Strategising for the circular economy through servitisation

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Abstract

Purpose – From a firm-centric perspective, this study aims to elaborate on the types of servitisation strategies that can support a firm's circular ambitions by asking: What is the role of servitisation in narrowing, slowing and/or closing resource loops? And, how are resources and capabilities arranged to provide such strategic circular service offerings?

Design/methodology/approach – Drawing on the experiences of an international manufacturing company from a dynamic capabilities perspective, the study offers an analytical framework that goes inside the firm's operationalisation of its service offerings to support circularity in terms of the strategic decisions made. This framework is later used to frame the findings.

Findings – The study highlights the case-specific feedback loops and capabilities needed to support circular transitions. Various resource and innovation strategies for circularity are combined along customer interfaces and in partnership with upstream actors. Yet, open innovation strategies are conditioned by physical distance to provide circular services in remote areas.

Research limitations/implications – The main contributions are empirical, analytical, conceptual and practical. The servitisation framework for circularity connects prior servitisation-circularity research and provides an analytical tool for framing future studies. The study also expands the definition of open innovation in that closed innovations for circularity can be achieved through "open" information exchange in knowledge networks, as well as provides advice for similar large manufacturing companies.

Originality/value – This study focuses on the strategic choices made by industrial firms for circular service provision and emphasises the environmental benefits from such choices, in addition to the economic and customer benefits covered in extant servitisation research.

Keywords Service innovation, Industry, Business-to-business services, Case study method, Circular economy, Responsible consumption and production (SDG 12), Innovation and infrastructure (SDG 9)

Paper type Research paper

1. Introduction

Circular economy (CE) principles are important for environmental and economic performance benefits by "*slowing, closing, and narrowing material and energy loops*" (Geissdoerfer *et al.*, 2017, p. 759). Such principles move beyond the traditional linear, economics-based business models of industrial firms towards broader conceptualisations of value whereby "*repairing, reusing, remanufacturing, refurbishing and recycling*" industrial products are paramount (Geissdoerfer *et al.*, 2017). While firm-centric business strategies such as servitisation help support circular ambitions in industrial firms (ibid.; Bolton, 2020), there is limited empirical research that takes the firm as the focal point of analysis. Rather, the extant research focus is often conceptual and/or emphasises circularity in industrial ecosystems (e.g. Kühl *et al.*, 2020; Yang *et al.*, 2018; Kanda *et al.*, 2021; Russell-Bennett *et al.*, 2023; Palakshappa *et al.*, 2023).

Recent studies call for more empirical research on the role of servitisation for circularity (see Bolton, 2020; Russell-Bennett *et al.*, 2023). Servitisation regards manufacturing firms moving from "*a product- to* [. . .] *service-centric approach*" which presents "*a significant change in the business model and the mission of the firm*" (Raddats *et al.*, 2019, p. 207). Gebauer *et al.* (2013, p. 40) comment that the manufacturing company is "*the focal firm in the service network. It manages the services supporting the whole life-cycle of the products as well as the service for designing customer-specific solutions*". While CE principles extend beyond the firm as part of a wider ecosystem, the role of internal servitisation strategies by focal industrial firms in supporting the circular transitions cannot be underestimated. Services can be added to improve the circularity of businesses (Tukker, 2015; Yang *et al.*, 2018) such as leasing equipment and/or maintaining, disposing, replacing and/or refurbishing products or parts (Spring and Araujo, 2017). As such, servitisation constitutes one strategy, among others, that supports the circular transitions of industrial firms by ensuring that resources are contained within the immediate business (network) (see Yang and Evans, 2019; Russell-Bennett *et al.*, 2023).

Servitisation creates value generating streams in industrial companies by building stronger customer relationships as a

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Journal of Services Marketing
38/10 (2024) 17–31
Emerald Publishing Limited [ISSN 0887-6045]
[DOI 10.1108/JSM-10-2023-0395]

Received 24 October 2023
Revised 12 January 2024
24 March 2024
Accepted 12 May 2024

source of competitive advantage (Seles *et al.*, 2022; Ulaga and Kowalkowski, 2022; Vandermerwe and Rada, 1988; Yang and Evans, 2019). When related to circularity, the value generated even extends to environmental performance benefits for industrial companies and customers (Lee *et al.*, 2012; Yang and Evans, 2019), as well as arguably future generations of stakeholders. To implement services that support circularity, manufacturers must first qualify their existing products, components and materials to be incorporated into circular flows and then design services that support the circularity of existing product portfolios (Spring and Araujo, 2017). In doing so, strategic decisions on resource strategies to narrow (e.g. design and process efficiencies), close (e.g. reusing and recycling material post-consumption) and/or slow (e.g. extending product life) resource loops are made, as well as decisions regarding which circular service offerings can be achieved in-house or in collaboration with industrial partners (see e.g. Bocken and Ritala, 2021; Aarikka-Stenroos *et al.*, 2021; Kühl *et al.*, 2020).

From a strategic viewpoint, there are critical choices that must be made in the design and implementation of circular services. While service offerings such as remanufacturing and maintenance have existed for many years and incorporated various value propositions in industrial firms (see e.g. Gebauer *et al.*, 2013), there remains limited empirical attention on how servitisation strategies, in particular, are used to support the circular transitions of an industrial firm (Scarpellini *et al.*, 2020; Spring and Araujo, 2017). Specifically, the strategic transition pathways towards circularity in terms of the internal decisions made for circular service provisions, as well as the resources and capabilities needed for these, constitute an important research avenue.

The aim of this study is to better understand the role of servitisation strategies for circularity, framed from a firm-centric perspective. This is not to say that circular servitisation strategies on their own can ensure industrial firms achieve their circular ambitions, but that circular service offerings can be used in combination with other strategies to support these. The following research questions are asked:

RQ1. What is the role of servitisation in narrowing, slowing and/or closing resource loops?

RQ2. How are resources and capabilities arranged to provide such strategic circular service offerings?

Through a qualitative case study of an international industrial manufacturing company, this paper draws on Bocken and Ritala's (2021) "Circular Business Model Strategy Framework" and the dynamic capabilities view (Teece, 2007) to put forward an analytical framework that goes inside the firm's operationalisation of its service offerings, and the resources and capabilities needed to support circularity. In doing so, its contributions are analytical (i.e. through the creation of the servitisation strategies for circularity framework at the front end of the paper), empirical (i.e. using the framework as an analytical tool to frame the findings at the back end of the paper) and conceptual through its key findings (e.g. nuancing the definition of open innovation). As such, the paper contributes to the limited empirical studies on the implementation of the circular strategies *within* industrial organisations [1] and the implications that these have for the wider CE of industrial networks, wherein the value generating streams from servitisation relate to economic, customer and importantly, *environmental* values, for current and future generations of stakeholders.

2. Operationalising the servitisation strategies for circularity framework

2.1 Servitisation actors and processes for circular business models

Servitisation is a business strategy that aids the circular ambitions of industrial firms by providing novel solutions, orientated around environmental performance as the core value proposition, in addition to other financial and customer benefits. This requires industrial firms to consider their core products and how complementary services can be offered to reverse resource flows (Spring and Araujo, 2017).

Raddats *et al.* (2019) provide a model that helps elaborate on why, how and what services are offered, as well as by whom from a strategic perspective that can be applied to circular servitisation strategies. Drawing on prior work (Cusumano *et al.*, 2015), Raddats *et al.* describe the different intentions behind *service offerings* as *helping product sales* (e.g. financing, insurance, repair or technical support), *expanding product functionality* or *substituting the product* (e.g. data processing services). These services can be *base* (e.g. product-equipment provisions), *intermediary* (e.g. maintenance and technical help) or *advanced* (e.g. assurance, agreements and warranties) (Baines *et al.*, 2013).

