

DEVELOPING THE CONCEPT OF LIFE-CYCLE OFFERINGS

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ABSTRACT

To extend the existing literature on life-cycle service offerings, this study clarifies the concept of life-cycle offerings by applying existing theory and empirical comparative case data. Our comparative case study uses previous theory and seven leading industrial cases to illustrate the concept, framework, and single components of a life-cycle offering. The developed concept enables manufacturing firm managers to analyze, benchmark, and develop their firms' life-cycle offerings to facilitate value creation and appropriation.

Keywords: Life-cycle service offering, industrial service business, service-dominant logic, service infusion, service business model

Paper type: Competitive paper

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1. INTRODUCTION

In the search for novel sources of profits, manufacturers have been moving from stand-alone products to bundled goods and services (Matthyssens and Vandenbempt 2008; Sawhney 2006). However, this process is complex (Auguste, Harmon, & Pandit, 2006; Kindström & Kowalkowski, 2009), and positive outcomes are never guaranteed. Previous research demonstrates the positive but nonlinear performance impact of services on sales growth (Kohtamäki et al., 2013) and company market value (Fang et al., 2008). However, this link may also be negative (Neely, 2008), which reveals a common service trap during service infusion (Brax, 2005; Gebauer, Fleisch, & Friedli, 2005). To overcome this trap, manufacturers have strengthened their service emphasis by extending service offerings to support their expanding installed base throughout an entire life cycle (Oliva and Kallenberg, 2003; Potts, 1988; Ulaga and Reinartz, 2011; Wise and Baumgartner, 1999) while migrating from services that support products to services that support customers' processes (Mathieu, 2001a). By aligning product-based services with customers' operational activities throughout the product life cycle (Raddats, 2011), manufacturers can capture long-term revenue streams, reduce costs, and secure economies of scale by standardizing service-operations management (Evans, 2007; Ulaga and Reinartz, 2011).

Since Vandermerwe and Rada (1988), studies have mapped the transformation of industrial firms from a product-based business model to a service-based business model. Although existing studies have provided multiple constructs and mixed terminology (Sakao, Sandström, et al., 2009; Windahl and Lakemond, 2010), the rapidly increasing theoretical material has also caused confusion by providing miscellaneous concepts that overlap with various meanings, as shown in recent literature reviews (Baines, Lightfoot, Steve, et al., 2007; Baines et al., 2009; Boehm and Thomas, 2013; Lightfoot et al., 2013; Nordin and Kowalkowski, 2010; Velamuri et al., 2011). More specifically, existing studies repeatedly suggest the need for a life-cycle perspective and frequently downplay the time-related aspect when classifying industrial offerings.

In this study, the concept of life-cycle offerings emerges from an abductive process that combines a critical review of the previous research with a multiple-case study to support and illustrate the conceptual discussion. To advance our understanding of industrial service life-cycle offerings, we develop the concept of life-cycle services by answering the following research question: How should life-cycle offerings be conceptualized in the context of industrial manufacturers? Our research contributes to the industrial service literature (Baines et al., 2009; Boehm and Thomas, 2013; Lightfoot et al., 2013) by exploring the concept of a life-cycle service offering and by mapping the types of services that are included in the life-cycle service offerings of leading industrial cases. Our data and systematic literature review provide a framework for the development of life-cycle services. The suggested framework facilitates future conceptual developments and enables manufacturing-firm managers to integrate services into product life cycles (Windahl and Lakemond, 2010). The framework enables analyses, benchmarks, and the development of life-cycle offerings, which facilitates the creation and appropriation of long-term value.

2. INDUSTRIAL SERVICE BUSINESSES AND THE CONCEPT OF SERVICE OFFERINGS

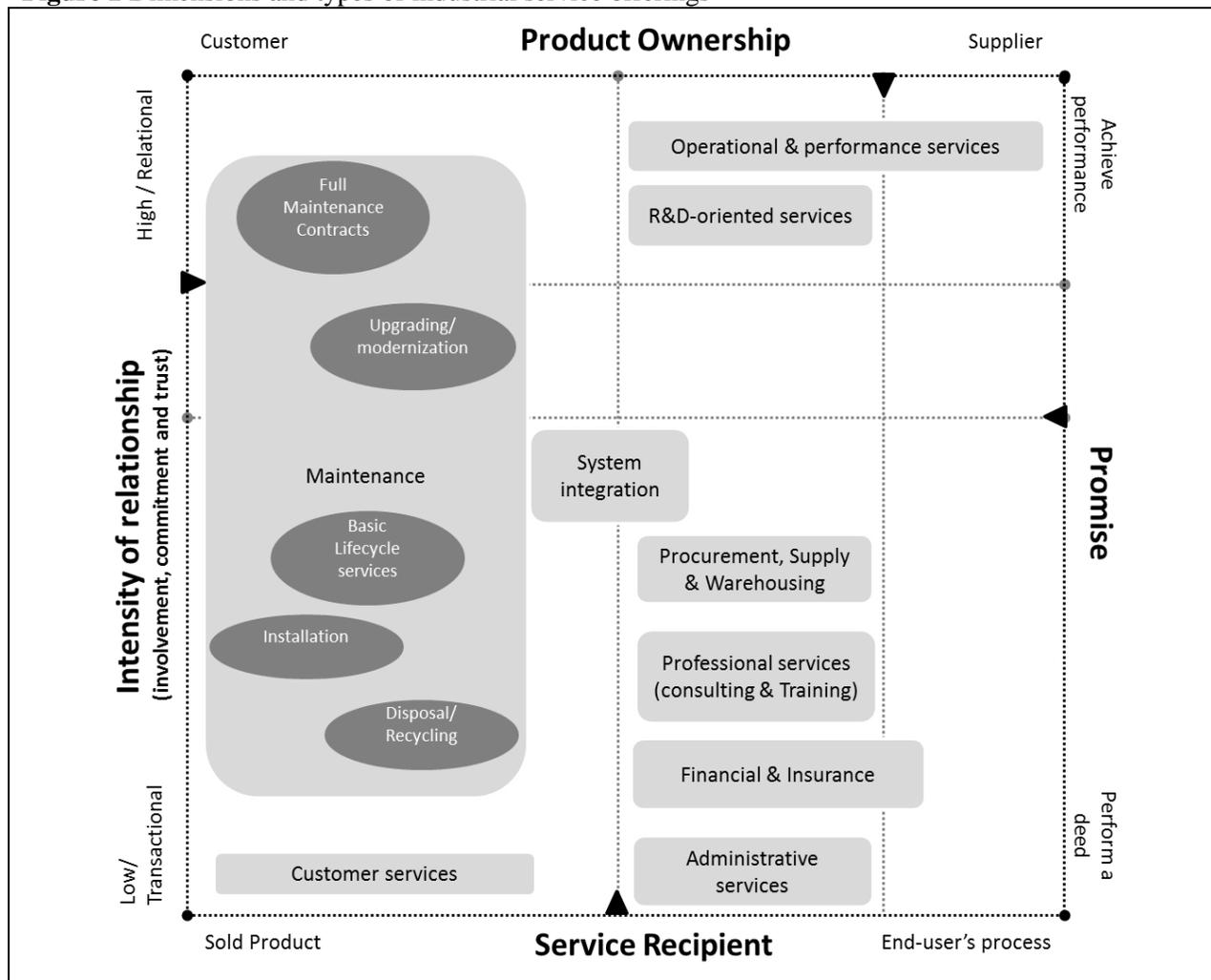
Studies of value migration from product manufacturing to service-dominant business designs have increased significantly during the last decade (Lightfoot et al., 2013). Recent, comprehensive reviews have identified many related but frequently detached research streams that address product-service combinations for hybrid value creation (Baines et al., 2009; Baines, Lightfoot, Evans, et al., 2007; Boehm and Thomas, 2013; Lightfoot et al., 2013; Wang et al., 2011; Velamuri et al., 2011). Due to a large number of studies conducted by researchers from various communities (e.g., product-service systems, service management, service marketing, service science, operations management, and service engineering), an abundant body of research has been produced over the past twenty years. Windahl and Lakemond (2010) conclude that the discussion of advanced industrial services lacks both a consistent body of literature and an extensive range of ambiguously defined notions. Some popular examples include “*solutions*” or “*integrated solutions*” (Davies, 2004; Foote et al., 2001; Wise and Baumgartner, 1999), “*service as product*” (Mathieu, 2001a, 2001b), “*functional sales or products*” (Alonso-Rasgado et al., 2004; Kumar and Kumar, 2004; Lindahl and Ölundh, 2001), and “*product-service systems*” (Goedkoop et al., 1999; Manzini and Vezzoli, 2003; Mont, 2002; Tukker, 2004). Based on previous studies (Baines et al., 2009; Clayton et al., 2012; Tukker and Tischner, 2006), we consider these integrated product-service offerings to be closely related concepts and varied forms of integration-, product-, service-, use-, or result-oriented product-service systems (PSSs) (Clayton et al., 2012).

