Digital servitization journey in small- and medium-sized enterprises: the contribution of knowledge-intensive business firms

Mario Rapaccini
Department of Industrial Engineering, University of Florence, Florence, Italy
Marco Paiola
Department of Economics and Management, University of Padua, Padua, Italy
Lino Cinquini
Institute of Management, Scuola Superiore Sant'Anna, Pisa, Italy, and
Riccardo Giannetti
Department of Economics and Management, University of Pisa, Pisa, Italy

Abstract

Purpose – This study aims to investigate the contribution of knowledge-intensive business services firms to small- and medium-sized manufacturers' digital servitization journeys, addressing the standardization versus customization dichotomy of services and solutions provision.

Design/methodology/approach – To identify the challenges that small- and medium-sized firms must face in the digital servitization journey and the role that knowledge-intensive business services firms may play in the innovation processes, the authors conduct a review on two still unrelated literature streams and develop a longitudinal single-case study, with a particular focus on knowledge generation mechanisms.

Findings – Digital servitization is a particularly challenging transformational journey for minor firms. Knowledge-intensive business services firms can act as sources, facilitators, and carriers of knowledge, and they can orchestrate further contributions of other external partners and firms.

Research limitations/implications – The paper contributes to theory describing the roadmap and the role of external service providers in digital servitization journeys of smaller firms', that are frequently excluded from mainstream research although being the backbone of European economies.

Practical implications – Digital servitization in minor manufacturing firms requires a long-term orientation and a multi-stage roadmap. Mixing standardized technology-based solutions and complementary professional services, knowledge-intensive business services firms can significantly contribute to lowering the journey's uncertainties, operational complexity, and costs.

Originality/value – The paper sheds lights on how the collaboration between knowledge-intensive business services firms and small manufacturers generates novel knowledge and capabilities that contribute to takle the challenges of the different stages of the digital servitization roadmap.

Keywords Digital servitization, SME, KIBS, Product-service systems

Paper type Research paper

Highlights

- Digital servitization is a transformational journey particularly challenging for minor size manufacturers that are the backbone of European economy.
- Digital servitization in SMEs requires a long-term orientation and a multi-stage roadmap.
- The contribution of KIBS firms in customers' digital servitization is twofold: they act as sources, facilitators and carriers of knowledge; and they orchestrate further contributions of external firms.
- Partnering with KIBS can greatly favour the digital servitization journey in SMEs; mixing standardized solutions and complementary services, KIBS firms can significantly help in reducing costs and operational complexity.

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1. Introduction

Servitization is "the transformational process whereby a company shifts from a product-centric to a service-centric business model and logic" (Kowalkowski *et al.*, 2017a, 2017b, p. 8). In this move, digital technologies play a crucial role (Momeni and Martinsuo, 2018; Paiola and Gebauer, 2020). Previous research claims that digital servitization (DS) can bring remarkable benefits (Baines *et al.*, 2009; Paschou *et al.*, 2020). However, this transformation is risky (Gebauer, 2005), as it impacts radically the business model (BM) configuration of product-centric firms (Kohtamäki *et al.*, 2019; Visnjic *et al.*, 2017). In addition, the necessity of introducing digital technologies to support the move to digital services may require qualified contributions from external partners (Hasselblatt *et al.*, 2018; Andersson and Mattsson, 2016). This is particularly true in the case of small- and medium-sized enterprises (SMEs) that frequently need partners to integrate their capabilities and tackle with such complex innovations (Rajala *et al.*, 2008; Franco and Haase, 2015; Saccani *et al.*, 2014). In this scenario, companies that provide knowledge-intensive business services (KIBS) are recognized as important carriers of innovation for SMEs (Muller and Doloreux, 2009; Zhou *et al.*, 2017). For this reason, some studies address the contribution of KIBS firms to servitization of large and small manufacturers (Kohtamäki and Partanen, 2016; Ayala *et al.*, 2017). However, many aspects of this interplay remain largely underexplored (Rapaccini *et al.*, 2020a, 2020b; Grandinetti *et al.*, 2020). This is particularly the case of minor businesses that are frequently excluded from mainstream research (Luoto *et al.*, 2017). With a particular focus on servitization enabled by digital technologies, i.e. the so-called "digital servitization" (Ayala *et al.*, 2019; Bustinza *et al.*, 2021), this paper aims at filling this gap. More specifically, this study answers the following questions:

RQ1. What are the problems that SMEs face in their DS journey?

RQ2. What are the contributions made by KIBS firms to address the mentioned problems?

The remainder of the paper is organized as follows: Section 2 presents the theoretical background of this study. Firstly, this section shows the problems that SMEs face in their DS journey and responds to *RQ1*. Then, it summarizes the review of a second stream of literature, which as said regards the mechanisms through which KIBS firms play their roles as agent of innovation in the context of SMEs. Section 3 illustrates the research methodology use to collect empirical material, while Sections 4 and 5, respectively, present and generalize the paper findings. This section also connects the contributions made by KIBS firms to the DS roadmap that has been identified. Section 6 concludes this study, highlights its implications and limitations and suggests avenues of future research.

