WHAT YOU NEED TO SUCCEED WITH DIGITAL SERVICE-ORIENTED BUSINESS MODELS: A CONFIGURATIONAL ANALYSIS OF ITALIAN MANUFACTURERS

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Abstract

The paper aims at explore what are the conditions affecting the ability of manufacturers in developing and supplying advanced digitally based services. Given the multiple and conjunctive causality of the investigated phenomenon, a Qualitative Comparative Analysis has been performed via the calibration of a qualitative investigation of BMI adopted in 19 small- to large-sized manufacturing firms located in northern Italy.

The analysis assesses the impact of a series of theoretically relevant causal factors for the targeted outcome variable. It allows us to identify one configuration with optimal consistency, showing that level of the involvement, customer relations and external service suppliers are crucial for developing successful digitally based advanced services.

Findings suggest manufacturing firms' managers should: first, capitalize as far as possible on internal valuable knowledge and assets, mapping and leveraging useful people and technologies. Second, scout external service providers related to technology and strategy/organization that can help them in making the value proposition evolve. Third, they have to build and foster customer intimacy and capitalize on key customers, either leveraging on the extant sales / field service structures or envisioning new direct data exchange channels.

Keywords
Servitization; Digital technologies; Business Model; Manufacturing; Italy.

1. Introduction

IoT technologies (IoT, Cloud, Data analysis) have an increasing role for service-led growth of manufacturing firms, in particular for enabling BtoB advanced solutions (Suppatvech et al., 2019; Paiola and Gebauer, 2020). Manufacturers are exploring recent developments of digital technologies that offer unprecedented possibilities for providing new digital services and innovating extant Business Models (BM) (Grandinetti et al., 2020; Kohtamäki et al., 2019).

Emerging technologies such as IoT, cloud services and data analysis are in fact empowering a new form of digitally-enabled servitization (Pirola et al., 2020), that extends and enhance manufacturing firms' possibilities of servitizing their offerings: a growing research stream has begun to study technology as a trigger of "digital servitization" as a specific research stream (Paschou et al., 2020).

Connectivity, remote condition monitoring, and data analysis empower use- or output-oriented revenue models (Grubic, 2014; Visnjic et al., 2017), change the relation with customers and trigger new digitally-enabled service-oriented business models (Grandinetti et al., 2020), breaking away from product-oriented and capex-based traditions (Adrodegari et al., 2015).

However, these transformations are not without consequences for traditional manufacturers, whose business models are potentially being disrupted by the effects of technological applications (Frank et al., 2019; Gebauer et al., 2020). In particular, incumbent firms are particularly struggling to leverage technologies due to the fact that the potentially disruptive effects of digital transformation have to be balanced with the protection of the extant business model.

The present paper's aim is to answer the following research question: what are the conditions that affect incumbent manufacturing firms' development of digital services?

The multiple and conjunctive causality associated to the investigated phenomenon suggested the authors to adopt a configurational approach implementing a Qualitative Comparative Analysis (QCA) (Ragin, 2000) involving 19 small- to large-sized manufacturing firms located in northern Italy.

2. Literature review

3.1. IoT Technology and service offerings in manufacturing

IoT technologies (IoT, Cloud, Data analysis) are at the base of new advanced BtoB services and solutions (Pirola et al., 2020; Leminen et al., 2020), enabling service-oriented business models that radically disrupt traditional manufacturing strategy, towards digital servitization (Paiola and Gebauer, 2020; Paschou et al., 2020). Digital servitization impose incumbent manufacturers to modify their value proposition, offering new data-based product-, process- and customer-oriented advanced services (Paiola and Gebauer, 2020).

These new digital services can have different impacts on firms' BM: from simply lowering the cost of traditional product-related services, to enriching products and services with unprecedented features (for availability and remote controlling), to radically changing the revenue model by enabling completely new relations with the market. This can enable the transformation of the value proposition towards use- or output-based types (Adrodegari et al., 2015).

Digital servitization is a complex effort for manufacturers that ask for disruptive changes in their business models (Kohtamäki et al., 2019). Different elements of the firms' BM are involved in DS transformations, from value creation (capabilities), to value proposition and value distribution (service concept, market segmentation, customer relations and trade channels), to revenue and profit mechanisms (cost and revenue impacts).

Notwithstanding the mentioned contributions, literature has so far overlooked to dedicate a specific research effort to understand modern technology-based service development strategies in medium- to large-sized BtoB incumbent manufacturing firms (Sjödin et al., 2020).