In this context, service-infusion processes (Gebauer, 2008; Löfberg, Witell, & Gustafsson, 2010) are frequently described as step-by-step pathways (Matthyssens and Vandembemt, 2008; Oliva and Kallenberg, 2003; Penttinen and Palmer, 2007). During a service transition, manufacturers may occupy different positions on the products-to-services continuum, which provides extended offerings within the operative life cycle of a sold product (Gebauer, Edvardsson, Gustafsson, & Witell, 2010; Kumar & Kumar, 2004; Morris & Davis, 1992; Oliva & Kallenberg, 2003; Samli, Jacobs, & Wills, 1992). Using a variety of analytical dimensions, studies on servitization originally focused on categorizing services (Jacob and Ulaga, 2008). An example of this approach is Mathieu's (2001a) differentiation between services that support a product and services that support a client, an approach subsequently extended by other scholars (Antioico et al., 2008; Cova et al., 2000). Similarly, Oliva and Kallenberg (2003) distinguish between product- and process-oriented services and between transaction- and relationship-based services. Other researchers have completely or partially adopted this model (Kujala et al., 2010; Nordin, 2004; Penttinen and Palmer, 2007; Windahl and Lakemond, 2010). However, there are also alternative examples, including the value proposition (Ulaga and Reinartz, 2011), level of customization (Mathieu, 2001b; Nordin, 2004), and relational intensity (Mathieu, 2001a; Nordin, 2004; Oliva and Kallenberg, 2003; Ulaga and Reinartz, 2011). Two additional dimensions have been introduced by Windahl and Lakemond (2010), who distinguish between customer- and supplier-owned equipment, and by Kowalkowski, Brehmer, and Kindström (2009), who differentiate between bundled and unbundled services.

The existing literature has also shown that service strategies typically require the development of particular service offerings composed of different types of services (Gebauer, Paiola, & Edvardsson, 2010); therefore, service offerings manifest and correspond to service strategies

(Gebauer, Fischer, & Fleisch, 2010; Kohtamäki et al., 2013). According to Homburg et al. (2003), a service offering is defined as an emphasis on the sales and marketing of industrial services. A vast number of single services have been categorized based on some of the previously mentioned analytical dimensions. Although service offerings are typically product related and focus on the installed base, they increasingly include services as products that become business opportunities *per se* (Mathieu, 2001b; Oliva and Kallenberg, 2003; Windahl and Lakemond, 2010). Therefore, researchers have observed a shift in service offerings from basic to more advanced services (Nordin, 2004; Oliva and Kallenberg, 2003) and different types of solutions (Davies, 2004; Nordin and Kowalkowski, 2010; Windahl and Lakemond, 2010). Based on previous studies, we reflect the main dimensions when operationalizing service offerings (Figure 1).

Figure 1 Dimensions and types of industrial service offerings



SOURCE: Authors' elaboration, based on literature review.

Windahl and Lakemond (2010) acknowledge two perspectives when describing the service expansion process and highlighting previous studies. The transition inherent to service expansion is commonly described as consisting of different positions on a products-to-services continuum,

in which manufacturers provide extended service offerings for their installed bases throughout their products' operative lives (Kumar and Kumar, 2004; Oliva and Kallenberg, 2003; Stremersch et al., 2001). This transition is also characterized as an extensive strategic change in which customized life-cycle solutions are offered (Davies, 2004; Penttinen and Palmer, 2007; Windahl et al., 2004). Although both viewpoints stress the importance of the life-cycle approach, this perspective is not always explicitly stated; however, there are some exceptions (e.g. Gebauer, Edvardsson, et al., 2010) that attribute an analytical dimension to this perspective in the most extensive classifications of industrial-service offerings.

3. RESEARCH METHODOLOGY

In this study, the concept of life-cycle offerings emerges from an abductive process that combined a systematic review of previous studies with a multiple-case study to support and illustrate the conceptual discussion. We applied a nonlinear systematic blending in which “theoretical framework, empirical fieldwork and case analysis” co-evolved while swinging as a pendulum between the observed world and the theoretical model (Dubois and Gadde, 2002). We developed a precise search protocol and applied it while adhering to a systematic review methodology (Tranfield et al., 2003). We also identified significant academic contributions by searching three major databases. Our complementary empirical evidence stems from seven large global corporations in four industries. As described in the following sections, our evidence-based methodological approach depended on a first step in which we established a classification of life-cycle services from previous studies and then illustrated and conceptually discussed that classification using real case studies.

3.1. Systematic literature review

To evaluate the theoretical and empirical relevance of the concept of life-cycle offerings, a sample of articles was identified by adapting the methodological approaches of other researchers during a systematic review of the literature on the servitization of manufacturing (Baines et al., 2009; Baines, Lightfoot, Evans, et al., 2007; Lightfoot et al., 2013; Nordin and Kowalkowski, 2010; Velamuri et al., 2011). Thus, we identified a set of substantive keywords that were used to locate and classify the most relevant articles. Due to the existence of different “research communities” (Baines et al., 2009; Lightfoot et al., 2013), the purpose-selected set of keywords was sufficiently extensive to identify articles from those research streams.

To identify the relevant literature on life-cycle services, we searched for scholarly, peer-reviewed journal articles in English using selected keywords in the following major databases: (1) ABI Inform Global/ProQuest, (2) EBSCO (Business Source Premier, Academic Search Elite, and Econlit), and (3) Emerald Journals. Using the approach by Newbert (2007), we required the selected articles to contain a minimum of one of the following primary keywords (anywhere) in their text to avoid unrelated articles: “lifecycle”, “life-cycle”, “through life”, “through-life”, “lifespan”, or “life-span”. To ensure substantive relevance, we also required that the selected articles include a minimum of one of the following supplementary words in their title, keywords, or abstract: “industrial services”, “integrated solutions”, “customer solutions”, “service science”, “product service systems”, “outcome-based contracts”, “functional sales”, “functional products”, serviti*, “full-service”, “service solutions”, “service agreements”, “service contracts”, or “service

offering”. Because we did not limit the search to any specific area/industry, we did not combine our substantive keywords with any other word, such as manuf* or indust*. We intentionally removed a few potential keywords (such as “life time”, “long-term”, “service-dominant”, and PSS) because we considered them sources of noise after discovering that the databases returned many unrelated hits when these keywords were included.

Our first round of searching returned more than 950 hits (Table 1). After excluding duplicates and scanning the abstracts, we preselected 220 articles explicitly indicating that manufacturing firms should consider the concept of life cycle services when servitizing their offerings. After downloading these articles, we scanned them for relevance by checking other papers recommended by the search engines as related items (primarily, relevant conference proceedings). We also carefully examined the lists of references in the selected articles to detect additional potential papers. To validate our search, we performed multiple searches by randomly introducing the keywords into Google Scholar. We completed the search process when the additional retrieved articles appeared to be irrelevant. After adding a few more articles (primarily, relevant conference proceedings), the final pre-sample of references was composed of 237 articles from 72 academic journals.