2. Theoretical background

2.1 Digital servitization in small- and medium-sized enterprises

DS is the enablement of servitization through digital technologies (Ardolino *et al.*, 2017; Paschou *et al.*, 2020; Gebauer *et al.*, 2021). The rationales that drive manufacturers to infuse services into their businesses include the erosion of margins from product sales, the intensification of rivalry and the search for new business opportunities (Michalik *et al.*, 2019). Like larger firms, SMEs can be forced into servitization by competitive pressures and product commoditization (Confente *et al.*, 2015). When servitization is successfully implemented, manufacturers can differentiate their offerings (Man *et al.*, 2002), increase revenues and profits (Kowalkowski *et al.*, 2017a, 2017b), stabilize their cash flows (Kowalkowski *et al.*, 2013) and mitigate the impact of global crises (Rapaccini *et al.*, 2020a, 2020b). The shift of manufacturers to digital services has been observed in numerous industries and involves firms of different sizes (Paschou *et al.*, 2020; Ambroise *et al.*, 2018), but it does not always represent a panacea (Baines *et al.*, 2009). Servitization is seen as a risky move that forces to tackle with extremely ill-structured problems (Struyf *et al.*, 2021). When dealing with DS, firms also need to take into account the effect of digitalization (Confente *et al.*, 2015). For instance, these originate as cost savings in service delivery (Kanovska and Tomaskova, 2018), insights from data collected from connected equipment (Basirati *et al.*, 2019) or higher differentiation from rivalry (Peillon and Dubruc, 2019; Coreynen *et al.*, 2017). There is, however, no free meal, as digitalization brings more complexity and changes to the organization and practices (Kanovska and Tomaskova, 2018; Kohtamäki *et al.*, 2020).

The extant literature acknowledges that even smaller firms can profit from the infusion of digital services in their product-centric businesses (Grandinetti *et al.*, 2020). However, this move requires tackling with various problems (Chalal *et al.*, 2015; Teso and Walters, 2016; Tauqeer and Bang, 2018). These are summarized in Table 1.

The relevance of external contributions in the move towards digitally based forms of servitization highlights how inter-organizational relations are crucial in such transformations, especially in the context of minor manufacturers. Industrial marketing scholars have used the network approach to conceptually and empirically investigate buyer–supplier relationships (Håkansson and Snehota, 1995). Using a dyadic or a multi-actor interface perspective (Anderson *et al.*, 1994; Araujo *et al.*, 2016), adopting the firm's strategy and the institutional points of view (Waluszewski, 2011), this literature maintains that some of the elements that explain why some BM innovations are more successful than others could be embedded in buyer–supplier relationships. Partnering with technology-based service providers and KIBS may contribute to value creation (Aarikka-Stenroos and Jaakkola, 2012).

Recently, the relational perspective has extended its focus on the effects of digitalization on product and service innovation, investigating subjects that are particularly significant for this study, such as the interdependencies implied by BtoB solutions among suppliers and end-user firms in capital goods industries (Windahl, 2015); the role of platforms in digital transformation (Andersson and Mattsson, 2016); the impact of co-creation with customers in the provision of BtoB advanced services (Ruiz-Alba *et al.*, 2019); the evolution of small-sized KIBS firms from consultants to Industry 4.0 solutions providers (Mersico *et al.*, 2022); and the relevance of interfaces between manufacturing firms and Internet of Things (IoT)-related suppliers within DS initiatives (Ferreira and Lind, 2022).

The mentioned literature contributed to the shaping of this paper. In fact, we assume that DS is a complex innovation that challenges the business architecture of product-centric firms (Visnjic *et al.*, 2017). We also assume that KIBS partners can help manufacturers – especially minor firms – to address this

Table 1 Problems that SMEs have to address when moving to DS

Problem	Detailed descriptions and relevant references
Financial paradoxes: undergoing simultaneously through a service and digital transformation is risky, investments are not always paid back	• Servitization is risky (Gebauer et al., 2005*) especially in highly competitive industries (Confente et al., 2015; Michalik et al., 2019) • Smaller firms might not reach the minimum scale needed to obtain profits from services and from digital services (Confente et al., 2015; Michalik et al., 2019; Malleret, 2006) • Financial results could be negatively impacted by simultaneously moving along the trajectories of servitization and digitalization in unbalanced ways (Kohtamäki et al., 2020*; Gebauer et al., 2021) • Coordinating the transformations of servitization and digitalization could be harder for smaller manufacturers (Paiola et al., 2022b)
Culture and organization: minor manufacturers struggle to change the product-dominated culture and organization	• Manufacturing firms that want to compete with services have to change the company's culture and develop a more service-oriented mindset (Dubruc et al., 2014*; Dahmani et al., 2016) • DS requires strategic alignment, appropriate leadership and commitment (Kohtamäki et al., 2020), all things that are not abundant in SMEs (Peillon and Dubruc, 2019) • Servitization requires changes to the traditional product-based organization (Hsieh and Chou, 2018; Michalik et al., 2019; de Jesus Pacheco et al., 2019*; Hsieh and Chou, 2018)
Limited resources and knowledge gaps: SMEs suffer the changes requested by DS due to their limited resources, capabilities and know-how	• New capabilities are necessary for DS (Kohtamäki et al., 2020*; Peillon and Dubruc, 2019; Coreynen et al., 2017) • Manufacturers need to learn how to design digital services that create value for the customers (Zambetti et al., 2021; Rapaccini and Adrodegari, 2022) • Digital technologies such as IoT, cloud computing and data analytics are crucial to deliver smart services (Porter and Heppelmann, 2015; Ardolino et al., 2017; Paschou et al., 2020) • Smaller firms usually lack the required know-how for introducing digital technologies (Hsieh and Chou, 2018*; Confente et al., 2015*; Hernandez Pardo et al., 2013*; de Jesus Pacheco et al., 2019*) • The smaller the firm, the greater the limitation of resources for technological and managerial innovation (Kohtamäki et al., 2020; Hsieh and Chou, 2018; Peillon and Dubruc, 2019)
Accessing customers' data: It is not easy to convince customers to share field data from connected equipment	• SMEs have a poor reputation as service provider (Confente et al., 2015; Michalik et al., 2019) • Customers could be reluctant to connect their equipment and share their sensitive data in exchange for digital services, due to cybersecurity threats and confidentiality concerns (Peillon and Dubruc, 2019) • Without access to data from connected equipment, firms cannot generate insights about customers' needs (Kanovska and Tomaskova, 2018*)
Operational complexity: SMEs can be overwhelmed by the higher operational complexity required by a digital service business	• Delivering services is inherently complex for manufacturing firms (de Jesus Pacheco et al., 2019; Michalik et al., 2019; Confente et al., 2015) • The complexity of service management could be mitigated by the introduction of dedicated information systems (Baines et al., 2009; Coreynen et al., 2017) • In smaller companies, digital innovation and servitization require relevant changes to the operational practices (Turunen and Finne, 2014; Peillon and Dubruc, 2019; Kanovska and Tomaskova, 2018*; Kohtamäki et al., 2020*; Paiola and Gebauer, 2020)
Business ecosystems: In their journey to DS, SMEs should consider the necessity of establishing and orchestrating new business ecosystems, but their attitude to partnering with other firms is rather limited	• The provision of digital services requires numerous actors to collaborate (Bikfalvi et al., 2013; Leminen et al. 2018; Charterina et al., 2016; Wang et al., 2022) • Orchestrating business ecosystems for digital services is complex and entail establishing and controlling interfaces and processes of third parties (Confente et al., 2015; de Jesus Pacheco et al., 2019; Michalik et al., 2019) • SMEs have limited attitudes towards open innovation (Michalik et al., 2019; Paiola et al., 2013)

