvement of ecosystem partners, a manufacturing firm is able to expand the scope of the value proposition to its customers. Moreover, ecosystem relationships need to be aligned through utilizing multiple value capture mechanisms – namely, efficiency, accountability, shared customer value and novelty – to ensure a viable business model. Thus, the successful interplay between business model changes and digital technology adoption has to be conducted with the close involvement of ecosystem partners.

Our findings have important implications for the practitioners as well. For instance, digital servitization is likely to create a sustained competitive advantage, considering that a digital entrant would struggle to compete with a sophisticated value delivery system that underpins smart solutions. Moreover, "pure" product manufacturers may struggle to compete in digitalization with the manufacturers that are used to offering advanced services, such as customized solutions. Having in place a sophisticated business model based on customized solutions may offer a better vantage point for smart solutions. Furthermore, the strong interdependencies among the products, services and software have implications for organizational design. While, in some contexts, it may be wise to separate the digital business model from physical products and services, this could be detrimental to digital servitization as it could distort the interdependencies and continuous use of the existing business model elements. Our findings caution against separating digital activities entirely from products and services, as in the case of GE Digital. Furthermore, a progression in value capture mechanisms calls for a periodic revision of key performance indicators and incentives along the digital servitization journey. For instance, it would be hard to imagine progressing with novelty or shared customer value if the KPIs and incentives of the relevant employees are strictly set to promote efficiency gains. Moreover, the complex interplay between business model and digital technology has important implications for manufacturers. A manufacturer that pursues digital servitization should be aware of both the discontinuous and the continuous aspects of the business model change process. While it is important to develop organizational design that supports continuity, it is also important to plan for the discontinuity (e.g. inform key stakeholders on the temporary decrease in performance when the new business model is introduced).

Our study has several limitations, which opens up various avenues for future research. The current study provides a detailed account of how a traditional manufacturing firm undertakes digital servitization. Therefore, our findings provide theoretical generalizability for other manufacturing firms that are pursuing a similar business model change trajectory. However, cross-case generalizability and the external validity of these findings may be limited because of the single case study design. To increase generalizability, comparative case study analysis that includes failure cases could help isolate the necessary features of the successful process. Furthermore, large sample surveys are needed to investigate the relationships between different elements of the business models, the contextual factors and performance. Furthermore, we have studied digital servitization from the perspective of the focal firm. Although a focal-firm perspective provides an overall view of the evolution of interorganizational relationships during the transformation, our approach also encompasses supply chain partners and ecosystem actors. Observations from multistakeholder perspectives should be incorporated into future research.

Another opportunity for future research could be to seek evidence for equifinality – a presence of different paths that lead to the same outcome (Fiss, 2011; Ragin, 2008). For example, Sjödin *et al.* (2016) used fuzzy-set qualitative comparative analysis (fsQCA) to demonstrate that different capability configurations can enable a manufacturing firm to offer advanced service offerings. Although we were not able to advance a similar conclusion, it would be interesting to see whether smart service offerings could be reached through different paths (e.g. by closely involving ecosystem partners and adapting novel digital technologies). Thus, servitization and business model researchers are encouraged to further investigate the presence of equifinality in relation to digital servitization. Finally, while our focus is on business model design and digital technology, we have noted that the product R&D strategy, the organizational design choices and the environmental factors (e.g. technology readiness and customer demand) play an important role in the process of digital servitization. We would encourage colleagues to pursue research that illuminates these factors.

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