Developing and validating a multi-dimensional scale for operationalizing industrial service offering

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Abstract

Purpose – The purpose of this paper is to develop a new scale for measuring the scope (i.e. breadth and depth) of industrial service offering.

Design/methodology/approach – The scale and its constructs are developed by combining the key insights from prior literature and practitioners gained through expert interviews; validating the constructs by 3 item-construct validation rounds with 9 academic experts; and by testing and further revising the scale, with a sample of 91 manufacturing firms.

Findings – The distinct contribution of the study is the construction and validation of a new multi-dimensional scale for operationalizing the scope of industrial service offering. In addition, the identified service categories (i.e. pre-sales services, product support services, product life-cycle services, R&D services and operational services) extend the current literature on service typologies.

Research limitations/implications – The data are somewhat biased toward small- and medium-sized industrial firms. Hence, the development of the measurement in the context of large industrial firms provides one fruitful avenue for further research.

Practical implications – For managers of industrial firms, the identified service categories provide novel insight on how to develop, bundle and commercialize industrial services to their varying customer segments.

Originality/value – This study develops a multi-dimensional, fine-grained, statistical and relationship-level scale for measuring the scope of industrial service business. Moreover, this study tests and further develops the scale with quantitative empirical data.

Keywords Industrial services, Manufacturing firms, Measurement development, Service business, Service offering

Paper type Research paper

1. Introduction

Manufacturing firms are increasingly shifting the focus of their businesses from tangible products to intangible services (Antioco *et al.*, 2008; Fang *et al.*, 2008; Gebauer *et al.*, 2011; Jacob and Ulaga, 2008). The reasoning behind such strategic shift encompasses the need to achieve competitive advantage (Anderson and Narus, 1995; Heskett *et al.*, 1997) by locking in customers and by locking out competitors (Neely, 2008) as well as to generate new and more stable sources of revenues (Quinn *et al.*, 1990; Wise and Baumgartner, 1999) and higher profit margins (Mathe and Shapiro, 1993). This implies that industrial companies are moving away from simply selling industrial goods as traditional manufacturing companies to strategically reposition themselves by offering "integrated solutions" (Tuli *et al.*, 2007; Helander and Möller, 2008) or "hybrid offerings" (Ulaga and Reinartz, 2011).

The literature acknowledges that such repositioning labeled as, for example, servitization (Kastalli and Van Looy, 2013) or service infusion (Ostrom *et al.*, 2010) requires various changes in a firm's corporate culture and human resource management (Homburg *et al.*, 2003); organizational structures (Sheth and Sharma, 2008; Neu and Brown, 2005); pricing methods (Steiner *et al.*, 2016); and internal capabilities (Ulaga and Loveland, 2014; Rönnberg Sjödin *et al.*, 2016a, 2016b). While these studies unquestionably generate valuable knowledge on this topical phenomenon, the essential question of how to measure the scope of industrial service business – that is, the breadth and depth of the service offering of an industrial firm – has received limited attention in the academic literature (Parasuraman, 1998).

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Prior studies acknowledge this shortcoming related with a need for a multi-dimensional scale for measuring industrial services. According to Gebauer (2008, p. 281), "the literature offers little conceptualization of service offerings as a key dimension in the service strategy [of manufacturing firms]". Indeed, several studies in the field emphasize the need to investigate the impact of service business and service strategy on performance (Gebauer *et al.*, 2010; Kastalli and Van Looy, 2013). Yet, sophisticated operationalization of industrial service business for conducting such studies does not seem to exist. Ostrom *et al.* (2010, p. 26), for example, highlight that the topic of "'creating and enhancing service standards and metrics that link to financial outcomes of the firm' is one of the key areas of future research". Gebauer *et al.* (2012, p. 130), in turn, state that "there is still confusion about what is the appropriate explanatory variable to describe service provision" and that "future research could discuss how to conceptualize and operationalize the main construct of the research field of service provision". Finally, prior studies have measured industrial service business as an aggregate, firm-level phenomenon. This level of analysis, however, theoretically contradicts the service literature, which states that the value of service business is co-created in interaction between the firm and its customers (Grönroos, 2008; Payne *et al.*, 2008; Tuli *et al.*, 2007; Vargo and Lusch, 2008; Ylimäki and Vesalainen, 2015). Moreover, a manufacturing B2B firm typically has different kinds of customer relationships (Gebauer *et al.*, 2011) and several customer segments (Powers and Reagan, 2007) and, as consequence, different product-service offerings (Raddats, 2011; Cannon and Perreault, 1999). Therefore, one aggregate firm-level measurement is not always the most appropriate level of analysis to deduce theoretically relevant implications.

Motivated by these studies, we argue that a clear need exists for a rigorous, comprehensive, relationship-level and statistical measure to operationalize and analyze the scope of industrial service business. As such, our study contributes to the service literature by developing and validating a new measurement, which captures the service offering of an industrial firm. More specifically, this measure provides possibilities to undertake empirical examinations of several conceptual propositions and hypotheses related to antecedents, mediators and moderators that influence industrial services-performance relationship.

2. Theoretical background

2.1 Defining and classifying industrial services

Prior literature offers numerous definitions of industrial services (Mathe and Shapiro, 1993; Morris and Davis, 1992; Oliva and Kallenberg, 2003). We build on the view of LaLonde and Zinszer (1976, p. 344) who define industrial service as "those activities that occur at the interface between the customer and the corporation, which enhance or facilitate the sale and use of the corporation's products and services" but extend it with the fairly simple statement from Berry (1980, p. 24), who posits that "services are consumed but not possessed". In other words, the key distinguishing factor between products and services is the aspect of ownership (Edvardsson *et al.*, 2005; Lovelock and Gummesson, 2004). Thus, we define industrial services as all value-adding activities that are consumed, but not possessed, by the industrial customer.

The scope of the industrial service business resonates closely with how such services are classified. Prior studies offer several service typologies, which are summarized in Table I.