Note: *Papers that study manufacturers of different sizes, including a significant amount of SMEs

transformation. The next sub-section reviews the literature on this topic.

2.2 Contributions of knowledge-intensive business services firms to small- and medium-sized enterprise innovation

Any firm providing knowledge-intensive services to business customers can be defined as a KIBS firm (Miles *et al.*, 1995). This broad definition includes not only consultancy firms and providers of professional service but also technology vendors and system integrators (Zhou *et al.*, 2017). The literature discriminates between two major categories, namely, professional (P-KIBS) and technological KIBS (T-KIBS) (Miles *et al.*, 1995). The first group includes those firms that provide professional services such as tax and accounting, law and engineering. T-KIBS instead provide technology-based solutions through goal-oriented projects and services. By mixing different mechanisms for crafting novel knowledge, both T-KIBS and P-KIBS firms can contribute to SMEs innovation (Strambach, 2001; Das and Teng, 2002; Shearmur and Doloreux, 2013). They in fact induce changes to the practices and routines of their clients (Muller and Zenker, 2001). In particular, it is agreed that T-KIBS create opportunities for innovation, while P-KIBS support their implementation (Miles *et al.*, 1995; D'Antone and Santos, 2016).

In this interplay with their customers, KIBS enable the generation of new knowledge (Wagner *et al.*, 2014) or the

codification of the existing one (Drejer and Vinding, 2005). In this sense, KIBS act as knowledge source, facilitator or carrier (Muller and Zenker, 2001; He and Wong, 2009; Miles, 2012). The novel knowledge originates by moulding the stocks possessed by the KIBS with those of its customer. Otherwise, they can be carried by the KIBS across the industries to contaminate new domains. This virtuous cycle has been observed in numerous studies, which confirm that KIBS first absorb, then carry and finally release the absorbed knowledge to the new context (Bettencourt *et al.*, 2002, Paiola, 2012).

In their role of knowledge source, facilitator and carrier, the KIBS implements different forms of interactions with its customers (Muller and Zenker, 2001; Gadrey and Gallouj, 1998; Sundbo and Gallouj, 2000). Zhou *et al.* (2017) discriminate complementary from supplementary interactions. The first occurs when the knowledge mastered by the KIBS is combined with that of the customer to create some new stocks via in-depth relationships. The second is the case of pre-existing knowledge that is crafted into a solution that the KIBS then gives to its customer. In this latter case, of course, the customers play a less active role, and the corresponding interactions with the KIBS are more easier and focused. The complexity of the interactions between the KIBS and the customer firm also depends on the extent of customization of the services provided (Miles *et al.*, 1995; den Hertog, 2000). The KIBS firms usually tailor their services to meet their customer needs (Muller and Doloreux, 2009; den Hertog, 2000). However, in certain cases, the customer prefers more standardized solutions, which are usually more convenient and faster to adopt (Töllner *et al.*, 2011). Extant literature agrees on the advantages of standardization in the context of smaller business (Tether *et al.*, 2001) and pinpoints that customization–standardization trade-off is an important driver of innovation (Bettiol *et al.*, 2012; Landry *et al.*, 2012). Table 2 summarizes the potential contributions made by KIBS firms to SMEs innovation.

Integrating the considerations of Tables 1 and 2, we can develop the research framework of this study. As mentioned, this paper aims at investigating the contributions made by KIBS firms to address the problems of SMEs undergoing DS. We assume that these contributions may have the form of novel knowledge stocks that are generated in the interplay between the KIBS and their customers. In other cases, these stocks may pre-exist and are just carried across domains by the KIBS. In addition, the novel knowledge could be created through the provision of custom services in goal-oriented projects or through pre-arranged

