



UNIVERSITA' DEGLI STUDI DI PADOVA
DIPARTIMENTO DI SCIENZE ECONOMICHE ED AZIENDALI
“M.FANNO”

CORSO DI LAUREA MAGISTRALE IN
BUSINESS ADMINISTRATION
(Management Track)

TESI DI LAUREA

*“Digital Servitization journeys and the role of technology providers: a survey of
Italian manufacturing firms”*

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ANNO ACCADEMICO 2022 – 2023

Dedication

"And ever has it been known that love knows not its own depth until the hour of separation."

- Gibran Khalil Gibran

I will eternally cherish the love and unwavering support of my family and friends, who consistently stood by my side, even across the great distances spanning from Beirut, Padova, Muscat, California, Yerevan, to Munich.

A deep appreciation to my mema whose inspiration and positivity continue to influence my life even in her absence.

Il candidato dichiara che il presente lavoro è originale e non è già stato sottoposto, in tutto o in parte, per il conseguimento di un titolo accademico in altre Università italiane o straniere. Il candidato dichiara altresì che tutti i materiali utilizzati durante la preparazione dell'elaborato sono stati indicati nel testo e nella sezione "Riferimenti bibliografici" e che le eventuali citazioni testuali sono individuabili attraverso l'esplicito richiamo alla pubblicazione originale.

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Firma dello studente

A handwritten signature in black ink, appearing to read "Angela", written over a faint horizontal line.

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Abstract

This study focused on the digital servitization journey and the role of KIBS in Italian manufacturing firms. After laying the theoretical groundwork and diving into the definitions of each of the concepts of servitization journey, digital servitization, and knowledge-intensive business solutions in the first chapters, the focus then shifted toward the empirical analysis whose data was collected through a survey distributed firms in the North of Italy. After doing so, the questionnaire responses and the variables were analyzed, and some descriptive statistical analysis was conducted to understand the relationship between them. After which, a variable selection was made to be plotted in the fsQCA model and different paths were identified, all of which led the firms in our sample to develop advanced services. Based on these paths, three propositions were made which are in line with the theoretical premises that were taken into consideration.

Introduction

The purpose of this paper is to understand the current state of the digital servitization journey followed by a specific region in the North of Italy. We first started by looking into the general definitions of servitization, the journey taken by firms following this track, and then the move towards digital servitization in specific. When speaking about digital servitization and what companies need in order to create the necessary atmosphere in which such solutions can be implemented successfully, it is imperative to take a more inclusive view and understand the role of the ecosystem surrounding such companies.

All of these concepts, as well as a better definition of the audience in question, constituted the foundations necessary to understand the empirical research that was conducted. The data of this research was gathered through a questionnaire, which, as explained in the fourth chapter, consisted of four general topics: Company definition, Services, Digital Solutions, as well as Partner Collaboration. All of these four topics were defined in the first 3 chapters of this study. After conducting the necessary preliminary analysis, the aim of the empirical analysis was to answer the research question:

“ What are the key factors that drive the development and enhancement of advanced services within an ecosystem of digital solutions?”

After careful consideration of all the data collected, we analyzed the findings of our model and came up with different conclusions regarding the conditions needed to exist/ or not exist within a firm in order to make way for the development of advanced services.

Chapter 1:

Introduction to The Servitization Journey

In order to lay the groundwork for this study, it is crucial to define and frame the concept of servitization and understand the journey taken by companies to insert this type of offering in their product mix. After defining the servitization concept, we will look into the servitization roadmap followed by firms, gradually moving from simple offerings to more complex and advanced solutions. Next, we will be looking at the steps needed to transition from a regular product-centric firm to a more servitized firm.

By understanding the concepts tackled in this chapter, we will be able to move on with this research in Chapter 2 by delving deeper into the concepts of digital servitization and the ecosystem surrounding it which are key to the empirical research we conducted and discussed later in this paper.