As Table I demonstrates, the moment of transaction forms the traditional basis for classifying industrial services (LaLonde and Zinszer, 1976; Morris and Davis, 1992; Samli *et al.*, 1992). However, this classification has a certain limitation. More specifically, service marketing scholars emphasize that the service business does not sequence itself on the basis of transactional moments (e.g. the sale of industrial equipment) but is an ongoing (Grönroos and Helle, 2010) and interactive (Wynstra *et al.*, 2006) or "co-creative" (Payne *et al.*, 2008) process that is typically established and maintained by relationship management (Barry and Terry, 2008; Edvardsson *et al.*, 2008; Rönnberg Sjödin *et al.*, 2016a, 2016b; Tuli *et al.*, 2007; Vargo and Lusch, 2008).

More recent studies, in turn, recognize the role of relational dimension of service business and establish their typologies on such dichotomies of product vs process-based services (Mathieu, 2001; Oliva and Kallenberg, 2003) and input vs performance-based services (Ulaga and Reinartz, 2011). Such typologies are obviously valuable in advancing theoretical development. Yet, they tend to be based on conceptual arguments or in-depth case studies, thus lacking the statistical support of empirical data. To our knowledge, only two of the recent classifications are based on quantitative evidence. Gebauer (2008) examines the fit between the external environment and the strategy of manufacturing firms and yields four service offering typologies, namely, after sales services, process-oriented services, research and development services and operational services. Raddats and Kowalkowski (2014), in turn, base their classification on two dimensions (single vs multi-vendor orientation; product vs customer orientation) and identify three service typologies:

1 product-attached services;
2 operations services on own products; and
3 vendor independent operations services.

While being pioneering studies in the field, both of them leave room for more fine-grained, service-specific measures. Overall, the variety of classifications reflects the heterogeneity and complexity of industrial service offerings.

2.2 Measuring the scope of industrial service business

Prior studies operationalize the scope of industrial service business in several ways. Martinez-Tur *et al.* (2001) conceptualize the structural complexity of services by measuring the number of services a firm offers customers. Homburg *et al.* (2003), in turn, examine the role of corporate culture and human resource management in implementing a service-oriented business strategy in industrial companies. They conceptualize the service-orientated business strategy with two measurements. The first measurement, number of services, features five categories of services with a total of 30 services. Respondents rate these services on a dichotomous scale (0 = *offered*; 1 = *not offered*; cf. Gebauer, 2008). The second measurement is the emphasis respondents place on services; that is, how strongly a respondent's firm

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Table I Key studies on classifying industrial services

Service categories	Basis of classification	Author(s)
Pre-transaction (or pre-sale) services (e.g. written customer policy) Transaction services (e.g. order cycle time) Post-transaction (or post-sale) services (e.g. replacements and repairs)	Conceptual argumentation: the moment of transaction of an industrial good	LaLonde and Zinszer (1976), Samli *et al.*(1992)
Pre-transaction services related to internal operations (e.g. formal production schedules) Transaction services related to physical appearance (e.g. employee appearance to customers) Transaction services related to order status (e.g. providing order status information) Transaction services related to order accuracy (e.g. billing and shipping accuracy) Post-transaction services related to start-up (e.g. installation, training) Post-transaction services related to problem handling (e.g. preventing stockouts, product tracing for recalls)	Conceptual argumentation and a survey: the moment of transaction of an industrial good	Morris and Davis (1992)
Services supporting the product (e.g. delivery, technical support) Services supporting the customer's process (e.g. training, R&D)	Conceptual argumentation with a case study: service supporting the supplier's product vs supporting the client's action	Mathieu (2001)
Basic installed base services (e.g. documentation, installation, repairs) Maintenance services (e.g. preventive maintenance, spare part management) Professional services (e.g. process-oriented engineering, research and development) Operational services (e.g. management of the operations and maintenance function)	Case study: transaction-based vs relationship-based services and product-based vs end-user's process-based services	Oliva and Kallenberg (2003)
Information and consulting services (e.g. product demonstrations) Services for training and consulting (e.g. feasibility studies) Services in the business-related field (e.g. insurance) Services for technical security and optimization (e.g. installation) Services supporting the process of cooperation (e.g. project management)	Conceptual argumentation and interviews	Homburg *et al.* (2003)
Consumption services used by the industrial customer (e.g. office cleaning) Instrumental services that help improve the customers' core processes (e.g. consulting) Component services offered further to the customers' customers (e.g. outsourced baggage handling in airports) Semi-manufactured services that act as an input in the final customer offering or process (e.g. outsourced weather forecasts in airline route planning)	Conceptual argumentation: the service use situation of the customer	Wynstra *et al.* (2006)
After sales services (e.g. spare parts, repair, basic training, inspection/diagnosis) Customer support services (e.g. maintenance services, process optimization and consulting, advanced operator training Outsourced services (e.g. maintenance services, process optimization and consulting, advanced operator training) Development services (e.g. design and construction services, process-oriented R&D)	Quantitative survey on environmental-strategy fit	Gebauer (2008)
R&D services (e.g. process design, process-oriented engineering, development services) Basic services for the installed base (e.g. product-oriented training, help desk, repair services) Maintenance services (e.g. preventive maintenance, full maintenance contracts, process optimization) Operational services (e.g. managing the whole maintenance function, managing spare parts logistics)	Conceptual argumentation: service strategies of manufacturing firms	Gebauer *et al.* (2010)
Product attached services on own products (e.g. installation, training, support) Product attached services on own and third party products (e.g. installation, training, support) Operations services on own products (e.g. managed services, asset availability) Vendor-agnostic operations services (e.g. systems integration, technical consultancy)	Conceptual argumentation with a qualitative analysis: single vs multi-vendor orientation; and product vs customer orientation	Raddats and Easingwood (2010)
Product life-cycle services (e.g. delivery, inspection, recycling) Asset efficiency services (e.g. remote monitoring, software customization) Process support services (e.g. efficiency audit, logistics consulting) Process delegation services (e.g. fleet management, supply management)	Conceptual argumentation with a case study: goods-based vs process-based services; input-based vs output-based services	Ulaga and Reinartz (2011)
Product-attached services Operations services on own products Vendor independent operations services	Quantitative survey on two dimensions: single vs multi-vendor orientation and product vs customer orientation	Raddats and Kowalkowski (2014)

emphasizes various service categories when selling the services to customers (1 = *not at all*; 5 = *very actively*). Gebauer *et al.* (2010) investigate the service strategies of manufacturing companies. By building on prior studies, they form five service categories and assess them on three dimensions:

1 the number of services offered (0 = *offered*; 1 = *not offered*);
2 the number of customers the services are offered to (1 = *few customers*; 5 = *many customers*); and
3 how strongly these services are emphasized (1 = *not strongly*; 5 = *very strongly*).