Table 2 Potential contributions made by KIBS firms to SMEs innovation

Aspect	Description	Main references
KIBS type	– *P-KIBS* provide professional services such as tax, legal and accounting services –*T-KIBS* deliver technology-based solutions and services	Miles *et al.* (1995), Zhou *et al.* (2017); D'Antone and Santos (2016)
Potential outcomes	Partnering with KIBS firms can be beneficial for SMEs in terms of *cost reduction*, *flexibility*, *resilience*, *business growth*, *compliance* and *better reputation*	Aarikka-Stenroos and Jaakkola (2012)
Range of activities	– *Market-related innovation*: KIBS firms facilitate market-related innovation such as needs exploration and solution findings – *Technology- and process-related innovation*: KIBS firms support the implementation of new information systems, procedures and workflows that change the customer routines and practices	Das and Teng (2002), Drejer and Vinding (2005); Muller and Doloreux (2009), Shearmur and Doloreux (2013); Paiola (2012), Wagner *et al.* (2014)
Mechanisms of knowledge generation	– *Sources*: KIBS directly create new knowledge that is transferred and/or eventually combined with those of their customers, to mould original solutions – *Facilitators*: KIBS just facilitate accessing external/pre-existing sources of knowledge – *Carriers*: KIBS firms borrow and adapt knowledge from other industries to create customer- or industry-specific applications	den Hertog (2000), Muller and Zenker (2001); He and Wong (2009); Miles (2012)
Interactions	– *Complementary interactions*: KIBS firms and customers jointly mould their knowledge to create novel stocks – *Supplementary interactions*: KIBS firms leverage their existing knowledge to craft solutions that are provided to their customers	Töllner *et al.* (2011); Zhou *et al.* (2017)
Reciprocity	– *Uni-directional*: KIBS just transfer their knowledge to the customers – *Bidirectional*: both counterparts absorb each other's knowledge; the knowledge absorbed by the KIBS in a given context is carried out and transferred to other contexts	Gadrey and Gallouj (1998), Sundbo and Gallouj (2000); Muller and Zenker (2001), Bettencourt *et al.* (2002); He and Wong (2009)
Customization	– KIBS firms typically differentiate their offering through *highly customized solutions* – T-KIBS firms usually generate value through *prearranged modular service packages*	den Hertog (2000), Muller and Doloreux (2009); Consoli and Elche-Hortelano (2010); Tether *et al.* (2001); Bettiol *et al.* (2012)
Scalability	– The higher the customization, the greater the problems of scaling up the service solutions provided by KIBS firms to SMEs	Landry *et al.* (2012)

solutions. On the base of this considerations, Table 3 shows the questions on which this study speculates. These questions inform the collection of the empirical material, whose method is explained in the next section.

3. Research methodology

3.1 Case selection

This paper uses an in-depth, longitudinal single-case study (Crotty, 1998; Voss *et al.*, 2002) to advance the current knowledge about the role of KIBS firms in supporting the DS of SMEs, as case-based inductive research is appropriate when dealing with a new topic (Welch *et al.*, 2011). In line with the principles of theory-building empirical research (Meredith, 1993; Meredith, 1998; Melnyk and Handfield, 1998), we used a case study to collect empirical material and explore the phenomena under investigation (Tronvoll *et al.*, 2020). We adopted a longitudinal perspective that brings additional insights and counterbalances the limitations due to lack of replication (Eisenhardt, 1989; Pettigrew, 1990; Yin, 2006).

The eligible case had to comply with the following criteria (Seawright and Gerring, 2008): being a small- or medium-sized manufacturer involved in the DS move; collaborating with a KIBS firm in a long-term goal-oriented project, which allows for longitudinal exploration and retrospective reconstruction; willing to disclose in-depth information from primary and secondary sources; and providing access to acknowledgeable informants (Pettigrew, 1990). In line with similar studies (Grandinetti *et al.*, 2020; Paiola and Gebauer, 2020), the combination of these criteria drastically narrowed the number of eligible firms. A small manufacturing company (hereafter ALPHA; being the names of the firms anonymized for confidentiality reasons) complying with the mentioned criteria was identified. This firm was collaborating with a technology partner (hereafter BETA) that had been entitled to introduce an industrial internet platform through which ALPHA intended to connect the equipment of its customer base. This digital platform would in addition enable the delivery of advanced digital services such as condition monitoring and predictive maintenance.

3.2 Framing the case and the methods for data collection and analysis

According to Leonard-Barton (1990, p. 249), "a case study is a history of a past or current phenomenon, drawn from multiple sources of evidence. It can include data from direct observation and systematic interviewing as well as from public and private archives". Therefore, we collected data from different sources. Firstly, we used primary data and gathered information from meetings and interviews with managers of ALPHA and BETA. In line with our objectives, the unit of analysis of this paper is represented by the interplay between ALPHA and BETA (Waluszewski, 2011), and the focus is on the contributions made by KIBS (see Table 3) to push forward this complex transformation (Visnjic *et al.*, 2017). At the beginning of the research, the authors established a relationship with the ALPHA director, who was informed about the research aims. We were introduced to some co-workers, such as the managers of the sales, of the service and of the engineering departments. In the case of BETA, which is also a small firm, we interacted with the director/owner and with the software engineer in charge of the ALPHA project. Then, we identified other sources of information such as company presentations, financial reports, sales and maintenance contracts. Finally, in line with Wouters (2009), we obtained other information by the discussion with an MSc Management Engineering student. To fulfil his degree obligations, he actually worked for six months

Table 3 Questions on which this study speculates

Financial paradoxes	KIBS contributions
How can SMEs move towards DS with affordable investments? In this move, which roadmap should be followed to balance the service infusion with the adoption of digital technologies?	What is the contribution made by KIBS to the mentioned problems? In which form is this contribution provided? In which case there is the creation of novel knowledge? In which others the stocks are already existing? Are these stocks carried across domains and other industries? Is this knowledge accessed through the provision of custom or standard solutions? What extent of reciprocity has the interaction between a SME and a KIBS firm in their DS journey interplay?
Culture and organization	
How can SMEs develop more service- and digitally oriented mindset and change their organization to compete with digital services?	
Limited resources and knowledge gaps	
How can SMEs develop the know-how and capabilities requested for the DS transformations, under the constraints of limited resources and budget?	
Accessing customer's data	
How can SMEs convince their customers to connect their equipment and share data? How can SMEs transform these data into useful insights that will drive the development of digitally enabled advanced services?	
Operational complexity	
How can SMEs tackle with the complexity that arise from delivering digital services? Can this complexity be mitigated by introducing information systems and digital platforms?	
Business ecosystems	
How can SMEs establish and orchestrate the business ecosystems that implement and deliver the digital services?	

as a full-time intern at ALPHA. During this time, he collaborated actively to the DS project. He then worked with us as an assistant throughout the case study and helped us in shedding lights on the progress of the DS journey. Table 4 summarizes the sources of information and gives more details on informants, meetings and interviews duration.