Meanwhile, *service strategies* elaborate on how services are offered within firms (Raddats *et al.*, 2019). These include the structural decisions around, for example, having integrated or separated service and production divisions (Oliva *et al.*, 2012), as well as the *resources and capabilities* needed to develop, offer and deliver base, intermediary and advanced services (see also Gremyr *et al.*, 2014) in-house or in collaboration. As Gebauer (2008) illustrates, the configuration of service strategies offered by industrial companies can range from after sales services based on cost leadership and product functionality, to service differentiation based on value through customer support or cost leadership by outsourcing service provision. Service strategies may also include research and developmental services with partners (ibid.).

A characteristic feature of these important works on service strategies, is their focus on financial and customer value based on a traditional business logic. However, this fails to incorporate the environmental aspect of value pertinent to circular principles and the reverse resource flows that entails for industrial companies (Spring and Araujo, 2017). That being said, the extant emphasis on product functionality, quality issues, service developments and differentiation are also important for circular service offerings, and may well be achieved through offering intermediary and advanced services that focus on slowing, closing or narrowing resource loops.

The connections between servitisation and circularity are also evident in studies on service networks as orchestrated by focal manufacturing firms. As an example, Gebauer *et al.* (2013) draw on the interactions between upstream-downstream

actors to characterise the service networks of manufacturing organisations. Both the vertical life-cycle network and horizontal service integration networks proposed by Gebauer *et al.* assert the importance of a focal firm in designing, manufacturing and *maintaining* equipment through the life cycle of a product. This is achieved by offering services for the equipment produced by the firm and includes the participation of upstream suppliers and downstream customers to achieve such strategies, whereby the focal firm is the orchestrator of interactions to provide specific service solutions (see Möller *et al.*, 2005) [2]. Although the focus here is on the longevity of industrial products, such life cycle approaches to service networks can easily be related to circular principles; that is, to *"repair, reuse, remanufacture, refurbish and recycle"* industrial products (Geissdoerfer *et al.*, 2017).

In summary of this strategic perspective on servitisation and related to the context of circularity, two analytical areas can be discerned as important:

1 The managerial strategies implemented and their structural effects (i.e. decisions related to, in this case, circular service provision and offerings – *the why, how and what services are offered*); and,
2 The firm's capabilities and availability of resources to meet these strategic aims in collaboration with the customers buying those very services (i.e. decisions related to resources in terms of *what more is needed to ensure the success of such circular service offerings and by whom?*).

It is these two areas that the following sub-sections are centred on.

2.2 Managerial strategies for circular business models

Bocken and Ritala (2021) provide a typology of the different strategic choices that managers make when implementing or, in this case, transitioning towards circular business models. While the innovation strategy regards *"the extent to which circularity is achieved with internal or external stakeholders"*, the resource strategy regards *"how companies achieve circularity by narrowing, slowing or closing resource loops"* (ibid., p. 184). An understanding of these intra-organisational dimensions and their connection to one another is therefore important for knowing more about how industrial organisations implement servitisation for circularity.

Service models can be introduced for the various resource strategies proposed by Bocken and Ritala (2021, p. 185):

> For example, a product may be produced using cleaner production processes (narrowing the loop), using recycled materials (closing the loop) and in a way that the product is durable and that services allow for a long product lifetime (slowing the loop).

Meanwhile, innovation strategies distinguish between closed and open innovation (see Chesbrough and Appleyard, 2007). Closed innovation regards organising circularity within the firm's boundaries through, for example, initiatives that encourage customers to close the loop by returning used products to be remanufactured in-house, which is beneficial to retain control and monitor resources (Bocken and Ritala, 2021). Open innovation, on the other hand, uses external parties to achieve circularity. Some examples include firms working together to combine industrial waste into new products or partnering with distributors to resell customer products (ibid.). Combining these resource and innovation strategies, leads to various archetype strategies for circular business models with different value logics, many of which include service offerings.

2.3 Resources and capabilities for circular business models

An internal qualification of the resources and capabilities needed to develop and deliver circular service offerings in relation to product biographies is also important for industrial firms (Spring and Araujo, 2017). According to the dynamic capabilities view (DCV), competitive advantage is not only the result of the resources themselves, but also the firm's competencies: *"[d]ynamic capabilities enable business enterprises to create, deploy, and protect the intangible assets that support superior long – run business performance"* (Teece, 2007, p. 1319). This asserts that competitive advantage can be achieved through sensing, seizing and transforming capabilities, in this case, for circular transitions.

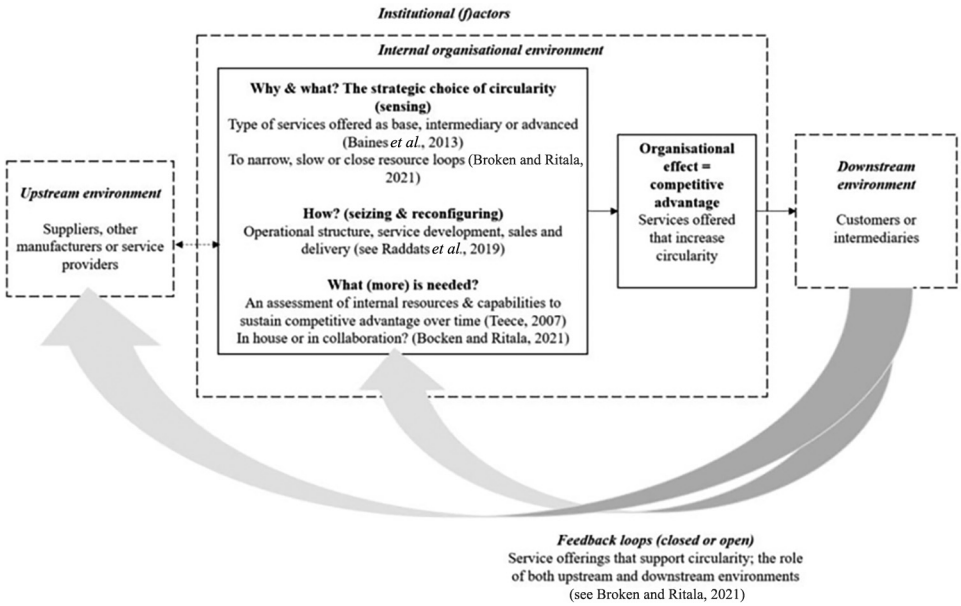
Amui *et al.* (2017) propose the DCV as important for elaborating on complex issues such as sustainability given that the capability of sensing regards the ability to identify new business opportunities. When related to the work of Raddats *et al.* (2019) and Cusumano *et al.* (2015), this would imply that sensing relates to why and what services are offered, and seizing regards taking up the opportunities identified through new service offerings. For circularity, this would mean the operational aspects put in place to meet circular strategic ambitions, for example, through the development of new services (Khan *et al.*, 2020). Meanwhile, reconfiguration regards the ability of the organisation to reconfigure its structures and resources in response to market and technological changes. For circularity, knowledge integration and redevelopment are vital for reconfiguration capabilities (Khan *et al.*, 2021). Wade *et al.* (2022) even suggest that firms must have "strong capabilities in experimentation" for circular solutions. Based on the DCV, therefore, the strategic choices made by an industrial organisation in terms of its service offerings for circularity require the focal firm to sense its market and wider institutional concerns regarding particularly, ecological value (see Palakshappa *et al.*, 2023). Meanwhile, the seizing and reconfiguring capabilities regard the (re)organisation of resources and capabilities based on closed or open innovation strategies to achieve this.