Finally, Raddats and Kowalkowski (2014) develop a list of 11 items corresponding to their framework of multi vs single vendor orientation and product vs customer orientation (e.g. "My company has taken over some of our customers' business processes") and analyze them on a seven-point Likert-scale (1 = strongly disagree; 7 = strongly agree). All of these measurements tend to focus on a broader service category level, thus neglecting the relative importance of each specific service. In such, these measurements offer an opportunity for developing comprehensive, service-specific measures.

Regarding more straightforward measurements, some recent studies calculate the extent of the service business by investigating the volume of the firms' revenues generated by services. Antioco *et al.* (2008), for example, ask "What percentage of your company's revenues is generated by services?" and provide eight categories from which the respondents could choose. Neely (2008), in turn, measures different services offered by manufacturing firms and relates them to the extent of their level service development. Fang *et al.* (2008) assess service ratio by using a database that provides firms' sales revenue for different business segments, dividing these segments into categories of services and non-services. Suarez *et al.* (2013) and Cusumano (2008) operationalize service provision by equating it with the share of service revenues. These convenient measuring approaches have one major limitation related to the various pricing policies found among industrial companies; indeed, prior studies have suggested that negotiated (Indounas, 2009) and reference pricing (Bruno *et al.*, 2012) as well as price bundling (Steiner *et al.*, 2016; Stremersch and Tellis, 2002; Stremersch *et al.*, 2001) are used widely in industrial markets. Yet, these common pricing policies make it difficult to distinguish (Desiraju and Shugan, 1999; Noble and Gruca, 1999) and report (Gebauer *et al.*, 2012; Kastalli *et al.*, 2013) product revenues from service revenues at an aggregate level. Hence, these measurements do not fully capture the complexity and heterogeneity of the industrial service business or, as Gebauer *et al.* (2012, p. 129) state, "Simplifying the measurement of service provision may lead to erroneous conclusions".

Given these various measurement approaches, we concur with Gebauer *et al.* (2012, p. 129), who state that "there is great variance in the way service provision has been operationalized" and argue that development of multi-dimensional scale for measuring industrial service offering represents an important step toward an advanced understanding of manufacturing companies' service business.

3. Methodology

3.1 Development of measurements

Building on the work of Antioco *et al.* (2008), Boyt and Harvey (1997), Gebauer *et al.* (2010), Homburg *et al.* (2003), Morris and Davis (1992), Oliva and Kallenberg (2003) and Samli *et al.* (1992), we created an initial list of 29 industrial services. To complement the key literature, we relied on two corresponding sources of in-depth knowledge. First, we had explorative discussions with five academics in the field of industrial and service marketing, who provided additional insights into prior studies on industrial services and assisted in developing or brainstorming previously missed or ignored industrial service items and measurement scales. Second, our research project had an advisory board, which included four practitioners (three CEOs and one R&D manager) operating in four different manufacturing firms. During the research project (2008-2010), the advisory board met several times with the authors, who presented initial drafts of the new measurement and collected feedback via discussions. The role of the advisory board was vital as it provided practitioner-oriented viewpoint and validation on our scale development. This iterative and reflective process between theory and practice generated a list of 36 industrial services in Four initial categories based on prior theory (Gebauer *et al.* 2010; Oliva and Kallenberg, 2003; Homburg *et al.* 2003):

1. technical and optimization services (e.g. installation, just-in-time systems, spare parts);
2. R&D services (e.g. prototyping, feasibility studies, analyzing potential for manufacturing a product);
3. business services (e.g. procurement services, performance services); and
4. product information sharing services (product demonstrations, customer seminars, technical documentation).

The categories were synthesized to build a basis for measurement development. Moreover, these initial categories were needed for guiding the development and recognition of service items. At this point, categories were kept broad so that they would not limit identification of service items but would provide initial structure.

Before collecting data, we pre-tested the constructs for content validity by following the guidelines of Hardesty and Bearden (2004) and Polit *et al.* (2007). The validation process involved nine scholars in the field of industrial and service marketing research to assess whether each item fitted the definition of the construct. We developed and sent out a web-based questionnaire for the scholars to use in assessing the item-construct fit, with a scale ranging from one to four (1 = *not relevant*, 2 = *somewhat relevant*, 3 = *quite relevant*, 4 = *highly relevant*). In total, the validation process required three validation rounds before the measurement was considered methodologically rigorous.

During these validation rounds, three services were discarded because of low content validity:

1. namely, sales personnel visits to customer organizations;
2. just-in-time delivery service; and
3. providing a customer magazine.

After the evaluations, we calculated the content validity index (Average I-CVI) and compared the Average I-CVI (I-CVI/AVE) value to the threshold value of 0.8 (Davis, 1992; Polit *et al.*, 2007). All constructs, except for "business services", exceeded the threshold, which returned an I-CVI/AVE value of 0.78 that is slightly below the threshold. The final pre-validated questionnaire includes 33 industrial services divided into 4 service categories (Table II).

After the pre-validation of the construct, a questionnaire was developed. Before collecting the data, we sent the questionnaire to the managers of the advisory board for additional comments, which resulted in a final survey. Finally, we translated the measure (i.e. the list of industrial services and the Likert scale statements) from English into Finnish and asked an expert academic to back-translate from Finnish into English to ensure translation equivalence (Brislin, 1970).

