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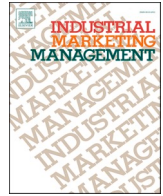
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The tribes in the field of servitization: Discovering latent streams across 30 years of research

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ABSTRACT

The servitization domain consists of over three decades of multi-disciplinary research on service activities in industrial contexts. Servitization literature combines different research streams that share a set of critical concepts. Existing meta-analytical studies have organized information content of sub-streams, homogenized theoretical propositions, and concepts to discover shared patterns, and identified an implicit meta-narrative. This study reverses the meta-analysis direction to deconstruct the servitization body of knowledge using the dynamic topic modeling (DTM) methodology to analyze 550 research articles. DTM enables complex forms of content analysis that combine quantitative and qualitative analysis. The analysis demonstrates how these streams have informed the development of the servitization domain and shaped the collective construction of this body of knowledge. The contributions of this study are threefold. First, the study increases understanding of the conceptual dynamics and thematic trends within the servitization research domain and the nuances between the sub-streams. The study offers some strategies for the future development of the field, facilitating the renewal of the servitization-related research agenda. Second, it illustrates the role of DTM as an alternative tool for conducting a literature review. Finally, it supports the development of a common language for the servitization field, thereby reducing the entry barriers for new contributors and favoring the knowledge transfer to professionals.

1. Introduction

Recent studies document the swift development of the scholarly literature that investigates the increase in service activities in product-based industries (Brax & Visintin, 2017; Kowalkowski, Gebauer, & Oliva, 2017; Rabetino, Harmsen, Kohtamäki, & Sihvonen, 2018). This field is known as servitization based on the term adopted from the early work of Vandermerwe and Rada (1988) by Baines et al. (2007). Frequent use in the following publications institutionalized ‘servitization’ as the preferred label for conceptualizing the increasing service-oriented activities observed in the manufacturing industries (Rabetino et al., 2018). Thus, by adding advanced services to their portfolio, manufacturers are seen as moving from product-focused business models to providing advanced lifecycle services, integrated solutions, and product-service systems (Brax & Visintin, 2017; Rabetino, Kohtamäki, & Gebauer,

2017).

‘Servitization’ is a relevant contemporary research stream in industrial marketing management, operations and supply chain management, and increasingly strategic management. With several special issues (Kamp & Parry, 2017; Kowalkowski, Gebauer, Kamp, & Parry, 2017; Kowalkowski, Gebauer, & Oliva, 2017) and over 100 articles, Industrial Marketing Management is among the leading outlets for publishing servitization research. Rapid development and practical relevance of the field call for well-designed systematic literature reviews (SLRs) that clarify and integrate servitization research for a broadening audience. Recent SLRs extend beyond the early summaries and adopt frameworks and methods that allow them to provide adequate coverage of many essential themes in servitization research and reveal latent or implicit patterns in the literature (Brax & Visintin, 2017; Luoto, Brax, & Kohtamäki, 2017; Rabetino et al., 2018; Raddats, Kowalkowski, Benedettini,

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Burton, & Gebauer, 2019).

In particular, Luoto et al. (2017) study the structural, stylistic, and rhetorical aspects of servitization articles for the period 1988–2013. From a critical viewpoint, they identify and outline a meta-level narrative of servitization research and invite scholars to challenge it through critical inquiry. The meta-narrative is a widespread understanding of servitization as a phenomenon institutionalized in this research domain's academic discourse. It illustrates how the traditions of discussion and the positioning of research questions concerning servitization are socially constructed through continuous evolution and involve implicit patterns that are difficult to understand for those who have not been part of such a developmental process.

Recognizing the internal dynamics that constitute the current understanding of the servitization research domain is a prerequisite for challenging any underlying assumptions that might prevent progress (Kowalkowski, Windahl, Kindström, & Gebauer, 2015). While our analysis focuses on servitization research, the same principle applies to other research domains of industrial marketing management. This task calls for scrutinizing the historical emergence of the foundational beliefs and the practical and historical conditions that have shaped the domain (Alvesson & Sandberg, 2013).

Thus, the present article aims to explain how the servitization meta-narrative has emerged and developed over the past three decades. Specifically, novel use of the dynamic topic modeling (DTM) methodology allows this SLR to pursue a threefold research purpose, to 1) explore the constitutive foundations of the servitization research domain; 2) increase transparency on the nuances in the text that signal proximity with sub-streams; and 3) reconstruct the development of the sub-streams over time.

DTM enables complex forms of content analysis that combine quantitative and qualitative analysis. The algorithm uses statistical analysis to identify clusters within large, chronologically-ordered sets of textual documents based on their proximity to evolving vocabularies (Blei & Lafferty, 2006). A systematically built set of servitization research articles is used herein. The following steps require analytical interpretation skills from the analysts: first, they scrutinize the alternative clustering models found by the software and interpret the clusters. Second, focusing on the best model, they identify patterns and explain the development of the clusters over time.

Therefore, this study combines DTM and SLR methodology to analyze the vocabulary of the research domain, addressing two research questions:

1. *What internal dynamics (sub-streams and other patterns, either explicit or latent) are discovered in servitization research?*
2. *How have internal dynamics and patterns evolved during the 30 years following the introduction of the servitization concept?*

The article is organized as follows: The fundamental concepts and common analytical levels adopted in servitization research are introduced; connections between these levels enable the mixed methodology approach. The mixed methodology logic is explained: qualitative content analyses complement the statistical analyses of DTM to shape a final result with a theoretically-coherent interpretation. The methodology section describes the creation of the set of articles, the dynamic topic modeling method, and subsequent interpretive content analysis. The resulting model with seven sub-streams is presented, and its observed patterns are explained. To conclude, the contributions and implications of the research are discussed.

2. Analytical levels in decomposing a research domain: narratives, topics, and vocabularies

2.1. Meta-narrative reveals the domain's collective taken-for-granted mindset

Scientific contributions are assimilated to disciplinary knowledge through a socially constructed consensus, which uses language as its medium (Astley, 1985). A narrative is a structured storyline that provides meaning to a phenomenon in a particular context. Narratives resonate among particular subgroups within a larger community (Vaara & Tienari, 2011). Variations of narratives coexist and constitute a widespread conceptualization of the phenomenon in concern; in academic research fields, these *meta-narratives* are institutionalized through practices, structures, and academic discourse traditions.

Luoto et al. (2017) examined the stylistic, structural, and rhetorical aspects of servitization research and revealed a meta-narrative that pervades throughout the research domain. Indeed, its storyline sounds familiar to experienced scholars. This meta-narrative depicts servitization as the *metamorphosis* of large manufacturing companies (Brax, 2005; Gebauer, Fleisch, & Friedli, 2005; Mathieu, 2001a) that, triggered by changing market conditions like commoditization and competition from low-cost countries, add services to their portfolio of offerings (Oliva & Kallenberg, 2003; A. Tukker, 2004), thereby extending their presence further down in the industry value chain and reaching closer towards their end customers (Davies, 2004; Holmström, Brax, & Ala-Risku, 2010). The product-end of the continuum represents a traditional specialized manufacturing position where services are externalized, typically provided by distributors or specialist service providers. At the opposite end are service-based business models; the physical products may be provided as services, where the customer subscribes to a long-term contract and pays for use, performance, or availability of this resource. Mixed offerings like advanced product-service systems (PSS) and integrated solutions (Brax & Jonsson, 2009) fall between the extremes. This metamorphosis is viewed as desirable and almost mandatory for large manufacturers in mature industries. Such transition typically builds on organic growth and requires total reconfiguration of resources. Because the transformation is expected to be profitable but, paradoxically, known to be painful and risky, the meta-narrative emphasizes the role of management in steering manufacturers through cultural and structural organizational resistance.

Research in the field has criticized the early, implicit assumptions concerning this transformation as being incremental (Brax, 2005), almost linear (Brax & Jonsson, 2009), and unidirectional move forward a conceptualized product-service continuum (Finne, Brax, & Holmström, 2013; Kowalkowski, Gebauer, & Oliva, 2017; Valtakoski, 2017). Brax and Jonsson (2009, p.542) point out that "The basic assumption in the literature is that goods exist first in the firms' offerings, and the challenge in becoming a solutions provider is related to integrating services into the goods." Afterward, Kowalkowski et al. (2015) use problematization to form alternative assumptions from empirical evidence. Later meta-analytical research has integrated the servitization domain by discovering theoretical patterns in the research literature and systematically reviewing the backing evidence to validate these patterns. Brax and Visintin (2017) examined the transformation hypothesis and developed a meta-model to capture the different configurations of PSS value constellations along the product-service continuum, revealing and clarifying the conceptual complexity in labeling the different offerings in the context of servitization.