The collection of information from the mentioned sources spanned two years (2019–2020). Considering the information gathered from the research assistant, our observation covers a four-year horizon (2018–2021). Such extended time spans are comparatively rare in the research on digital innovation (Aarikka-Stenroos and Jaakkola, 2012). As said, primary data source came from direct observations. The authors personally interviewed the managers and employees indicated in Table 4. We followed a semi-structured questionnaires that addressed the questions of Table 3. The interviews were audio-recorded and transcribed. Then, the transcripts were sent to each informant for their review to strengthen the research consistency (Beach *et al.*, 2001; Karlsson, 2016). The interview transcriptions were independently analysed and interpreted by the authors in relation to the paper objectives, having preventively shared the research methods, materials and interpretative logics (Eisenhardt, 1989). In writing the case study, the temporal bracketing method was used (Langley, 1999). The reliability and trustworthiness of the results were strengthened via triangulation of data from different sources (Flick, 2018). Finally, to improve the research credibility and reliability (Lincoln and Guba, 1985), a document with some preliminary findings was submitted for publication in the proceedings of a scientific conference on servitization research, receiving a peer review by experts. The following section presents the findings of the case study.

3.3 Case description

ALPHA is a small Italian manufacturing company with approximately €6m of revenue and 30 full-time employees. It produces generators for technical gas (e.g. hydrogen, nitrogen and zero/dry air). Founded 30 years ago, ALPHA has already achieved a steady scale: the yearly growth, on average, has been less than 3% during the years of this research. ALPHA's products are mostly sold to industrial customers operating in food and beverage industry and for packaging applications. Irrespective of its small size, the company has a good international reputation and counts over 20,000 installations in 30 different countries. Besides a few smaller German and Italian companies, its rivals are large companies such as Hitachi (335,000 employees), Parker (57,000) or Atlas Copco (34,000). Competition comes also by producers of technical gases sold in cylinders such as the giant Air Liquide (66,000 employees worldwide). To defend its market position, ALPHA has put in place the typical pre- and post-sales offering and provides services such as commissioning, maintenance contracts, warranty extensions and quality certifications. In the early 2018, ALPHA started this ambitious project to connect its installed base with a digital platform and start delivering digitally enabled advanced services. For this aim, ALPHA entered into a partnership with BETA, a small software company but rapidly growing, that has deployed this proprietary platform for DS. This platform can be used by original equipment manufacturers as well by third-party service networks to connect industrial equipment and control remotely their status, check faults, order consumables and spare parts and activate workflows for field services. Adopting the platform requires no particular investments, as this is sold in the form of Software-as-a-Service (SaaS) (i.e. *pay-as-you-go*). In addition, the platform comes with standard/built-in modules (e.g. navigation panels, menus, dashboards, reports and workflows).

4. Findings

Empirical evidence showed that the DS journey was structured in four stages according to a multi-year roadmap (see Figure 1). This roadmap has been jointly developed by ALPHA and BETA during their initial interactions. More precisely, the sequence of activities to be carried out was proposed by BETA on the base of its previous experiences. ALPHA adapted this sequence to fit with the context. The structure of this roadmap greatly influenced the interplay between ALPHA and BETA, as explained in the following sub-sections.

4.1 Stage 1: strategic road-mapping

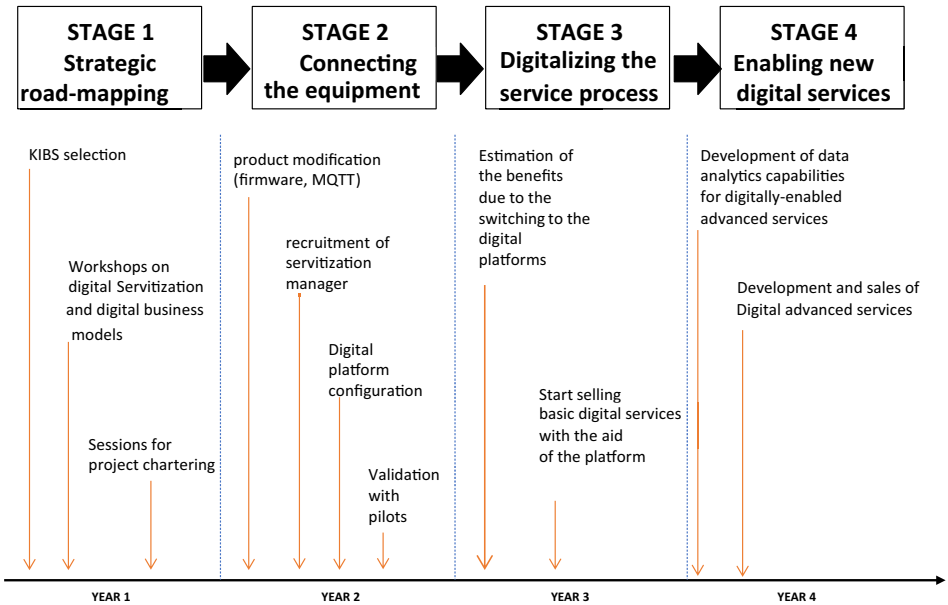
As supported by our empirical material, the strategic intentions and commitment of the managing director of ALPHA were key to setting up the stage for the DS project. His decision was boosted by the tax savings granted by the Italian Government to companies investing in connected equipment and Industry 4.0 technologies. The manager envisioned a good opportunity for offering digital services over the connected base to grow the ALPHA business. Being aware that ALPHA lacked adequate resources and skills, he selected a partner (i.e. BETA) to

