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## Suppliers Developing Customer Knowledge for Data-enabled Service Innovations

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**Abstract:** Multiple companies may be involved in the development and delivery of data-enabled industrial services, so the flow of knowledge between companies is necessary and, yet, potentially problematic. The purpose of this paper is to increase understanding of customer knowledge development for data-enabled service innovations in the context of industrial services. We investigate manufacturer's and technology supplier's approaches to customer knowledge development on service innovations using a qualitative comparative case study. Our findings reveal six categories of drivers and barriers to developing customer knowledge: development priorities, customer service experience, customer knowledge diffusion, customer knowledge creation issues, organizational issues and inter-organizational issues. Two different approaches are identified for customer knowledge development, relationship-led approach and value-led approach, depending on the actor's position in the supply chain. As managerial contribution our study suggests manufacturers to utilize technology supplier's complementary approach for customer knowledge development to improve their service innovation processes.

**Keywords:** data-enabled service innovation; customer knowledge development; industrial services; technology suppliers; multi-actor view

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## 1 Introduction

The development of customer knowledge poses a compelling challenge for manufacturers' service innovations in business-to-business markets (Johansson et al. 2019). Manufacturers need such knowledge to meet customers' needs through the conceptualization of services, design of service systems, and refinement of service processes (Edvardsson & Olsson 1996). Service innovation can be defined as the process of creating and implementing novel ideas, methods, or technologies to improve the delivery, quality, efficiency, or experience of services offered to customers, resulting in added value for both service providers and customers (Randhawa & Scerri 2015). Service innovations here mean new industrial services driven by data-enabled technologies, such as the Internet of Things and data analytics, which provide added value for customers (Witell et al. 2016).

While existing research has covered customer knowledge development from service sales and delivery perspectives, insights into customer knowledge development during manufacturers' innovation processes are still scarce (Johansson et al. 2019). Customer knowledge development is a supplier's process to develop an understanding of evolving customer preferences for new services (Joshi & Sharma 2004). For industrial service innovations, customer knowledge should be developed in multi-faceted ways (Johansson et al. 2019). There is a need for a broader exploration of customer knowledge development in manufacturers' service innovations, especially regarding data-enabled services.

Companies need to manage the development of customer knowledge and technological enablers simultaneously to succeed in their service innovation efforts in data-enabled service development. In this paper, data-enabled services refer to industrial services enabled by technological capabilities, such as the Internet of Things and data analytics, which support manufacturers' service transformation path (Ardolino et al. 2018). These capabilities are not developed in isolation, but usually as an integral part of a manufacturer's new service offerings. Manufacturers may develop new digital capabilities internally or lean on technology suppliers, such as software companies, cloud platform providers, and data integrators (Momeni et al. 2023). Existing literature recognizes the importance of collaboration between manufacturers and technology suppliers (Rapaccini et al. 2023; Smania et al. 2024), as each actor has its unique access to customer knowledge depending on its supply chain position and distance from end users.

Various tensions such as different levels of innovation capabilities and commitment between a manufacturer and a technology supplier may prevent actors from collaborating successfully during service development (Smania et al. 2024), and the technology supplier's viewpoint on service innovations is weakly understood. It is imperative to understand both manufacturer's and technology supplier's approaches to customer knowledge development during service innovation processes, to foster their effective collaboration.

This research aims to increase understanding of customer knowledge development for industrial data-enabled service innovations. Especially, the focus is on drivers and barriers and supply chain actors' different approaches to developing customer knowledge for service innovation. In this paper following research questions are addressed:

RQ1: What are the drivers and barriers for actors in different supply chain positions, when developing customer knowledge for data-enabled service innovations?

RQ2: How do these actors develop customer knowledge for data-enabled service innovations?

Our focus is on manufacturers and technology suppliers which are positioned in different parts of the supply chain and therefore have to deal with different types of challenges when developing customer knowledge for service innovations. While there are previous studies of technology supplier and service provider relationships during innovation processes in business-to-business context (Homayounfard & Zaefarian 2022), there is a need to understand the customer knowledge development in the context of manufacturers' innovation processes where technology suppliers are involved.