Table 1 Summary of the selection process

	Number of references	ProQuest Central	EBSCO	Emerald Journals
Articles that indicate the importance of product life-cycle services after the first search (including a minimum of one primary keyword in the text and one secondary keyword in the title, abstract, or keywords).	958	181	329	448
Number of articles after eliminating duplicate items and scanning the abstracts for relevance.	220			
Number of articles after accounting for relevant references from other sources.	237			
Number of articles that address the concept of life-cycle services.	46			
Journals with a greater number of articles	Journal of Cleaner Production (18), Industrial Marketing Management (17), Journal of Manufacturing Technology Management (16), International Journal of Operations & Production Management (14), International Journal of Advanced Manufacturing Technology (11), Journal of Business & Industrial Marketing (11), Journal of Service Management (8), Journal of Quality in Maintenance Engineering (7), International Journal of Production Research (7), Journal of Engineering Design (6), Harvard Business Review (6), CIRP Journal of Manufacturing Science and Technology (6), Managing Service Quality (6), Journal of Marketing (5), and CIRP ANNALS—Manufacturing Technology (5).			
Authors with the largest number of contributions	Roy, R. (11), Kowalkowski (10), Gebauer (9), Sakao (7), Kindström (6), Markeset (6), Sundin (6), Shimomura (5), Aurich (5), Kumar, U. (5), Lightfoot (5), Tiwari (5), Witell (5), Kumar, R. (4), Lindahl (4), Mont (4), Shehab (4), Baines (4), Arto (4), and Alcock (4).			

SOURCE: Our elaboration, based on results from academic search engines.

Consistent with previous literature reviews, our review show an increase in the number of publications after 2005 (Lightfoot et al., 2013). More specifically, 187 of the 237 articles were published during the past nine years. After we scanned and gathered concepts and ideas from many of the pre-selected articles, we selected for additional reading and discussion 46 papers that analyze the concept of life-cycle offerings. According to the “extended” pre-sample, our systematic search also shows a significant concentration of journals from which the papers originate. As shown in Table 1, 144 of the 237 articles were published in 15 journals, which

represents all of the research streams identified by recent literature reviews (Baines et al., 2009; Velamuri et al., 2011). By repeating the pattern of previous literature reviews, some of the researchers on our list are distinguished by the number of their contributions. Although our keywords cover an extensive conceptual range, we may have overlooked a few articles during the search process due to differences in terminology. Recent publications may also have been overlooked because they are not cited in the literature or are not available in the databases. After considering the journals and the authors included in our list of references, we are confident that the selected items accurately represent all research streams.

3.2. Case studies

We complemented our systematic review with a multiple-case study. The qualitative research method is the most appropriate approach for understanding a phenomenon that has not been satisfactorily investigated (Gephart, 2004; Harker, 1998). Case studies are a particularly suitable choice when addressing subjects that have not been extensively examined (Leonard-Barton, 1990) and are justified when researchers have explored a relevant topic under difficult-to-replicate conditions (Dubois and Araujo, 2007; Dubois and Gadde, 2002; Dyer and Wilkins, 1991; Eisenhardt and Graebner, 2007; Siggelkow, 2007). Therefore, we used a multiple-case study as our research strategy to illustrate and discuss the concept of a life-cycle offering.

3.2.1. Case selection and sample

Case selection is a recurrent challenge when conducting case studies (Dubois and Araujo, 2007; Eisenhardt and Graebner, 2007). We used a straightforward “purposeful” sampling selection method. The selected companies are proper cases to illustrate the notion under consideration and provided uncommon research access (Eisenhardt and Graebner, 2007; Yin, 1994). Our companies have been implementing active servitization strategies while continuously redesigning their service offerings. Therefore, we considered these firms as “information-rich” cases warranting an in-depth analysis (Patton, 2002:231). The companies included in the study represent some of the most influential players in their representative markets. The first industry in our sample—pulp and paper—was represented by four companies. A single case company represented each of the remaining industries (power, mining, and chemistry). They were selected based on their analogical qualities to one another and to the pulp and paper industry.

3.2.2. Data collection process

Our data consisted of the total service offerings obtained from the web pages of seven companies in four industries that provide solutions for the “process industries” along with the interviews that were conducted to test those solutions. Company web pages were selected as a source because interview-based methodologies were thoroughly explored and provided a limited, example-based depiction of company offerings. The sample size of the offerings in these seven companies varied from 105 to 455 services per company. We subsequently interviewed company representatives to develop and readjust the service offerings. According to the interviewees, if all types of spare parts and consumables are considered separate services (which is debatable), then the maximum actual offering is 400,000 services per company. However, the limited sample size of the web pages of these companies provided a condensed picture of different service types and

concepts even after several specific services were omitted. Although the web pages of each company did not provide a comprehensive depiction of the offerings, they did provide a large sample size that described the reality of company offerings according to the interviewees. The 1,638 identified services were categorized using a framework of the most common analytical dimensions in the existing categorizations.

We also interviewed five specialized researchers to develop and readjust the model of life-cycle services. During the process, triangulation and different sources of active and passive data were applied to corroborate the accuracy of the data (Yin, 1994), to increase the reliability of our study (Beverland and Lindgreen, 2010), and to identify different aspects of the considered phenomenon (Dubois and Gadde, 2002). Information from web pages and interviews was supplemented by other sources of evidence to strengthen the validity of our cases (Gibbert et al., 2008; Yin, 1994). For instance, we collected supplementary information by analyzing company documents.

4. Results

4.1. Constructing the concept of life-cycle offerings: results from the literature review

“Durable manufactured products require added services as they advance through their life cycles” (Antioco, Moenaert, Lindgreen, & Wetzels, 2008:337). Numerous studies from various research streams have considered time when describing service offerings (Table 2). However, few explicitly introduce the life-cycle phases as an important analytical dimension when classifying industrial services. LaLonde and Zinszer (1976) distinguish services offered before, during, and after a sale. Samli, Jacobs, and Wills (1992) classify services into pretransaction or presale services (e.g., written customer policy), transaction services (e.g., order cycle time), and post-transaction or post sale services (e.g., maintenance). Subsequently, several alternative categorizations have been proposed, particularly during the last fifteen years. Many of these categorizations address specific types of industries and/or business models. For instance, the life-cycle business potential for project-based integrated solutions is typically addressed by considering several specific stages: bid, design, build, and operate (Brady et al., 2005; Davies, 2004; Roehrich and Caldwell, 2012).

Table 2 Stages in product life-cycle service offerings

Frambach, Wels-Lips, and Gündlach (1997)	1) Product services prior to the purchase decision, 2) directly relevant to the purchase decision, and 3) following the purchase decision.
Homburg and Garbe (1999)	1) Before the sale, 2) during the sale, and 3) after the sale.
Oliva and Kallenberg (2003)	1) Product specification, 2) installation, 3) operation, 4) upgrades, and 5) decommission.
Markeset and Kumar (2003)	1) Acquisition, 2) installation, 3) maintenance related, 4) performance enhancement, and 5) system retirement.
Maxwell and van der Vorst (2003) and Maxwell, Sheate, and van der Vorst (2006)	1) Function/product conception, 2) raw materials, 3) production process, 4) distribution, 5) consumption and 6) End-of-life (reuse/recycling/energy recovery/treatment/disposal).
Aurich, Fuchs, and De Vries (2004)	A. Product life cycle: 1) engineering, 2) production, 3) usage, and 4) recycling/disposal. B. Manufacturer’s view: i. Physical part: 1) product design, 2) product

	<p>manufacturing, 3) spare-parts manufacturing, and 4) product remanufacturing.</p> <p>ii. Non-physical part: 1) service design and 2) servicing (preparation, execution, and finalization).</p> <p>C. User's view: 1) product purchasing, 2) product usage, and 3) product disposal.</p>
Cunha, Duarte, and Alting (2004)	1) Design engineering, 2) manufacturing and assembly, 3) installation and usage, and 4) disassembly and recycling.
Ward and Graves (2005)	1) Design and engineering, 2) manufacturing, 3) in-service operations/customer support, and 4) disassembly.
Koivuaho and Laihonen (2005)	1) Resources, 2) resource processing, 3) manufacturing, 4) distribution, 5) use and service, 6) product take-back, product remanufacturing, 7) resource remanufacturing and 8) disposal.
Cohen et al. (2006)	1) Design, 2) production, and 3) customer support.
Lee et al. (2007)	1) Design, 2) resource provision (and recycling), 3) manufacturing (and remanufacturing), 4) logistics, 5) marketing/sales (and refurbishing), 6) use (and reuse), service and 7) end of life.
Lusch, Vargo, and Tanniru (2009)	1) Conception, 2) development, 3) production, 4) in-use, and 5) disposition.
Molloy, Siemieniuch, and Sinclair (2009)	1) Concept, 2) assessment, 3) demonstration, 4) manufacture, 5) in service, and 6) disposal.
Gebauer et al. (2010) and Paiola, Saccani, Perona, and Gebauer (2013)	Services supporting 1) pre-sales, 2) sales, and 3) after-sales.
Tillmann, Tzortzopoulos, and Formoso (2010)	1) Preproduction, 2) production, 3) distribution, 4) use, and 5) end of life.
Roy and Cheruvu (2009) and Datta and Roy (2010)	1) Design, 2) delivery, and 3) adaptation.
Wang et al. (2011)	1) Market research, 2) design, 3) manufacturing, 4) sales, 5) supply, 6) operations, 7) recycling, and 8) improvement.
Lelah et al. (2011)	1) Fabrication (including the procurement of raw materials and production), 2) transportation, 3) installation and use, and 4) end-of-life stage.