3.2 Measurement models

The final questionnaire asked the respondents to identify a single customer relationship with the most extensive (i.e. greatest share of revenue) and diverse (i.e. breadth) service business. Thereafter, the questionnaire guided the respondents to evaluate each service on two dimensions. On the first dimension, respondents evaluated how actively each service was offered in the customer relationship (Likert scale:

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Table II Dimensions of industrial services, service items measured by a Likert scale and item source (literature/interview)

Service category	Related services
Optimization services	Installation service (Gebauer *et al.*, 2010; Oliva and Kallenberg 2003; Homburg *et al.*, 2003; Morris and Davis, 1992; Samli *et al.*, 1992)
	Delivery service (Oliva and Kallenberg, 2003; Homburg *et al.*, 2003; Morris and Davis, 1992; Ulaga and Reinartz, 2011)
	Technical support for similar products offered by other manufacturers (Raddats and Easingwood, 2010; Raddats and Kowalkowski, 2014)
	Repair service (Gebauer *et al.*, 2010; Oliva and Kallenberg, 2003; Boyt and Harvey, 1997)
	Spare parts (Gebauer *et al.*, 2010; Oliva and Kallenberg, 2003)
	Electronic ordering system for the customer (Homburg *et al.*, 2003; Morris and Davis, 1992; Samli *et al.*, 1992)
	Recycling service (Oliva and Kallenberg, 2003; Homburg *et al.*, 2003)
	Product upgrade service (Homburg *et al.*, 2003)
	Maintenance (Gebauer *et al.*, 2010; Oliva and Kallenberg, 2003; Boyt and Harvey, 1997; Samli *et al.*, 1992)
	Warranty (Morris and Davis, 1992; Samli *et al.*, 1992)
Research and development services	Product tailoring service (Homburg *et al.*, 2003; Samli *et al.*, 1992)
	Prototype design and development service (academic/practitioner interviews)
	Feasibility studies (Homburg *et al.*, 2003)
	Problem analyses (Oliva and Kallenberg, 2003; Homburg *et al.*, 2003)
	Analyses of product's manufacturability (Oliva and Kallenberg, 2003)
	Research services (Gebauer *et al.*, 2010; Homburg *et al.*, 2003)
Business services	Procurement service (Homburg *et al.*, 2003)
	Warehousing services for other manufacturers' products (Homburg *et al.*, 2003)
	Mediation of products (Homburg *et al.*, 2003)
	Project management (Homburg *et al.*, 2003)
	Service for operating the product sold for the customer (academic/practitioner interviews)
	Service for operating customer's process (Gebauer *et al.*, 2010; Oliva and Kallenberg, 2003)
	Consulting service (Oliva and Kallenberg, 2003; Homburg *et al.*, 2003; Boyt and Harvey, 1997; Ulaga and Reinartz, 2011)
	Mediation of personnel (Homburg *et al.*, 2003)
	Financing service (Homburg *et al.*, 2003; Samli *et al.*, 1992)
	Insurance service (Homburg *et al.*, 2003)
Product information sharing services	Product demonstrations (Gebauer *et al.*, 2010; Homburg *et al.*, 2003)
	Customer seminars (Homburg *et al.*, 2003)
	Technical user training (Gebauer *et al.*, 2010; Oliva and Kallenberg, 2003; Homburg *et al.*, 2003; Morris and Davis, 1992; Samli *et al.*, 1992)
	Documentation service (academic/practitioner interviews)
	Written information material (Homburg *et al.*, 2003)
	Customer consulting and support by phone (Homburg *et al.*, 2003)
	Cost-benefit calculation (Homburg *et al.*, 2003)

0 = *not offered*; 1 = *not active at all*; 7 = *very actively*). This evaluation builds on recent studies in the field (Gebauer *et al.*, 2010; Homburg *et al.*, 2003, 2002) and is in line with Bitner's (1995, p. 247) "making service promises". On the second dimension, the respondents evaluated the significance each service has for the overall revenues in the customer relationship (Likert scale: 0 = *not offered*; 1 = *not significant at all*; 7 = *very significant*). This dimension, too, builds on the recent studies by investigating the revenue generation of services (Antioco *et al.*, 2008; Suarez *et al.*, 2013) and thus resonates well with Bitner's (1995, p. 247) "enabling and keeping service promises".

For measurement, we used both of these dimensions for improved knowledge about the scope of industrial services. Of each service item, the two measurements (offering and revenue generation) were summed together to capture both perspectives of one service item (e.g. how actively installation service is offered, and what is the revenue contribution of the installation service). This was done for each of the 33 different service items, which were then used as items in the measurement model. This approach was applied because activeness in offering captures the firm's internal emphasis or "push" to offer each service (Homburg *et al.*, 2003), whereas the revenue contribution captures the customer demand (Adner and Zemsky, 2006) or "pull" for such services (Kastalli *et al.*, 2013).

In addition, we needed to decide whether to apply the formative or reflective measurement model (Diamantopoulos and Siguaw, 2006). A reflective measurement model is appropriate when the latent variable captures the shared variance between the items and thus reflects the latent phenomenon (Borsboom *et al.*, 2004; Law *et al.*, 1998; Rossiter, 2002). Consequently, our scale applies a reflective measurement model because the items reflect the overall latent scope of industrial services (e.g. shared variance between items measuring R&D services) (Law *et al.*, 1998). Moreover, a reflective measurement model is appropriate as our scale can be considered a reflection, and not a sum, of the state of a firm's service strategy. In the alternative case of a formative measurement model, the dimensions would need to cover all of the firm's potential service dimensions and services and, thus, provide summation for the scope of industrial services (MacCallum and Browne, 1993, p. 533). However, this is very challenging because of diversity in the empirical world. Thus, we adopted a reflective measurement model, where the measurement functions as a reflection of a firm's scope of industrial services, measured as a shared variance between items and dimensions.

3.3 Empirical study

3.3.1 Data collection, response pattern and respondents

Firms for the present study were drawn from a sample database that contains information about all Finnish

businesses liable to pay value-added taxes. The sample data set includes firms operating in the machine and equipment manufacturing industry (SIC 28) in Finland that employ 20 or more persons. We decided to include small firms in the sample, as their perspective has not been widely captured within existing studies, and we wanted our scale to measure industrial service offering across large variation of firm size (Raddats and Kowalkowski, 2014). This results in an original sample size of 404 firms.