The meta-narrative is neither static nor uniform. It is based on contributions from related sub-disciplines, susceptible to discursive tendencies, and the result of thirty years of evolution (Baines, Lightfoot, Benedettini, & Kay, 2009). The dynamism in the construction of the servitization storyline materializes not only in the constant addition of new concepts but also in the questioning of the dominant principles found at the core of the classic servitization meta-narrative, such as the

forward-linear transition path along the continuum from a product-dominant to a service-dominant position discussed above. Therefore, the current conceptualization of servitization differs considerably from the concept introduced by Vandermerwe and Rada (1988) and its reformulation by Baines et al. (2007).

Nuances of argumentation in the evolving narrative reveal underlying assumptions that represent different sub-streams. For individual scholars in the publication process, understanding such contextual variation – including inherent differences for theoretical propositions, preferred concepts, and definitions, as well as influential contributions – is a critical success factor. Correspondingly, collective awareness of the theoretical dynamics within servitization research facilitates coherence and consolidation of the domain (Rabetino et al., 2018).

2.2. Vocabularies reveal differences between research themes within a domain

Scientific narratives are grounded in embedded vocabularies that develop through linguistic conventions between academics (Astley, 1985). Vocabularies are systems of words and meanings used by collectives in communication, thought, and action and are purposefully mobilized to construct understanding, interests, and identities (Vaara & Tienari, 2011). Therefore, narratives and vocabularies simultaneously influence each other (Berger & Luckmann, 1967; Loewenstein, Ocasio, & Jones, 2012).

Linguistic artifacts function as tools through naming phenomena and managing meanings within a research field (Czarniawska-Joerges & Joerges, 1988): concepts gain the status of a key concept in the domain through repetition over time. Intentional communication materializes vocabularies into text where related labels, expressions, terms, words, metaphors, and narratives gradually form a discourse (Bort & Kieser, 2011). Thus, the words used by academics in a scholarly community to discuss a phenomenon influence the members' thinking about this subject and direct their attention and choices in conducting research, and eventually, what counts as knowledge in the research stream (Gartner, 1993; Locke & Golden-Biddle, 1997).

Established in such collective experiences of using specific words to convey meanings, vocabularies embody the socially constructed, legitimized collective reality in an area of specialization (Kuhn, 1970). Because vocabularies within a research domain develop over time and differ between research themes, they can be used 1) to identify such conventions within the domain and 2) to discover patterns of evolution in a set of literature where the articles are published over a longer timeframe (Blei & Lafferty, 2009).

2.3. Conceptual complexities observed in servitization research

Highly reliant on qualitative evidence (Rabetino et al., 2018), the servitization research gains persuasive power from narrative components. Building on specific embedded vocabularies, storytelling, and narrative styles are essential means of communicating research outcomes and interacting with other members of the servitization domain. In this context, a well-known challenge in servitization research is the abundance of alternative concepts to describe 1) the organizational transformation and its direction, scope, nature, and other characteristics, and 2) the resulting product-service offerings and business models (Rabetino et al., 2018). Existing reviews have not explored the use of the alternative concepts systematically and in detail, and to what extent they may signal the existence of sub-streams in the servitization research domain.

In the servitization discourse, the obvious starting point is conceptualizing the transformative process, which has been called servitization (Vandermerwe & Rada, 1988), service transition (Fang, Palmatier, & Steenkamp, 2008), service maneuvers (Mathieu, 2001b), service infusion (Brax, 2005), move to services or going downstream (Oliva & Kallenberg, 2003; Wise & Baumgartner, 1999), and many more. The

term 'servitization' is a neologism developed and adopted by the interdisciplinary community that brought together scholars from industrial marketing management, operations management, and industrial engineering and management. The early community was small and faced opposition from academic gatekeepers external to the servitization domain. Thus, some of the above terminologies are grounded on authors' original theorizing and others simply accommodated to requests from editors and reviewers.

The other crucial aspect of terminology is to label the various outcomes and intermediate results of the transition; the early work in the servitization domain engaged in explorative and comparative case research to identify and define them. The final and intermediate results of servitization transformation address the different offerings these companies have added to their portfolio, mixing tangible product and service components (e.g., integrated solutions, product-service systems). Paradoxically, classifying these offerings may also extend the servitization-related vocabulary with further labeling (Gaiardelli, Resta, Martinez, Pinto, & Albores, 2014; Rabetino, Kohtamäki, Lehtonen, & Kostama, 2015). Servitization outcomes include characterizations of the firms' business models and positioning in the industry value chain. For example, manufacturers and integrators moving downstream (or forward along the product-service-continuum) may redefine themselves as solution providers (Davies, 2004; Oliva & Kallenberg, 2003; Storbacka, Windahl, Nenonen, & Salonen, 2013; Wise & Baumgartner, 1999). The resulting vocabularies build on the linguistic conventions of both the base disciplines from which servitization originates (especially industrial marketing management and operations management) and the key journals publishing servitization research.

3. Methodology

3.1. Research design

This article investigates the research questions presented above using the dynamic topic modeling method (Blei & Lafferty, 2009). In addition to the streams that have been identified in the pre-existing literature explicitly, this study identifies the latent topics, patterns, and sub-streams of servitization research through the analysis of the embedded vocabularies. It qualitatively examines their characteristics and conceptual dynamics with further comparative content analysis. Moreover, using the servitization research domain as its analytical context, this article demonstrates how different vocabularies associated with alternative sub-streams and research themes inform and shape the research domain and its meta-narrative.

The research process was designed to identify the sub-streams and themes of the servitization research domain based on their preferred concepts and language by focusing on the relative differences in their vocabularies. The clustering method of the current research design considerably extends the systematic literature review methodology (Tranfield, Denyer, & Smart, 2003) by incorporating elements that inherently exploit the evolutionary nature of scientific discovery. Specifically, dynamic topic modeling allows efficient inductive discovery of latent topics from a broad mass of literature, based on the likelihoods of certain words to be members of topic vocabularies as a function of time. The method falls under the domain of unsupervised machine learning, as the researcher must assess the best fit among the alternative clustering results and examine them further to produce theoretically relevant observations of the literature set. This task requires implementing the following three steps: 1) the formation of the article data set; 2) the processing and modeling of article data; and 3) content analysis (Fig. 1).

3.2. Forming the article data set

The recent systematic literature reviews on servitization (Brax & Visintin, 2017; Rabetino et al., 2018) were examined (cf. Fig. 1, step 1a) to develop the following comprehensive search query string (1b):

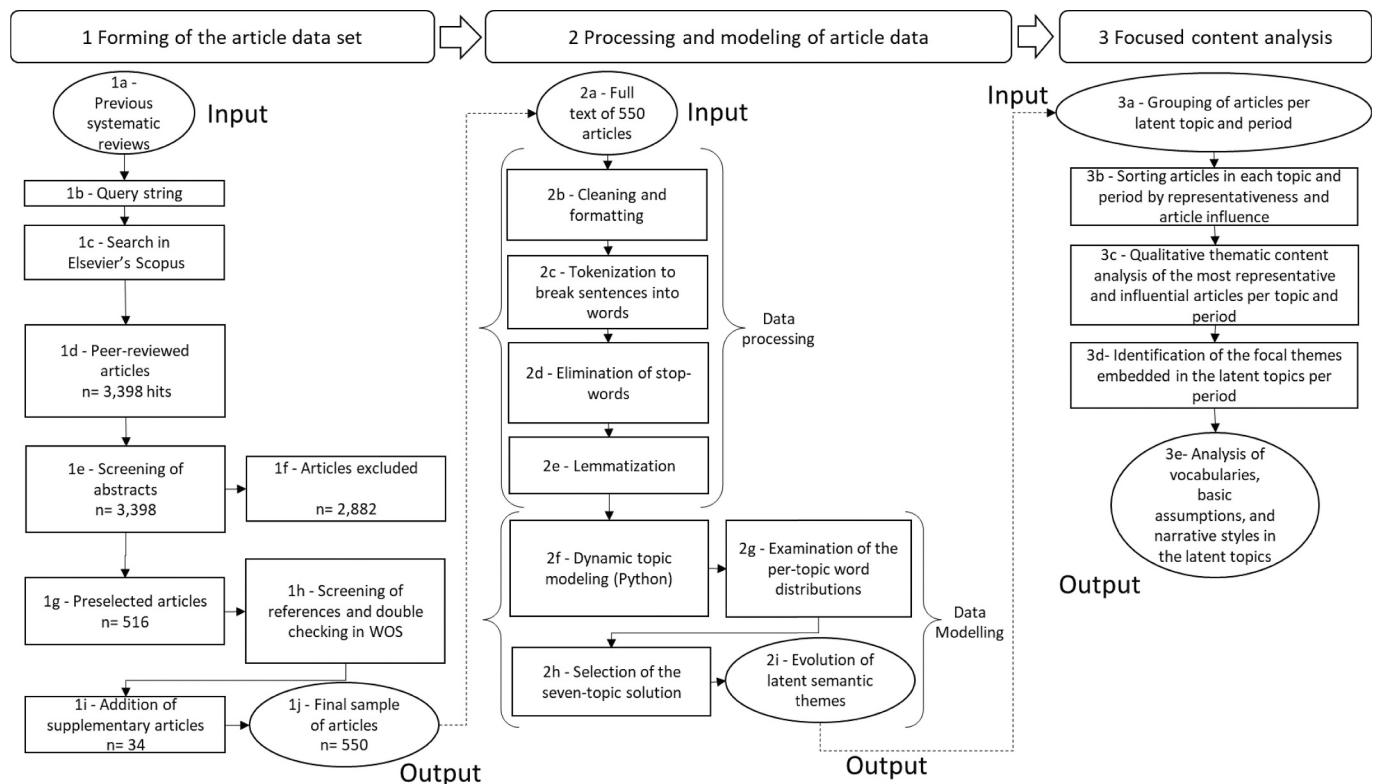


Fig. 1. Methodology.