SOURCE: Our elaboration based on our review of the literature.

Although the representations are similar, some peculiarities exist depending on the research community to which each researcher belongs. While the classifications typically adopted in industrial marketing are primarily based on generic depictions (Cohen, Agrawal, & Agrawal, 2006; Frambach, Wels-Lips, & Gündlach, 1997; Gebauer, Edvardsson, Gustafsson, & Witell, 2010), other representations distinguish larger numbers of life-cycle stages. Researchers who work within the service operation/engineering streams emphasize manufacturing and logistic-related stages, while researchers who work within the product-service-system community also highlight raw-materials acquisition and the reuse/remanufacturing/recycling-related phases. The design stage (product and service) is central to both groups. However, with rare exceptions (Arto, Wikström, Hellström, & Kujala, 2008), researchers typically use examples to explain service offerings without detailing those services for each stage of the life cycle.

Initial similarities vanish when the analysis deepens, and we examine the composition of different service offerings at various stages of the life cycle. The concept of “life cycle” becomes particularly important when describing long-term service offerings. Researchers have traditionally used the label “product life-cycle services” to refer to basic after-sale services that

support the installed product base. For example, product life-cycle services is one category in the four-type taxonomy of the hybrid offering proposed by Ulaga and Reinartz (2011: 15). They propose that "...product life cycle services (PLS) refer to the range of services that facilitate the customer's access to the manufacturer's good and ensure its proper functioning during all stages of its life cycle, whether before, during, or after its sale...". Examples of this type of service consist of delivery, inspection, re-grooving, and recycling. Similarly, Kowalkowski et al. (2009) and Kindström and Kowalkowski (2014) use spare-parts provision, repair, safety, and inspection in their examples of life-cycle services. These offerings primarily support a product's expected function (Mathieu, 2001a). By extending the scope of the offerings based on the classification by Gebauer, Edvardsson, et al. (2010), Paiola et al. (2013) define the concept of life-cycle solutions, which consists of services that support the following areas: 1) the sales phase (services that augment the product offering and basic services for the installed base), 2) services that support the after-sales phase (advanced services for the installed base), and 3) services that support the pre-sales phase (design and construction). Those authors reserve the category of services that support the reconfiguration of customer activities (outsourcing services for customer processes) to include that category in the concept of "total solutions".

However, the concept of life-cycle offering includes this type service too. "Product lifecycle services are aligned to process-oriented services" (Raddats, 2011: 338). These services are typically intended to improve "customer's accessibility to product function, efficient and effective use of it, and retrieval of performance attributes" (Markeset & Kumar, 2003: 378). Therefore, product life-cycle services may include outsourcing services that are delivered through the entire life cycle. Some distinct examples (Table 3) include operating the product (Wise and Baumgartner, 1999), the modification of processes to work with the product (Allmendinger and Lombreglia, 2005), network implementation and asset management (Raddats, 2011), and designing a customer's production process (Paiola et al., 2013). As suggested by Meier (2004), contracting models comprise the most advanced stage of the life-cycle-oriented business models, which are considered to be user-oriented, "customer integrating networks" that include supplementary equipment (e.g. sensors) and "new financing concepts" (e.g., leasing, pay-on-production, and pay-for-performance) in which "equipment remains on the balance sheet of the supplier". Solution business models are "natural extensions into life-cycle thinking" (Storbacka, Windahl, Nenonen, & Salonen, 2013: 713).

Table 3 The conceptualization of life-cycle service offerings

Authors	Conceptualization	Examples
Wise and Baumgartner (1999)	"...maintaining a product throughout its life cycle, from sale to disposal..." (p.135).	Financing and leasing; maintenance, scheduling and capacity planning; parts-depot operations; refurbishment and resale; and product operation (p. 135).
Allmendinger and Lombreglia (2005)	"[Smart services]...intervene, assist, and reap benefits..." [from] "...activities that are directly connected with owning and using your product." (p. 135). "...the activities the customer engages in to procure, own, use, and dispose of [the product]" (p. 134). "Having outlined the customer's activities in the life cycle of your product, you'll want to take a second look, this time studying the adjacencies." (p. 136).	Financing the purchase; installing the product; modifying other products or processes to work with the product; adapting the product to its environment or to a specific use; maintaining the product and replacing parts; replenishing materials; training personnel to use the product; using the product; upgrading the product; disposing of product waste; and disposing of the product (p.136).
Raddats (2011)	"...product-related activities throughout the lifecycle of a PCB's [product-centric businesses'] products..." (p. 332).	Maintenance services; repair and overhaul; information management; operational support; systems integration; logistics support; supply-chain management; training and education; design and engineering; upgrade and life extension; technical support and consultancy; asset life-cycle services; repair and maintenance; testing and design validation; product retrofitting; refurbishment of

Authors	Conceptualization	Examples
		existing plants; turnkey solutions and systems (p. 342); installation and commissioning; asset management; performance solutions; financial services; integrated information technology services; care services; solutions; managed services; and network implementation (p.341).

SOURCE: Our elaboration based on the literature review.

Advanced offerings, such as performance offerings (Windahl et al., 2004), output-based solutions and availability contracts (Datta and Roy, 2010), product-service systems (Goedkoop et al., 1999), integrated solutions (Brady et al., 2005; Davies, 2004), project-based life-cycle solutions (Kujala et al., 2010), and total service solutions (Ward and Graves, 2005), increase product scope, configure a value-creating system, and require the use of a life-cycle approach (Tillmann et al., 2010). These offerings are composed of product- and process-oriented life-cycle services that are composed of discrete services (Davies, 2004; Raddats, 2011; Ward and Graves, 2005). For instance, Kowalkowski (2011) states that providing process optimization and predictable maintenance is a necessary condition for companies seeking to offer performance-based contracts. By taking advantage of modularity to address the trade-off between customization and standardization (Raddats, 2011; Sawhney, 2006) while designing scalable and repeatable solutions (Davies et al., 2006; Salonen, 2011; Storbacka et al., 2013), companies can simultaneously include different services in their evolving life-cycle offerings to deliver the proper value proposition to different segments of heterogeneous customers while implementing and managing multiple business models (Kindström and Kowalkowski, 2014; Kujala et al., 2010; Paiola et al., 2013; Raddats, 2011; Storbacka et al., 2013; Ward and Graves, 2005). Alternative entry points for conducting business with customers based on diverse service offerings exist at different stages of the life cycle (Artto et al., 2008).

The concept of life-cycle offerings is embedded in customer centric organizational thinking, which is based on long-term relationships (commitment and trust) and focused on understanding the activities that customers perform when using and operating a product—from product conception to design and production to operations and decommissioning (Cornet et al., 2000; Davies, 2004; Galbraith, 2002; Johnstone et al., 2009; Prahalad and Ramaswamy, 2000; Windahl et al., 2004; Wise and Baumgartner, 1999). Consequently, understanding the concept of life cycle requires the use of the following life-cycle perspectives (Aurich and Fuchs, 2004; Koivuaho and Laihonen, 2005): marketing (introduction, growth, maturity, and decline), production (development, production, sales, delivery, after-sales, and disposal/secondary use), and customer (purchase, operating/support/maintenance, and disposal). Segmenting services based on when they are delivered in relation to the sale of the product that they support is risky because customer expectations may differ from the definitions employed by providers that adopt a product centric perspective (Kumar and Kumar, 2004; Raddats, 2011). Adopting a customer's life-cycle perspective involves the consideration of three stages: product purchasing, usage, and disposal (Vandermerwe, 1993).