Introduction

Servitization can be broadly defined as the shift from a product-oriented offering to a service-oriented one: more often than not, these two offerings are not mutually exclusive. In other words, firms that adopt servitization strategies offer various types of services associated with their existing products along with the products themselves. This strategy is aimed to add value to traditional products by bundling them together with complementary services. These hybrid offerings will help firms when it comes to forming defensive mechanisms to protect them from competition, by adding the perceived value to their offering by their customers and thus distinguishing them from their counterparts.¹

The ultimate goal of these firms would be to move “from free to fee”, meaning, to start generating direct revenue from services that used to be offered for free to customers. More often than not, customers might not be willing to pay for the additional services, or, the firm itself does not have the right mechanisms or skills in place in order to extract revenue from these offerings. For such a shift to happen, the organization must begin viewing the sales function as more of a

¹ Baines et al.(2009), "The servitization of manufacturing: A review of literature and reflection on future challenges", *Journal of Manufacturing Technology Management*, Vol. 20 No. 5, pp. 547-567. [link](#)

strategic one, and not merely an operational one. Moreover, the role associated with sales tends to evolve into a cross-functional capacity where the employees have the responsibility of engaging in service sales in the case where internal challenges prevail within the organization. Hiring service experts is often pivotal in firms undergoing the shift from free services to paid ones, as it is not a transformation that can be taken lightly because of the many obstacles that might come along the way. More details on these obstacles will be tackled throughout this report in the respective sections. ²

Servitization Journey & Phases: Types of Services

The move from a product-reliant mix to a more hybrid mix cannot happen overnight. This transition, if not handled properly, and through the right stages, can lead to a mismanagement of revenue and value streams. In order to take a deeper look into the servitization journey that takes place within a firm undergoing this process, it is worth mentioning the case study findings in the study of Baines & al. (2019). Based on their empirical analysis, the authors found that this process can be categorized into 4 stages: exploration, engagement, expansion, and exploitation. The definition of each of these stages can be in the theoretical framework called the Servitization Progression Model described in the figure below. ³

In short, this Model represents the consecutive stages organizations go through while undergoing the process of evolution of services from simple ones to more complex and advanced service offerings while taking into account the five forces both internal and external that affect the firm ensuring this transformation.

² Mustak et al.(2023), “Free-to-Fee Transformation of Industrial Services.” *Journal of Service Research*, 26(1), 21–43. [link](#)

³Baines, et al. (2020), “Framing the servitization transformation process: A model to understand and facilitate the servitization journey”, *International Journal of Production Economics*, Vol. 221 [link](#)