Table 4 Data sources for the case study

Primary sources: Meetings and interviews with managers (between February 2019 and November 2020)			
Company	**Meeting/Interview with**	**No. of meetings[a] and interviews[b]**	**Total duration (min)**
ALPHA	Managing director (owner)	2 + 1	260
ALPHA	Sales department Manager	1 + 1	45
ALPHA	Service department manager	2 + 2	300
ALPHA	Engineering department manager	1 + 1	60
BETA	Managing director (owner)	3 + 2	340
BETA	Software engineer	1 + 1	80

Notes: [a]Meetings indicate collective discussions (in presence or virtual) around the studied topics, organized in respect to the research goals or to other circumstances (e.g. events, workshops, webinars) relevant for collecting direct information; [b]Interviews indicate an individual/vis-a-vis discussion (in presence or virtual) with the named respondent, following pre-defined research protocols and guided by semi-structured questionnaires

Figure 1 Multi-stage roadmap for the DS journey of ALPHA



collaborate in the DS project. Their encounter was promoted by an external consultant, who was already into a collaboration with ALPHA. The occasion for a first meeting between ALPHA and BETA was a workshop on digital innovation organized by the local innovation district. The BETA proposal was in line with the ALPHA's objectives as well with the financial constraints: a digital platform that could be easily set up, with little need of customization – at least in the initial stage – with a *pay-as-you-go* schema. No ALPHA staff should have been initially allocated full time to the DS project. BETA was therefore considered the right partner to deploy and test some pilot projects with the idea of scaling up in case of success.

In this early collaboration stage, the team covering key positions in ALPHA (e.g. Sales, Aftermarket, Engineering) was asked to be supportive to the project. They organized some meetings to share views in respect to the challenges and risks of DS. They used the BM canvas tool (Osterwalder and Pigneur, 2010) to analyse the current situation and envision the move to digitally enabled advanced services (last stage). This process revealed the possibility to generate new streams of revenues from the sales of basic and advanced digital services:

- direct sales – i.e. through the e-commerce module of the digital platform – of spare parts and consumables;
- sales of condition monitoring and preventive maintenance contracts; and
- sales of energy and process optimization and of productivity management services whose capabilities would have been originated from the data collected through the platform.

It was, however, agreed that the company should have focused on digitizing the current (basic) service offer. To avoid conflicts, it was further decided to on-board to the DS plan the dealer network of ALPHA. The dealers were therefore informed of the intention of developing a new digital service offering that this network would have been entitled to sell. BETA deployed a branded version of the digital platform, which was named "ALPHA4YOU". In this stage, BETA provided numerous contributions. Firstly, they helped in defining the possible BM based on the offering of digitally enabled advanced services. In doing so, ALPHA provided BETA with information about market opportunities and competitors' moves. BETA suggested how to digitize and differentiate the actual offer of services. This interplay with BETA was crucial to unveiling prior knowledge possessed by ALPHA. BETA also contributed to a large extent in shaping the strategic roadmap, which was also dictated by the previous experiences of BETA. This company, in fact, had carried out previous projects in industries such as machine tools, ovens and production printers.

4.2 Stage 2: connect products

The second stage of this journey consisted in modifying the electronics and control software of the equipment sold to connect them to ALPHA4YOU. This was done with the aid of an external software company. Although a relevant duty, this impacted little on the DS roadmap. In fact, the technical specifications were defined entirely by BETA. More precisely, the KIBS dictated the requirements for connectivity protocols (e.g. MQTT and other IoT standards), took care of any concern regarding cybersecurity and hacker attacks and orchestrated the work of this third party. At the end, the connection to ALPHA4YOU was enabled from the effort and knowledge of BETA, and little aid was given by ALPHA beside the authorization to lead this task.

This stage was characterized by another relevant fact. Also following the suggestion of BETA, the ALPHA director hired a young manager who was entrusted with the responsibility of the DS project. Besides being the interface with BETA, this manager was asked to perform directly some technical activities on the platform. BETA trained him to deliver autonomously

simple interventions (e.g. editing CSS and basic JAVA scripts, working with HTML pages) and customization (e.g. reports, workflows). Through this move, ALPHA fulfilled both the cultural (e.g. developing more digital-oriented mindset) and skill gaps (i.e. support the deployment of the digital platform). The contribution of BETA was again relevant, as they provided the technical training and supported this young professional in playing his role as DS manager withing the company's organization.

4.3 Stage 3: digitalize the service delivery process

Soon after ALPHA4YOU went live, ALPHA launched a campaign to communicate to its customers the opportunity of having connected machines and a basic offering of digitally enabled services. The DS manager and the company director analysed the benefit of having real-time data from connected machines. These benefits were explicated in terms of potential reduction of the costs of contractual maintenance. At the light of the consistent savings, the director developed a proposal for selling packages of digitally enabled maintenance services to the buyers of new units, if these would have accepted to connect the new equipment to ALPHA4YOU. Similarly, some customers were offered extended warranty coverages. As said, the pay back of these digital services was evaluated by the DS manager who used his knowledge about the ALPHA4YOU functions to conceive the data that the platform could have provided in short, as far as the base of connected machines grows. This information was used to formulate hypotheses about the performance of the digitized service process, in terms of both efficiency (e.g. reduced intervention time, higher productivity) and effectiveness (e.g. increased first-time-fix). It was possible to estimate also the reduction of the delivery costs from the use of ALPHA4YOU. At the end, this leads to setting the prices of this new digital service offer. In addition to supporting the deployment of the platform (for which it was crucial the training released to the DS manager at previous stages), BETA contributed with indications about the actions to put in place to promote such digital offering towards the existing base of customers, as well as to avoid pitfalls with the dealers' network.