These technological and managerial evolutions affect different aspects of servitization-related research (Kowalkowski et al. 2017), entailing a revisitation of the servitization narrative (Baines et al., 2017) in order to consider:

- specific ways of approaching advanced digital services of minor incumbent manufacturers (Paiola and Gebauer, 2020; Peillon and Dubruc, 2019);
- the relevance of prior knowledge and extant capabilities that can be valuable for the development and deployment of advanced digitally based services (Paiola et al., 2021);
- the importance of collaboration (Tronvoll et al., 2020), extending the focal manufacturer perspective with a multi-actor capabilities approach (Story et al., 2017);
- the role of customer relations and key customers contributions (Grandinetti et al., 2020).

3.2. Service Business Model innovation in incumbent manufacturers: the conditions

Incumbent manufacturing firms may have specific ways of approaching the development of new digital advanced services using IOT technologies. This is related to several individual and internal factors, such as: the limitations of their slack resources; the quality and quantity of their internal capabilities, especially in regard to digital technologies; their traditional manufacturing culture and low familiarity with (advanced) service logics and orientations (Paiola and Gebauer, 2020; Peillon and Dubruc, 2019).

Digital servitization may leverage internal resources or existing inter-organizational relationships (in addition to newly formed partnerships). Previous studies have highlighted the role of relational embeddedness in service ecosystems (Sklyar et al., 2019), referring to the impact on economic outcomes of the socially-rooted overall participating actors' relational structure and dynamics (Granovetter, 1992). Relational embeddedness can be related both to internal and external actors involved in service ecosystems: internal relational embeddedness influences the manufacturer to access and combine resources from corporate counterparts and sustain internal learning processes (Forsgren et al., 2005).

In particular, valuable prior knowledge and capabilities may already exist within the firm, and be unlocked and leveraged in order to reduce the mentioned disadvantage that incumbent firms may experience in the development and deployment of new digital services (Paiola et al. 2021). Extant capabilities and assets related to the necessary level of service orientation (service readiness) and the ability of mastering digital technologies and solutions, especially related to connectivity, data gathering and data analysis (digital readiness) are in some cases already present in the firm and have to be sensed and exploited in "pre-experienced" explorations of the new solutions (Paiola et al., 2021).

However, little intra-organizational embeddedness is one of the circumstances that bring medium-sized manufacturing firms to turn to external actors to initiate and sustain digital servitization, unveiling the urgency of considering the increasing relevance of the ecosystem perspective (Sklyar et al., 2019; Kohtamäki et al., 2019). In this scenario, external contributions can play a crucial role for minor incumbent manufacturers in order to approach the complex and new capability-related challenges related to digitalization and servitization (Sjodin et al., 2016). New specific external relationships with technology-related service suppliers may have to be established in order to start and/or sustain the evolution of new digital services in the offering, leading to the formation of inter-organizational relations in the form of dyadic relationships (Raddats et al., 2017), multi-actor relationships (Story et al., 2017), or ecosystems of multi-actor coupling engaged in reciprocal value proposition (Tronvoll et al., 2020).

Inter-organizational relations encompass also the important point related to the type and quality of the relation between the manufacturing firm and its customers, a well-known and established concept in industrial marketing literature (Ulaga and Eggert, 2006; Athanasopoulou, 2009), whose impact on digital servitization is amply neglected (Grandinetti et al., 2020). In fact, high-quality supplier-customer relationships are crucial and can be exploited also via internet and digital technologies (Gaiardelli et al., 2014). Recent findings suggest that access to customers and data are critical to enable advanced digital services (Paiola and Gebauer, 2020) and improve relationship quality (Grandinetti et al., 2020), sustaining a form of co-created digital servitization (Green et al., 2017).

3. Methodology

The previous literature review allowed us to identify the relevant conditions that affect service-oriented business model innovation in incumbent manufacturers in the following:

a) valuable prior and extant capabilities (service readiness and digital readiness);
b) congruous investment levels in the new technologies;
c) customer intimacy and collaboration;
d) new partnering with service providers in the ecosystem.

The multiple and conjunctive causality associated to the investigated phenomenon suggested the authors to adopt a configurational approach. Therefore, a Qualitative Comparative Analysis has been performed using fuzzy sets (Ragin, 2000; Fiss, 2011), in which information coming from a qualitative investigation of BMI adopted in 19 small- to large-sized manufacturing firms located in northern Italy has been calibrated in order to make configurations emerge and apply set-theory methodology. The following sections describe the methodological approach adopted in the study.