Figure 1 summarises the prior discussion into an analytical model that frames this research. This is intended to help elaborate on how industrial organisations implement servitisation to support their circular ambitions. Categorising the findings around the strategic choices made and how these are realised in practice *within firms* is important given that extant research emphasises macro-level approaches focused on circular ecosystems (Merli *et al.*, 2018; Aarikka-Stenroos *et al.*, 2021; Kanda *et al.*, 2021). Meanwhile, the analytical model takes the internal strategic servitisation decisions made by an industrial firm for circular transitions as its point of departure; that is, even if these strategic decisions are contingent on the involvement of various upstream and downstream actors (illustrated in the feedback loops) as part of a wider (industrial) network [3].

3. Method

A case study approach is useful for research *"in"* organisations by providing illustrations for explaining the empirical world

Figure 1 Analytical model on the type, role and use of servitisation strategies for circularity



Source: Author's own

(Dubois and Araujo, 2004, 2007). Specifically, a single case study of an international industrial company was considered suitable for the purpose of this research to elaborate on how servitisation strategies support the circular ambitions of an industrial firm through inputs from downstream and upstream actors (see Halinen and Törnroos, 2005). Single case approaches have been adopted in other studies that take the organisation as the focal unit of analysis (e.g. Guenzi and Storbacka, 2015; Wu *et al.*, 2016). This approach can be built upon in further case study designs to increase the analytical generalisability [4] of the findings.

3.1 Case background

The case organisation selected is an international manufacturer of heavy equipment for mining and construction customers, hereafter referred to as Company X. Company X has an extensive product portfolio of high-quality and highly customised industrial machines that are designed to last. This contributes to customer lock in as customers buy the services offered to improve the productivity and longevity of their machines.

Although headquartered in Europe, Company X has a huge international presence, with production sites and customers in over 150 countries, and has few direct competitors for its machines [5]. It functions somewhat as a decentralised company, with several global divisions. While two of the divisions relate to the types of products sold, the remaining three focus on the aftermarket, namely: aftermarket services [see Oliva *et al.*, 2012]), attachments and digital solutions. This structure was a recent development (2020) and the reason behind it was to organise the company in a way that relates to its core revenue-generating streams. Within each division, responsibilities are further divided into regions. While some departments such as marketing and R&D are specific for each division, others such as HR or IT serve support functions for the group.

Company X's strategy is influenced by institutional pressures to become more sustainable, such as the European Union's incoming Corporate Sustainability Reporting Directive (CSRD) (2022 / 2464/EU) and associated reporting standards that assert the need for applicable firms to reduce and report Scope 3 emissions (i.e. the emissions from the machines sold to customers). This has implications for not only the types of machines sold but also the types of services offered to reduce emissions (e.g. replacing diesel machines with electric ones) [6]. The company also has a vision, as communicated in visionary video footage by its CEO, for complete circularity by 2030. This means that like many other industrial companies, Company X is transitioning from its linear past to incorporate circular elements more explicitly into its strategy.

While servitisation has been adopted since 2012 to provide customers with solutions for maintaining the longevity of their machines, the circular elements of Company X's service portfolio have increasingly come into focus (e.g. midlife and remanufacturing), and additional services have been introduced to support circular ambitions (e.g. electrification that incorporates batteries and chargers as services). These services are part of a wider portfolio that includes other services (e.g. training and automation services) which support social sustainability ambitions such as workplace health and safety. Overall, such factors make Company X a good case to explore the role of servitisation on circularity in terms of the internal strategic choices made to achieve such circular service offerings.

Of particular importance to circular service provision in Company X is the aftermarket service division and the "sustainability department". The aftermarket service division incorporates managers who make decisions regarding what services to offer and why. Meanwhile, the sustainability "department" is both divisional and cross divisional in that

there are sustainability managers assigned to each division that report to the Board, as well as other (more senior) sustainability personnel that are assigned strategic roles in relation to, for example, electrification, meaning that they work across divisions. Service sales, however, are conducted within the cross-divisional service centres that are located around the world and closest to the customers. Personnel within the service centres have responsibilities that extend beyond service sales at the customer interface, to include the sales of capital equipment and attachments, among others. These responsibilities are sometimes undertaken by dealers affiliated to Company X in certain parts of the world.

3.2 Empirical data

Fifteen semi-structured interviews with people mainly working in the aftermarket (services and attachments divisions), but also within the support functions of IT and sustainability, form the main bulk of the primary data. Importantly, even though sustainability functions as its own department, various interviewees spoken to from the aftermarket also have distinct roles that constitute sustainability issues (e.g. electrification strategies that include batteries and chargers as services etc.).

Most interviews were arranged through a snowballing approach, and some were directed to by the primary company contact, the Process and Application manager. Where possible, interviews were conducted on site in Company X buildings and production sites. However, given the geographical scope of Company X and its distance work approach, many interviews were conducted online with Aftermarket managers across Europe, Africa and North America. This was beneficial as it allowed access to interviewees in geographically diverse places (characteristics of international manufacturing companies) that would otherwise not have been possible. Additionally, site visits to the local factory and the warranty and quality department, as well as internal video footage of the CEO's strategic sustainability ambitions inform the empirics (see Table 1 below).

In addition to the interview transcripts, notes were taken during and after the site visits, and often referred to in later interviews to clarify points. The service portfolio (obtained directly from the primary contact) and annual sustainability reports constituted examples of secondary data that were drawn on to inform the backgrounding questions. Combined, both primary and secondary material provide a rich data set for the purpose of this study and its emphasis on servitisation as one firm-centric strategy that can aid an industrial firm's transition to increasingly circular business models.

The initial interview guides were operationalised around understanding Company X's servitisation strategy and its organisational structure (i.e. who were the main decision makers, how it planned to meet its service ambitions and connections to circular strategies etc.). These initial guides became increasingly theory informed over time as the links between servitisation and circularity came increasingly into focus. In this sense, both the analytical development of the servitisation for circularity framework and empirical data-gathering and analysis occurred concurrently, suggesting an

Table 1 Main primary data sources

Role & interviewee code if applicable	Division or department	Empirical material	Length
Process and Application Manager (S1)	Service Division	Meetings ×2 (at site)	150 min
		Interview (online, 2023–04–11)	60 min
		Interview (online, 2023–05–05)	60 min
CEO	Top Management	Keynote speech of strategy summit (video footage)	30 min
Global Operations Manager (S2)	Service division	Meeting (at site)	60 min
		Interview (online, 2023–04–21)	40 min
Process and Application Manager (S1), Group Warranty & Quality Manager (S6), and Marketing Product Manager (S3)	Service Division	Site visit (2023–04 - 03)	150 min
Global Customer Success Director (S4)	Service division	Interview (online, 2023.03.31)	45 min
Global Engineering and Mobile Device Manager (S5)	Service Division	Interview (online, 2023.04.05)	50 min
Vice President of IT (IT1)	Information Technology Department	Interview (online, 2023.04.05)	45 min
Global Technical Service Manager (A1)	Attachments Division	Interview (online, 2023.05.02)	45 min
Supply Chain Sourcing Manager (S8)	Service Division	Interview (online, 2023.04.11)	45 min
Group Warranty & Quality Manager (S6)	Service division	Interview (at site, 2023–05–04)	60 min
		Visit to Warranty and Quality Department (2023–05–04)	30 min
Marketing Product Manager (S3)	Service Division	Interview (at site, 2023–05–16)	60 min
European President (S10)	Service Division	Interview (online, 2023–05–08)	45 min
Global Sustainability Booster (Sust1)	Sustainability Department	Interview (at site, 2023–05–11)	60 min
Global Product Manager Service Agreements (S7)	Service Division	Interview (online, 2023–06–09)	45 min
Vice President of Operations (S9)	Service Division	Interview (online, 2023–05–10)	45 min
Zero Emission Manager (Sust2)	Sustainability Department	Interview (at site, 2023–06–05)	70 min
Total			*20 h*

Source: Author's own

overall abductive approach (see Alvesson and Sköldberg, 2017). Nevertheless, the main concepts in the analytical model were not explicitly addressed through the questions. Rather, a more inductive approach to coding in terms of the content of the responses was used and then connected to the "why", "what" (more) and "how" questions of the analytical model (Figure 3). See Supplementary File A for examples of the questions asked.