4.4 Stage 4: develop and activate new digital product-service offerings

The objective of this last – still ongoing – stage is to develop further the offering of advanced digital services. As mentioned, the BM at this stage includes the digital sales of consumables and spare parts, and the provision of digital services such as process optimization, productivity management and gas certification. The corresponding e-commerce feature has been recently implemented through the activation of a specific ALPHA4YOU module. This pushed ahead the total sales of ALPHA, which in the last fiscal year reached their highest value (+€6m). Conversely, other advanced services are still under development, and their development is still an early exercise. This latter activity has been in fact delayed due to the impact of COVID-19. The company manager said that they want to accurately assess the financial implications of such advanced offering, before moving further. Analogously, attempts to sell the equipment as a-service have not yet been made. This is indeed the declared target of the DS roadmap originally elaborated. In this last stage, however, the contributions from BETA become more and more rarefied. ALPHA prefers, in fact, to be autonomous in its decision to hold on or move further.

5. Discussion

This case study sheds light on the processual nature of DS in SMEs and shows the contribution made by KIBS to this journey. Empirical evidence confirms that partnering with a firm that provides both professional and technology-based services can facilitate the DS of a smaller manufacturer. This is in line with the extant literature (Miles *et al.*, 1995; D'Antone and Santos, 2016). Tables 5 and 6 generalize our case findings and connect them to the theoretical framework of Section 2. Both these tables summarize the contributions made by KIBS firms to the DS of SMEs. The first discusses these contributions in the perspective of KIBS as innovation agent. Conversely, the second table connects the identified contributions to the problems encountered by SMEs in their move to digital services. Besides integrating the answer to *RQ1* that has been given in Section 2.1, these tables respond to *RQ2*.

6. Concluding remarks

6.1 Conclusions

Despite their role in world economy, SMEs are frequently excluded from mainstream research (Brunswicker and Vanhaverbeke, 2015). In particular, the challenges faced by smaller manufacturers in the transition to digital services have been frequently overlooked (Uden and Naaranoja, 2009; Paiola *et al.*, 2013). Against this background, this paper investigates the problems that SMEs must address in their move to digital services and acknowledges the contributions made by KIBS firms to this transformation (Muller and Doloreux, 2009; Shearmur and Doloreux, 2013; Zhou *et al.*, 2017). We integrate two literature streams and collect empirical material from a longitudinal, in-depth single case study to shed lights on the interplay between a KIBS firm and a small manufacturer that are partners in a DS initiative. We unveil the mechanisms through which novel knowledge and capabilities are generated to address the problems of DS in SMEs. This paper has both theoretical and managerial implications that the next section illustrates.

6.2 Theoretical and managerial contributions

Our findings confirm the relevance of KIBS firms in customers' innovation claimed by previous studies in the industrial marketing relational perspective (Aarikka-Stenroos and Jaakkola, 2012) and enhance the extant literature maintaining that KIBS firms contribute significantly to the DS journey of SMEs. KIBS' contributions are manifold, as they complement and supplement numerous capabilities of smaller manufacturers and affect the way in which DS is put into action (Christensen *et al.*, 2017). Specifically, SMEs receive a combination of (customized) P-KIBS and (standardized) T-KIBS along their journey. On one side, customization allows exploring the ill-structured challenges of DS that are context- and industry-specific (Coreynen *et al.*, 2017). On the other, the provision of standard services and pre-arranged solutions reduces the operational complexity connected to the impact of digitalization and servitization. It follows that in

Table 5 Contributions of KIBS firms to the DS journey of SMEs (perspective of KIBS as innovation agents)

Aspect	Discussion and generalization of case study findings
KIBS type	Contributions given are in the form of both professional (P-KIBS) and technology-based (T-KIBS) services, as both these contributions are crucial for DS of SMEs
Potential outcomes	Firms that integrate the mentioned capabilities and play simultaneously the role of P- and T-KIBS can reduce the challenge of the DS transformation in SMEs. SMEs also benefit from the deployment of standard/pre-arranged solutions that lower the costs of DS
Range of activities	Contributions are diverse and regard both market-, process- and technology-related knowledge stocks that originate along the DS journey
Mechanisms of knowledge generation	KIBS firms contribute to creating the knowledge requested by the DS journey through different mechanisms: • At the beginning, KIBS complement their knowledge with those of their customers to mould new stocks (e.g. BETA and ALPHA craft the BM and roadmap for DS); KIBS also carries the knowledge absorbed in other contexts and previous experiences. In sum, at the beginning, the KIBS act as knowledge source and carrier • In further stages, KIBS facilitate access to (already existing) technical knowledge (e.g. customizing the digital platform and connecting the equipment through IoT protocols). In doing so, they mostly act as knowledge facilitator
Interactions	The interplay between KIBS firms and SMEs along the DS journey is mostly based on complementary interactions (preliminary stages). However, as far as the DS roadmap advances and problems become less ill-structured and better defined, the KIBS is also called to craft solutions that supplement the requested knowledge (e.g. dictating the specifications for connecting the equipment to a third part)
Reciprocity	Both unidirectional and bidirectional flows of knowledge have been observed. However, there is no doubt that the KIBS engaged in the intense/long-term collaborations is greatly interested in absorbing a large deal of knowledge from the case
Customization	When starting a DS journey, the problems are seldom well structured and defined. Therefore, especially in preliminary stages, the KIBS contribute to problematization through customized services. As far as the problems become clear, the use of pre-arranged solutions and packages is beneficial for the SME. Theorising more on these findings, we can say that the provision of articulated combinations of standardized and customized services complies better with the context of SMEs, which have resource constraints as well as specific needs to address
Scalability	Technology issues do not prevent scalability. Actually, the decision of scaling up the digitally advanced service business can be constrained by the need of evaluating accurately the risk and impact on traditional business of this move