The paper is structured as follows. First, the data-enabled service innovation and customer knowledge development literature from a multi-actor perspective is reviewed to understand previously identified drivers and barriers to developing customer knowledge for service innovation purposes. We focus on literature covering research on companies from different parts of the supply chain to identify how their interconnected relationships and distance from end users are related to their customer knowledge development. Second, research methods are introduced and third, findings are presented. This study reveals six categories of drivers and barriers to developing customer knowledge for data-enabled service innovations: development priorities, customer service experience, customer knowledge diffusion, customer knowledge creation issues, organizational issues and inter-organizational issues. The study identifies two different approaches to customer knowledge development, namely the relationship-led approach and the value-led approach, depending on the actor's position in the supply chain. Furthermore, this study extends our understanding of technology suppliers' and manufacturers' relationship dynamics during manufacturer's innovation processes. Finally, we discuss the limitations of the study and suggest directions for future research.

## **2 Literature review**

### *Multi-actor view on data-enabled service innovations*

Concerning traditional services, manufacturers may focus on customer involvement to define the content for the service and utilize internal resources to compose integrated teams for the service innovation process (Johansson et al. 2019). Data-enabled services engage manufacturers in collaborative innovation processes with technology suppliers and selected end-customers. To advance with data-enabled service innovations, manufacturers need to exploit the capabilities of their technology suppliers (Smania et al. 2024) as these types of service innovations require the development of various data and analytic technologies, such as application programming interfaces (APIs) for accessing the data, data lakes for storing the data, and data visualization applications, but also customization of services according to varying customer needs (Lehrer et al. 2018). Such service innovations set new demands for the service innovation process where new partners in a supply network are involved in a more extensive manner (Goduscheit & Faullant 2018).

Technology suppliers' contribution to a manufacturer's service innovation process is oftentimes treated from the perspective of how manufacturers can benefit from their technology capabilities, for example, specialized technical knowledge or disruptive technologies (Homayounfard & Zaefarian 2022). Technology suppliers can contribute to the service innovation process in various ways (Rapaccini et al. 2023) but may confront many challenges, such as the level of shared knowledge between the organizations, which can affect the supplier's readiness to contribute to the innovation process and eventually determine the innovation process success (Homayounfard & Zaefarian 2022). While manufacturers' internal integrated development teams are suggested to improve the success of industrial service innovation processes (Johansson et al. 2019), technology suppliers who may collaborate with these teams and their approach to service innovation processes are not sufficiently covered in the existing literature.

### *Customer knowledge development*

Technology enables service customization to respond to changing customer needs, but manufacturers need to manage the level of service standardization to avoid the complexity of highly customized services (Kindström & Kowalkowski 2014; Vendrell-Herrero et al., 2024). For data-enabled service innovations, this means that manufacturers are required to develop customer knowledge for this purpose. Companies should utilize different ways to develop customer knowledge for service innovations (Johansson et al. 2019). Manufacturers with direct customer access may utilize digital solutions, such as remote monitoring systems, to capture equipment usage data to gain knowledge of the customer's operating environment and reveal latent customer needs (Momeni & Martinsuo 2018). Also, the manufacturer's internal customer knowledge can be utilized for service innovation purposes (West et al. 2020).

Existing studies emphasize the customer involvement practices, such as continuous dialogue with end-customers' lead users, joint experimentation, and interaction with potential new customers to understand what new service elements customers value (Den Hertog et al. 2010) and to define the scope of the new service. It is evident that customer participation in different phases of the service innovation process together with other approaches improves the success of service innovations in the markets (Johansson et al. 2019). However, manufacturers should also consider which customers to involve, especially in turbulent environments (Carbonell & Rodriguez-Escudero 2014; Goduscheit & Faullant 2018). Activities for user involvement in different innovation process phases necessitate direct connections to users as conducting these activities requires identification of users to be involved and various types of interactions with the users depending on the intensity of the user involvement process (Alam 2002).