(TITLE-ABS-KEY ("servitization" OR "servitisation" OR "service infusion" OR "service transition" OR "service transformation" OR "servicification" OR "servicisation" OR "servicization" OR "from products to services" OR "complex products and systems" OR "customer solutions" OR "product-service offerings" OR "solution business models" OR "advanced services" OR "integrated solutions" OR "industrial services" OR "performance-based contract" OR "outcome-based contract" OR "service-driven manufacturing" OR "solution selling")) AND (LIMIT-TO (DOCTYPE,"ar") OR LIMIT-TO (DOCTYPE,"re") OR LIMIT-TO (DOCTYPE,"ip")) AND (LIMIT-TO (LANGUAGE,"English"))).

A set of servitization-related articles was first identified by conducting a systematic search in Elsevier's Scopus (1c), a comprehensive database that has been the primary source of information in recent servitization-related publications (Kowalkowski, Gebauer, & Oliva, 2017; Lee, Seo, & Geum, 2018).

Compared to other available databases, Scopus offers the broadest coverage, particularly in social science and peer-reviewed journal articles published after 1995 (Falagas et al., 2008; Tukker, 2015). Indeed, Scopus covers the content of many other databases. According to the latest information (as of January 2020), Scopus includes 25,100 titles from 5000+ publishers, including Elsevier, Springer, Taylor & Francis, Sage, Emerald, and Wiley (1.7 billion cited references, dating back to 1970). Besides the best coverage, Scopus has the best quality management processes, is continuously updated, and offers the most versatile search options (Pranckutė, 2021). Consequently, we have decided to use Scopus for our initial search, and then we double-checked the results by examining the reference lists of the retrieved items (snowballing) and using an auxiliary search in WoS.

As this study focuses on the evolution of the scholarly vocabulary, the search was limited to peer-reviewed academic articles on servitization published (or in press) as of March 30, 2018 (1d). Although the latest articles have not been included in the study, this is not a limitation. According to our data, it takes around four years for an article to

have an influence indicator (see 3.4) greater than zero. Much more time is needed before it has any relevant influence on the narratives. As a further search criterion, conference proceedings, books, and book chapters were purposely excluded. Only articles published in journals including a peer-review in the editorial process were included without using any other exclusion or inclusion criteria concerning the publication outlets (e.g., publication title or publisher). All publications from other servitization-related research streams (e.g., PSS and service science) were also excluded to ensure thematic consistency.

The first round of searching returned 3398 hits. Articles were next scanned for relevancy based on the screening of their titles and abstracts (1e). To be selected, an item had to discuss servitization either as an organizational process (e.g., a change in the business model) or as the product-service offering that results from such a process. Accordingly, 2882 articles were excluded based on relevance screening (1f), with the most common exclusion criterion being that the article focused on services but not on servitization. After scanning for relevance, 516 articles were preselected (1g). Next, the lists of references were scrutinized, and a double-checking was implemented in Web of Science to isolate (1h) additional relevant articles (1i), and a small set of publications was added. The 550 selected articles (1j) match the number of servitization articles reported in recent publications (Kamp & Parry, 2017; Rabetino et al., 2018).

3.3. Processing and modeling of article data

Machine learning methods necessitate textual data to be pre-processed. The preparation process typically includes standard tasks such as tokenization, lemmatization, and removing certain *stopwords* (Liu, 2019). Therefore, the full text of the 550 selected articles (step 2a in Fig. 1) underwent several preprocessing steps before the modeling phase (Blei & Lafferty, 2009). First, to clean and format the data (2b), all punctuation words shorter than three letters and numbers were removed, and all uppercase letters were transformed into lowercase. Second, tokenization was performed to break sentences into separate

words (2c). Third, all *stopwords*, including articles, prepositions, and pronouns, were eliminated (2d). Several English (e.g., the, in, with, etc.) and user-defined *stopwords* that frequently appear in academic articles (e.g., paper, study, show, research, case, and discuss) were removed. Thus, only nouns, verbs, adjectives, and adverbs were included in the analysis. Fourth, a lemmatization process was performed to replace words by their lemmas to reduce dimensionality without the loss of generality (2e).

Data modeling and text analysis techniques developed in computer science, such as topic modeling, became available decades ago. Several topic modeling techniques exist (Moro, Pires, Rita, & Cortez, 2018). The existing topic modeling applications in business research typically use the Bayesian statistical technique of Latent Dirichlet Allocation (LDA) (Blei, Ng, & Jordan, 2003) as a tool. By using the co-occurrence (co-location) of the observable words in a given collection of existing documents, LDA follows a generative process that allows researchers to computationally uncover unobservable patterns of textual content (Liu, 2019) and infer both the hidden distribution of latent topics by document and the distribution of words on these latent topics; LDA also allows researchers to recognize the most appropriated topic composition and the weight of each topic in each document (Blei, 2012; Kaplan & Vakili, 2015). The technique assumes that each document is a combination of topics where all latent topics are present in each document in different magnitude but only some are relevant, whereas a latent topic is a probability distribution over words (Kaplan & Vakili, 2015; Lee et al., 2018) where each word can belong to several topics (Loureiro, Guerreiro, Eloy, Langaro, & Panchapakesan, 2019). For reasons of space, we do not include specific technical details. An exhaustive explanation of LDA can be found in many technical publications by Blei and his co-authors (Blei, 2014; Blei et al., 2003; Blei & Lafferty, 2009), and its detailed application in organizational research is also available in different recent publications (Croidieu & Kim, 2018; Kaplan & Vakili, 2015; Lee et al., 2018; Loureiro et al., 2019; Moro et al., 2018).

The present study applies Dynamic Topic Modeling (DTM), a dynamic variant of LDA (Blei, 2014; Blei & Lafferty, 2006), to analyze the evolution of latent semantic themes based on the full text of the 550 time-indexed servitization documents (2f). DTM infers a set of statistical topics that maximally describe each document's content while recognizing their chronological order, which distinguishes DTM from LDA and makes DTM suitable for documenting the temporal evolution of academic research (Kobayashi, Mol, Berkens, Kismihók, & Den Hartog, 2018). The DTM model was fitted to the textual data and the periods chosen following the recent review by Kowalkowski, Gebauer, and Oliva (2017). Although several implementation options are available (Liu, 2019), this article used the Python package “gensim” (regarding the Dirichlet parameters, α = was estimated based on the corpus and β = 0.5).

The number of topics is an input parameter (Moro et al., 2018). To determine the final number of topics, we initially specify a range for the number of topics by examining the perplexity and log-likelihood of each candidate topic model (a measure of “fit” of the model to the textual data). Having less than four topics produces models that are too generic for the data and increasing above fifteen topics does not deliver a relative gain in terms of fit (Loureiro et al., 2019). Consequently, the per-topic word distributions for the values that ranged from 4 to 15 topics were examined (2g) based on topic coherence and exclusivity. Topic coherence is a measure of the internal coherence of topics and highly correlates with human judgments of topic quality, while topic exclusivity measures the distinctness of topics by comparing the word distributions of different topics. Although a topic is exclusive if many of its top words are unlikely to appear within the top words of other topics, topic modeling allows for polysemy, which means that words can take different meanings depending on the contexts (Kaplan & Vakili, 2015).

Regarding the model assessment and selection process, we begin by estimating the DTM model with the number of topics ranging from four to fifteen. The log-likelihood (perplexity) and coherence of each

estimated model were assessed. Their overall fit increases as the number of topics increases, but the rate of improvement flattens out as the number of topics exceeds ten. Additionally, internal coherence is flat for models with four to nine topics but deteriorates quickly when the number of topics exceeds ten. In both cases, the corner solution for the range of an optimal number of topics is from seven to ten. After the initial statistical screening, four models (7-, 8-, 9-, and 10-topic models) were selected for closer inspection. Using topic coherence and exclusivity metrics, we assessed the available models by examining the words and documents associated with each topic and comparing the model predictions with expert opinions (looking for consensus) to ensure external reliability. As a result, the seven-topic solution was chosen (2h).