3.1. The investigated cases

The study encompasses 19 firms belonging to the manufacturing industry and operating in BtoB contexts. They belong to several important Italian industries and have different sizes, including small- and large-sized firms, whereas extremely large MNE are absent. Table 1 reports basic facts and data related to each firm, and indicates also details regarding the interviews and the firms' informants involved.

Table 2 reports the basic information related to the technologies adopted by the investigated firms, such as the technologies employed (IoT devices, cloud repositories and services, data analysis and big data) as well as the possibility of retrofitting the extant installed base in order to leverage it for the new digital services.

Table 1. Basic facts of the investigated firms

	Industry	Rev.	Emp.	Product type (prevalent)	Value System	Sales Model	Interviews, Roles, Total duration
1	Professional equipment	3	8	Standard	OEM	Indirect	1, SM, 2h
2	Machine tools	8	26	Custom	OEM	Direct	1, CEO, 1,5h
3	Professional equipment	6	30	Standard	OEM	Indirect	1, CIO, 2h
4	Packaging machines	20	84	Custom	OEM	Direct	2, CEO, CMM, 2h
5	Packaging machines	30	110	Custom	OEM	Direct	2, CEO, 3h
6	Packaging machines	50	120	Custom	OEM	Direct	2, SM, 3,5h
7	Inspection machines	37	143	Custom	OEM	Indirect	1, CTO, COO, 2h
8	Professional equipment	105	150	Standard	OEM	Indirect	2, CEO, 2,5h
9	Heating control systems	48	195	Standard	OES	Indirect	2, CTO, CMO, 2h
10	Food machines	150	250	Standard	OEM	Indirect	2, SM, CTO, 3h
11	Diagnosis machinery	90	458	Standard	OEM	Indirect	1, CMM, CTO, 2h
12	Heating control systems	166	602	Standard	OES	Indirect	2, CTO, CIO, 2,5h
13	Machine tools and plants	202	652	Custom	OEM	Direct	1, CTO, CHRO, 2h
14	Retail Equipment	241	697	Standard	OEM	Direct	2, CTO, 3h
15	Automotive components	157	743	Standard	OES	Indirect	2, CEO, CTO, 2,5h
16	Water management devices	278	761	Standard	OEM	Indirect	1, SM, CTO, 3h
17	Heating components	276	801	Standard	OES	Indirect	1, CEO, CTO, 1,5h
18	Heating equipment	235	820	Standard	OES	Indirect	2, CEO, SM, CTO, 3h
19	Retail Equipment	225	975	Standard	OEM	Direct	1, CMM, 2h

All the firms recognize the importance of IoT technologies for the future of their business, but show different levels of involvement in the exploration of the service-related possibilities offered by technology. Innovative orientations towards process-related services, that aim at using remote condition monitoring in order to enhance the efficiency of the installed base, are in some cases latent or only emergent in their first forms, or almost fully accomplished. Less frequent is the idea of approaching outcome-oriented contracts – given the complexity of the endeavor – that at the moment regards only two of the sampled firms.

Table 2. Basic features of IOT related BMI in the investigated firms

	Industry	Digital technologies	Retrofit	BM service orientation shift	Impact on BM elements
1	Professional equipment	IOT, Cloud	No	=	null or very limited
2	Machine tools	IOT	Yes	To process (planned)	null or very limited
3	Professional equipment	IOT, Cloud, DA	No	=	VCr
4	Packaging machines	IOT	No	To process (planned)	null or very limited
5	Packaging machines	IOT, Cloud, DA	No	To outcome	VCr, VP, VD, Vca
6	Packaging machines	IOT, Cloud, DA	Yes	To outcome	VCr, VP, VD, Vca
7	Inspection machines	IOT	No	To process (planned)	null or very limited
8	Professional equipment	IOT, Cloud	No	To process (planned)	VCr, VP, VD
9	Heating control systems	IOT, Cloud	N.A.	=	null or very limited
10	Food machines	IOT, Cloud, BD, DA	No	=	VCr, VP, VD
11	Diagnosis machinery	IOT, Cloud, BD, DA	N.A.	To process	VCr, VP, VD, Vca
12	Heating control systems	IOT, Cloud	N.A.	=	VCr
13	Machine tools and plants	IOT, DA	No	To process	VCr
14	Retail Equipment	IOT, DA	Yes	To outcome (planned)	VCr, VP, VD
15	Automotive components	IOT, Cloud, DA	Yes	To process	VCr, VP, VD
16	Water management devices	IOT, Cloud	Yes	To process	VCr, VP, VD, Vca
17	Heating components	IOT, Cloud	Yes	To process (planned)	VCr
18	Heating equipment	IOT, Cloud	Yes	To process (planned)	null or very limited
19	Retail Equipment	IOT, Cloud, BD, DA	Yes	To outcome (planned)	VCr, VP, VD

As shown in table 2 these strategic transformations have different impacts on the BM, from cases in which the new applications have impacts only in value creation activities (VCr), to more thoroughly developed cases in which value proposition (VP), value distribution (VD) and value capture (VCa) elements have been involved.