3.3 Data analysis procedure

The data analysis procedure involved various stages of reiteration. The first stage regarded revisiting the interview transcripts and field notes and grouping interesting quotations or other data into preliminary codes. These preliminary codes were then broadly related to the analytical model and categorised under the "why and what services were offered" and the "how and by whom such service offerings were achieved" in practice. These categorisation terms were used to structure the findings section.

The second stage regarded elaborating on these quotations through a narrative description for the first categorisation. Information from corporate reports and the company website were also necessary here to know why certain strategic objectives were set. A narrative presentation of the findings (rather than further coding) was deemed sufficient as the reasons for engaging in circular service strategies and offerings were more descriptive or fact based (i.e. the "why"); i.e. relating to the "sensing" aspects of the analytical model.

For the second categorisation (i.e. the "how and by whom?"), the initial quotations and notes were merged into two sub-groupings after various rounds of iteration that connected to the seizing and reconfiguring aspects of the analytical model, namely: proactive service provision and preventative maintenance, and electrification infrastructure. The key findings from these groupings were then operationalised into a summary figure to illustrate the connections between the core capabilities and resources needed to meet them (i.e. Figure 2).

As a final step, the findings from both headings were summarised into the analytical model (Figure 3) on the "firm-level" strategic aspects of servitisation for circularity. Within this model, three key feedback loops became apparent regarding the actors and processes involved in circular service provision by Company X. These were then elaborated on and related to the wider (service) marketing literature and theory in the following discussion, particularly Bocken and Ritala's (2021) earlier work on circular business model strategies (Figure 4).

4. Findings

> Circularity is the future. Customers are looking for that. We are growing like hell in offering services such as remanufacturing components [. . .]. Sustainability means money for our customers and for us today (S8).

Company X has clear strategic ambitions to engage in circularity through the services that it provides. Indeed, the pace of such strategies has increased in recent years due to Company X's headquarters being in Europe and the introduction of various directives and standards (e.g. Non-Financial Reporting Directive, EU Taxonomy, CSRD) that mandate applicable companies to account for and report on various issues related to the CE in economic terms (e.g. environmental protection, double materiality, Scope 1, 2 and 3 emissions, climate and biodiversity transition plans).

While such external mandates (i.e. demands and expectations), stemming from both customers and policy, constitute accounting, control and reporting issues for Company X, they also drive internal strategic decisions related not only to why, but also the ways through which, Company X implements strategies that support circularity; one of which includes its approach to servitisation and the services offered that is the focus of this research. It is precisely *how* Company X senses (why and what services), seizes and reconfigures (how and by whom) its internal resources and capabilities to provide (more) circular service offerings that the following findings are structured around.

4.1 Why and what services? Strategies for circular service offerings

As already mentioned, the official transition towards servitisation began in 2012 as Company X recognised the need to move away from providing products to providing solutions as a revenue-generating stream. The value of service provision for Company X is clear, with the aftermarket being more than 50% of its repeat business and customer experience is orientated around having safe, reliable, productive and sustainable products. Over time, such services have become increasingly marketed in terms of their circular effects:

> Service matters because we start with selling a machine. But, this machine has a life. And, we need to make sure that this machine performs during its life and that's a big part of our business. So, we make sure that the customer has a successful experience when using our products. And, then that is also how we gain more business. So, service really becomes more like circular, because we need to take care of the machine (S9).

Even though a roadmap for electrification was already established in 2011, the environmental value of service provision has come increasingly into focus as Company X transitions towards a (more) circular business model due to legislative and customer demands:

> Over the last decade, the bigger focus is not so much on the price of a machine but looking at the total cost of ownership and the value of product, as we see an increased value of low carbon products (Sust2).

Out of the 12 core services currently offered in the growing service portfolio, electrification, midlife and remanufacturing are being pushed because of their importance to not only economic but particularly, environmental performance. As of 2023, there was an internal target to have 50% of the machines sold on such service agreements (S7).

To detail, services embraced under electrification include providing batteries and charging points as services whereby diesel machines are replaced with battery-powered ones. This has been an imperative strategy for Company X since 2011, partly because of the EU's Battery Directive (2006/66/EC) and New Battery Regulation (2023/1542) as part of the European Green Deal [7]. Such institutional concerns recognise the importance of electrification infrastructures to reduce the reliance on fossil fuels yet are not without their own challenges, especially in terms of battery production as the Zero Emission manager notes (e.g. mining lithium for battery production and humanitarian concerns, especially in the Democratic Republic of Congo).

Focusing on service provision, however, Company X provides the batteries and charging infrastructures as services through leasing contracts with industrial customers, meaning that Company X *"owns the asset [*i.e. *the battery] and the customer pays when they use it"* (S9). This is marketed to the industrial customer as beneficial for having a low total cost of ownership and:

> [. . .] serves circularity, because we keep the ownership of the battery when it's time for replacement, we will replace it. We'll take the old one back and make sure we have a plan for recycling or second life (Sust2).

It also ensures customer lock-in in terms of service provision with Company X. Currently, however, battery recycling is conducted in collaboration with an upstream partner as Company X does not have the internal resources or capabilities to do this internally.

Meanwhile, the midlife service involves component replacements, upgrades and/or technological additions to extend product life. This service has, over time, been increasingly marketed as circular, much like the remanufacturing service which is based on a core recycling programme, where parts are returned to be reused in further product designs and replaced with remanufactured alternatives. Additionally, service agreements and audits are sold as services to ensure the high productivity and reliability of the machines which can also support circular resource loops. These services are either sold at the same time as the machines or marketed via the service centres after commissioning. All services described aim for energy, materials and waste to be embedded within increasingly closed loops whereby Company X directly provides the circular service offerings to its customers, even if some services require partner organisations (e.g. recycling batteries).

While there are marketing campaigns each year with sections on the circular economy targeting Company X's biggest mining customers, the service centres are nevertheless key for meeting KPIs related to the circular service agreement targets:

> We need to be able to say to a customer, 'okay, maybe this part is a little bit old, have you thought about midlife?' Or, 'this diesel machine is becoming outdated, how about we do a battery conversion?' (Sust1)

Providing the best service therefore requires *"figuring out what services to provide, how to provide them and what kind of [service] portfolio can achieve that"* (S4). This relies on getting data directly from the machines while in operation, as well as from customer interactions with service centre staff or through selling service agreements that include machine servicing at periodic intervals:

> Getting data is a fantastic opportunity to know more. Imagine that we were only doing the capital equipment and not the service, right? You send out the machines and you don't have a clue what happened, right? You need that feedback loop regarding what is not working and through this, you build the relationship with the customer (S5).

Knowing exactly how the machines are used (i.e. operational hours, peak usage etc.) and when they need to be serviced or components replaced is essential not only for customer satisfaction related to product longevity and performability, but also for R&D related to circular product innovations. It is also important for developing services that support social sustainability goals such as training and machine automation that relate to safe productivity. Company X's service portfolio is currently operationalised in a way that makes it easier for customers to repair and replace components through modular system designs. One key part of this is moving away from reactive to preventative maintenance through getting information from the machines, customers and technicians. Another is through upselling services related to product maintenance and circular solutions, which are not only key for Company X's circular ambitions but also important from a traditional business logic to increase customer lock in.

4.2 How and by whom? Capabilities and resources for circular services

Although the aftermarket service division is responsible for developing and providing services in connection with the product portfolio (i.e. the service portfolio) at the more strategic level of the organisation, the service centres are responsible for selling them.