Customer knowledge can be developed generally with two different approaches: by increasing understanding of customers, customer preferences and characteristics via customer studies or by focusing on customer interactions where customer information is collected during the socialization process with the customers (Garcia-Murillo & Annabi 2002). The development of customer knowledge has been covered in previous research in terms of the interactions between manufacturers and their customers. For example, the study of Johansson et al. (2019) reveals different ways to develop customer knowledge,

such as customer participation and integrated development teams. However, their study does not consider how the actors' position in the supply chain may influence customer knowledge development. Companies in different parts of the supply chain may adopt different approaches. In particular, technology suppliers upstream in the supply chain are dependent on manufacturers who can control and influence network parties, such as end users, due to their network position (Smania et al. 2024). Although the power relations between manufacturers, technology suppliers, and customers are identified in current research (Smania et al. 2024), little understanding is provided about drivers and barriers to customer knowledge development concerning actors' supply chain positions.

### *Drivers and barriers to developing customer knowledge*

Despite the growing interest towards different supply-chain actors during service innovation processes (Homayounfard & Zaefarian 2022; Smania et al 2024), there is limited research to understand the drivers of why these different actors developed customer knowledge for the innovation process and barriers that may challenge the development process. Existing research focuses on manufacturer-customer relationships and different ways to develop customer knowledge between these actors (Johansson et al. 2019; Witell et al. 2014). Especially, utilization of service design tools to increase shared understanding of customer processes (West et al. 2020) and possibilities of remote data collection (Goduscheit & Faullant 2018; Momeni & Martinsuo 2018) are identified to drive manufacturer's customer knowledge development. Understanding of barriers which limit the utilization of such possibilities is less covered. Some rare studies discuss the lack of the manufacturer's internal capabilities for data analysis (Goduscheit & Faullant 2018), challenges to identifying which customers to involve in the customer participation process (Alam 2002) and reliance on intuition instead of utilization of collected customer feedback (Carbonell & Rodriguez-Escudero 2014) as barriers to customer knowledge development.

Although technology suppliers' contribution to manufacturers' service innovation processes is identified in recent literature (Smania et al. 2024), the research on technology supplier's view on customer knowledge development is scant. To support customer knowledge development during the manufacturer's service innovation processes, technology suppliers may utilize their capabilities, such as service design approaches, to facilitate service innovations and to shift focus from technology to value considerations (Korper et al. 2020). To do so, technology suppliers may be motivated to involve end users to integrate user feedback in the development process to fasten the development (Homayounfard & Zaefarian 2022). Yet, the supplier may have a limited (indirect) connection to end users as the manufacturer controls their customer relationships (Mosch et al. 2021; Smania et al. 2024). Therefore, suppliers may confront challenges of limited knowledge sharing, and dependency on manufacturers' market knowledge and organizational processes (Homayounfard & Zaefarian 2022), which in turn limit the possibility of accessing the end users and integrating customer knowledge into their development processes (Smania et al. 2024).

As technology suppliers' readiness for collaborative service innovation processes can define the success of the innovation process (Homayounfard & Zaefarian 2022), it is necessary to explore the technology supplier's drivers and barriers for developing

customer knowledge to further understand the relationship dynamics between manufacturers and technology suppliers during the innovation process.

### **3 Research methodology**

#### *Research design*

We used a qualitative case study approach to investigate the phenomenon of the customer knowledge development process in its context in data-enabled, industrial service innovation, to supplement extant knowledge (Dubois and Gadde 2002). We conducted a comparative case study with two focal companies to explore the phenomenon from two different perspectives. We followed systematic combining, an abductive approach, where data collection and search for new theories continue in a parallel, meaning continuous matching between frameworks, data sources, and analysis (Dubois and Gadde 2002). Our focus is on the companies' approaches to customer knowledge development as previous studies indicate that companies with different capabilities and supply chain positions use different ways to customer knowledge development (Goduscheit & Faullant 2018; Korper et al. 2020; Momeni & Martinsuo 2018).