3.2. The QCA approach and its validity for the present research

Configurational theory is founded on the premise that the same set of causal factors can lead to different outcomes depending on how such factors are combined (Greckhamer et al., 2008). Therefore, when causality in the research phenomenon is both multiple (an outcome has more than one cause) and conjunctive (the causes work together to produce the outcome), Qualitative Comparative Analysis (QCA) represents an appropriate method (Krauss et al., 2017).

In particular, QCA can help servitization scholars in studying the complex field of advanced service provision (Sjodin et al. 2016; Goduscheit & Faullant, 2018; Sjodin et al. 2019). Especially, the analysis of small-n situations in which the number of cases is too large for traditional qualitative analysis and on the same time too small for many accustomed statistical analysis e.g. between ten and fifty cases, presents one of the strength of QCA (Ragin 2000; Ragin 2008).

3.3. The variables, their codification and calibration

As highlighted in the preceding sections, the literature review has highlighted some factors that condition incumbent manufacturers service BMI based on IoT technologies (see table 2 for a description). These are reflected in the empirical analysis of our cases, whose data structure is shown in figure 1, evidencing the role in digitally based service business model innovation of the following factors:

a. valuable prior and extant capabilities (service readiness and digital readiness);
b. congruous investment levels and commitment in the new technologies;
c. customer intimacy and collaboration;
d. new partnering with service providers in the ecosystem.

Figure 1. Data structure

I order categories	II order themes	Aggregate dimensions
Architectural design for replication and scalability	Focused and standard DPSS	D-PSS design and features
Selective use of technological devices for performance leverage		
Changing value logic: services lead to products up and cross selling		
Development of more complex solutions in order to increase value		
From focus on own products to customer’s processes (extended to competitors’ products)	Custom and complex DPSS	
Data- and and knowledge-based advanced services directly affecting customer lock-in		
Standard and simpler solutions bundled with new product releases for replication		
Role of lead users and pilot customers in shaping the solution	Relations with customers	Ecosystem leverage
Large customers are a replication market for simplified versions of the solution		
Role changes from simple supplier to knowledge and innovation partner		
Large customers are a replication market for the solution (also for new versions)		
Role changes from product supplier to main contractor / integrator / orchestrator	Relations with the ecosystem	
New relations in the ecosystem with established suppliers and activities		
Relations wth new actors in the ecosystem		
Activities Internalization vs externalization depending on the phase		
Firm’s overall technological readiness, freedom of experimentation and learning process	Technological preparedness	Preparedness
Reactive and proactive approaches in technological experimentation		
Avoid technological trap, limited use of internal technological dept.s (R&D, IT)		
Avoid exploitation trap, maintaining explorative innovation activities		
Firm’s overall servitization readiness	Service-related preparedness	
Sales and communication skills for advanced service solutions		
Advanced and data based services and products / components in multi-year contracts		
From cost-based to value-based pricing and value erosion protection		

These factors represent the conditions that affect the configurational analysis, and are calibrated in crisp mode in our analysis, as shown in table 3. Variables are operationalized based on set membership scores that express cases belonging to a set described by certain properties or characteristics (conditions) with scores 0.00 = full non-membership and 1.00 = full membership (Basurto and Speer, 2012). Such calibration process is possible only using the in-depth theoretical and substantive knowledge of the researcher (Ragin 2008).

Therefore, each firm is assigned with a 0 or 1 depending on the fact that prior capabilities are valuable, investments and commitment in digitally-based innovation is congruous, customer intimacy is relevant, and they partner with technology-related service providers specifically for the sake of BMI.

The output variable is instead calibrated in the fuzzy form, depending on the extent of BMI, where attributions depend on how many BM blocks are involved in the innovation, starting from Value Creation, to value distribution and value capture, as described in table 3.