We used two graphical tools that enable combining the statistical measures of topic validity with human judgment, allowing us to set lower bounds for topic membership and track the evolution of the clusters across time. First, LDavis (Sievert & Shirley, 2014) is an interactive visualization tool to explore patterns by observing the estimated models in an *inter-topic distance map* based on the 30 topmost relevant words for each topic. The best fit regarding the number of topics was also examined from the inter-topic distance maps. When the number of topics increases above the best fit, the relative size of the topics in the map decreases and homogenizes because large topics fragment into clusters of small, highly overlapping topics. If the number of topics is below the best fit, topics do not overlap, but their size grows and again homogenizes. Their representative keywords become less coherent because thematic variation within a topic increases. The best fit shows a variation in the sizes of the topics with less overlap in the map. This visual analysis of the models also confirmed seven topics as the best fitting model to describe this dataset representing the servitization domain. Second, we developed a tool that presents snapshots of examined models for a period, a star-shaped graphical representation of the topic model where a dot represents each article. Dots are associated with their topic by color; from this interactive representation, the researchers can connect the articles and their relative locations in the topic model, thereby examining the potential model at the level of the articles' actual content. This representation was beneficial in the interpretive, qualitative content analysis that followed the modeling phase.

DTM provides a vocabulary (words and their frequencies) for each article and compares the resulting vocabularies to uncover the latent topics. Thus, DTM assumes that each selected article describes servitization with a suitable vocabulary. Thus, the 550 vocabularies can be characterized by seven latent topics that evolve from one period to the next (2i) (Table 1).

3.4. Content analysis

The automatic labeling of topics is not reliable due to their multinomiality over a set of words (Kaplan & Vakili, 2015). The labeling was performed based on the vocabularies and the content analysis of the articles, which also served as an instrument for interpreting the themes and the discourse style of each topic (Table 2). DTM provides a list of articles in each latent topic (step 3a in Fig. 1) and two indicators per paper: representativeness and influence (3b). Representativeness is a continuous variable [0–100] that describes how much the vocabulary in an article resembles each latent topic's vocabulary for its publication period. Influence is a continuous variable [0–100] that describes how much an article alters each latent topic's vocabulary in the period following its publication. Thus, DTM allows researchers to show how the evolution of the sub-streams, reflected by the latent topics and their embedded vocabularies, nurtures the emergence of a dynamic research domain, and identifies the specific articles that contribute to the development of each sub-stream in the servitization research domain.

Although each article was assigned to one latent topic based on its maximum representativeness, which means the topic that it was most collated with (Loureiro et al., 2019), an article can influence many latent

Table 1
Latent topics in the servitization research.

Topic label (original)	Sub-stream label (given)	Characterizing vocabulary
T1	Strategic fit for a profitable service transition	service, orientation, product, strategy, manufacturing company, cluster, factor, differentiation, employee, revenue, css, sbu, manager, oriented, culture, related, organizational design, financial performance, organizational structure, orientation corporate, development, overall profitability, innovation, sbus, industrial, business, profitability, pcb, offer, company, activity chain.
T2	Customer relationships and business logic in B2B service infusion	service infusion, logic, marketing, brand extension, competence, brand position, relational capital, value constellation, operant resource, value, brand, relationship learning, kam program, fsqca, organizational arrangement, value creation, exchange, buyer seller, manoeuvre, branding, central local, rental agreement, microfoundation, service, offering, local central, dominant logic, fuzzy set, mutual value, relationship initiation, industrial.
T3	Solutions marketing and delivery	solution, integrated solution, supplier, customer, project, solution provider, network, business, actor, component, company, need, capability, focal firm, role, relationship, develop, intermediary, integrator, firm, business model, division, integrate solution, management, offering, delivery, network actor, integration, life cycle, integrate, modularity.
T4	Complex solutions in capital goods	cop, project, government, policy, technology, construction, firm, technological, user, industry, military, innovation, corporation, client, export, cop project, production, foreign, large, produce, mass production, software, sector, occupation, economy, employment, ibm, incumbent, eco innovation, standard.
T5	Managing performance-based contracting and complex performance	pbc, salesperson, sale, contract, sale force, obc, salespeople, hybrid offering, base contract, contractual, procurement, sub supplier, obcs, personal selling, pss provider, vendor, marketing, value use, buyer, shipyard, selling, trust, work, buying, procure complex, company image, individual, contracting, outcome base, performance, contractual relational.
T6	Operations and supply chain management for after-sales industrial services delivery	maintenance, supply chain, cost, service, quality, spare, repair, company, operation, delivery, product, logistic, manufacturer, capacity, inventory, customer, support, servitisation, demand, price, process, requirement, manufacturing, music, warranty, customisation, retailer, vertical integration, decision, reliability, maintenance engineering.
T7	Product-centric servitization	servitization, pss, business model, organization, service, community, transformation, servitize, journey, advanced, servitized, product, iot, transition, sustainability, manufacturing, big datum, production economic, gamification, systematic review, organizational,

Table 1 (continued)

Topic label (original)	Sub-stream label (given)	Characterizing vocabulary
		challenge, research community, big data, value proposition, design, bmi, servitization journey, value creation, digital servitization, internet thing.

topics at different levels of intensity. Early articles are highly influential on all subsequent vocabularies, while contemporary articles have limited general impact and influence one vocabulary. The most representative and influential articles were qualitatively scrutinized (3c). Through the content analysis of these articles and based on the vocabularies provided by DTM, thematic patterns were identified, and summary tables of the sub-streams and periodical themes within them were created, including the discursive elements per latent topic and period (3d). The analysis also includes summaries of the core argumentation line of the representative articles. The elements were chronologically organized and described, focusing on their content via the representative and influential articles, thereby tracking the evolution of the seven sub-streams of servitization through the themes discovered for each period (3e).

4. Discovering the sub-streams of servitization research and their thematic evolution

As explained above, DTM classifies articles based on vocabularies embedded in latent topics that represent different research streams, and the best fit for the modeling was apparent with the model that distinguished seven topics. Based on the content analysis of the path-defining articles in each topic, we labeled the latent topics as the following sub-streams of servitization:

- 1) Strategic fit for a profitable service transition,
- 2) Customer relationships and business logic in B2B service infusion,
- 3) Solutions marketing and delivery,
- 4) Complex solutions in capital goods,
- 5) Managing performance-based contracting and complex performance,
- 6) Operations and supply chain management for after-sales industrial services delivery, and.
- 7) Product-centric servitization.

4.1. Vocabularies in each latent topic

4.1.1. Strategic fit for a profitable service transition

The first topic brings about a research stream to which Kowalkowski et al. (2015) referred to as service-led growth strategies. According to this stream, service orientation became a necessary condition for differentiation, competitive advantage, and performance in industrial contexts under complex, competitive conditions such as increasing competition and product commoditization (Bowen, Siehl, & Schneider, 1989; Matthyssens & Vandenbempt, 1998; Vandermerwe & Rada, 1988). Driven by financial, marketing, and strategic motives (Gebauer et al., 2005), manufacturers must move from products to service dominance along service transition pathways (Martin & Horne, 1992; Matthyssens & Vandenbempt, 2008), often represented as a product-service continuum (Oliva & Kallenberg, 2003). Many generic service strategies exist (Boyt & Harvey, 1997; Samli, Jacobs, & Wills, 1992; Sawhney, Balasubramanian, & Krishnan, 2004) and implicate costs and benefits that call for “effective” environment-strategy-structure “fitting” configurations (Bowen et al., 1989; Gebauer, 2008; Gebauer, Edvardsson, Gustafsson, & Witell, 2010; Neu & Brown, 2005, 2008). Unique

Table 2The evolution of the sub-streams in the servitization research domain based on identified latent topics.^a