Table 6 Contributions made by KIBS firms to the DS journey of SMEs (perspective of the problems of SMEs)

Problem	Discussion and generalization of case study findings
Financial paradoxes	SMEs become aware of the financial risks associated with DS, thank to the role played by their KIBS partners in the early stage of the DS journey; however, despite they trust their partners, they do neither delegate the crucial financial decisions nor ask for support in evaluating the pay back of the new digital offering. As a result, the contribution of KIBS appears rather negligible due to the reluctance of the SMEs to share sensitive data Setting up a clear roadmap can facilitate the balance between servitization (e.g. Stages 1 and 4 in our case) and digitalization (e.g. Stages 2 and 3 in our case)
Culture and organization	A long-term roadmap facilitates cultural and organizational changes. KIBS firms contribute to this process by providing digital competences and collaborating to put in place the organizational interventions
Limited resources and knowledge gaps	A KIBS partner that integrates professional and technological services is of great help in overcoming the limitation of resources of SMEs and fulfilling the numerous knowledge gaps of the DS challenges
Access to customer's data	In the preliminary stages, KIBS contribute to exploring customer needs and market opportunities for DS. The use of a ready-to-go/easy-to-use digital platform can increase the reputation of smaller manufacturers as provider of digital services. With a branded platform, customers can be more easily convinced to connect their equipment and share their data
Operational complexity	The provision of a digital platform that incorporates standard packages and pre-arranged workflows can reduce the operational complexity stemming from the move to digital services
Business ecosystems	KIBS can contribute to orchestrating third parties, setting the ground for the creation of new digital service ecosystems

the case of SMEs, the theoretical distinction between the two categories of KIBS pointed out by Miles *et al.* (1995) (i.e. T- and P-KIBS) can be rather blurred.

In line with previous studies (Baines *et al.*, 2020; Paiola *et al.*, 2022a), we also found that cultural and organizational issues can be tackled through multi-year strategic roadmaps through which the company can dictate the pace of the DS journey (Hernandez Pardo *et al.*, 2013; Confente *et al.*, 2015). In minor businesses, it is presumably assumed that complex offerings of digitally enabled advanced services can be developed solely after consolidating the company's "digital mindset" (i.e. development of the base of connected equipment, digitization of the offered services). This echoes the extant literature around the number and types of external relations to the evolution phase and the technological maturity of manufacturing firms (Leminen *et al.*, 2018).

We also noticed that customized services from the KIBS partner are mostly requested in the early stage of this transformation, while standard services and pre-arranged solutions are more requested in the following stages. For instance, having a ready-to-go digital platform to connect the equipment with IoT technologies can reduce to a great extent the time to market of the basic offering of digital services when advancing through the DS roadmap. It also turned out that smaller firms prefer *pay-as-you-go* approaches (e.g. SaaS) in respect to the adoption of the mentioned technologies, as this requires lower investments. This seems particularly significant for radical innovations that – such as DS – have higher risks of failure (Consoli and Elche-Hortelano, 2010). Another finding from this research concerns the fact that KIBS firms, at a certain stage of this transformation, can be asked to directly orchestrate some customer's partners that have to perform some crucial but not strategic tasks. Therefore, we claim that KIBS can also contribute to the creation and orchestration of digital business ecosystems. Lastly, our study confirmed that KIBS firms simultaneously operate as carrier (e.g. previous experiences about DS roadmap) and source (i.e. the digital platform already in place) of knowledge (den Hertog, 2000). Although less frequent, KIBS can give also access to stocks that are existing and required for DS (e.g. specifications and protocols to connect the equipment) (He and Wong, 2009). Lastly, the study confirms that KIBS can be notably attracted by the opportunity of learning from the case company. The reciprocity among the collaborating counterparts can be thus key for the success of DS.

6.3 Limitations and further research

This paper has some limitations. Our findings come from a single-case study. This affects to a large extent their analytical generalizability. Expanding the given theoretical insights in any contexts and situations is somehow questionable. Therefore, a first avenue for future research is to apply our research framework in wider case settings to compare and validate these findings. Samples could include also large firms, and in this case, it could be to address how much the company size moderates the contributions by KIBS firms with respect to the problems and stages of DS. Another avenue is to integrate the empirical investigation with quantitative data to appreciate the statistical relevance of the phenomena under study. Using case-based or survey-based research, further studies could investigate the SME contexts in which the journey to digital services progressed with apparently little or no contributions from external partner.

Because of the longer time span required to show the financial implications of DS, our case does not provide evidence on these aspects. Thus, we cannot infer anything about whether SMEs can reduce the risk of incurring negative results from DS, and how much of this mitigation is due to partnering with KIBS. This is a topic for further developing the research. The last consideration concerns regulatory and environmental factors. We confirm the importance of public funding in creating favourable contexts for innovation (i.e. digital hub, fiscal incentives for investing in digital technologies). It is indisputable that these incentives tipped the balance in favour of the DS initiatives. This also deserves future research.

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Corresponding author

Marco Paiola can be contacted at: marco.paiola@unipd.it