Prior to sending out the web-based questionnaire, the research team contacted all the potential respondent companies and discussed identifying a respondent in a relevant managerial position to evaluate the comprehensive nature of the service business in a single customer relationship. From the 404 companies, 262 persons promised to answer the questionnaire, 37 persons declined and 105 remained unreachable. In total, the research team conducted 989 answered phone calls, an average of two calls per company. Persons who were unreachable were called several times. Ultimately, the survey yielded 91 successfully completed questionnaires, accounting for a satisfactory response rate of 23 per cent (Baruch, 1999) after accounting for the refusals (25 per cent). Furthermore, the respondents received two e-mail reminders during the data collection period. In line with the key-respondent approach, 4 per cent of the respondents were chief executive officers, 57 per cent were key account/sales managers, 15 per cent were production managers, 12 per cent were R&D managers, 4 per cent were business developers and 8 per cent remained unclassified; 93 per cent of the respondents were male.

3.3.2 Nonresponse bias and data profile

The data were tested for nonresponse bias. We compared the actual respondent companies to the nonrespondents on three variables – revenues, profits and balance sheet values – to determine that those who did not respond did not significantly differ statistically from the respondents. In addition, we compared the first third of the respondents to the last third on the key study variables (Armstrong and Overton 1977; Werner *et al.*, 2007). Again, the groups do not significantly differ statistically; thus, the data are free from nonresponse bias.

To describe the respondent companies and relationships, we use median values, as they allow for a more accurate description of the data than averages allow. A typical respondent firm in the sample generates an annual turnover of approximately €13.6m, has a return on investment of 19.4 per cent, employs a staff of 100 and serves 120 customers. In a typical customer relationship, product business generates 63 per cent of the turnover, whereas the service business generates 20 per cent, and subcontracting (i.e. manufacturing industrial components by application of customers' product specifications, when the customer owns the product rights; Nellore and Söderquist, 2000) generates 17 per cent of the turnover. The companies produce 90 per cent of the services they sell by themselves, whereas only 10 per cent outsource their service operations. In terms of pricing services, in 58 per cent of the transactions, the service prices are embedded in the product prices. In 35 per cent of transactions, pricing is based on consumption; in 16 per cent, pricing is based on fixed invoicing (€/month), and, in 6 per cent, pricing is based on the value created for the customer (e.g. productivity or decrease in costs). Finally, the suppliers' factories and service units are located nearby their customers (factories ≈ 130 km, service units ≈ 120 km).

4. Results

4.1 Explorative factor analysis

To determine the dimensional structure of the measurement method, we conducted an explorative factor analysis using SPSS 22.0 (Anderson and Gerbing, 1988; Jöreskog and Sörbom, 1989). We applied the maximum likelihood extraction with an oblique rotation method (Promax). As an exclusion criteria, items with low communalities (<0.3) and substantial loadings on two or more factors, as well as items that did not have factor loadings on any factor (<0.4), were removed (Stevens, 1992; Tabachnick and Fidell, 2007). Final decisions on removing items were based on these criteria and by examining the representativeness of each item identified as a candidate for deletion.

The analysis began with the original 33 items. As a result of the explorative factor analysis, 12 items were excluded one by one, rerunning the analysis each time. Excluded items include delivery service, electronic ordering system for the customer, recycling service, product upgrading service, problem analyses, procurement service, warehousing service for other manufacturers' products, mediation of personnel, consulting service, mediation of products, financing services and insurance services.

A parsimonious and interpretable solution, which displays a simple structure and comprises a respectable 21 of the original 33 items, is presented in Table III. All items have significant loadings on their five main factors (highlighted with boldfaced numbers in Table III), each with eigenvalues greater than 1 (Tabachnick and Fidell, 2007). The five-factor solution coincided with the scree plot image, corresponding with those identified in the literature and explaining 67 per cent of the variance in the data. The factor solution demonstrated a statistically significant Bartlett test of sphericity ($\chi^2 = 1{,}056$, df = 210, $p < 0.000$) (Bartlett, 1950), whereas the KMO value (0.85) was above the typical threshold of 0.5 (Kaiser, 1970). The resulting items also illustrated acceptable communalities above the threshold of 0.3, except the item "technical support for similar products of other manufacturers", which we kept in the analysis due to satisfactory factor loading (Tabachnick and Fidell, 2007). In the final factor solution, the first factor accounted for 40 per cent of the variance, whereas all the factors with eigenvalues above 1 accounted for 67 per cent of the total variance. The fact that all items load onto their main factors and most of the items show no significant side-loadings suggests satisfactory discriminant validity. Despite high side-loadings of installation, maintenance and documentation services, they were kept in the analysis because of their acceptable main loadings.

4.2 Confirmatory factor analysis

To further analyze the dimensionality of service scope, we conducted a confirmatory factor analysis using AMOS Version 4.0. The maximum likelihood estimation was applied, as suggested by the methodology literature (Anderson and Gerbing, 1988; Jöreskog and Sörbom, 1989). The model was tested and improved by leaving out items one by one and

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Table III Pattern matrix illustrating factor structure and item factor loadings

Items	Factor 1	2	3	4	5	Communalities
Installation service	0.40	−0.15	**0.49**	−0.06	−0.08	0.48
Technical support for similar products of other manufacturers	−0.09	0.12	**0.44**	0.14	−0.02	0.26
Repair service	−0.12	−0.04	**1.06**	−0.03	−0.03	0.91
Spare parts	0.08	−0.01	**0.44**	0.31	−0.11	0.40
Maintenance	0.43	−0.02	**0.48**	−0.06	0.02	0.63
Warranty	−0.01	0.04	0.30	**0.40**	0.04	0.41
Research	0.06	**0.58**	0.10	−0.07	0.13	0.48
Product tailoring service	−0.02	0.30	0.05	**0.52**	−0.12	0.46
Prototype design and development service	0.00	**0.63**	0.08	0.22	−0.14	0.53
Feasibility studies	0.07	**0.84**	0.04	−0.15	0.05	0.68
Analyses of product's manufacturability	−0.05	**0.80**	−0.21	0.06	0.00	0.61
Project management	**0.43**	0.04	0.18	0.07	0.00	0.39
Service for operating the product sold for the customer	**0.52**	0.10	0.17	−0.16	0.29	0.64
Service for operating customer's process	**0.82**	−0.05	−0.03	−0.10	0.09	0.62
Product demonstrations	−0.05	0.00	−0.08	0.03	**0.97**	0.85
Customer seminars	0.05	0.03	−0.05	0.19	**0.71**	0.73
Technical user training	0.20	−0.09	0.05	**0.48**	0.29	0.65
Documentation service	**0.71**	−0.04	−0.15	0.40	−0.20	0.61
Written information material	0.05	−0.10	−0.09	**0.92**	0.12	0.85
Customer consulting and support by phone	−0.11	0.10	0.24	**0.55**	0.18	0.66
Cost-benefit-calculation	**0.78**	0.14	−0.10	0.10	−0.06	0.66
Variance explained by the factor (%)	**0.40**	0.11	0.06	0.05	0.05	