Focal companies were selected based on their active involvement and experience in data-enabled service innovations. We purposefully selected the companies from different parts of the same service delivery supply chain to investigate how their position in the supply chain is related to their customer knowledge development. As part of a broader study, we gained access to two firms actively involved in innovating data-enabled services and representing different supply chain positions, namely industrial machinery manufacturing and technology supply. ForestCo (pseudonym) operates globally in the machinery industry, provides forest machinery and traditional product-related industrial services, and is renewing and broadening its service portfolio with new data-enabled services. ForestCo has direct end user connections and also operates via dealers with their customers. TechPro (pseudonym) is a technology and consulting company developing data-enabled, consulting, and platform services for customers operating in multiple industries and is involved in manufacturers' data-enabled service innovation processes. TechPro has limited access to the actual end users of the services. TechPro acts as one of ForestCo's technology suppliers and therefore the companies are partly involved in collaborative data-enabled service innovation processes.

#### *Data collection and analysis*

As primary data sources, we used semi-structured interviews. Table 1 summarizes background information on the focal companies and interviewees. The interviewees ranged from top-level executives to experts who were actively involved in data-enabled service innovation. The interviewees from TechPro were selected based on their involvement in industrial service innovation processes, direct industrial customer collaboration experience and knowledge of industrial domain customers and data-enabled service development. The interviewees from ForestCo were selected based on their knowledge and involvement in the company's data-enabled service development, experience of collaboration with technology suppliers as a part of service innovation

processes and understanding of ForestCo’s existing service processes. In total, 11 interviews were conducted and lasted between 50–80 minutes. The interviews were audio recorded and transcribed verbatim.

The interview questions were designed to understand companies’ general approach to data-enabled service innovations, roles and responsibilities to support service innovation processes, and practices to developing customer knowledge inside the organization and together with external organizations. We asked for examples of data-enabled services developed in a collaboration between the manufacturer and technology suppliers but avoided limiting the study to the services the studied companies developed in collaboration to understand the companies’ challenges and approach more broadly.

As secondary data sources, we used public company documents such as annual reports, service descriptions and information provided at company websites to include an understanding of companies’ end-customers, examples of data-enabled services and the importance and share of industrial service business in companies overall offering for the interviews, data analysis and data triangulation purposes.

**Table 1** Summary of focal companies and interviewees.

	<i>TechPro</i>	<i>ForestCo</i>
Revenue	~200 M	~755 M
Employees	~2000	~1900
Main offering	Technology and consulting	Forest machinery
Service offering	Data solutions, connectivity services, cloud services, software development, business design, life-cycle management	Traditional services: customer support, service agreements, full service, spare parts, training Data-enabled services: digital solution platform, multifleet service, API services, fleet monitoring services
Interviewees	Transformation designer Artificial intelligence design lead Head of industrial domain Account manager Delivery lead	Director of global services Manager, service agreements Product manager, digital services Sales manager, digital services System specialist, global services User experience manager

In data analysis we used an open coding method, that is, an interpretive process where data are thoroughly explored, conceptually labelled, and compared to find similarities and differences and where conceptually similar themes are grouped to form categories (Corbin and Strauss 1990). After the first exploratory readings of the data, we labelled the first-order themes to identify drivers and barriers to customer knowledge development of both companies and marked direct quotes with corresponding first-order themes. Then we identified second-order themes based on the following factors: internal and external reasons interviewees expressed in the interviews to developing customer knowledge and challenges that reflected the actor’s unique position in the supply chain. This phase of

analysis resulted in three categories of drivers: development priorities, customer service experience, and customer knowledge diffusion, and three categories of barriers: customer knowledge creation issues, organizational issues, and inter-organizational issues.