Building on McAloone (2006), Datta & Roy (2010: 144) highlight two life-cycle phases that are associated with a PSS: the life cycle of a physical object and the “activity life-cycle relationship between the solution provider and customer”. Evans (2007: 57) refers to “...a “life cycle” of the services that customers need from initial purchase to final disposal. In this model, the end-to-end life cycle of a given product line is brought together into a single service model, covering

activities such as customer management, product or service creation, implementation, operation, and support.” By examining a product’s life cycle through customers’ eyes (Allmendinger and Lombreglia, 2005; Brady et al., 2005; Wise and Baumgartner, 1999), manufacturers are able to develop service opportunities derived from suppliers’ primary activity-related areas and close adjacent areas (Allmendinger & Lombreglia, 2005; Sawhney et al., 2004).

A life-cycle offering requires the emergence of new “all-in-one” markets (Cacciatori and Jacobides, 2005) while persuading customers about the convenience of new value propositions (Penttinen and Palmer, 2007) and encouraging them to adopt a life-cycle standpoint (Matthyssens and Vandembemt, 2008). However, customers are also increasingly concerned about long-term costs (Helander and Möller, 2007) and system performance (Kujala et al., 2010). Thus, customers demand complete solutions (Aurich et al., 2010), including innovative life-cycle services to increase the availability, productivity, and efficiency of their methods of production (Meier, 2004). These offerings include outsourcing both noncore activities (Meier, 2004; Raddats, 2011) and rarely, but possibly, core processes (Gebauer, Friedli, & Fleisch, 2006; Storbacka et al., 2013). Providing customers the ability to achieve the lowest possible total cost of ownership (TCO) relative to comparable offerings can be a powerful selling argument in an effort to boost the potential value that a product and/or service can deliver to customers during the entire product life cycle (Anderson and Narus, 2004; Carr and Ittner, 1992); therefore, this condition can be a source of sustainable competitive advantage (Slater, 1996).

The acquisition cost of a product or capital expenditure (CAPEX) is only a part of the TCO. By also considering operational expenditures (OPEX), which include operating and maintaining a product during its life cycle (Davies, 2004; Wise and Baumgartner, 1999), advanced long-term offerings typically attempt to minimize capital costs and guarantee availability (Alonso-Rasgado et al., 2004). With predictive maintenance, for instance, suppliers can improve system reliability while reducing life-cycle costs (Holmström et al., 2010). The TCO and the life-cycle cost analysis are closely related concepts (Ellram and Siferd, 1998). For manufacturers seeking to offer rental services, performance-based contracts (Kowalkowski, 2011), and availability contracts (Datta and Roy, 2010), it is necessary to provide life-cycle cost calculations using capital budgeting or present-value methods (Matthyssens and Vandembemt, 2008). Companies have adopted different long-term approaches, such as through-life (Baines and Lightfoot, 2014; Datta and Roy, 2010; Ward and Graves, 2005) and life-cycle management (Aurich and Fuchs, 2004; Dimache and Roche, 2013; Schweitzer and Aurich, 2010). These approaches focus on “required user functionality” while managing and optimizing a company’s product through its life cycle (Aurich, Mannweiler, & Schweitzer, 2010: 141). However, using an extensive list of techniques to consider the whole life-cycle cost (WLCC), Datta and Roy (2010: 147) conclude that “studies in WLCC are focused on product and are primarily carried out at the design stage with very little knowledge of maintenance- or operation-associated cost drivers and processes”.

Although the life-cycle profit management perspective is pivotal for suppliers (Auguste, Harmon, & Pandit, 2006; Kindström & Kowalkowski, 2009), creating appropriate offerings from a customer perspective in collaboration with customers is also a crucial factor for obtaining the benefits of servitization (Raddats, 2011). Combining products and services in a flexible manner to address heterogeneous customer needs is crucial when life-cycle solutions are provided (Windahl and Lakemond, 2010). Beginning during the design phase manufacturers and

customers must plan and co-develop maintenance and product-support concepts to secure product functionality and performance at an acceptable cost (Markeset and Kumar, 2003) in order to prevent unnecessary waste and equipment unavailability caused by downtime and ineffective strategy implementation (Markeset and Kumar, 2005). Risk adoption and value creation are two major concerns for manufacturers when designing advanced service offerings (Lightfoot et al., 2013).

One important aspect is to design (Geum and Park, 2011; Sundin et al., 2009) and develop (van Weenen, 1995) the physical product (product engineering) and services (service engineering) in an integrated manner and from a life-cycle perspective (Aurich et al., 2006; Cavalieri and Pezzotta, 2012; Datta and Roy, 2010; Meier, 2004). The target is repeatedly placed on designing and selling PSSs to deliver desirable user functionality while attaining long-term societal impact through environmentally sustainable production and consumption (Baines, Lightfoot, Steve, et al., 2007; Jovane et al., 2008; Manzini and Vezzoli, 2003; Mont, 2002). Numerous studies also consider product remanufacturing to be a central life-cycle activity (Ahn, 2009; Mont et al., 2006; Robotis et al., 2012; Sundin et al., 2009; Östlin et al., 2009).

Many different methodologies and tools for the development of PSS offerings have been developed during the last decade (Geum and Park, 2011; Kuo et al., 2009; Maussang et al., 2009; Phumbua and Tjahjono, 2012). Eco-design (Heiskanen and Jalas, 2003; Lelah et al., 2011) and life-cycle design (LCD), for example, are efficient methods of environmentally friendly design that were developed during the 1990s (Roy, 2000). These studies demonstrate a strong customer (Rese et al., 2009) and service orientation beginning at the design of the PSS (Geum and Park, 2011) and also employ an approach in which sustainability is considered throughout the life cycle (Pawar et al., 2009).

According to Wang et al. (2011), two primary domains with different terminologies but similar connotations can be identified when analyzing methodologies for PSS development. First, authors working in the stream known as functional product development (FPD) propose different methodologies of FPD in which life-cycle products and services are developed in an integrated manner (Alonso-Rasgado et al., 2004; Alonso-Rasgado & Thompson, 2006; Isaksson, Larsson, & Öhrwall Rönnbäck, 2009; Lindahl & Ölundh, 2001). Second, due to dissatisfaction with traditional fields, such as marketing-based new service development (NSD) and operation-based service design (SD) (Cavalieri and Pezzotta, 2012), the discipline known as service/product engineering (SE/SPE) adapts engineering models, tools, and methods to the service sector while establishing the systematic design and development of services and the management of service development processes (Aurich et al., 2010; Wang et al., 2011). SE, with its extensive definition of service (Arai and Shimomura, 2004; Hara et al., 2009; Sakao and Shimomura, 2007), has become a new conceptual stream for the design of a PSS (Geng et al., 2011).

A recent article by Cavalieri and Pezzotta (2012) includes an extensive literature review. Those authors identify the primary structured methodologies, such as CAD (Komoto and Tomiyama, 2008; Sakao, Shimomura, et al., 2009), while presenting an extensive list of development process models and commonly used methods. However, those authors also conclude that by excluding application of the concept of life-cycle engineering (LCE), the theory of life-cycle assessment (Aurich et al., 2006, 2010), and the integrated product and service engineering methodology

(Lindahl, Sundin, Rönnbäck, Ölundh, & Östlin, 2006), most studies only focus on “the beginning-of-life phase” (Cavalieri & Pezzotta, 2012: 282). In particular, Aurich et al. (2006: 1482) note that “the design of technical services is still predominantly performed with little or no systematization... detached from the product design”. They identify three design objects when performing key activities during the service design: the result-oriented product dimension (availability, performance, lifetime, and eco-efficiency), the activity-oriented life-cycle process dimension (order taking, servicing, maintenance, and training), and the result/activity-oriented information dimension (collecting/sharing information).