Topic/period	1988–2000	2001–2005	2006–2009	2010–2013	2014–2018
Strategic fit for a profitable service transition	Service orientation and strategies for competitive advantage in industrial services: implications and challenges	The transition from products to services: antecedents, hard and soft factors, fit, challenges, and the continuum and the service paradox in implementing service-oriented strategies	Motivations for the development of services in manufacturing firms Service strategies, configurations, and fit Service business and its revenue: service innovation growth and barriers	Strategy-structure configurations (separate or integrate?) and their impact on service performance and competitive advantage Service and business model innovation: Implications for firm performance (the non-linear relationship between service offerings and firm performance) Service logic, relational capital, and value creation, visualization, and assessment for service infusion in B2B contexts	Strategic fit, resource configurations, value chain position, risk management, and performance implications for servitization success in manufacturing companies Challenges and failure in servitization (deservitization and reverse servitization as emerging themes) Configurations for successful service infusion: technology-driven business models, service design and innovation, value visualization and cocreation, and learning in B2B buyer-seller relationships
Customer relationships and business logic in B2B service infusion			Business logics and B2B relationships in the transition from goods to service(s) in industrial service production		
Solutions marketing and delivery	Looking for competitive advantage: The move towards solutions	Organizing to deliver solutions: balancing customers' needs, and organizational structures and capabilities	Knowledge integration, organizational structure, strategic alignment, barriers, and network-based value creation in solution- and project-based firms	Business models for integrated solutions in project-based firms: transformation, fit, capabilities, revenue models, and value co-creation and knowledge integration practices in networks	Managing customer solutions in project-based firms: configurations, modularity, knowledge and resource integration, capabilities, and strategic learning in the cocreation of integrated product-service solutions within multi-actor business networks
Complex solutions in capital goods	Towards repeatable solutions: policymaking, innovation management, technology management, organizational capabilities, and learning in project-based complex product systems	Organizational capabilities and structure, strategy, and value system configuration for complex product systems and high-value integrated solutions	Systems sales and the solution-selling imperative: configuring organizational capabilities and structure		
Managing performance-based contracting and complex performance			Contracts, relationships, and integration: towards the procurement of complex performance	Relational assets, supply governance, benefits and uncertainties, and practices for relieving the challenges of performance-based contracting in manufacturing	Performance-based contracting and complex performance in long-term supply relationships: operations strategy, relational capabilities, innovation, selling, and critical factors and value drivers in outcome-based business models in business markets and public infrastructure
Operations and supply chain management for after-sales industrial services delivery	Product life-cycle services as a strategic opportunity	Product support strategy and after-sales services profitability: service offerings and delivery strategy, and maintenance concepts for industrial systems	Practices for industrial service operations and through-life management: managing the after-sales service supply chain	Processes and operations in maintenance contracts, supply chain management, and field-service delivery: the role of information and remote monitoring technologies	Make-or-buy and pricing decisions in supply chains for providing preventive maintenance and after-sales life cycle services
Product-centric servitization			Operations strategy for the product-centric servitization in manufacturing: challenges and financial consequences of delivering integrated products and services	Operations strategies supporting servitization Business partnering and networks in servitization ICT in servitization Reversed servitization paths	Drivers, challenges, barriers, strategic alignment, business models, and organizational transformation and change for performance and profitability in servitization implementation Resource realignment, capability configurations, and dynamic capabilities in servitization Value networks and platforms in servitization Digitization and gamification in servitization

^a Based on the influential and representative articles.

skills, investments, and assets are critical success factors for building new competitive positions, creating customer value, and generating competitive advantage (Matthyssens & Vandenbempt, 1998). Soft factors such as corporate culture and human resource management are essential to gain differentiation when implementing service-oriented strategies (Homburg, Fassnacht, & Guenther, 2003). The transition requires restructuring the organization (e.g., separating the service unit) and involves strategic hurdles and challenges, even a service paradox (Brax, 2005), rooted in different cognitive factors and organizational arrangements (Gebauer et al., 2005). The transition results in incomplete exploitation of the financial benefits of the service extension that typically leads to a positive yet nonlinear relationship between the scope of service activities and profitability (Fang et al., 2008; Visnjic Kastalli & Van Looy, 2013).

4.1.2. Customer relationships and business logic in B2B service infusion

The second topic not only focuses on service marketing and industrial marketing matters such as customer relationships in B2B contexts but also introduces the language of service-dominant logic into the discussion of the divergences and convergences between the transition from product to service in business markets (Jacob & Ulaga, 2008) and the transition towards SDL in the service marketing transition (Vargo & Lusch, 2008). When bringing together ideas such as service logic, service innovation, and new service development in a manufacturing context (Kindström & Kowalkowski, 2009), the service function extends beyond the service unit (Kowalkowski, 2011). In particular, three essential parts of the sales function (organization, roles, and competencies) must be adapted for the service infusion (Kindström, Kowalkowski, & Alejandro, 2015). The key account management programs are central to coordinating sales activities, which must rely on marketing and purchasing strategies encountered by buyer and seller firms (Rehme, Kowalkowski, & Nordigården, 2013). Well-regarded brand reputations, relevant service competencies, and strong buyer-seller relationships are crucial for a successful infusion (Brown, Sichtmann, & Musante, 2011). Additionally, B2B manufacturers use different visualization strategies to communicate the value and benefits of unique service-enhanced product offerings. The optimal type depends on the offering life cycle and stakeholder type (Kindström, Kowalkowski, & Nordin, 2012). Service infusion entails a business model reconfiguration with “*equifinal*” outcomes in which “... service offerings, service pricing, service capabilities, and the service infusion interact in affecting success and failure” (Forkmann, Henneberg, Witell, & Kindström, 2017, p. 275).

4.1.3. Solutions marketing and delivery

In the third latent topic, solutions innovation emerges as new business models require a new “configuration” of competences and organizational adjustments in processes and rewards (Shepherd & Ahmed, 2000). The delivery of solutions calls for moving from a product focus to a customer-centric orientation and developing a new configuration of technical and integration competencies such as consulting and partnering (Windahl, Andersson, Berggren, & Nehler, 2004). Customer centricity requires a fit or multisided alignment among strategy, structure, people, rewards, and processes (Galbraith, 2002). Managing strategic learning and knowledge integration (Liinamaa & Wikström, 2009), cultivating supplier-customer relationships (Helander & Möller, 2007; Tuli, Kohli, & Bharadwaj, 2007), and co-creating value with customer networks are also critical processes (Cova & Salle, 2008; Windahl & Lakemond, 2006). The transition towards solutions can take different paths (Penttinen & Palmer, 2007). Two ideal ways of organizing the integrated sale and delivery of solutions are 1) the system integrator that coordinates the integration of components supplied by other firms and 2) the vertically integrated system-seller that produces all product and service components in a system (Davies, Brady, & Hobday, 2007). Regardless of the type, modularity is necessary for implementing solution-based business models (Storbacka et al., 2013).

4.1.4. Complex solutions in capital goods

The fourth latent topic is rooted in the literature on innovation and technological change (Tushman & Anderson, 1986; Utterback & Abernathy, 1975). For authors in this tradition, complex products and systems (CoPS) constitute a different class of economic activity; CoPS are an innovation that draws on integration and delivery capabilities to provide integrated solutions to large (public-private) projects. CoPS require user involvement and project-based organization to integrate and deliver repeatable life-cycle integrated solutions, which consist of highly customized engineering-intensive goods simultaneously produced by many contractors (Davies & Brady, 2000). As part of their growth strategies, (life cycle) integrated solutions refer to combinations of products and services. In contrast, system integration is a business model aiming to reposition the company in the value stream. This business model requires moving from a product focus to a customer-centric orientation and a new “configuration” of service capabilities (e.g., consultancy, finance, operations, and partnering) to address different customers’ needs (Davies, 2004). Integrated solutions also involve diverse challenges and calls for proper (fitting) organizational structures (Davies, Brady, & Hobday, 2006).

4.1.5. Managing performance-based contracting (PBC) and complex performance (PCP)

The fifth latent topic involves two associated streams closely connected to the literature on CoPS, operations and supply management, and solutions (Essig, Glas, Selviaridis, & Roehrich, 2016). First, in public-private partnerships, the PCP business model requires a precise understanding of the role of contractual and relational capabilities and involves “make or buy” decisions and contracts, which, for suppliers, implicates changing their service delivery structures (Kreye, Roehrich, & Lewis, 2015). Rooted in contractual literature concerning make-or-buy decisions (e.g., transaction cost economics and agency theory) and public-public partnerships, PCP literature considers different buyer-supplier governance challenges in inter-organizational behavior, such as contractual, relational, and integration challenges (Lewis & Roehrich, 2009; Roehrich & Lewis, 2014). Second, including maintenance and operations, the PBC business model also involves uncertain buyer-supplier relations of dependence (Hypko, Tilebein, & Gleich, 2010a) in which behavioral and information alignments are vital for achieving outcomes (Ng, Ding, & Yip, 2013). PBC providers are paid based on delivered outcomes, and consequently, financing (Hypko, Tilebein, & Gleich, 2010b) and pricing strategies (Liinamaa et al., 2016) are two essential elements. Commercial (contract negotiation) and operational (implementation/delivery) risks are the main threats faced by providers that adopt this business model (Hou & Neely, 2018). Accordingly, this model also calls for an alignment with upstream suppliers (Kleemann & Essig, 2013).

4.1.6. Operations and supply chain management for after-sales industrial services delivery

Different models of after-sales services and the importance of creating and managing the service supply chain for competitive advantage have been discussed since the early 2000s (Cohen, Agrawal, & Agrawal, 2006). Although the “configuration” of the after-sales supply chain became a central matter, there is no optimal configuration but only contingent configurations (Saccani, Johansson, & Perona, 2007). Servitized supply chains must be more responsive than their production equivalents and rely more on real-time information (Johnson & Mena, 2008). In contrast, information and long-term capacity management are critical issues for field service delivery when combining manufacturing and service operations in one system (Lehtonen, Ala-Risku, & Holmström, 2012; Olhager & Johansson, 2012). A life-cycle approach is needed, which involves strategic choices such as decisions regarding product/service quality and pricing (Cohen & Whang, 1997), cost-effective service strategies for each customer segment with evolving needs (Lele, 1997), and specific challenges in each phase (Potts, 1988).