Following this phase, we discovered that the two companies have differences in how they approach customer knowledge development. Therefore, in the latter steps of the data analysis, we concentrated on reviewing the data holistically, to identify the companies' overarching approaches to customer knowledge development. In this phase, we labelled direct quotes as first-order themes and identified categories (second-order themes) that described the approach of the focal companies. These categories were selected based on customer information types, customer knowledge development sources, and companies' methods for customer knowledge development identified from the first-order themes. The approach of ForestCo consists following categories: customer information collection from internal sources, customer involvement and reliance on customer intimacy to gather customer information, emphasis on customer feedback validation and business impact assessments, and development focus on existing customers and product-based customer segments. In contrast, TechPro's approach consists of the following categories: utilization of a diverse set of customer information sources, emphasis on end user meetings and observations to gather customer knowledge, focus on in-depth customer knowledge analysis, development of non-solution related customer knowledge, and customer segmentation based on the customer insight of end user needs. Consequently, we named the approach of ForestCo as a relationship-led approach and the approach of TechPro as a value-led approach. As a last analysis step, we conducted a cross-case analysis which is presented in the Findings chapter. Cross-case analysis was done with cross-tabulation by comparing each of the identified categories of drivers and barriers between the two focal companies. Similarly, cross-tabulation was used to compare similarities and differences between the categories of relationship-led approach and value-led approach. Excerpts from the interviews are used in the Findings to highlight the main issues.

## 4 Findings

### *Drivers and barriers to developing customer knowledge for data-enabled service innovations*

Interviewees in TechPro stated that they use different types of customer knowledge, such as information collected from the end users and customer service as well as information on customer segments and roadmaps to set priorities for service innovations and to understand the current situation at the customer site. ForestCo develops customer knowledge from customer feedback, service agreements, direct customer discussions, and meetings to evaluate the impact and relevance of new services for customers' business and operations.

Interviewees in both companies identified various drivers and barriers to developing customer knowledge for data-enabled service innovations. These drivers and barriers are divided into six categories: development priorities, customer service experience, customer knowledge diffusion, customer knowledge creation issues, organizational issues and inter-organizational issues which are presented in Table 2.

**Table 2** Drives and barriers to developing customer knowledge for data-enabled service innovations.

	<i>TechPro</i>	<i>ForestCo</i>
<i>Drivers</i>		
Development priorities	<ul style="list-style-type: none"> <li>• Development prioritization and scope management</li> <li>• Development decision making</li> <li>• Technology decision making</li> <li>• Refinement of development assignments</li> <li>• Alignment of development objectives</li> </ul>	<ul style="list-style-type: none"> <li>• Prioritized customer needs for development</li> </ul>
Customer service experience	<ul style="list-style-type: none"> <li>• Identification of new service opportunities</li> <li>• Motivation to integrate end user experiences into development process</li> </ul>	<ul style="list-style-type: none"> <li>• Alignment of internal service operations and new customer needs</li> <li>• Identification of opportunities to enhance existing customer operations</li> <li>• Alignment of product-focused and data-enabled service offerings</li> </ul>
Customer knowledge diffusion	<ul style="list-style-type: none"> <li>• Identification of latent end-customer needs</li> <li>• Increased joint understanding of end-customer needs</li> <li>• Utilization of service design capabilities to create shared understandings of end-customer needs</li> </ul>	<ul style="list-style-type: none"> <li>• Identification of latent end-customer needs</li> <li>• Increased awareness of changing end-customer needs</li> <li>• Integration of end-customer knowledge into development processes</li> <li>• Wider access to end-customer knowledge</li> <li>• Increased joint-understanding of end-customer's business and context</li> </ul>
<i>Barriers</i>		
Customer knowledge creation issues	<ul style="list-style-type: none"> <li>• Form of customer knowledge</li> <li>• Quality of customer knowledge</li> <li>• Source of customer knowledge</li> </ul>	<ul style="list-style-type: none"> <li>• Form of customer knowledge</li> <li>• Quality of customer knowledge</li> <li>• Lack of common processes for end-</li> </ul>

	<ul style="list-style-type: none"> <li>• Information sensitivity</li> </ul>	<ul style="list-style-type: none"> <li>customer knowledge development</li> <li>• Identification of common end-customer needs</li> <li>• Geographically or culturally varying end-customer needs</li> </ul>
Organizational issues	<ul style="list-style-type: none"> <li>• Information-technology-orientation</li> </ul>	<ul style="list-style-type: none"> <li>• Internal service ownership issues</li> <li>• Internal change resistance</li> <li>• Internal strong product-orientation</li> </ul>
Inter-organizational issues	<ul style="list-style-type: none"> <li>• Access to end-customers</li> <li>• Manufacturer's service ownership issues</li> <li>• Manufacturer's change resistance</li> <li>• Manufacturer's strong technology orientation</li> <li>• Manufacturer's decision making processes</li> </ul>	<ul style="list-style-type: none"> <li>• End-customers' willingness to be involved in service development</li> <li>• Technology supplier's service developers' level of end-customer knowledge</li> <li>• Technology supplier's service developers' access to end-customer data</li> <li>• Knowledge transfer to technology supplier's service developers</li> </ul>