The availability of information is a critical resource (Lehtonen et al., 2012). Consequently, the design and implementation of effective knowledge and information management systems to support modularity (Storbacka et al., 2013) and learning from in-service experiences throughout the product life cycle have become a source of competitive advantage and may determine the success and profitability of complex relationship-based industrial service offerings (Azarenko et al., 2009; Davies, 2004; Goh and McMahon, 2009; Johnstone et al., 2009; Koivuaho and Laihonen, 2005; Pawar et al., 2009). Because technology supports service processes, ICT systems are critical to providing advanced-life-cycle industrial services (Kowalkowski and Brehmer, 2008). Accurate cost estimation and risk assessment are important determinants of a provider’s profitability (Azarenko et al., 2009; Ward and Graves, 2005), which increases the value of reliable information and systematic performance measurement (Schweitzer and Aurich, 2010; Storbacka et al., 2013).

With respect to the embedded transfer of risk from customers to manufacturers (Aurich et al., 2006; Azarenko et al., 2009), a few important aspects should be considered when analyzing life-cycle offerings. To increase performance and reduce costs, terms included in long-term agreements are key tools for aligning parties’ divergent incentives (Aurich and Fuchs, 2004; Azarenko et al., 2009). Suppliers may design performance contracts to protect themselves from customers’ natural desire to unbundle many of the operational expenditure services (Storbacka et al., 2013). Pricing logic is also an important concern when examining profitability and considering value appropriation in the context of life-cycle service offerings (Roegner et al., 2001; Stremersch et al., 2001; Windahl et al., 2004). Some researchers have suggested that innovative revenue models, such as usage-, performance-, and value-based pricing, is the right approach (Bonnemeier et al., 2010; Sawhney, 2006). Companies use diverse models for the same product at different phases of the life cycle (Cohen et al., 2006). Others try to determine the optimal burn-in time and the ideal warranty period (Shafiee et al., 2013). Robotis, Bhattacharya, and Van Wassenhove (2012) conclude that bundles should be priced using a “skimming strategy throughout the product life cycle”.

In addition, suppliers frequently must build partnerships or use their networks to deliver complex value propositions (Davies et al., 2007; Ward and Graves, 2005; Windahl and Lakemond, 2006). Davies et al. (2007) propose two ideal types of organizing the integrated sale and delivery of solutions: (1) a system integrator that coordinates the integration of components supplied by other firms, and (2) a vertically integrated system seller that produces all of a system’s product and service components. Those authors have no evidence to support either of these pure types and suggest an increase in a complex hybrid form that combines the advantages of both pure types. Because extending product life through servicing may prevent the purchase of new

products, manufacturers must have clear estimates to demonstrate that gains from services offset losses from not selling new equipment. Prolonged product life can decelerate technical progress because the novel technology embedded within products “will then be distributed and used over longer periods and so will be replaced much later” (Brouillat, 2009: 439).

4.2. Case description and case analysis

4.2.1. Valmet

Valmet (formerly a division of Metso Corporation) is a large Finnish global technology and service supplier that delivers to customers in the pulp, paper, and power industries. Valmet generates 2,703 million in net sales, 38% of which is derived from the service business, and its target markets generate 11.3 billion Euros. Its operating profit is 189.2 million Euros. Valmet’s offerings range from production lines, expert services, and maintenance services to spare and wear parts. According to its web site, Valmet offers 455 services.

4.2.2. Voith

Voith is a large German global engineering company with a portfolio that includes plants, products, and industrial services. The operative business consists of four group divisions: Voith Hydro, Voith Industrial Services, Voith Paper, and Voith Turbo. During fiscal year 2011-12, the Voith Group generated net sales of 5,724 million Euros—47% from Europe, 27% from the Americas, and 24% from Asia. In the same year, Voith generated an operational income of 341 million Euros and a net income of 114 million Euros. Thirty-eight percent (2.2 million Euros) of the company’s net sales during that time derived from service sales. Voith Paper, which is the focus of this study, provides both products and services to customers in the paper industry. Its products range from complete automation lines and solutions to single spare parts and consumables, and it offers services that range from maintenance services to optimization services and technical support. Voith Paper generated net sales of 1,738 million Euros during fiscal year 2011-12 and a net income of 84 million Euros. According to its web site, Voith offers 193 services.

4.2.3. Andritz

Andritz Group is a large Austrian global technology and service supplier that delivers to customers in process industries. During 2011, Andritz generated revenue of 4,596 million Euros, of which 27% (1,241 million Euros) derived from service sales—1,731 million Euros from Europe, 1,153 million Euros from Asia, and 951 million Euros from South America. In 2011, Andritz’s operating income was 386 million Euros. This study focuses on the company’s pulp and paper division, which generated 1,856 million Euros in net sales. The target markets for the division generated 11.3 billion Euros. The service sales comprised 30% (557 million Euros) of the pulp and paper division’s net sales. The operating income of the division was 137 million Euros. Andritz Pulp and Paper offers products ranging from complete production lines to single components and solutions that support customer functions. Its services include maintenance contracts, equipment optimizations and upgrades, engineered-wear products, replacement parts, and technical support. According to its web site, Andritz offers 105 services.

4.2.4. ABB

The ABB Group is a multinational company that is headquartered in Switzerland. ABB delivers to industrial and commercial customers in approximately 100 countries. In 2011, ABB generated revenues of 37,990 million Euros, operating income of 4,667 million Euros and a net income of 3,315 million Euros; 39% of its revenues derived from sales in Europe, 32% from sales in Asia, and 25% from sales in the Americas. The ABB Group is divided into five segments: power products, power systems, discrete automation and motion, low-voltage products, and process automation. This study primarily focuses on two divisions—discrete automation and motion and process automation—both of which primarily deliver to customers in varying process industries. In 2011, the discrete automation and motion division generated revenues of 8,806 million Euros and an operating income of 1,664 million Euros, whereas the process-automation division generated revenues of 8,300 million Euros and an operational income of 963 million Euros. The ABB Group provides an extensive variety of products and services, such as power and automation technologies. The products offered by ABB range from single-wear products and spare parts to turnkey plants; services provided by the ABB Group include maintenance, repair, overhaul, installation, and technical support services, along with different types of optimization, upgrades, automation, and training. According to its web site, the ABB Group offers 426 services.

4.2.5. Wärtsilä

Wärtsilä is a large Finnish global company that delivers power solutions to marine and energy markets. In 2012, Wärtsilä generated net sales of 4,725 million Euros; its operating sales generated 515 million Euros. The company is divided into three segments: marine solutions, power plants, and services and support. In 2012, Wärtsilä Services generated net sales of 1,908 million Euros, which comprised 40% of the company's total net sales. This study focuses on services for power plants. Wärtsilä's products include complete plant deliveries and spare parts; the services that it offers include operations throughout the installation life cycle. Wärtsilä divides its service functions into four categories: life-cycle efficiency, services and support, spare parts, and field services. In the developed markets, power-sector demand is primarily driven by CO₂-neutral generation and a reduction in older, coal-based power. In the shipping and shipbuilding industries, the company's largest opportunities are in environmental and fuel-efficient solutions. The demand for the company's services is dependent on the total installed base in the power plants and marine sectors; this development is stable. According to its web site, Wärtsilä offers 218 services.

4.2.6. Neste Jacobs

Neste Jacobs is owned by the Finnish company Neste Oil (60%) and the American company Jacobs Engineering (40%). Neste Jacobs is a global provider of technology, engineering, and project services for the oil and gas, bio refining, petrochemical, and chemical industries. The company generated net sales of 79 million Euros in 2011. Neste Jacobs offers few physical

products; instead, it focuses on advanced industrial services and specializes in engineering, procurement, and construction management services in close co-operation with its clients. Neste Jacobs differs from the other companies studied because it was founded by industrial companies but does not possess a strong manufacturing background. Neste Jacobs also offers services such as life cycle, troubleshooting, and commissioning. The company's strategy is to build long-term partnerships; a high percentage of its work is based on repeat business from existing clients. As a part of its strategy, Neste Jacobs seeks growth in new areas, such as technology development and consulting. According to its web site, Neste Jacobs offers 118 services.