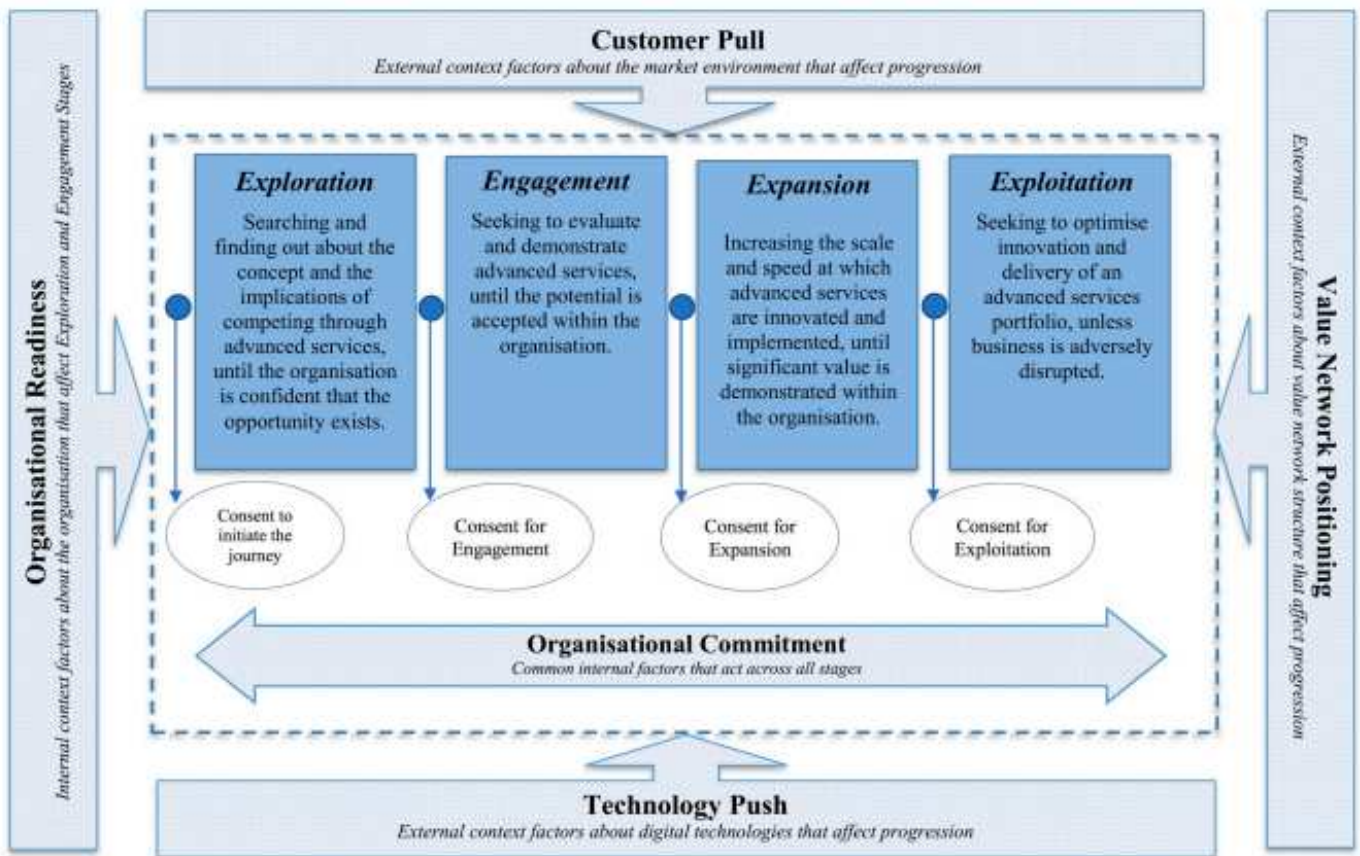


Fig 1: The servitization Progression Model⁴

We will first start by describing each stage in this process and the important things for a company to keep in mind during each step:

The **exploration** stage, as explained in the literature mentioned above, is primarily focused on the research conducted by the companies whereby they try to understand how services of the kind would affect their organization in terms of structure, revenues, competition and more. It is important to bear in mind that the timelines of these stages might differ from one company to another depending on the industry they operate in, the geographical scope of their operations, as well as the service culture within their organization.⁵ Moreover, some companies are more advanced compared to their counterparts regarding the amount of persistent industry and

⁴ Baines, et al. (2020), "Framing the servitization transformation process: A model to understand and facilitate the servitization journey", *International Journal of Production Economics*, Vol. 221 [link](#)

⁵ Baines, et al. (2020), "Framing the servitization transformation process: A model to understand and facilitate the servitization journey", *International Journal of Production Economics*, Vol. 221 [link](#)

competitive research they have done throughout the years. The more valuable data they have collected over the years that can be translated into insights to use to undergo servitization, the less the first exploration stage will take. Some firms may even have to resort to external sources of research entities in order to make decisions about their next steps, this is especially true for companies that do not have a separate function in place to handle research and business development.

Next, comes the **engagement** stage where the firm tries to onboard stakeholders by raising their awareness regarding the importance of servitization.⁶ These stakeholders involve all players from key decision makers such as the Chief Financial Officer, the Chief Operating Officer and the Marketing Director to the lower-level employees who have more hands-on experience in the day-to-day operations. This phase is very delicate and if handled properly, the organization will perceive a smooth transition. If the organization's culture is more robust to change and the employees don't have the right motivation, the management might experience some opposition from the members of the organization. In such cases, it is important to have mechanisms in place to manage this transition in the right way while maintaining the support of members of the organization.

After the engagement stage comes the **expansion** stage, where the focus is shifted to more complex services and how to scale them to serve a wider market. The latter can be identified by advanced services within the service-classification framework in the literature of Baines & Lightfoot (2014) discussed in detail in the section above.⁷ Throughout this stage, it is important to keep working on the cultural change action plans and activities. Services can be difficult to scale since they are more dependent on human resources than products. That is why, there should be Standard Operating Procedures (SOPs) in place in order to be able to formalize and standardize the tasks and functions involved in order to guarantee sustainable quality. The standardization of such offerings can come in handy when a firm starts to experience the “service paradox” described in one of the previous sections. Procedures of this kind aim to reduce costs while giving a firm the ability to have a plan of action in place to meet any need in terms of performance in their customers' firms. Moreover, it is worth mentioning that SOPs should be

⁶ Baines, et al. (2020), “Framing the servitization transformation process: A model to understand and facilitate the servitization journey”, *International Journal of Production Economics*, Vol. 221 [link](#)

⁷ Baines, T. and W. Lightfoot, H. (2014), "Servitization of the manufacturing firm: Exploring the operations practices and technologies that deliver advanced services", *International Journal of Operations & Production Management*, Vol. 34 No. 1, pp. 2-35. [link](#)

reviewed periodically and optimized based on the historical data and cases that occurred, with time, these procedures will be more elaborate and inclusive of different scenarios, and the different workers involved will develop the skills necessary to handle the tasks needed to be accomplished.