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TechPro and ForestCo both reported *development priorities* as a driver for customer knowledge development. Especially TechPro emphasized their clear focus on development prioritization and scope management, decision making, refinement of development assignments and alignment of development objectives. For example, positioned further away from the end users and with limited access to validate the end user input TechPro relies on priorities set by the manufacturer and requires detailed knowledge to proceed with the actual development tasks and sees customer knowledge as a way to set priorities for the innovation process development with time and budget constraints.

“And quite often when I’m prioritizing ideas with customers, like what should we do, what is the most important thing, the number of users is often quite easy way to understand the scope.” (Artificial Intelligence Design Lead, TechPro)

Also, *customer service experience* was identified as a driver in both companies. TechPro aims to reveal new service opportunities but is also motivated to integrate end user experiences into development processes by emphasising end user understanding and

human-centric methods to developing customer knowledge. ForestCo is undergoing a transformation from traditional product-focused services to developing and exploiting data-enabled service innovations. Therefore, ForestCo is driven by the need to align the end user needs, internal service operations and existing product-focused service operations with new data-enabled services. For this purpose, customer knowledge is needed not only to understand opportunities to enhance existing customer operations with data-enabled services but also to ensure the efficiency requirements for internal service operations are met and align with customer needs, such as customer-specific service intervals for machines.

Both companies reported similar issues regarding the driver of *customer knowledge diffusion*. TechPro and ForestCo were both interested in revealing latent end-customer needs. TechPro actively utilizes its service design capabilities for this effort and ForestCo its direct end user connections. Both of the companies have identified the need to increase the level of joint-understanding of end user needs and ForestCo especially experiences the rapid changes in end user needs. ForestCo is seeking ways to increase joint understanding of end-customer business and context and evaluating how to better integrate this knowledge for service development and enable wider access to customer knowledge for development collaborators. ForestCo involves customers in innovation processes to mitigate the risk of implementing service features that were earlier prioritized based on customer knowledge but may no longer be relevant for customers' operations.

“We have to really think that nowadays when the things are going fast forward, so if it takes long time to develop something it might be that it's already an old thing when we have published [the new service]. I think this is something how we all the time attach the customer to this development.” (Manager, Service Agreements, ForestCo)

Both companies experienced similar challenges related to the barrier of *customer knowledge creation issues*. The companies were challenged with the form and quality of customer knowledge, hindering its operational application for service innovations. For example, the limited amount of quantitative data to support the customer knowledge development was identified to challenge the decision making of which service features to include for the data-enabled service under development. TechPro faced issues from the manufacturer's side related to information sensitivity and sources of customer knowledge with customer insights collected via salespersons or other manufacturer's internal sources with limited possibilities to validate or enrich such knowledge during the innovation process. ForestCo was challenged with identifying the common end-customer needs required to set the boundaries for data-enabled service development scope as those needs vary according to different variables, for example by end-customer culture and geographically changing demands. Also, ForestCo interviewees reported lacking common processes for end-customer knowledge development inside the organization.

“I think it's unfortunately more or less through the human interaction. That data is also something that it's really all around in our organization, so you really need to know where I can find this” (Sales Manager, Digital Service Systems, ForestCo)

Both of the companies reported *organizational issues* as barriers to customer knowledge development. TechPro interviewees raised an issue of its own organization's focus on the information technology part of the development which in turn might limit TechPro's contribution to customer knowledge development efforts. ForestCo interviewees experienced internal challenges with service ownership issues, change resistance and strong product orientation. For example, ForestCo sales personnel are undergoing a learning process from product-oriented sales to solution sales and aiming to centralize the collected customer feedback which is currently spread across the organization and therefore not utilized in an efficient way.