4.2.7. Outotec

Outotec is a Finnish global company that delivers both technologies and services to the metal and mineral-processing industries. More than 80% of its sales derive from its core businesses and the remainder is increasingly obtained from the energy, chemical and industrial water-treatment industries. In 2012, Outotec generated net sales of 2,087 million Euros, an operating profit of 184 million Euros and a net profit of 128 million Euros. Outotec operates globally through four business areas: nonferrous solutions, ferrous solutions, energy, and light metals and environmental solutions and services. The first three of these areas focus on providing technology solutions for customers in the minerals and metals industry and the last area focuses on industrial services. Sales of services, which are the focus of this study, totaled 476 million Euros in 2012, comprising 23% of Outotec's sales. Outotec offers services and service solutions that include spare parts, maintenance and technical services, modernization, and operations. In the metal and mineral-processing industries, the company's investment decisions are increasingly driven by environmental and energy-efficiency factors. This strategy increases the demand for advanced technologies and sustainable solutions for mineral and metal processing and environmental solutions. The company's service sector is expected to expand by penetrating the old installed base and increasing the services delivered to the new installed base. According to its web site, Outotec offers 123 services.

Table 4 provides detailed information about the cases, the number of services provided by each case firm, and the target and scope (horizontal and vertical) of services. In the following cross-case analysis, the companies' service offerings are compared.

Table 4 Case analysis

	Valmet (Formerly Metso; pulp, paper and power)	Voith (Paper)	Andritz (Pulp and paper)	ABB (Discrete automation and motion and process automation)	Wärtsilä (Services)	Neste Jacobs	Outotec (Service business)
Sales (M€) (target business unit/s)	2,703	1,661	2,282	16,127 (revenues)	1,908	91	506
Employees (target business unit/s)	11,000	9,223	6,774	55,518	11,000	1,000	1,565
Main products (entire company)	Technology and services for pulp, paper, and board	Technologies and products for the entire paper manufacturing process.	Machinery for paper and paperboard	Automation and power technologies	Technology and products for the marine and energy markets	Solution provider (oil & gas)	Mechanical and process engineering design
Service share of sales (entire company)	38%	38%	30%	N.A.	40%	100%	23%
Number of identified services*	455	193	105	426	218	118	123
Main Service offerings *	Administrative services	0	0	0	1	0	2
	Basic (installed base) services	292	68	52	163	74	38
	Consulting services	15	1	1	38	36	9
	Customer services	1	2	1	7	8	2
	Financing services	3	0	1	1	5	0
	Maintenance services	14	6	4	24	17	1
	Operational/outourcing services	19	2	2	39	26	10
	Optimization services	76	75	27	119	37	14
	Research and development services	29	36	17	20	13	49
	Recycling services	2	1	0	2	0	0
Supply management and warehousing	4	2	0	12	2	0	
Target*	Services supporting products	84.1%	86.5%	82.9%	72.8%	60.5%	60.2%
	Services supporting customer processes	15.9%	13.5%	17.1%	27.2%	39.5%	39.8%
Scope*	Discrete service	26.2%	39.4%	28.6%	28.6%	17.4%	17.9%
	Bundle/solution	73.8%	60.6%	71.4%	81.4%	82.6%	82.1%
Duration*	Short term	18.7%	74.6%	72.4%	66.9%	64.2%	69.9%
	Long term	81.3%	25.4%	27.6%	31.1%	35.8%	30.1%

SOURCE: Published data from 2012. The elaboration is based on our database.* Estimations are based on the number of services listed on the companies' web sites.

4.3. Cross-case analysis: Synthesizing the model for life-cycle offerings

Based on the abductive process in interaction with the theoretical and empirical data, we summarize the concept of life-cycle service offerings (Figure 2). From the supplier perspective, the final framework classifies life-cycle services as pre-sales, sales, after-sales, and disposal/de-commissioning-phase services. From the customer perspective, the framework classifies life-cycle services as purchasing, usage, and disposal services. Based on previous studies (Mathieu, 2001a; Oliva and Kallenberg, 2003), we also distinguish between services supporting the product (SSP), services supporting customer processes (SSCP), transaction-based services and relation-based services.

Our analysis shows certain similarities regarding the scope of the offerings across cases. Although companies focus on bundles and solutions instead of discrete services, these integrated offerings exhibit a short-term orientation. Because companies use modular platforms, many service offerings may be implemented at different life-cycle stages (Artto et al., 2008). Aligned with the findings of Artto et al. (2008), companies focus on different phases of the life cycle but do not employ a full life-cycle approach for all customers. Although companies can adopt this approach, customers are frequently not ready for long-term commitments or do not completely recognize the benefits related to a full life-cycle offering. Industry matters in this regard. Thus, helping customers to visualize the value of their offerings is an important concern for companies that sell advanced services (Kindström et al., 2012).

Although our case companies can be considered leaders in their respective markets and the process of servitization in these companies began several years ago, the majority of services remain oriented towards product support. As our data suggest, these offerings that are typically referred to as “customer service” (Gebauer, Edvardsson, et al., 2010; Mathieu, 2001b) can be considered as a commodity for companies that have already expanded from products to services. Because these offerings represent a threshold for competing in the service market, many companies do not mention them on their web sites. All of the case companies, however, offer many of these services during the sales phase, such as product demonstration, cost-benefit analysis, standard product demonstrations, benefit visualization, and warranties and insurance. Product documentation/information, customer information, help-desk support, expert sales, and ordering system services are also delivered in the after-sale phase (usage phase, from the customer’s perspective).

Figure 2 Life-cycle service offerings of industrial firms

Manufacturers' view	Pre-sales	Sales phase	After-sales phase				De-commissioning		
R&D services 3/3 R&D oriented support (4) 4/4 System design (21) 3/3 Customized service development and prototype design (6)		7/6 Technology startup/ shutdown service (17)						Relational-based services SSCP	
		Operational / Outsourcing services	5/5 Function co-ordination (11)	4/4 Performance/ output guarantees (8)	1/1 Network infrastructure providing services (1)				
			1/1 Service for operating the product sold to the customer	1/1 Product leasing with operatives					
			5/5 Short-term project management service (38)	2/2 Complementing network services (4)					
			0/0 Full outsourcing contracts	7/2 Network orchestrator services (2)					
			Supply management & warehousing 2/2 Just in time delivery (3) 4/4 Spare parts management (8)	Maintenance services 5/5 Full service contracts (17)					
				5/4 Full maintenance contracts (13)	Optimization services	6/5 Outsourcing separate functions/ parts of functions (27)			
		5/5 Product customization service (24)	4/4 System integration (11)	1/1 Supply services for other manufacturers' products (1)	5/5 Predictive maintenance (9)	6/6 Process optimization (34)	5/5 Site lifecycle services (start-up, relocation, shut-down) (13)		
		7/7 New product development (23)	6/6 Data collection & analysis (60)	3/2 Supply services (3)	5/5 Preventive maintenance (15)				
		5/5 New product testing (26)							
Customer services 7/3 Cost-benefit analysis (3) 7/0 Standard product demonstrations 7/1 Benefit visualization (1) 7/0 Warranty & insurance			2/2 Warehousing services for own-manufactured products (2)	7/5 Planned maintenance activities (19)	6/6 Enhanced control solutions (automation) (135)	Recycling services	Transactional-based services SSP		
			Procurement service	7/2 Transactional maintenance services (3)	7/7 System modification/ modernization (28)	6/6 Technology modification/ modernization (98)		2/2 Recycling service (3)	
			7/3 Product transportation/ delivery service (6)		3/3 Overhauls (4)	7/7 System optimization (34)		3/2 Disposal (2)	
				Basic (installed base) Services	7/7 Inspection & diagnoses services (78)	6/6 Basic control solutions (automation) (34)		2/2 Cleaning service (13)	
				7/4 Installation services (13)	7/6 Repair service (46)	0/0 Maintenance for similar products of other manufacturers		7/7 Basic operative lifecycle service packages (121)	0/0 Product pick-up from customer's site
				7/7 Spare parts and consumables (414)					
				7/1 Help-desk support (1)	7/1 Expert sales service (1)	7/1 Customer information (1)			
				7/3 Product documentation service (3)	7/2 Ordering system (3)	7/5 Product information (10)			
				7/6 Technical training & consulting (82)		2/2 Extended warranty (2)			
Consulting services 6/5 Business consulting & training (24)		5/3 Process-oriented training (8)					SSCP		
		3/3 Administrative training (4)	1/1 Expert labor hire (1)						
				7/0 Billing service	6/1 General administrative services (2)				
					2/2 Lease (3)	0/0 Rental			
Administrative services Administration out-tasking			1/1 Customized administrative services (1)				SSCP		
Financing Services Product PURCHASING			2/0 Additional insurance service	2/2 Monetary financing service (5)	2/2 Lease (3)	0/0 Rental	Product DISPOSAL		
				Product USAGE					
Users' view									

SOURCE: Elaboration based on our database.