The last stage in the servitization journey is the **exploitation** phase. During this phase, the organization aims at contaminating the servitization attitude of different business units and upgrading their product designs to include features that can lead to more advanced service offerings. Mainly, these upgraded features aim at gathering and sharing information through IoT technologies which will be discussed in detail in the next sections tackled by this study.⁸

It was noted in the research that there were some instances of short overlaps between consecutive stages, but intuitively, it just seems to be a transitory period for companies undergoing the shift towards a later stage in servitization.

Moving on to the five forces highlighted in the servitization progression model, it is worth noting that they are a combination of internal and external forces that define the speed in which a company goes through these transitions:

- **Organizational Readiness:**

This internal force has an influence on the first two stages from the shift of simple to advanced services: the exploration stage & the engagement stage.

Bernerth (2004) mentioned the following statement: “readiness is more than understanding the change, readiness is more than believing in the change, readiness is a collection of thoughts and intentions toward the specific change effort” (p. 40).⁹

In order to form a deeper understanding of this force, it is worth looking into the research conducted by Weiner (2009) regarding this topic. While this research was looking into change readiness in general and not specifically in the servitization sense, the findings can be applied to this context. Organizational readiness to change can be affected by many factors including but not limited to organizational culture, policies,

⁸ Baines, et al. (2020), “Framing the servitization transformation process: A model to understand and facilitate the servitization journey”, *International Journal of Production Economics*, Vol. 221 [link](#)

⁹ Bernerth (2004), “Expanding Our Understanding of the Change Message.” *Human Resource Development Review*. 3. 36-52. 10.1177/1534484303261230. [link](#)

past experience, organizational resources & structure. These factors, along with the situational analysis conducted collectively by the members of the firm in question, define the preparedness of this collective group for the transition in question.¹⁰

It is important for a firm to intervene proactively to prepare its members for the planned changes.

- **Organizational Commitment:**

This internal force can best be described by taking a look into the literature presented by Cook and Wall (1980) arguing that there are three main factors contributing to organizational commitment, the first one being identification, in other words, the sense of pride and belonging that an employee feels to be a part of the organization. The second factor is the feeling of involvement in decision-making and idea generation, and the willingness of the employee to contribute to the growth of the organization. The third and final aspect discussed by the authors is the sense of loyalty to the company.¹¹

In a nutshell, the more committed an employee is, the less they are resistant to the changes that it might undergo. However, it is important to note here that for an employee to be committed to the organization, certain measures must be taken by the relevant authorities such as the Human Resources department to ensure that they are motivated and satisfied with their jobs and compensation mechanisms.

- **Value Network Positioning:**

Next, we will move on to discuss the external forces affecting this progression the first one being the **value network positioning**. In the framework in question, this force includes the relationship with the distributors of the organization, as well as the one with its dealers and vendors.

As highlighted in the literature of Hakanen et al. regarding the servitization in global business-to-business distribution, the shift from traditional manufacturing to more evolved service-oriented manufacturing has led firms to have unprecedented complications relative to the organization of their global product and service distribution. In order to increase the efficiency of such activities, some measures can be taken such as working on improving the logistics chains. In the case of the existence of

¹⁰ Weiner, B.J. (2009), "A theory of organizational readiness for change." *Implementation Sci* 4, 67 (2009). [link](#)

¹¹ Mathews et al., (2002). "Dimensionality of Cook and Wall's (1980) British Organizational Commitment Scale revisited." *Journal of Occupational and Organizational Psychology*. 75. 10.1348/096317902320369767. [link](#)

various intermediaries between the manufacturer and the end-user, having a more customer-centric offering becomes more challenging. The latter is due to the more complicated information sharing at different levels of the supply chain and as described by the authors “ Knowledge is highly dispersed between the companies in global distribution”. For instance, there are many cases in which distributors are the ones who have direct contact with the final customers and thus have the data and the feedback from the end-users, and they might not be willing to share this information with the manufacturers for strategic reasons.¹²