At the group level, a cross-divisional Service Council of senior managers was established in 2022 to *"track what is working [in the aftermarket], establish and share the best practices in the organisation and seek together how improvements can be made"* (S8). It was seen as a way of *"finding synergies and collaboration when it comes to service provision in a very divisionalised organisation"* (S5). This collaboration involves discussions relating to circularity through its recently developed CE working group, which aims to connect the circular services offered in the aftermarket with other circular strategies and organisational divisions. Other working groups have been established in areas such as CRM data management and digital solutions, which are considered important for providing information that supports circular transitions. As of 2023, key individuals within the Council had been assigned responsibility for the working groups to bring actionable decisions to others in the Council.

Evidently, there are global (i.e. Service Council and aftermarket service division back office) and local (i.e. the service centres) dimensions when it comes to making service decisions and then providing those very services in terms of seizing opportunities and reconfiguring structures. Within both these strategic and operational levels, various capabilities and resources are important for the circular service provision.

4.2.1 Proactive service provision and preventative maintenance

Having the right resources in place is seen as vital for providing responsive circular services. There has been the felt need at the group level to develop competencies in remote monitoring to be able to offer preventative maintenance. This is often achieved through smart services and other digital technologies that have benefits for inventory management to *"reduce a lot of waste"* (S5). Notwithstanding the benefits, *"preventative maintenance comes with a risk because you're taking a machine that was working and now you're saying ' 'I m going to mess with it'"* (S1).

Another strategy to ensure the longevity of its products (i.e. slowing resource loops) is the scheduled maintenance on most machines after 250 operational hours. Similar to the remanufacturing and midlife services previously described, circularity has increasingly come into such services whereby old parts are now exchanged for reconditioned ones (if necessary) at these scheduled maintenance points. There are also retrofit options to replace parts of modular product designs.

While Company X attempts to keep its resources circular through the services that it offers, and is increasingly marketing more traditional services as circular, some issues nevertheless

remain. For example, having customers all over the world impacts other circular issues such as the carbon emissions associated with product and replacement transport. To redress this, Company X replaces products and components from regional sources, but this is not always possible. Furthermore, even if some components are specific to Company X's machines, many spare parts or attachments can be sourced from other parties (e.g. its main competitors or other suppliers) when it is too costly for Company X to produce them in particular locations.

Suppliers were noted as being particularly important upstream partners for any warranties or claims related to service provision within Company X as part of supply chain control. Through a connected digital infrastructure, Company X can extend the (future) lifespan of its machines whereby the services offered support internal and external innovations:

> The supplier will run an analysis of the materials and then if the supplier says that something was wrong, we will of course approve the claim. But, more than that, then we would like the supplier to implement the changes so that this doesn't happen again. Warranty is one thing but it's quality as well. If we receive more claims or more issues, this means more things to improve. Then, the quality will grow and [. . .] that can relate to the whole business model. With this information, you can pass it to R&D and to innovation (S6).

Proactive service provision therefore requires not only having the right resources and information in place, but also the wider capabilities of Company X and its suppliers through collaborations. The data coming in from the machines not only translate into actionable insights in terms of service provisions but are used for the continual R&D on, for example, product innovations and the materials used to facilitate (more) "sustainable" service offerings (Sust1). There are various in-house R&D teams within each division, composed of engineers who aim to innovate not only the products but the types of materials being used in the transition to more circular business models.

Nevertheless, the most important resource referred to by the interviewees was the "on the ground" personnel who have *"deep technical knowledge"* (Sust2) in addition to other social qualities:

> We need to demonstrate that we are superior [to our competitors]. We don't need a battalion of people, but we need just the right person. The people we have are strongly connected with the customer. [. . .] It is powerful is to have the right person. [. . .] service is the best way to be the best in the market (S10).

The personnel in the customer service centres are seen as the main interface for interactions between Company X and its customers. These interactions take place all over the world and are embedded within cultural codes of accepted practice that cannot be exclusively controlled by the group level. While, indeed, the staff at the service centres hold tacit knowledge in terms of "how to act" with their regional customers, they are also required to have company-specific knowledge (i.e. knowledge of the company's products and services from all divisions). This includes more general knowledge of the sustainability and circularity specifics of each product and service sold, and the ability to communicate the benefit of services connected to circularity to customers, given the internal targets connected to these. The managers within the service centres not only liaise with those at group level, but also ensure their staff are trained in the variety of products and services offered and have specific KPIs related to circular services.

Additionally, the knowledge contained within the team of technical staff is also paramount for machine services such as scheduled maintenance and midlife. Some of these technical personnel are located directly on site (as part of a service agreement) in the world's biggest mines. This is considered a key strategic move for customers to ensure machine productivity and reduced downtime. Others even serve competitors' machines and vice versa: *"In certain areas, [where] we do not have technical staff nearby [we] sometimes need to use our competitor to bring samples to the laboratory for testing" (S8)*. The intention behind this was not only out of necessity, but also with the hope that future contracts could be won for service provision and capital sales due to the technical expertise and relationship skills of Company X's technicians, which would lead to the satisfaction of competitors' customers.

Another notable example for the development of preventative maintenance is Company X's participation in an Advanced Service Group, which involves other manufacturing companies in different industries and research institutes. Through this, Company X learns how to develop its circular capabilities by *"learning from the experiences [of other actors] and what they see as the mandatory things to do like monitoring the machines or equipment* [. . .] *(S9)*. This is *"an ecosystem of knowledge"* (S9) for Company X to tap into that extends beyond its immediate industrial ecosystem.

4.2.2 Electrification infrastructure

In addition to the more "general" resources and capabilities already noted, there are some specific ones required for the services connected to electrification. Company X requires an electrification infrastructure given that it *"cannot introduce new technology without implementing the support"* (Sust2). However, this cannot always be provided in-house.

There have been recent mergers and acquisitions made by Company X: *"We are in the process of buying an electrical infrastructure company. Where actually the machine is just a piece of that ecosystem"* (S4). As well as offering batteries, chargers and financial solutions to customers (e.g. payment/leasing plans), there have also been some considerations of the CE in terms of future developments to provide solar panels for the chargers on site. This would allow the company to further develop its current *"business models into more circular ones"* (Sust1).

Even so, offering batteries as a service entails various infrastructural challenges, beyond those previously mentioned:

> In in the middle of nowhere, you need to build roads, you need to build the infrastructure, and you need to think about how [electricity] grids can be optimised. [. . .] And, I mean it's really complicated to do these things. Sometimes the mines are in Peru at 5000m altitude. But, we sell to everybody and so for us, it's very important to have this [supporting infrastructure]. [. . .] In the past, we kind of owned the vertical way, but going forward the problem statement for us, how do you work within an ecosystem because you can't own it (S4).

Such challenges require Company X to consider – what *more* is needed and by whom? It also appears that the transition from more linear to circular business models, as part of wider circular ecosystems for Company X, is ongoing as Company X does not currently have the internal capabilities to provide its electrification infrastructure on its own due to the geographical scope of its customers. The above attempts to acquire infrastructure partners are an attempt to redress this.