The number of companies that provide an offering/the number of companies that explicitly mention the offering on their web page (the number of this type of service, as listed on company web pages).

During the after-sales phase, basic services and optimization services represent the largest share of services compared to the total number of services offered. With respect to the latter, almost all companies are able to deliver all services (e.g., modernization and/or optimization of system/product/processes and enhanced-control solutions), whereas spares and consumables represent an important share of the services within the former offering, which may comprise 50% of total service revenues. Repair, inspection and diagnosis, and automation are also prominent services in our sample. None of our cases, however, has serviced the installed base of its competitors. This result supports the findings of previous studies (Arto et al., 2008). In the decommissioning phase, only three companies offer a recycling-related service and none provide a remanufacturing-oriented service. As suggested by Pawar et al. (2009: 476), “new design methodologies” and “new business models” are probably required for business managers’ acceptance of more socially and environmentally oriented PSSs, despite strong academic support for such PSSs.

Although basic maintenance services, such as transactional and planned maintenance, are included in all of the analyzed service offerings, five of the companies also offer more complex services, such as preventive and predictive maintenance, full maintenance, and full-service contracts that support customer processes. With respect to these services, a network orchestrator, short-term project management, outsourcing of separate functions, and system integration are the most relevant outsourcing offerings provided by the case companies. Companies are not geared towards offering services for operating products sold to the customer and leasing products with operatives. When analyzing services that are oriented towards assuming an end-user’s operations, the conclusion by Oliva and Kallenberg, (2003: 170) which suggests that “given their current state as early stage service providers, this is a transition that most manufacturing firms probably will not initiate soon”, remains valid.

In addition, the share of services dedicated to supporting research- and development-related activities is also significant in each case. This fact probably indicates the importance of participating in the design and early development of a product as a way to advance the entry point into a customer’s business (Wikström et al., 2009), which creates a dual opportunity to simultaneously lock in customers and sell long-term service agreements. It is also a way to control a product’s characteristics from the beginning to facilitate subsequent maintenance and updates. This finding is particularly relevant when providing advanced services, such as performance guarantees. However, these offerings are predominantly based on services that support products, such as the development and testing of new products.

However, other offerings are not particularly extensive among the analyzed companies. First, offerings that consist of supply-management and warehousing-related services extend beyond the core interests of our case companies. In addition to product delivery/transportation services, which are offered by all of the companies, only spare-parts-management services serve an important role. Because spare parts comprise an enormous business, four out of the seven companies offer these related services to support customers’ processes. Second, administrative and financial services are also found in the inception stage. Two of the four companies that offer financial services have formal portfolios, which are (in both cases) incomplete. The most extensive administrative services are general and billing services, which are rarely mentioned on the companies’ web sites. Finally, when considering consulting offerings, the most generalized

services are those that focus on business and technical (SSP) consulting and training activities.

As noted by Kindström and Kowalkowski (2014: 102), our cases suggest that “service innovation takes place throughout the service typology”, whereas “firms are not limited to a predefined set of service innovation trajectories, from less to more complex, as prior research generally suggests”. Consequently, companies may not follow a single strategy, but instead may simultaneously follow the four strategies for providing solutions identified by Paiola et al. (2013: 400): “(A) Selling after-sales services, (B) integrating after-sales solutions, (C) selling life-cycle solutions, and (D) orchestrating total solutions”.

5. Conclusions and implications

5.1. Theoretical implications

This study critically reviews and explains the frequently mis-specified concept of life-cycle offerings and illustrates the types of services that leading corporations include when providing life-cycle service offerings. Our research extends the literature on servitization, integrates theoretical insights from different research communities, and presents an empirical illustration of life-cycle offerings, which is based on examples from large companies. The majority of the cases studied differ from the iconic firms that are usually proposed as examples and are leaders in their markets. Thus, we explore examples of different companies that have begun the process of servitization due to market relevance but that are not well-known, idyllic cases, which frequently provide a biased and idealistic depiction of the process.

This study extends the industrial-service literature (Baines et al., 2009; Boehm and Thomas, 2013; Lightfoot et al., 2013) by developing the concept of life-cycle service offering and by mapping a variety of life-cycle service types. Combined with a systematic literature review, the data enable researchers to develop a framework for life-cycle services. The designed framework facilitates future conceptual developments and enables manufacturing-firm managers to integrate services into product life cycles, which reveals the need for additional studies (Windahl, 2010). The framework enables analyses, the establishment of benchmarks, and the development of life-cycle offerings to facilitate long-term value creation and appropriation.

The developed framework classifies life-cycle services from the manufacturer’s perspective as pre-sales, sales, after-sales and disposal/decommissioning-phase services. From the customer perspective, the framework classifies life-cycle services as purchasing, usage, and disposal services. Identified services were classified into categories, such as administrative services, basic (installed base) services, consulting services, customer services, financial services, maintenance services, operational/outsourcing services, optimization services, research and development services, recycling services, and supply management and warehousing.

Some of the life-cycle service offerings among the company cases were typical. Basic, optimization, and research and development services are offered by many companies. In addition, preventive and predictive maintenance, along with full-service contracts, are relatively typical among the case companies. Warehousing and financial services are relatively rare among

the case companies. Because our case companies are considered to be significantly servitized, they are not representative of the industry. The cases provide a relatively extensive portfolio of life-cycle services based on a variety of service strategies (Kindström & Kowalkowski, 2014; Paiola et al., 2013).

5.2. Managerial implications

Our framework and discussion facilitate future conceptual developments and enable manufacturing-firm managers to analyze, benchmark, and develop their firms' life-cycle offerings to facilitate long-term value creation and appropriation. The developed framework is important to managers who are responsible for the development of service solutions, because it demonstrates how services can be integrated into a product's life cycle. Studies suggest product-service blueprinting as an approach to facilitate product-service integration.

Life-cycle services provide a means to differentiate integrated solutions from product manufacturers by providing add-on services. Because services may be relatively easy to imitate, protective actions should be recommended. The integration of services into a product's life cycle may provide a means to decrease the imitability of services that protect a servitized manufacturer's competitive advantage.

Some manufacturers are moving towards more advanced integrated solutions. Offering an advanced service does not require that customers purchase that service in large numbers. Thus, an appropriate life-cycle concept, that is, integration of services into a product's life cycle, may be a worthwhile strategic action that supports product sales and facilitates service sales. Selling more advanced services and solutions will require additional sales processes.

To understand the challenges of life-cycle service delivery, a manufacturer that is developing an advanced service portfolio, such as life-cycle services, should be aware of the resources needed to effect timely service delivery. Thus, manufacturers should develop an appropriate capability base to support service delivery for the product life cycle. Because the development of a service culture within a technology organization is complex, we suggest the development of a life-cycle service offering to servitize a manufacturer's organization. Service co-production can provide an appropriate tool for advancing service-dominant logic within a technology organization.

5.3. Limitations and suggestions for future research

This study contains limitations. The sample must be appropriately extended to generalize its findings. Although our empirical evidence enables us to present a detailed illustration of life-cycle service offerings, the data are insufficient for investigating significant issues that are highlighted in our literature review. Because our study is limited to life-cycle service offerings, future studies should consider the business models in which service offerings are embedded.

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