Table 3. Variables, attributes and calibration

Variables		Meaning	Attributes	Calibration
Conditions	PREVEX	Valuable prior capabilities	service orientation digital readiness valuable extant relations	Crisp
	OUTFIT	Congruous investment levels in the new technologies	Outfit completeness (IoT devices, retrofit, Cloud, data analysis) TMT commitment in BMI	Crisp
	CUSTREL	Customer intimacy and collaboration	Direct relation with customers Data exchange Customization of products and services Collaboration in pilots and leads	Crisp
	KIBS	New partnering with service providers in the ecosystem	New ad-hoc service providers inolved for the BMI	Crisp
	SIZE	Firm's size	Firms' employees number	Numerical
Output	BMI	Value proposition completeness	Elements / blocks of the BM involved in the innovation	Fuzzy No BMI: Fully out [0] Effective Value creation: more out than in [0.33] Effective Value distribution: more in than out [0.67] Effective Value capture: fully in [1]

Table 4 reports the calibrated values assigned to each case, in relation to the conditions and the output variables.

Table 4. Conditions values assigned to cases

	SIZE	CUSTOM	PREVEX	OUTFIT	CUSTREL	KIBS	BMI
1	8	0	0	0	0	0	0
2	26	1	0	0	1	0	0
3	30	0	0	0	0	0	0,33
4	84	1	0	0	1	0	0
5	110	1	0	1	1	1	1
6	120	1	0	1	1	1	1
7	143	1	0	0	1	0	0
8	150	0	1	1	1	1	0,67
9	195	0	1	1	0	0	0
10	250	0	1	1	0	1	0,67
11	458	0	1	1	0	1	1
12	602	0	1	1	0	0	0,33
13	652	1	1	1	1	0	0,33
14	697	0	1	1	1	0	0,67
15	743	0	1	1	0	1	0,67
16	761	0	0	1	0	1	1
17	801	0	0	0	0	1	0,33
18	820	0	0	0	0	0	0
19	975	0	1	1	1	1	0,67

3.4. Preliminary elaborations, necessary and sufficient conditions

A preliminary bivariate correlation analysis using SPSS 27 has been performed on the variables in order to detect significative correlations among variables and eliminate redundant variables: that way the variable related to the amount of investments in the new technologies (OUTFIT) resulted correlated with other variables already present and has been excluded by the analysis. The resulting model is therefore: Model: BMI = f(SIZE, PREVEX, CUSTREL, KIBS).

The first step in QCA is the analysis of necessary conditions, that are conditions or combinations of conditions with a consistency score over the threshold of 0.9 (Schneider et al., 2010). The results of this analysis shows that not exceeding the mentioned threshold, none of the conditions is necessary for the presence of BMI.

The following step is to carry out a sufficiency test through the construction of a truth table, that show the possible configurations that explain the outcome, as described in the next section.

4. Findings and discussion

The following step is to carry out a sufficiency test through the construction of a truth table, that shows the possible configurations that explain the outcome, as described in the next section.

Table 5 describes the truth table and the configuration emerging from the analysis, using the variables related to the firms' size (SIZE), the existence of valuable prior capabilities (PREVEX), customer intimacy and collaboration (CUSTREL) and new partnering with service providers in the ecosystem (KIBS).

A frequency threshold of 1 and a consistency threshold of 0.80 have been chosen in this elaboration: only configurations that have at least one case and a consistency above 0.8 are considered empirically relevant. Output fit is judged based on the key statistics of coverage and consistency (both ranging between 0 and 1): coverage measures the proportion of membership in the outcome explained by the identified configuration(s); consistency reflects the extent to which the presence of the supposedly sufficient configurations actually produces the outcome (Krauss et al. 2017).

According to current best practice, there is no commonly agreed minimum coverage a QCA analysis must reach. On the other hand, consistency should at least reach 0.75 (Ragin, 2008), and each solution should meet a threshold of 0.70 for proportional reduction in inconsistency (PRI) (Greckhamer et al., 2018).

Table 5. Truth table of the analyzed conditions (intermediate solution)

	Raw coverage	Unique coverage	Consistency
---------- ---------- ----------			
SIZE*~PREVEX*CUSTREL*KIBS	0.230681	0.230681	1
solution coverage: 0.230681			
solution consistency: 1			

Model: BMI = f(SIZE, PREVEX, CUSTREL, KIBS), analyzed with the Quine-McCluskey Algorithm (frequency cutoff: 2; consistency cutoff: 1).