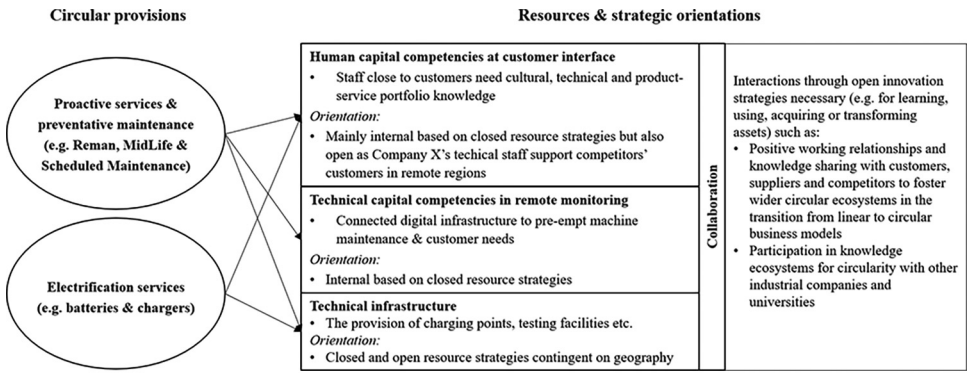
4.3 Summary of findings

Figure 2 summarises and connects the key service provisions and resources required by Company X to provide (circular) services related to preventative maintenance and electrification. These provisions are dynamic in that Company X assesses and uses both its existing internal and external resources to provide and develop its circular service offerings through obtaining feedback (e.g. from machines, customers and its employees) that is translated into actionable insights. It also draws on industrial knowledge regarding how to innovate and/or provide circular services. All these resources are contingent on interactions with upstream and downstream actors, which is expressed in the model through "collaboration" as an overarching resource necessary to support circular transitions. This collaboration can draw on both closed and open innovation as illustrated as feedback loops in the summative "servitisation for circularity framework" (Figure 3) that are elaborated in the discussion that follows.

5. Discussion

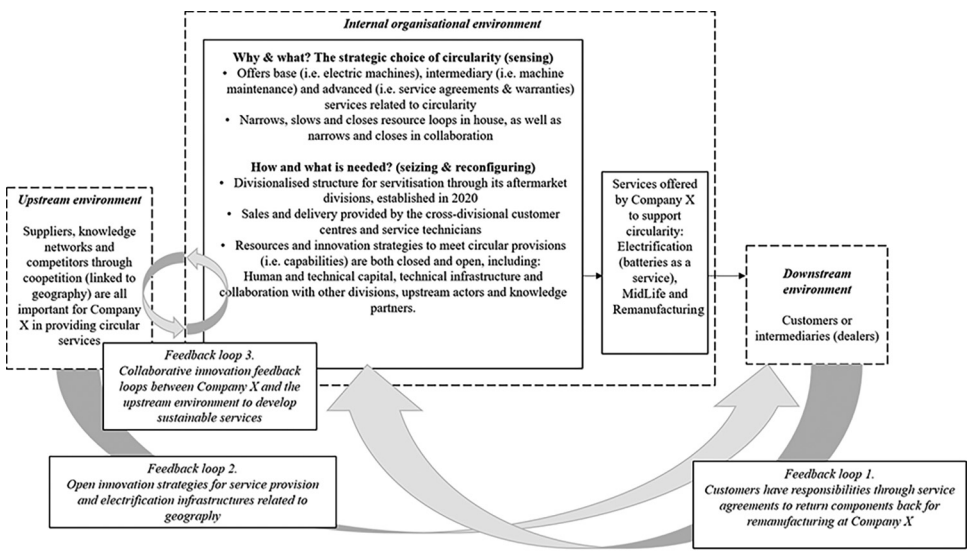
The findings illustrate both the decisions related to circular service provisions by the case company in terms of why, how and what services are offered, and overview what are considered to be the important resources and capabilities needed to meet such service offerings. Looking into how servitisation is used to support circular transitions in industrial firms from a strategic perspective moves beyond the extant servitisation focus on cost leadership and bottom-line performance (e.g. Gebauer, 2008; Cusumano *et al.*, 2015; Raddats *et al.*, 2019). It does this by emphasising the economic *and* environmental values for industrial firms, their customers and suppliers through service strategies as part of wider orchestrated strategic networks (cf. Möller *et al.*, 2005), in this case for circular ambitions. It also extends prior research on the characteristics of service networks orchestrated by focal manufacturing firms by explicitly incorporating circularity into the "life-cycle concept" (see Gebauer *et al.*, 2013) [8].

Figure 2 Empirical connections between capabilities and resourced needed for circular service offerings in Company X



Source: Author's own

Figure 3 Summary of findings in the servitisation strategy for circularity framework



Source: Author's own

Overall, the case points to a combination of both closed and open innovation strategies to narrow, slow *and* close resource loops, thus relating to many of Bocken and Ritala's (2021) innovation strategy archetypes as exemplified in Figure 4 below. The adoption of multiple resource and innovation strategic archetypes also indicates that Company X is seriously engaged with circularity through the services that it provides. However, when conditions prevail, Company X prefers to adopt and advance closed innovation strategies. In some ways, this contrasts the often-conceptual research focus on open innovation and ecosystem approaches as favourable for circular service solutions (e.g. Yang *et al.*, 2018; Kanda *et al.*, 2021; Russell-Bennett *et al.*, 2023; Palakshappa *et al.*, 2023); that is, as Company X seeks to repair, reuse, remanufacture, refurbish and recycle its own industrial machines in house.

customer interfaces between the focal organisation and its customers as downstream actors (i.e. industrial customers such as mining and construction companies) are key for closing and slowing resource loops (see also Figure 4).

Human capital was noted as particularly important for providing expert knowledge on circular solutions and increasing customer satisfaction as sources of competitive advantage. For example, the relationships formed by certain personnel (e.g. sales teams in the service centres and the technical staff) and customers were imperative for providing and maintaining the circular services offered. Yet, this relationship is binary as Company X would not succeed in its circular ambitions without its customers who, through their service agreements, return components and parts to be remanufactured. In this way, industrial customers should be seen as business partners to

Figure 4 Circular business model strategies for servitisation at Company X

Innovation Strategy \ Resource Strategy	*Narrowing loops*	*Slowing loops*	*Closing loops*
Open	***Open-narrowing*** Value captured by (potentially) saving costs through learnings gained from knowledge ecosystems Example: Participation in the Advanced Service Group	***Open-slowing*** Value captured through extending product life through sharing information with suppliers. Example: Information from warranties and quality claims is passed on to suppliers to improve component quality. Using competitors' technicians to serve machines in geographies not covered by Company X	***Open-closing*** Value is captured by reducing waste through ecosystem integration. Example: Not captured in the case.
Closed	***Closed-narrowing*** Value captured by saving costs and resources internally through process efficiencies. Example: R&D teams working on material and product improvements	***Closed-slowing*** Value captured by using less resources and focusing on long-lasting design and services in-house. Example: To offer customer warranties, repair and maintenance services such as midlife and remanufacturing.	***Closed-closing*** Value captured at the post-consumer recovery stage whereby materials are returned by customers and reused within the company boundaries. Example: Owning batteries and chargers as services, remanufacturing services all ensure materials return to be reused

Source: Adapted from Bocken and Ritala (2021)

A more detailed analysis of the findings and the actors involved in feedback loops for circular service provision from a firm-centric perspective (i.e. conscious strategic decisions for circular resource and innovation strategies related to Figure 4) is now elaborated.

5.1 Resource and innovation strategies for circular service provisions

5.1.1 Customer interfaces – human and technical

From a firm-centric strategic perspective (feedback loop 1, Figure 3), the case indicates a preference for closing and slowing resource strategies through the circular services offered by keeping materials (as resources) "in house" for not only financial performance benefits or economic value for industrial firms and their customers, as indicated in extant research on servitisation that includes examples of maintenance and remanufacturing services (e.g. Fundin *et al.*, 2012; Gebauer, 2008; Gebauer *et al.*, 2013), but also for *environmental* performance benefits as increasingly important for industrial networks and stakeholders. This means that, indeed, some aspects of circular servitisation are not new, but rather that emphasis on the "circular" or environmental values of such servitisation strategies for industrial firms is. Here, the support circular servitisation strategies. This remanufacturing process, nevertheless, can be achieved in house as closed strategies between industrial firms and their customers (as the preferred option) or in collaboration with industrial firms/customers *and* upstream partners (upon necessity). As an example, owning the battery is one clear strategy adopted by Company X to ensure customer lock in and support closed innovation as the preferred strategic approach through the ownership of assets (see also Spring and Araujo, 2017). However, Company X currently does not have the resources and capabilities to recycle the batteries in house, and this is when strategic partnerships with upstream actors come into play.