Note: Principal axis factoring with direct Oblimin rotation method; rotation converged in eight iterations; KMO = 0.852; Chi-square = 125.166; df = 115; significance = 0.243

comparing the fit statistics, theoretical framework and modification indices (Byrne, 2001).

4.2.1 Assessing the overall fit and parameter estimates

The confirmatory factor analysis, low item loadings, poor model fit and modification indices led to removing 6 items from the remaining 21 items. Deleted items include technical support for similar products of other manufacturers, product tailoring service, analyses of product's manufacturability, documentation service, written information material and cost-benefit calculation. The final measurement model resulted in the respective 15 items loading to 5 latent factors.

Several statistics assisted in evaluating the model fit. As Table IV summarizes, fit indices for the final model suggest an adequate model, as the chi-squared to degrees of freedom ratio is less than 2.00 and the p value is satisfactorily above the threshold of 0.05 ($\chi^2 = 76.57$, df = 59, $p = 0.588$) (Brooke *et al.*, 1988; Carmines and McIver, 1981). Furthermore, the root mean squared error of approximation (0.000) is at excellent level (threshold of 0.06) (Hu and Bentler, 1999). In addition, the model provides a good fit, as the normed fit index remains at 0.89, which is only slightly below the threshold of 0.90. Yet, prior studies have suggested that the normed fit index underestimates models with small sample sizes (Byrne, 2001). So, to interpret the model fit, we used the comparative fit index and incremental fit index, which take the sample size into account (Bollen, 1989). The comparative fit index (1.00) and incremental fit index (1.01) both demonstrated satisfactory values significantly above the threshold (0.90) suggesting an excellent model fit. In sum, the final resulting research model fits well with the data.

The first-order five-factor model provides the best fit with the data compared to the other model, as Table IV illustrates.

Table IV Confirmatory factor analysis fit statistics for alternative models

Model	χ^2	df	χ^2/df	*p*-value	NFI	CFI	IFI	RMSEA
First-order factor models								
One-factor model[a]	232.86	90	2.59	0.000	0.67	0.77	0.77	0.133
Two-factor model[b]	199.10	89	2.24	0.000	0.72	0.82	0.82	0.117
Three-factor model[c]	167.86	87	1.93	0.000	0.77	0.87	0.87	0.102
Four-factor model[d]	135.02	84	1.61	0.000	0.91	0.92	0.92	0.082
Five-factor model[e]	76.57	59	0.96	0.588	0.89	1.00	1.01	0.000
Second-order reflective factor models								
Five-factor model[f]	97.81	85	1.15	0.162	0.86	0.98	0.98	0.041

Notes: [a]One-factor model (First-order): all items load to the first factor; [b]Two-factor model (first-order): items of maintenance, operational and R&D services load to Factor 1, customer and product services to Factor 2; [c]Three-factor model (first-order): items of maintenance services load to Factor 1, operational and R&D services to Factor 2, customer and product services to Factor 3; [d]Four-factor model (first-order): items of maintenance services load to Factor 1, operational and R&D services to Factor 2, customer services to Factor 3 and product services to Factor 4; [e]Five-factor model (first-order): items of operational services load to Factor 1, R&D services to Factor 2, operational services to Factor 3, customer services to Factor 4 and product services to Factor 5; [f]Five-factor model (reflective second-order): one second-order factor, under which items of maintenance services load to Factor 1, R&D services to Factor 2, operational services to Factor 3, customer services to Factor 4 and product services to Factor 5

In addition, the second-order factor model performs worse than the first factor model, as expected. It still provides an excellent model fit and shows that the model applies as a first- and second-order factor model.

4.2.2 The final measurement model

The resulting measurement method includes 15 items categorized into 5 factors. The model fits satisfactory with the data, whereas the construct, dimensions and measurements provide satisfactory reliability and validity. Figure 1 illustrates the resulting dimensions of the industrial service scope, together with the items, item loadings, Cronbach's alpha (CA), composite reliability (CR) and average variance extracted (AVE) values for each dimension. The correlation matrix for the final items is reported in Appendix 1.

All in all, the findings suggest that the scope of service business consists of five dimensions or "bundles", of services. The first dimension includes two services, i.e. product demonstrations and customer seminars, which are typically used for attracting new customers for the industrial product business. Hence, we label them as "pre-sales services". The second dimension includes services such as warranty, technical user training, and customer consulting and support by phone. We classify them as "product support services". The third dimension includes such services as installation, repair services, spare parts and maintenance. As this dimension covers services that are needed to install, repair and maintain industrial products, we label it as "product life-cycle services". The fourth dimension incorporates research services, prototype design and development services and feasibility studies and is thus labeled as "R&D services". The services of the fifth dimension do not focus on the industrial product but on the customer's processes. Such services include project management service, service for operating the product sold for the customer, and service for operating a customer's process and are thus defined as "operational services".