In product support and service delivery negotiation processes, maintenance and service agreements are essential tools in ensuring a win-win situation concerning system performance, avoidance of conflicts, and low designed-in life-cycle costs of products (Kumar, Markeset, & Kumar, 2004; Markeset & Kumar, 2005).

4.1.7. Product-centric servitization

The last topic is not only conceptually and linguistically connected to the previous one (Wilkinson, Dainty, & Neely, 2009) but also linked to the first topic, with which it shares some foundational path-defining studies (e.g., Mathieu, 2001a, 2001b; Oliva & Kallenberg, 2003; Quinn, Doorley, & Paquette, 1990; Vandermerwe & Rada, 1988). Scholars in this stream focus on understanding the essential characteristics of servitizing manufacturers' operations strategies, which include the reconfiguration of the production and support for operations-related processes, practices, principles, and structures to deliver products and associated services efficiently and effectively (Baines et al., 2009). Although different approaches to servitization may coexist, such as product-, use-, result-, service-, and integration-oriented product-service systems, servitization is seen as both enabled by technology (Lightfoot, Baines, & Smart, 2011) and as impacting facilities practices, vertical integration, and the deployment of skills and people (Baines, Lightfoot, & Smart, 2011a, 2011b). Value creation calls for the simultaneous design of product, service, and organization (Pawar, Beltagui, & Riedel, 2009), which includes the development of specific structures (Wilkinson et al., 2009) and innovative service capabilities for competing through services (Bustinza, Vendrell-Herrero, & Baines, 2017). However, servitization does not always pay off; it involves financial risks (Neely, 2008), and manufacturers experience implementation challenges. Common hurdles include recognizing and communicating customers' expectations and values, product/service design, developing systems for delivery integration, and changing the organization's orientation towards services (Baines, Lightfoot, & Kay, 2009; Martínez, Bastl, Kingston, & Evans, 2010).

4.2. Representativeness and influence of the embedded vocabularies

In a multidisciplinary domain, the strength and influence of the vocabularies embedded in the seven latent topics vary over time while moving through a process of convergence in the way scholars utilize these vocabularies. Fig. 2 plots the five-year rolling average

representativeness of DTM-inferred topics, measured as the percentage of words in an academic article for which the associated topic is the most likely. Each cross-section in the figure reflects the representative or typical paper's content in a period, a time-varying mixture of the identified sub-streams of research.

The joint representativeness of the sub-streams totals 100%. Consequently, Fig. 2 depicts the evolution in relative terms (e.g., one sub-stream loses or increases its importance within the typical article relative to the other sub-streams). Therefore, the figure does *not* indicate that sub-stream specific vocabularies are disappearing, while others emerge and develop. It designates only the *relative importance of each vocabulary within the typical* (or representative) *article* at each point in time. Although the field might not be moving towards balance regarding the number of papers in each sub-stream, the typical servitization paper is moving towards balance in terms of the vocabulary that it includes, and the vocabularies' representativeness in the seven sub-streams has been converging over time.

4.3. Thematic evolution of the sub-streams of servitization research

Dynamic topic modeling discovers latent topics based on the relative proximities of their vocabularies and tracks their evolution over time. As explained in Section 2, this study begins with the underlying assumption that vocabularies and narratives continually shape each other through the conventions of the academic community specific to a research domain, and distinguishable patterns within a research domain represent sub-streams of the entire domain and the domain's meta-narrative. Here, the analysis concentrates on these sub-streams. The difference between the literature sub-streams and the 'topics' identified in the modeling points to the relationship between the two analysis methods. Sub-streams reflect the topics discovered with the software, but topics become sub-streams once researchers interpret identified vocabulary, meaningfully connecting and categorizing the original works as representing a particular theme. In the terminology adopted here, *domain* refers to the entire cross-disciplinary research area, *sub-stream* is the meaning given to the topic identified, and *theme* represents the focus in the sub-stream over a specific period. Sub-streams may not last across the entire history of the domain: some originate in the first period (1988–2000) the rest emerge later, and some lose their relevance or merge with other sub-streams (Table 2).

Within each latent topic, articles use vocabularies to build narratives

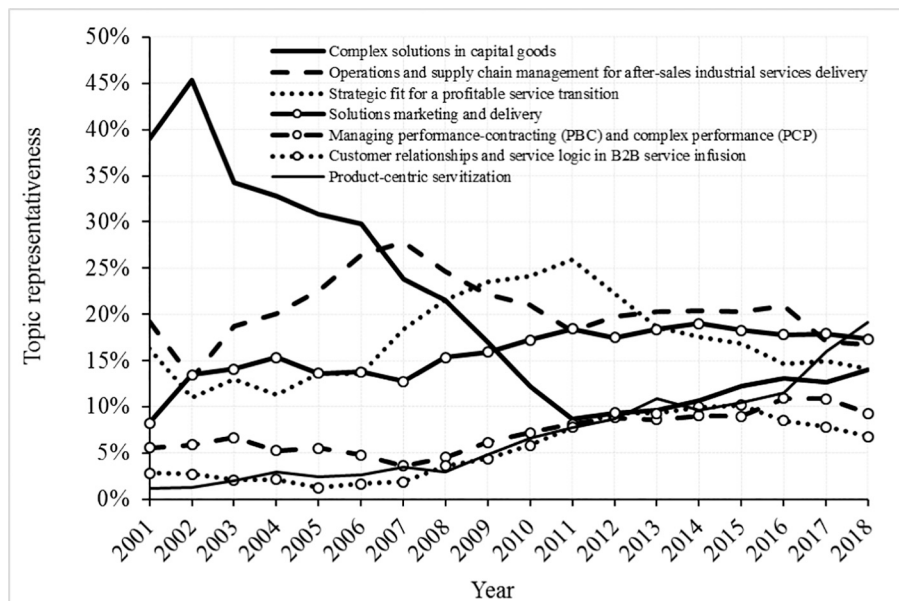


Fig. 2. The evolution of the topic representativeness in a typical article.

that convey their research argument to the readers. The algorithm cannot describe narratives or meaning but identifies the most influential or path-defining articles per topic and period. We represent the patterns, common themes, and perspectives emerging from these articles to characterize the sub-stream through the content analysis of the most influential articles in each latent topic. The seven sub-streams share vocabularies and discursive elements such as strategy, structure, business models, environment, barriers or challenges, outcomes, and performance. While the use of these elements has converged (Fig. 2), the dominant discourse in these sub-streams takes a ‘contingent,’ ‘configurational’ or ‘fitting’ perspective. However, some differences also exist in the sub-streams and the embedded vocabularies, which have diverse disciplinary origins and evolutionary patterns, and tend to follow specific standards, linguistic styles, and discipline-based vocabularies.

After the domain’s boundaries were already set in the early 2000s (Kowalkowski, Gebauer, & Oliva, 2017), four dominant vocabularies initially covered the content of a typical servitization article in the early days. The most representative vocabularies were the ones embedded in the sub-streams labeled ‘operations and supply chain management for after-sales industrial services delivery’ and ‘complex solutions in capital goods’; the latter is rooted in the literature on innovation and technological change (Tushman & Anderson, 1986; Utterback & Abernathy, 1975). The representativeness of the sub-streams’ embedded vocabularies referred to as ‘complex solutions in capital goods’ peaked in the early 2000s. In contrast, the representativeness of the sub-stream ‘operations and supply chain management for after-sales industrial services delivery’ peaked in the mid-2000s. With smaller representativeness, the vocabularies from the ‘solutions marketing and delivery’ and the ‘strategic fit for a profitable service transition’ sub-streams were also influential within the nascent scholarly domain. The vocabularies embedded in these two sub-streams were primarily built on articles in marketing and industrial marketing outlets, and their representativeness peaked from 2010 to 2013. In both cases, the marketing-related journals’ importance remains the highest. Still, the share of articles in operations management outlets relatively increased, and the share of articles in management journals gradually decreased from 2006 to 2009.

Several of the early vocabularies assimilated, and some later articles introduced new vocabularies and discursive elements. The vocabularies of the marketing-related ‘solutions’ and the innovation-related ‘CoPS’ sub-streams came together in the period 2006–2009. After this period, scholars no longer differentiate between these sub-streams when citing previous research (e.g., see Roehrich & Caldwell, 2012). Other sub-streams have developed more recently. For instance, although the term ‘servitization’ emerged in the late 1980s (Vandermerwe & Rada, 1988), the sub-stream referred to as product-centric servitization developed as a sub-stream in its own right during the period from 2006 to 2009 (Baines et al., 2007; Johnson & Mena, 2008). It started growing after the publications of Baines and colleagues (Baines, Lightfoot, Benedettini, & Kay, 2009; Baines, Lightfoot, Peppard, et al., 2009) and peaked from 2014 to 2018. Regarding its disciplinary origins and vocabulary, this sub-stream is conceptually and linguistically connected to the ‘operations and supply chain management’ sub-stream (Wilkinson et al., 2009) and linked to the ‘strategic fit’ sub-stream, with which it shares some foundational articles (e.g., Mathieu, 2001a, 2001b; Oliva & Kallenberg, 2003; Quinn et al., 1990; Vandermerwe & Rada, 1988).