While the characteristics of relationship interactions at the customer interface are strategically conditioned by the location of the service centres and technical staff close to some of the world's largest mines, the cultural appropriateness of such interactions appears embedded within location, rather than part of any explicit strategy made by Company X for selling circular services. Training is limited to the products and services offered, rather than based on any ethical norms or codes of conduct regarding "how to act" in particular geographies. Rather, human capital is mainly explained as a

resource for circularity in terms of the technical competencies and knowledge that staff bring to the relationship with downstream actors as important for customer satisfaction. This human aspect of technical competence is in addition to the technical competencies of the connected digital infrastructure from customer machines to pre-empt customer needs and thus provide proactive circular services through remote monitoring. This additionally touches upon the qualification aspects described by Spring and Araujo (2017) in that getting the right information from and about products (i.e. product biographies) is integral to circular service provision that moves beyond the disposal mentality of linear business models.

Interactions with downstream actors along customer interfaces (technical and human) as important for industrial service networks is nothing new (e.g. Gebauer *et al.*, 2013). What can be said, however, is that in a time where emphasis is placed on digital technologies as communication means for servitisation between industrial companies and their customers (e.g. Bortoluzzi *et al.*, 2022) that the human elements of service provision remain imperative for the success of circular services in Company X. This appears to be especially the case for industries characterised by highly customised, low-volume machinery and few direct competitors such as that of Company X. Here, data from smart systems and digital technologies are used only to the extent as to inform service centre and technical staff when and how (best) to offer circular services. Data help the staff plan their service offerings and execute their service capabilities in preventative or scheduled maintenance (see also Spring and Araujo, 2017). Data also help with inventory management. Thus, having the right people in the right place to communicate with industrial customers on circular service provisions and maintenance is an important strategy for circular service transitions. Like the findings of Chaudhary *et al.* (2022), this would require that open communication channels along customer interfaces and comprehensive training programmes for operational staff are put in place for industrial firms to succeed in their (circular) servitisation journeys.

5.1.2 Strategic coopetition, acquisitions and partnerships with upstream actors

While the closed innovation strategies appear more prominent in the above archetypes of Figure 4, the value gained through narrowing and slowing loops in collaboration with upstream actors cannot be underestimated (feedback loop 2, Figure 3). However, this is perhaps down to the character of Company X as an international company rather than one that supports open innovation as a key managerial strategy.

One interesting finding is the contingency of location that induces the need for (more) collaboration with upstream actors to provide the necessary circular services. This was illustrated in examples relating to electrification infrastructures and the need to partner with and/or acquire the infrastructure providers in remote areas. It was also illustrated by examples of using the technical staff and resources of competitors to service machines in locations that lack personnel, which can be important for machine maintenance services.

Rather than asserting that long term circular ambitions require partnered work and circular ecosystems based on open innovation *per se* as previous work in the more "domestic" market context suggests (e.g. Fehrer *et al.*, 2023), the reason behind adopting open innovation strategies and/or service ecosystems points to the international character of Company X and its remote customer base (i.e. mining machines in extreme geographic locations). This emphasises that industrial companies may well strategically aim to achieve circularity through internal solutions if resources permit. But, in cases where this is not possible (in this case exemplified by location), industrial companies must draw on wider service ecosystems to support their circular ambitions.

While the "international" aspect of servitisation has received limited research attention (Bıçakcıoğlu-Peynirci and Morgan, 2023), those studies have nevertheless focused on the performance effects of international servitisation strategies and the role of digital technologies, rather than the necessity of cooperation with competitors (i.e. "coopetition" [cf. Bengtsson and Kock, 2000]), or even attempts to partner or acquire alternative service providers to support circular transitions tied to geographic reach. The examples from Company X come down to the role of geographical distance, rather than differences in psychological or cultural context (see Kucza and Gebauer, 2011), for providing circular services in a global economy. As such, the attempts by Company X to acquire or partner with infrastructure providers can best be described as "insulated" (see Öberg, 2023). This is further indicated as a form of network orchestration by Company X (see Gebauer *et al.*, 2013; Möller *et al.*, 2005) given that industrial partners (not part of the original business network) are strategically brought on board to support Company X's circular ambitions as the battery recycling example highlights.

5.1.3 Open innovation strategies through supplier exchanges and participation in knowledge networks

While the preference appears to be for closed innovation strategies (see Figure 4), other upstream actors are nevertheless important for making service improvements, in addition to those examples already given (feedback loop 3, Figure 3). Open innovation strategies, characterised by information and/or knowledge exchange, are vital for improvements in product and/or component performativity and lifespan through quality improvements. Company X collaborates by exchanging knowledge with its suppliers on areas related to claims and warranties for component improvements. This is considered important not only for service improvements tied to component replacements, with clear links to customer satisfaction and indirect links to circularity, but also important for research and development in the product divisions. Additionally, Company X participates in a multisector knowledge sharing network (i.e. the Advanced Service Group), which involves businesses from other industries and research partners, and can be characterised of another type of orchestrated strategic net that extends beyond the typical business network (Möller *et al.*, 2005).

The role of knowledge-exchange networks for innovations and sustainable improvements constitutes an important, emerging stream of research that extends beyond the traditional business network (Johnstone, 2019; Öberg and Lundberg, 2022), in that business actors (that are not necessarily part of the same industrial network) can learn from one another in knowledge ecosystems. Here, knowledge exchange regards learning from the capabilities and experiences of "others", to adjust firm-centric information, practices and know-how

(Kogut and Zander, 1992). In this sense, knowledge-exchange relationships and networks can prove invaluable for environmental improvements linked to circularity. This implies the need to expand and nuance the definition of open innovation in that the innovation knowledge for circularity may be "open" (i.e. shared through service ecosystems and knowledge networks) but the circular solutions nevertheless provided in-house (i.e. as what Bocken and Ritala [2021] term closed innovation strategies).

5.2 Challenges of a firm-centric view of servitisation for circularity

In this study, servitisation is posed as one strategy adopted to help industrial firms as they transition from linear business models to increasingly circular ones by offering services to keep materials and resources in closed loops, orchestrated by the focal firm. The entry and use of raw materials at the production phase and the emissions associated with providing services in Company X with its huge global reach are also circular issues that have not been covered. This means that the strategic focus on servitisation needs to be embedded within the wider context of circular business models for industrial firms as one of many strategic tools that are used in combination with one another (e.g. sustainability controls, product and process innovations, and GHG accounting, among others) for circular business models and resultant CEs.

Moreover, like many other large multinational manufacturing companies, Company X's transition is ongoing and faces various issues in moving forward, especially when it comes to its electrification infrastructure and battery recycling capabilities. Albeit, through such provisions, other unsustainable practices may come into play (e.g. the construction of roads, pipelines etc. that compromise ecological and social systems). At the more pragmatic level, there is also an element of risk in offering preventative maintenance services for functional machines that can be seen as intrusive by the mining and construction customers.

Together, such challenges imply that Company X is not (yet) circular – and, from a more critical stance, perhaps will not be in the immediate future. However, the resource and innovation strategies it adopts nevertheless help move it one step closer to providing more circular service offerings. As the case examples highlight, in some instances, this might require collaborations with or even acquisitions of upstream actors as the focal firm senses if and how its assets can provide circular solutions for its customers.

6. Conclusion

The aim of this study was to better understand the role of servitisation strategies for circularity, taking an international industrial firm as the focal point of departure. The findings emphasise circular service offerings as increasingly important for gaining a competitive advantage in both environmental and economic senses by ensuring the lock in of not only customers, but also materials and parts for circularity.