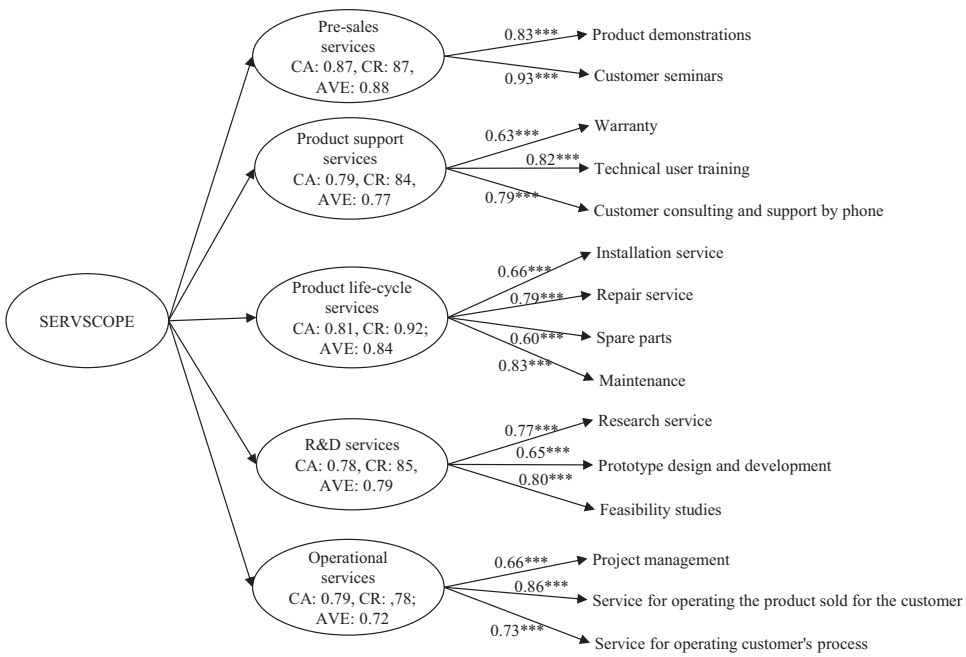
4.2.3 Reliability of the measurements

In terms of reliability, the constructs resulted in adequate Cronbach's alpha and composite reliability values, suggesting satisfactory reliability of the constructs. Cronbach's alpha values for each construct exceed the threshold of 0.7, being 0.87 for pre-sales services; 0.79 for product support services; 0.81 for product life-cycle services; 0.78 for R&D services; and 0.79 for operational services. Similarly, the constructs achieve satisfactory composite reliability values (threshold of 0.7), being 0.87 for pre-sales services, 0.84 for product support services, 0.92 for product life-cycle services, 0.85 for R&D services and 0.78 for operational services. In conclusion, the constructs demonstrate satisfactory reliability.

4.2.4 Convergent and discriminant validity

The items satisfactorily measure the latent construct they attempted to measure, as the loadings in the structural analysis were above 0.60 and statistically significant ($p < 0.001$). Similarly, the dimensions demonstrated satisfactory values for the AVE values, as all the AVE values exceeded the threshold of 0.5, being 0.88 for pre-sales services, 0.77 for product support services, 0.84 for product life-cycle services, 0.79 for R&D services and 0.72 for operational services. Thus, the model suggests high convergent validity. As for the discriminant validity, the final measurement model demonstrated an excellent model fit. It is also notable that the fit of the five-factor model was much better than the fit of other models, thereby demonstrating validity of the structure

Figure 1 Dimensions of industrial services, items, item loadings, Cronbach's alpha (CA), composite reliability (CR) and AVE values for each dimension



Note: Statistical significance ***$P < 0.001$

of the measurement model. Satisfactory model fit of the measurement model also provides evidence for a satisfactory discriminant validity of the constructs and items.

5. Discussion

5.1 Theoretical contribution

The distinct contribution of the present study is the development of a new tool to measure and operationalize the scope of industrial service business. This measurement combines and builds on the key features from the prior literature and on the insight gained through interviews with practitioners. More specifically, our scale is novel, as it captures the breadth (i.e. the extensiveness of the offered services) and depth (i.e. internal emphasis and revenue generation of each service) of industrial service offering. In addition, this study applies this new scale on the level of the supplier–customer relationship, as well as validates it through quantitative empirical data analysis. By doing so, we address a research gap which has been highlighted by several researches (Eggert *et al.*, 2014). As Ostrom *et al.* (2010, p. 27) state, the "service value measurement and optimization is truly a [research] priority in its infancy".

Academics can use this measurement when investigating the scope of service business as one construct in their research settings. More importantly, one of the novelties of our measurement is its relationship-specific approach which enables focused empirical studies on complex phenomena. For instance, the scale enables researchers to measure and reflect the extent and level of service strategy to facilitate testing of service-structure settings (Chandler, 1962) at the relational level. Or the scale can be used to examine the performance effects of different types of service offerings, as well as the role of variety of moderating or mediating factors (e.g. relational capabilities) between service offering and performance. This first version of the measurement (labeled as, for example, Servscope 1.0) also creates a fruitful platform for further development. More specifically, scholars can apply the scale to firm-level studies to examine the financial impact of industrial services on a product oriented firm revenue and growth which still remains an understudied relationship (Kowalkowski *et al.*, 2016; Gebauer *et al.*, 2010; Ostrom *et al.*, 2010). For these purposes, Appendix 2 provides the questionnaire with original 33 items and relationship-level questions as well as alternative questions for firm-level inquiries. In short, this new measurement is a valuable tool for academics operating in the field of industrial service business.

By developing a new measurement that distinguishes different service dimensions, we also contribute to prior literature in relation to classifying industrial services, which has been dominated by conceptual argumentation (Boyt and Harvey, 1997; Homburg and Garbe, 1999) and exploratory case studies (Mathieu, 2001; Oliva and Kallenberg, 2003; Ulaga and Reinartz, 2011). More specifically, our empirical evidence partially supports, yet partially challenges, these classifications. Interestingly, the identified first and the second dimension (pre-sales services and product support services) seem to partially confirm the seminal work of LaLonde and Zinszer (1976) and Samli *et al.* (1992), i.e. the moment of transaction of an industrial product forms a basis for identifying two categories of industrial services. Our service dimension of product-life-cycle services (Rabetino *et al.*, 2015), in turn, amplifies the work of Ulaga and Reinartz (2011, p. 17) or challenges the models of Oliva and Kallenberg (2003) and Gebauer (2008) by adopting service items from the categories of "basic installed-base services" and "maintenance services" (Oliva and Kallenberg, 2003, p. 168) or from the categories of "after-sales services" and "process-oriented services" (Gebauer, 2008, p. 284). Finally, the dimensions of R&D services and operational services correspond well with the prior classifications in the field (Gebauer, 2008; Gebauer *et al.*, 2010; Mathieu, 2001; Oliva and Kallenberg, 2003; Windahl and Lakemond, 2010). These two dimensions are largely discussed but have remained understudied within the existing literature, as they represent a more complex product-service combination which demands co-creation between provider and customer. All in all, our findings extend the current body of knowledge on industrial services by providing a new set of service categories that are based on quantitative data and a statistically rigorous empirical survey.