The sub-stream referred to as managing ‘performance-based contracting (PBC) to deliver complex performance (PCP)’ originated in operations management outlets by the end of the period from 2006 to 2009. The expansion came from 2014 to 2018, when most articles were published in operations management and marketing/industrial marketing journals. This sub-stream involves two associated themes closely connected to the literature on CoPS, as well as the ‘operations and supply management’ and the ‘solutions’ vocabularies (Essig et al., 2016). Pre-disposed by the paper of Lewis and Roehrich (2009), the PCP literature is rooted in contractual literature concerning make-or-buy decisions (e.g., transaction cost economics and agency theory) and public-private

partnerships. Its vocabulary became closer to the ‘product-centric servitization’ vocabulary after 2014 (e.g., Kreye et al., 2015).

Furthermore, the marketing-rooted sub-stream referred to as ‘customer relationships and business logic in the B2B service infusion’ has been built primarily on articles in marketing and industrial marketing outlets, with a particular proliferation of publications from 2010 to 2013. As discussed, this sub-stream introduces the theme of service-dominant logic (SDL) into the discussion of the divergences and convergences between the transition from product to service in business markets (Jacob & Ulaga, 2008) and the shift towards SDL in the service marketing transition (Vargo & Lusch, 2008).

The above analysis suggests that the vocabularies dispersed and shaped the sub-streams in the early stages of the field’s development. In subsequent phases, the way scholars utilize these vocabularies converged, which resulted in the homogenization of vocabulary across the different sub-streams. Thus, the servitization field has evolved towards a more integrated, shared vocabulary that has increased its internal consistency in how concepts are being used. Additionally, several themes have consistently remained relevant overtime in each sub-stream, although the relevance level varied, following a particular trend. We classified the themes into six groups (Table 3) according to their trend as follows 1) cold (strong negative linear time trend), 2) cooling (negative linear time trend), 3) wallflower (no time trend and a low number of publications), 4) evergreen (no time trend and a high number of publications), 5) warming (positive linear time trend), and 6) hot (strong positive linear time trend).

The analysis offers specific hints concerning the field’s future development (Antons, Kleer, & Salge, 2016), including several hot or getting hot research directions and some opportunities to revitalize

Table 3
Trends of persistent themes in servitization research.

TOPIC		Theme	Trend
T1	Strategic fit for a profitable service transition	Environment-strategy-structure fit for service orientation in manufacturing	Cooling
		Antecedents and challenges for implementing service strategies in manufacturing	Evergreen
T2	Customer relationships and business logic in B2B service infusion	Configurations for value creation in B2B service infusion	Warming
		Relational capital and relationship management for service offerings in B2B markets	Warming
T3	Solutions marketing and delivery	Value co-creation in network-based business models	Warming (fast)
		Strategies and critical factors for solution business development	Hot
T4	Complex solutions in capital goods	Definitional issues and policymaking in COPs	Cold
		Development path and strategies in COPs	Cold
		Capabilities, innovation, and industrial organization in COPs	Cold
T5	Managing performance-based contracting and complex performance	Selling PBC in B2B markets	Wallflower
T6	Operations and supply chain management for after-sales industrial services delivery	Governance in PBC	Wallflower
		Relationships in PBC	Warming
T7	Product-centric servitization	Supply chain capabilities for after-sale life-cycle services	Cooling
		Service operations and field service delivery	Cold
		Servitization as an organizational transformation	Warming (fast)
		Taking stock of the servitization field and its development	Hot
		Digital servitization	Hot

some cold or cooling themes. First, there is a warming up of themes related to product-centric servitization, such as organizational transformation (Bustinza, Gomes, Vendrell-Herrero, & Tarba, 2018) and firm boundaries (Huikkola, Rabetino, Kohtamäki, & Gebauer, 2020). Second, after an impressive accumulation of research, the need arose among servitization scholars to take stock of and account for the field's development, which translates into a growing number of literature reviews in a short period (Baines et al., 2017; Luoto et al., 2017; Martín-Peña, Pinillos, & Reyes, 2017; Rabetino et al., 2018; Raddats et al., 2019). Third, the study of servitization antecedents and challenges seems to be evergreen. Fourth, outcome-based contracts' relational aspects are warming (Korkeamäki & Kohtamäki, 2020; Sjödin, Parida, Jovanovic, & Visnjic, 2020; Visnjic, Jovanovic, Neely, & Engwall, 2017; Visnjic, Neely, & Jovanovic, 2018). This type of offering may become vital in emerging issues in adjacent disciplines and even at the heart of the PSS literature, such as the circular economy. Indeed, embedding circular economy into servitization research represents a twofold opportunity. Scholars can bridge servitization and PSS research and revive some cooled topics, such as the notion of life-cycle services (Rabetino et al., 2015). Finally, the scholarly domain's transition towards digital servitization is also evident, establishing a new research context.

Various warming themes are linked to new business models enabled by digital technologies (Paschou, Rapaccini, Adrodegari, & Saccani, 2020) and the consequent need for organizational alignment and fit. These processes may involve a future resurgence of contingent narratives in this new context (until recently in a cooling process). Indeed, the configuration concept is becoming popular to describe the emerging business model patterns and the need for fitting the patterns' components. Digital servitization also calls for an ecosystem approach (Forkmann et al., 2017; Kohtamäki, Parida, Oghazi, Gebauer, & Baines, 2019) and a change towards an inter-firm dominant logic (Tronvoll, Sklyar, Sörhammar, & Kowalkowski, 2020) built on an intensive stakeholder collaboration (Kamalaldin, Linde, Sjödin, & Parida, 2020; Sklyar, Kowalkowski, Tronvoll, & Sörhammar, 2019). The above trend may also lead to a warming up of a set of subjects, such as supply chain reconfiguration and make-or-buy decisions (Bustinza, Lafuente, Rabetino, Vaillant, & Vendrell-Herrero, 2019), service networks and ecosystems governance, and service-driven digital platforms (Cenamor, Rönnberg Sjödin, & Parida, 2017; Eloranta & Turunen, 2016; Tian, Coreynen, Matthysens, & Shen, 2021). There is an emerging discussion concerning modularity (Rajala, Brax, Virtanen, & Salonen, 2019; Salonen, Rajala, & Virtanen, 2018) that is closely related to platforms and ecosystems (Jovanovic, Sjödin, & Parida, 2021). In this context, early research on COPs (currently cold) and integrated solutions (Davies et al., 2006) can inform future digital servitization research developments. Finally, the growing relevance of value co-creation at an (eco)system level (Bustinza et al., 2019) may explain why relationships and relational capital seem to be heating up issues in different tribes.

4.4. The evolution of the servitization domain

Previous studies have chronologically documented the founding, emergence, and legitimation of new sub-disciplines within consolidated disciplines. Brown, Fisk, and Bitner (1994) describe the development of services marketing within marketing as the following three phases: differentiation and legitimization; conceptual foundations and growth; and consolidation. Similarly, service operations management has sought legitimation within the operations management discipline (Johnston, 1999). Servitization research shares foundational characteristics and theoretical legacy with service marketing and service operations management (e.g., focus on services, close interaction between academics and practitioners, interdisciplinary, and internationalization) and appears to follow a similar developmental path. Servitization is moving beyond the problem-centered phase and entering the consolidation stage (Kowalkowski, Gebauer, & Oliva, 2017). This evolution is characterized by 1) a more in-depth examination of traditional topics (Brax

& Visintin, 2017; Finne et al., 2013; Kowalkowski, Gebauer, Kamp, & Parry, 2017), 2) the incorporation of theories from consolidated disciplines (Valtakoski, 2017; Lee, Yoo, & Kim, 2016; Reim, Sjödin, & Parida, 2018), 3) an increase in methodological and theoretical rigor without losing practical relevance, and 4) a stronger mobilization of the members materialized in the consolidation of major conferences and an increase in international co-authorships.

Against the literature analysis, the following stylized facts outline the evolution of the servitization domain. Servitization scholars come from different research disciplines and have socially constructed their scientific narratives by integrating their disciplines' institutionalized vocabularies with vocabulary that characterizes the research topics in the servitization context. In doing so, they reproduce the disciplinary vocabularies and underlying assumptions by embedding them in the language of the servitization research domain. Thus, disciplinary roots shape the vocabularies and influence the collective processes through which the identity of servitization as scholarly field unfolds and the servitization meta-narrative (Luoto et al., 2017) emerged and has been developing. Although different sub-streams coexist, their styles and how scholars utilize these embedded vocabularies have converged. Moreover, as research on servitization accumulates, the relative growth in references to servitization-related articles indicates some effective differentiation from the disciplines mentioned above (Augier, March, & Sullivan, 2005).