Finally, several *inter-organizational issues* were raised. TechPro interviewees faced strong technology orientation, and resistance to change from the manufacturer who controls the end user connections. Also, TechPro was challenged with manufacturer's service ownership issues and decision-making processes with complex dependencies and parallel development effort priorities. ForestCo interviewees reported challenges to involve customers in the service innovation processes and high efforts of transferring customer knowledge to external developers with limited prior knowledge of end user needs and possible limitations to access the end-customer data.

“I think that one of the biggest challenges is how we can specify the need, how to have the specification so that everybody will understand what it should look like and what kind of features it should have for the person who is using that one. I think it's the communication between the business and the developer, so that they really understand each other, what is the need and how it should work. That, I would say, is probably the biggest, and it has been the biggest challenge over the years.” (Director of Global Services, ForestCo)

These challenges underscored the complexity of developing customer knowledge collaboratively, particularly when the control dynamics of end user relationships are involved.

### *Different approaches to develop customer knowledge for data-enabled service innovations*

To further understand the collaboration and relationship dynamics between manufacturers and technology suppliers during service innovation processes it is necessary to understand the different approaches these companies utilize for customer knowledge development.

ForestCo adopts a relationship-led approach, leveraging the insights collected via different customer touchpoints: sales, service personnel, and direct customer contacts. Positioned closer to the end-customer, ForestCo's employees serve as crucial channels for gathering customer knowledge throughout the entire product life cycle. Some of these practices include gathering customer knowledge from internal sources, such as sales, product management and service personnel, gathering requirements of different customer segments, facilitating cross-functional discussion to understand the customer problem, and customer journey mapping. The relationship-led approach allows ForestCo to accumulate fragmented yet rich data, capturing the complexity of customer interactions and preferences for example by involving selected customers in different service testing

phases. ForestCo relies on customer intimacy and their proximity to the end-customer provides a deeper understanding of the operational context and specific requirements related to ForestCo's equipment and ability to validate received customer feedback and assess business impact. However, interviewees at ForestCo also shared several challenges that arise, including biases or limitations of reliance on frontline service personnel as primary channels, not capturing the comprehensive range of customer perspectives from different customer segments. Also, ForestCo interviewees described the customer segmentation be based on product-based customer needs and development focus targeted mainly on certain service agreement customers with existing contact persons and regular contacts.

In contrast, TechPro adopts a value-led approach characterized by methodical, research-based practices that prioritize end user perspectives. The value-led approach ensures that customer knowledge is not only comprehensive but also aligns with the overarching goals of the organization. TechPro aims to utilize a diverse set of customer information sources. Some of the reported practices are seeking benchmark targets, conducting interviews and questionnaires with end users and manufacturers, conducting visits and observations, facilitating the discussion between the manufacturer and end users, and assisting manufacturers in utilizing the already existing information. By prioritizing a systematic and research-oriented approach, TechPro aims to ensure that customer knowledge is systematically analyzed from collected customer insights and is methodically integrated into the service innovation process, with a focus on delivering value to end users. TechPro interviewees also emphasized the development of non-solution related customer knowledge. For example, this type of customer knowledge collection was done by not mentioning solutions in the end user interviews and focusing to understand the end users' challenges and daily operations. The interviewees also expressed the importance of customer segmentation which is based on the customer insights of end user needs and not necessarily business-related metrics of the company. Some interviewees at TechPro explained that they may encounter challenges stemming from the distance between the company and end users, particularly when the manufacturer controls the customer interface. One primary challenge is the potential for information asymmetry, where critical aspects of customer needs and preferences may be filtered or diluted as they pass through the intermediary, the manufacturer. Additionally, the manufacturer's control over the customer interface may restrict TechPro's access to real-time feedback, hindering the agility needed to promptly respond to evolving customer requirements.