Finally, one specific counterintuitive finding is that the conventional industrial service of delivery (Morris and Davis, 1992; Oliva and Kallenberg, 2003) does not have a similar variance with the other services. Consequently, this service does not appear in the model. The rationale behind this finding could be that for an industrial firm, delivery service may be a basic "unprofitable necessity" (Oliva and Kallenberg, 2003, p. 165) that their clients require and are thus obligatory to stay in business.

5.2 Managerial implications

The present study is also valuable for strategic managers in industrial firms for several reasons. First, the scale and its items can be used as a managerial navigator to assess the current status of the service business. By examining the firm's current service portfolio, industrial managers can analyze the role of services in their overall business model and, more importantly, set objectives to develop their service business further. Second, the new classification of industrial services can help industrial managers divide their portfolio of services into logical groups. This assessment is useful for deciding which services should be developed and commercialized simultaneously or as "solutions" (Windahl, 2015), as well as for evaluating different possibilities for service bundling and product-service configuration (Lightfoot *et al.*, 2013). Third, the emerged service classification is a useful tool for developing service packages for different industrial customer segments (Thomas, 2016). Providing an extensive service portfolio for the collaborative key clients while offering less comprehensive service packages to other customer segments may be effective.

5.3 Limitations and future research opportunities

Although the research outlined here is comprehensive, there are some limitations that need to be considered when interpreting the results. One limitation of the study is that the data are slightly oversampled toward small- and medium-sized industrial firms from Finland. Consequently, low fit-indices may result from the non-normality of the data, despite the fact that the maximum likelihood estimation is not robust to

violations of multivariate normality (Williams and O'Boyle, 2008). However, multivariate normality may cause lower overall fit statistics (Williams and O'Boyle, 2008). Thus, the development of the measurement in the context of large industrial firms, or in different industries and countries, provides one fruitful avenue for further research. Second, we have used the existing literature, interaction with practitioners and quantitative data analysis to develop and validated the proposed scale. Still, with further maturity of the existing literature and the technological advancements among industrial practitioners, there is scope for further developing, fine-tuning and updating the proposed scale. The role of social media in developing and offering new industrial services (Bernard, 2016; Keinänen and Kuivalainen, 2015), for instance, may provide new and convenient (e.g. usage logs of online services) opportunities for operationalizing industrial service offering. Nevertheless, the present study represents a positive step toward operationalizing industrial service business.

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Appendix 1

Table AI Correlation matrix of the final items

	Service items	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1.	Installation service														
2.	Repair service	0.57**													
3.	Spare parts	0.33**	0.53**												
4.	Maintenance	0.55**	0.64**	0.46**											
5.	Research service	0.20*	0.26*	0.22*	0.30**										
6.	Prototype design and development service	0.07	0.24*	0.33**	0.25*	0.47**									
7.	Feasibility studies	0.11	0.21*	0.19	0.23*	0.62**	0.52**								
8.	Product demonstrations	0.19	0.24*	0.25	0.34**	0.43**	0.27**	0.38**							
9.	Customer seminars	0.23*	0.30**	0.28**	0.39**	0.43**	0.35**	0.42**	0.76**						
10.	Warranty	0.35**	0.44**	0.26**	0.42**	0.28**	0.28**	0.30**	0.33**	0.45**					
11.	Technical user training	0.38**	0.37**	0.43**	0.57**	0.40**	0.37**	0.31**	0.56**	0.62**	0.49**				
12.	customer consulting and support by phone	0.28**	0.44**	0.42**	0.46**	0.40**	0.43**	0.47**	0.51**	0.58**	0.56**	0.64**			
13.	Project management	0.45*	0.41**	0.28**	0.43**	0.26**	0.24*	0.24*	0.29**	0.39**	0.33**	0.47**	0.39**		
14.	Service for operating the product sold for the customer	0.38**	0.49**	0.33**	0.57**	0.30**	0.33**	0.39**	0.55**	0.52**	0.35**	0.53**	0.42**	0.56**	
15.	Service for operating customer's process	0.37**	0.36**	0.33**	0.54**	0.16	0.21*	0.22*	0.38**	0.42**	0.24*	0.45**	0.33	0.48**	0.65**

Notes: * $p < 0.05$; ** $p < 0.01$.

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Appendix 2

Table AII The questionnaire with original service items and two alternative levels of analysis

Service items	Relationship-level: How actively this service is offered in the customer relationship? Firm-level: How actively this service is offered for your customers?	Relationship-level: How significant this service is for the overall revenues in the customer relationship? Firm-level: How significant this service is for the overall revenues of your firm?
Installation service	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Delivery service	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Technical support for similar products of other manufacturers	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Repair service	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Spare parts	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Electronic ordering system for the customer	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Product upgrading service	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Recycling service	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Maintenance	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Warranty	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Research	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Product tailoring service	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Prototype design and development service	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Feasibility studies	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Problem analyses	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Analyses of product's manufacturability	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Project management	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Service for operating the product sold for the customer	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Service for operating customer's process	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Procurement service	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Warehousing service for other manufacturers' products	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Mediation of personnel	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Consulting service	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Mediation of products	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Financing services	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Insurance services	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Product demonstrations	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Customer seminars	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Technical user training	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Documentation service	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Written information material	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Customer consulting and support by phone	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant
Cost-benefit calculation	0 = not offered; 1 = not active at all; 7 = very actively	0 = not offered; 1 = not significant at all; 7 = very significant