The above stylized facts simultaneously reflect and direct the development of the servitization research domain. In particular, the processes of differentiation and mobilization had a fundamental role in constructing the domain's identity and common language. Vocabulary convergence occurred especially after 2009 when servitization scholars initiated new arenas for dialogue in the form of conferences and special issues (Kowalkowski, Gebauer, Kamp, & Parry, 2017). Several literature reviews – clear signs of mobilization and identity building – also appeared during this time (Baines et al., 2007; Baines, Lightfoot, Benedettini, & Kay, 2009). These processes fueled co-citation and co-authoring among servitization scholars (Rabetino et al., 2018) and the shaping of the meta-narrative described by Luoto et al. (2017).

The differentiation and mobilization processes can also be identified from the patterns observed in servitization literature. The expression 'servitization community' first appeared in the review of Baines, Lightfoot, Benedettini, and Kay (2009). In contrast, Lightfoot, Baines, and Smart (2013), p. 1408 first recognized servitization as "a field of research interest." The members' self-recognition of servitization either as a *domain* (Gebauer, Saul, Haldimann, & Gustafsson, 2017; Nudurupati, Lascelles, & Wright, 2016; Raja, Frandsen, & Mouritsen, 2017) or as a *field* (Alghisi & Saccani, 2015; Kamp & Parry, 2017; Kowalkowski, Gebauer, Kamp, & Parry, 2017; Leoni, 2015; Martín-Peña et al., 2017) has increased since 2015. Simultaneously, researchers began to use the expression 'servitization scholars' to refer to themselves (Díaz-Garrido, Pinillos, Soriano-Pinar, & García-Magro, 2018; Helms, 2016; Kowalkowski, Gebauer, & Oliva, 2017; Shi, Baldwin, & Ridgway, 2017; Spring & Araujo, 2017). The growing acceptance of servitization to replace early terms like 'service infusion' (Brax, 2005) or 'service maneuvers' (Mathieu, 2001b) signals the research domain's legitimization.

5. Conclusions

The purpose of this study is twofold. First, it aims to identify the servitization sub-streams based on latent topics defined through their vocabularies' relative differences. Second, it seeks to discover patterns of evolution by examining the thematic changes in the sub-streams and the dynamics of their influence across the 30 years of servitization research. Thematic topics are first identified based on their diverse vocabularies using dynamic topic modeling. The interpretive analysis of these vocabularies and the influential research in each period translates the topics into evolving sub-streams of servitization research. Thus, this analysis of thematic evolution within and among the sub-streams

‘deconstructs’ the servitization meta-narrative identified in earlier research (Luoto et al., 2017) and demonstrates the stages through which the domain formed.

From a conceptual perspective, this study presents insights to develop servitization research by examining its trends. Structuring a scholarly field using topic modeling can inspire future non-exclusive development strategies (Antons et al., 2016), including but not limited to the following ones. First, focusing on hot or reviving topics that attract growing interest and offer many gaps to be filled. Second, reviving cold or dying topics by redefining and integrating them into popular topics. Third energizing wallflower or anemic topics by adopting a new theoretical or philosophical perspective or unit/level of analysis. Finally, filling blanks in the topic landscape by identifying and importing hot topics that have not been explored yet from adjacent disciplines.

Relevant avenues for implementing the above strategies were already suggested (Luoto et al., 2017; Rabetino et al., 2018; Raddats et al., 2019). Besides, our analysis of the field’s evolution suggests that the observed semantic convergence preserves prior assumptions. While foundational beliefs are “camouflaged in commonly used concepts and phrases” (Alvesson & Sandberg, 2013: 58), uncovering these assumptions is crucial to theory-building (Alvesson & Sandberg, 2011). A theoretical contribution may come from adapting the assumptions to different analytical levels or contexts. When theorizing, understanding the assumptions also permits to expose internal inconsistencies in one theory or identify logical inconsistencies between alternative theories (Makadok, Burton, & Barney, 2018). Finally, the problematization of the field’s taken-for-granted beliefs (Sandberg & Alvesson, 2011) offers an approach to challenge the domain’s underlying assumptions and search for alternative narratives (Luoto et al., 2017).

According to Alvesson and Sandberg (2013), before applying problematization, researchers must scrutinize the emergence of the taken-for-granted beliefs in a literature domain and the practical and historical conditions that gave birth to them. This analysis can first focus on exemplar or path-defining studies and then review later work drawing on them (Alvesson & Sandberg, 2011). Indeed, DTM accounts for the path-defining studies over time and how they affected subsequent work. It offers a tool to identify how the servitization domain’s underlying assumptions were formed and reproduced, and a route towards identifying the latent narratives, somewhat responding to Luoto et al.’s (2017) call.

As an illustration, several underlying assumptions are evident in our analysis; others could be identified by scrutinizing the identified path-defining studies (which exceeds this study’s scope). The most obvious example is the assumption of the transition along a unidirectional product-service continuum (Oliva & Kallenberg, 2003). Scholars created an in-house root metaphor (Alvesson & Sandberg, 2013), which disseminated among the topics and was problematized by Kowalkowski et al. (2015). Alternatives include assumptions such as multiple servitization paths (Martínez, Neely, Velu, Leinster-Evans, & Bisessar, 2017), reverse servitization (Finne et al., 2013), and de-servitization (Valtakoski, 2017). Likewise, the assumption that servitization implies automatic benefits spawned a set of alternative propositions. Examples are the service paradox (Gebauer et al., 2005) and subsequent studies concerning the non-linear relationship between service offering and firm performance (Bustinza et al., 2018; Fang et al., 2008; Kohtamäki, Partanen, Parida, & Wincent, 2013; Visnjic Kastalli & Van Looy, 2013). Finally, servitization studies often explicitly or implicitly apply the Contingency Theory’s underlying assumptions to study strategy-structure configurations and the contingent fit. As our analysis shows, Raddats et al. (2019, 214) conclude that many service strategies have been proposed in the service literature, “...which are contingent on both external and internal factors”. The paradox theory offers a way to generate an alternative narrative (Kohtamäki, Einola, & Rabetino, 2020).

The present article extends SLR methodology by introducing

dynamic topic modeling to detect evolving time-bound latent topics based on their vocabulary. Specifically, this study makes a methodological contribution by illustrating the research possibilities of DTM combined with a thematic analysis (Hannigan et al., 2019). DTM presents an alternative that eludes some limitations inherent to the co-citation analysis approach used in pre-existing works (Díaz-Garrido et al., 2018; Martín-Peña et al., 2017; Pilkington, Raja, Hsuan, & Frandsen, 2017; Rabetino et al., 2018). Co-citation analyses are biased by how scholars use citations (Cozzens, 1989). The selection of articles to be qualitatively reviewed is subjective, and the chronological tracking of the field’s evolution is not straightforward. Author co-citation analysis can reveal servitization-related communities but has limitations in objectively isolating topics because one author may contribute to several subjects. Article co-citation or co-word analyses can identify generic topics, whereas DTM allows the refined analysis of topics based on their vocabularies. A systematic study of vocabularies may be useful when the settling of research communities harmonizes their terminology.

The research community is undoubtedly the principal audience for literature syntheses (Antons et al., 2016). Yet, because sayings in literature ultimately become doings in managerial life, any study that supports the understanding and construction of a common vocabulary favors the accumulation of knowledge and helps transfer this knowledge to practical life based on a better understanding of the phenomenon by managers. This process prevents what Shapiro, Kirkman, and Courtney (2007) referred to as the translation problem. The target group for this ‘translation’ is newcomers to the servitization field, including academics and practitioners. The study makes the various sub-streams transparent to those interested in servitization and helps them understand the existing differences’ disciplinary roots. This study, in turn, facilitates successful and swift publication processes and lowers the entry barrier to contribute to the servitization domain.

The study has three main limitations. First, although the algorithm classifies the articles based on vocabularies, the final solution regarding the number of latent topics is affected by the researchers’ viewpoints (as for most clustering methods). Second, despite the careful development of the search string, some articles may have been missed due to terminology differences. Although the latest publications have not been included in the analysis, this is not a limitation. According to our study, it takes almost five years for a paper to become influential. Third, this article analyzes the mainstream of the servitization research and leaves out other relevant servitization-related streams. PSS research differs from the servitization literature because it is based on a product-dominant view with a systemic approach.

We encourage future studies to use DTM and explore sub-streams within other industrial marketing management research domains and cross-disciplinary topics such as the PSS literature. We note that the term *digitalization* resembles servitization in many ways. It also denotes a radical transformation across industries. As the research accumulates, the patterns of the digitalization discourse can be examined. Finally, future research can fully exploit other opportunities around vocabulary structures, such as the study of word-to-word and word-to-example relationships (Loewenstein et al., 2012).

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