More specifically, the case company initially qualifies what resources and capabilities it has and then evaluates opportunities for novel value creation in providing circular service solutions or even reframing existing maintenance or remanufacturing services in terms of their environmental value. Adapting to its geographical reach, Company X seizes its opportunities and reconfigures resource and innovation strategies accordingly to ensure its circular services are not only offered but also provided and achieved through interactions with upstream and downstream actors. This means that multiple closed and open resource and innovation strategies for circular service provision are adopted to narrow, slow and close resource loops. Particularly, collaborative open innovation strategies are used due to the international character of the business to narrow and slow loops, as well as simply to provide circular service offerings across the globe. This implies that open innovation for circular service provision is motivated by circumstance (e.g. resource reach) in addition to economic and environmental performance, and that closed resource and innovation strategies for circularity are preferred.

6.1 Research contributions

The research contributions from this study are mainly analytical and conceptual, stemming from the introduction of the servitisation for circularity framework. Additionally, while some of the findings are specific for circular service provisions, others support earlier research on the role of servitisation for industrial firms.

First, this study offers an understanding of how servitisation strategies can support circularity by moving away from the extant research focus on servitisation as supporting bottom-line performance (e.g. Gebauer, 2008; Cusumano *et al.*, 2015; Raddats *et al.*, 2019) by explicitly bringing in the environmental elements of value resultant from such strategies. This study is one of the first to empirically link the types of servitisation strategies adopted by an industrial firm to support circular ambitions and top line performance. These strategies are used in combination with others to support the transition of industrial firms to (more) circular business models and, inter alia, CEs.

Second, through combining and building on previous servitisation and CE literature, this study puts forward a framework that can help researchers frame their empirical work on strategic servitisation for circularity. Using the "servitisation for circularity framework" as an analytical tool helps elaborate on the internal resources and capabilities needed for industrial firms to meet their circular aims (see Scarpellini *et al.*, 2020). It also helps frame in different cases when and what open innovation and resource strategies with upstream partners are necessary (illustrated through the feedback loops). This can allow researchers gain a better understanding of the managerial strategies for circular service offerings used in different companies and the dynamic capabilities needed to meet such offerings, taking a focal industrial firm as the unit of analysis rather than the business network.

Third, this study emphasises the importance of customer interfaces (both human and technical) for circular service provision. This finding is nothing new but rather builds upon the relationship marketing principle as an important coping mechanism for industrial companies operating in geographically diverse areas. It also confirms recent service-led research (e.g. Raddats *et al.*, 2019; Chaudhary *et al.*, 2022) which emphasises the importance of people for servitisation. Here, the degree of trust, communication and technical expertise at the customer interface appears especially important for low volume, highly customised product industries where human interaction between the seller and the buyer remains key.

Fourth, this study implies that open innovation strategies may be contingent on physical distance, rather than strategically designed from the outset as part of circular ecosystems. This finding is particularly novel in that coopetition, partnerships and acquisitions come down to locational factors, which affect (circular) service provision, rather than cultural or psychological distance (see Kucza and Gebauer, 2011).

Fifth, the findings nuance the definition of open innovation through collaboration in that innovation strategies can regard "open" knowledge exchange (e.g. through knowledge exchange networks) but the innovations themselves for circularity, nevertheless take place within the firm's borders (i.e. as closed innovation strategies [see Bocken and Ritala, 2021]).

Finally, the findings provide an example of network orchestration in practice for circular service offerings (cf. Möller *et al.*, 2005). Extending prior works that take focal manufacturing firms as point of departure (e.g. Gebauer *et al.*, 2013) to circular service offerings, the findings point to the use of certain upstream partners to support particular services (e.g. batteries as services). There are also examples of the case organisation being part of orchestrated innovation networks (e.g. the Advanced Service Group) composed of multisector actors. Such examples imply that knowledge innovations for circular service solutions may be (more) contingent on different types of orchestrated network forms that include actors not part of the immediate business network.

6.2 Managerial implications

Open innovation strategies with upstream actors are important for international manufacturing companies to 1) provide (circular) service offerings in geographically remote areas and 2) improve product performativity and lifespan through information exchange. This means that managers should be open to collaborations with competitors, suppliers and other stakeholders to ensure that circular services can be provided across the globe. Acquisitions may also be another strategy for circular service provision if resources permit.

Additionally, managers must ensure that the customer-facing staff (i.e. sales teams and technical personnel) have adequate knowledge of and technical training on the circular services offered. These personnel are vital for successful circular service strategies in their relationships with industrial customers as "business partners" for material and component circularity. That being said, servitisation is one strategy that can help industrial firms transition to more circular business models through the development of services that support circularity. Therefore, offering circular services needs to be combined with other strategies (e.g. product innovations, environmental controls, GHG accounting) for circular transitions to be realised.

6.3 Limitations and future research

This paper focuses on servitisation as one strategy that helps firms in their circular transitions. It is based on the analysis of one international industrial firm, and the managerial strategies it implements to support its circular ambitions, as well as the resources and capabilities needed to meet such strategic aims. In doing so, the contributions are mainly empirical, analytical and conceptual, rather than theoretical.

Future research should continue to explore the role of circular servitisation strategies for circular business models from a firm-centric perspective, especially those in different industries and contexts that focus on environmental value propositions. This is important as it appears that closed resource and innovation strategies are preferred in some instances, with contrasts much wider research focus on service and circular ecosystems. It could also be valuable to draw on different theoretical perspectives or frameworks (e.g. the resource-based view, dynamic capabilities, knowledge-based approaches and/or the business model canvas, among others) and/or building on the "servitisation for circularity framework" put forward in this study. This would benefit from multiple case study designs to increase the analytical and theoretical generalisations from the findings.

It would also be of particular interest to follow industrial companies through longitudinal research designs to assess the long-term impacts of (current) circular servitisation strategies on not only the companies being explored, but the wider effects on manufacturing industries in terms of the CE. Such research could aim to address the environmental consequences of servitisation strategies for industrial firms as well as their upstream and downstream partners (see Russell-Bennett *et al.*, 2023).

Additionally, the finding that geography conditions open innovation strategies (i.e. deliberate strategies to collaborate with upstream actors as part of a wider circular ecosystem) is based on this case. Future research could explore different industries and companies, providing researchers with a deeper understanding on the different types, roles and use of servitisation strategies for circularity, and the CE in different contexts, and the decisions behind when open or closed innovation strategies are preferred. For example, future research could elaborate on the circumstances when acquisitions and mergers are used as strategies to offer more circular services. This could build on recent research on the modes of servitisation (see Öberg, 2023), but for circular transitions in industrial economies. There could also be attempts to integrate CE principles more clearly into extant characterisations of service networks in manufacturing companies, building on the prior work of Gebauer *et al.* (2013). This is important given the various institutional pressures for CEs.

Notes

1 This point reflects the following literature reviewed via a keyword string searches in Scopus as follows: ((circular*) AND (serviti?ation OR "servitised offerings" OR "product service systems" OR aftermarket OR "service ecosystem*" OR "service eco-system*") AND (marketing OR "service marketing")).

2 This contrasts the traditional view of industrial networks as organically forming.

3 Figure 1 simplifies the systemic interactions of resource flows in wider business networks into a) upstream and b) downstream actors.

4 Not to be confused with the quantitative statistical generalisability.

5 There are various competitors for parts (i.e. tools and attachments).

6 There are also targets related to Scope 1 and 2 emissions associated with production, but these are orientated more

towards product innovations which constitutes another strategy towards circularity currently being undertaken by Company X.

7 This aims to minimise environmental impacts through strengthening European autonomy through circular solutions.

8 Gebauer *et al.* (2013) emphasise maintaining products through the services offered to ensure optimal performance throughout the product's lifespan, yet without explicitly incorporating the environmental performance benefits therein.

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Supplementary material

The supplementary material for this article can be found online.

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