Cases with greater than 0.5 membership in term SIZE*~PREVEX*CUSTREL*KIBS: 12 (1,1), 17 (1,1)

The intermediate solution of the truth table analysis is showed in Table 5. It encompasses one single configuration where conditions are composed as follows: SIZE*~PREVEX*CUSTREL*KIBS, meaning that size, customer relations and new external partners are present, whereas prior knowledge and capabilities are absent.

Firms' size (SIZE) is a relevant variable conditioning advanced digitally-based servitization in incumbent manufacturers, meaning that smaller firms are less likely to possess the necessary financial and knowledge-related resources in order to face the complexity of the transformation towards process- and outcome-oriented business models.

In addition, two types of inter-organizational relations are crucial in leveraging IOT for digital servitization. First, Customer intimacy and collaboration (CUSTREL) - that is a direct relation with the final-user firm with valuable data exchange, a relational quality that supports collaboration and piloting with key customers. Second, new partnering with service providers in the ecosystem (KIBS), that is the circumstance that new service providers are searched for and involved as suppliers of various digitally-related applications and solutions.

Finally, the configuration explicitly excludes that firms dispose of valuable prior capabilities (PREVEX), related to extant valuable knowledge and assets, that increase the service and digital readiness of the firms.

In particular, the cases that best represent the configuration show the abovementioned conditions very clearly. They are medium-sized manufacturing OEMs (with approximately 100-120 employees) that have invested considerable financial and professional resources (approx. 0,5mln€ each) in the exploration of IOT technologies, which they have started some 5-7 years ago. They didn't possess any relevant prior competence that could be particularly valuable for the innovation, apart from having a strong tradition in customization and quality of (traditional) services. They both had to scout external service providers that could be involved in the innovation process, and learned overtime how to interact with new technology and non-technology related suppliers and how to manage the overall project in relation to the business model evolution. They both see the importance of customer relations, and collaborate with lead-user firms or key customers for piloting and solution debugging.

5. Conclusions and limitations

Digitally-based advanced services are a current technological frontier for manufacturers (Paiola et al. 2020), and QCA is an overlooked but potentially insightful method for studying the field (Sjodin et al. 2019), highlighting conditions for succeeding in developing and deploying advanced digital services. This study focuses on Italian BtoB incumbent manufacturing firms whose businesses are involved by the development of IOT technologies, and analyzes what are the conditions that affect the implementation of Business Model Innovations. The study confirms and extends previous research, contributing to the literature on digital servitization in manufacturing. The truth table analysis presents a configuration that is particularly relevant for the study's research question, since it evidences the conjunct action of firms' size, customer intimacy and partnering with external service providers in absence of valuable prior capabilities in the firms. Our research evidence that when dealing with digital servitization size matters in the sense that medium- to large-sized firms are more likely to belong to the configuration of firms that implement thorough BMIs. This confirms previous studies evidence that highlights the role of large MNE OEMs in digitally-based BMI (Kohtamaki et al., 2020; Pelletier and Cloutier, 2019), but at a different scale, putting digital servitization on the agenda of minor firms (large MNE are excluded from our sample).

Moreover, the study extends previous scientific knowledge in regards to the role of prior capabilities and resources in the innovation processes and their relations with inter-organizational strategies (Paiola et al., 2021). Innovative firms that can capitalize on limited extant valuable capabilities may complementing that situation with external contributions, confirming that ecosystems remain critical for digital servitization (Kohtamäki et al., 2019). Our empirical data show that in the absence of prior relevant knowledge or valuable capabilities to be leveraged in the field of digital servitization, innovative firms resort to specific inter-organizational relations for the innovation purposes, both with customers and service providers, confirming and extending previous literature: deep and fruitful relations with customers can be critical in helping manufacturers in triggering, co-creating and refining new digital service offerings (Grandinetti et al., 2020), both in reactive and proactive ways (Paiola et al., 2021), collaborating in the learning process. In addition, collaborative partnering with service providers can supply and complement relevant capabilities necessary to implement the organizational and technological solutions that are necessary for the new digital services, confirming previous studies relating to relational embeddedness (Sklyar et al., 2019).

From the managerial point of view, findings suggest manufacturing firms' managers should: first, capitalize as far as possible on internal valuable knowledge and assets, mapping and leveraging useful people and technologies. Second, scout external service providers related to technology and strategy/organization that can help them in making the value proposition evolve. Third, they have to build and foster customer intimacy and capitalize on key customers, either leveraging on the extant sales / field service structures or envisioning new direct data exchange channels.

The main limitations of the study relate to the experimental application of the QCA in innovation-related situations, where the selection of the conditions and the calibration of the values may undergo a more thorough verification.

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