## **5 Discussion and conclusions**

This study makes three contributions. First, by answering the first research question, this study reveals six categories of drivers and barriers for actors in different supply chain positions to developing customer knowledge for data-enabled service innovations: development priorities, customer service experience, customer knowledge diffusion, customer knowledge creation issues, organizational issues and inter-organizational issues. This study adds understanding why actors in different supply chain positions develop such knowledge and which factors may hinder the development process, whereas existing research has focused on different customer knowledge development practices (Alam

2002; Den Hertog et al. 2010; Johansson et al. 2019; West et al. 2020) and sources of customer information and knowledge (Momeni & Martinsuo 2018; West et al. 2020) to improve the data-enabled service innovation processes. This study complements the existing research on customer knowledge development focusing on manufacturer-customer relationships (Johansson et al. 2019; Witell et al. 2014) by addressing the characteristics of the customer knowledge development process from technology supplier's and manufacturer's perspectives.

Second, the existing research on service innovations (Goduscheit & Faullant 2018; Homayounfard & Zaefarian 2022) has not sufficiently considered how actors' supply chain position may affect their customer knowledge development approach during service innovation processes. As an answer to the second research question, this study reveals actors' divergent approaches, relationship-led approach and value-led approach, to developing customer knowledge for service innovations, depending on the actor's supply chain position. Current literature has identified two main approaches for customer knowledge development, customer study-based approach and customer socialization-based approach (Garcia-Murillo & Annabi 2002). This study shows that manufacturer's relationship-based approach follows the approach focusing on social interactions with customers. This study extends the prior understanding by revealing that technology suppliers apply more study-based approach, at the same time showing capabilities to develop customer knowledge by utilizing customer socialization-based approach, but are constrained by their supply chain position (Mosch et al. 2021; Smania et al. 2024). Thus, our findings show that companies upstream in the supply chain may leverage the combination of customer study-based approach and customer socialization-based approach, but are impacted by the approach manufacturer applies for the customer knowledge development process.

Third, this paper extends the understanding of technology suppliers' and manufacturers' relationships dynamics during collaborative service innovation processes where customer knowledge development requires the involvement of end-customers. This study shows how, through the value-led approach, the actors positioned further away from the end users develop customer knowledge for service innovations. Extant literature confirms technology suppliers having essential roles in manufacturers transformation towards data-enabled services (Smania et al. 2024), but prior studies have paid limited attention to technology suppliers' perspective and contribution to customer knowledge development during manufacturer's service innovation processes. Whereas the previous research mainly focuses on manufacturers' internal capabilities (Den Hertog et al. 2010) to manage service innovations, the findings of this study reveal that manufacturers and technology suppliers can utilize their complementary approaches for customer knowledge development to improve their collaborative service innovation processes.

## **6 Managerial implications**

This study has several implications for managers. Managers in manufacturing and technology supplying companies need to consider the different approaches they apply for customer knowledge development. Manufacturers might benefit from integrating the complementary approach of technology suppliers for customer knowledge development to overcome the barriers of customer knowledge development in a collaborative manner.

Yet, the results indicate that the different approaches for customer knowledge development may result in conflicting demands if managers pay limited attention to the divergent approaches these actors adopt for customer knowledge development. Conflicting demands may set challenges for collaboration as the manufacturers and technology suppliers have differences between customer knowledge development drivers of development priorities and customer service experience. Results also indicate that data-enabled service innovations require manufacturers to support the customer knowledge development of supply chain actors involved in the process with limited end user connections.

## **7 Limitations and further research**

The research is based on data collected from two focal companies, and the choice of companies limits the transferability of findings. The study might have benefited from data collected from other suppliers holding a position in different parts of the supply chain and end-customers involved in the manufacturer's customer knowledge development process. The case study approach with limited number of interviews limits the generalizability of the findings. However, we selected the interviewees with experience and background from different supplier-manufacturer collaboration contexts to gain understanding from various service innovation processes. The future research could study customer knowledge development in different types of supplier-manufacturer relationships during service innovation processes. Also, future studies could extend the view to end-customers by investigating the customer knowledge development process in the triad of supplier, manufacturer, and end-customers. Future research could also explore how manufacturers involve suppliers to the customer knowledge development process.

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