There are different factors that may affect the willingness of different players in the industry to share information, especially when it comes to distributor-manufacturer relationships. This phenomenon is best described in the framework below:¹³

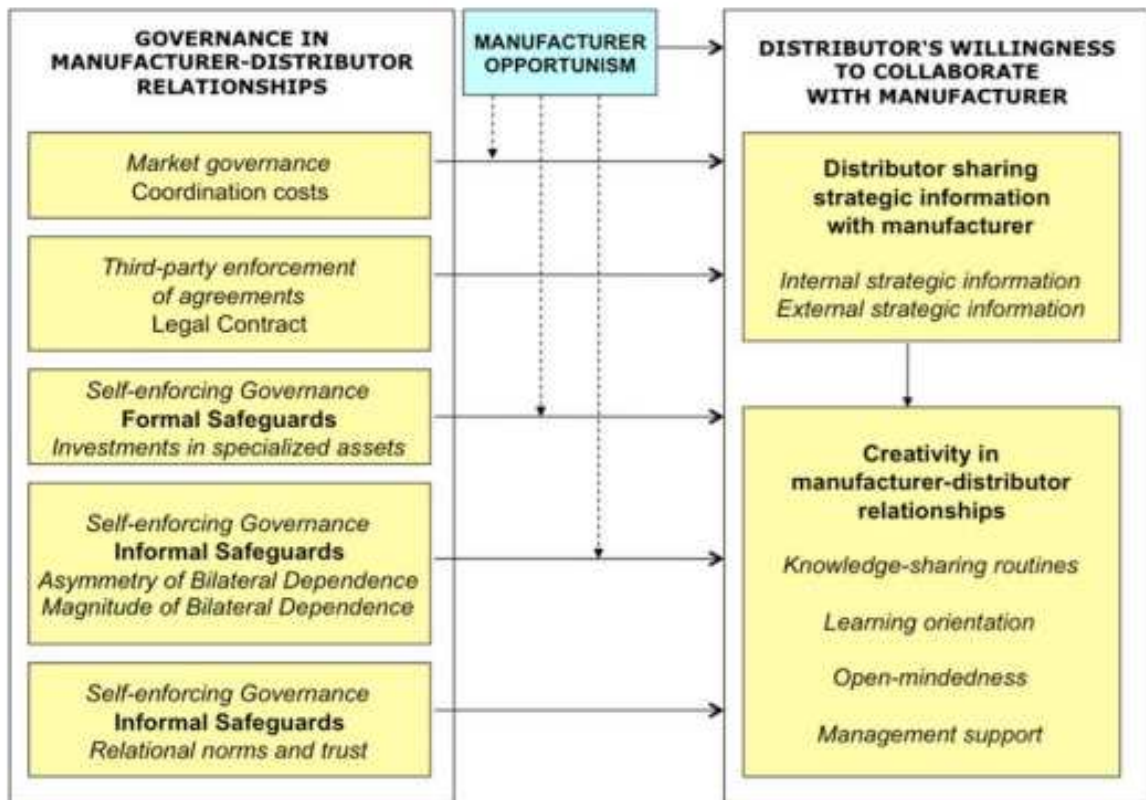


Fig 2: Dynamics of Manufacturer-Distributor Relationships

¹² Hakanen et al., “Servitization in global business-to-business distribution: The central activities of manufacturers”, *Industrial Marketing Management*, Vol. 63, 2017, Pages 167-178. [link](#)

¹³ Vázquez-Casielles et al., “Collaborative manufacturer-distributor relationships: the role of governance, information sharing and creativity”, *The Journal of Business and Industrial Marketing*, Volume 28, Number 8, 2013, pp. 620-637(18) [link](#)

As outlined in the figure above, the more these two players are willing to collaborate and share insightful information about the market, the more creativity and evolution there is in the industry. However, opportunism and self-serving behavior are common in such settings, and in many cases, this information asymmetry provides the stronger counterpart a bargaining power over its upstream or downstream partners or even a competitive advantage over its competitors. Hence, the dynamics of the relationships between channel partners and most importantly the information flow has a great deal of effect on the progression of the firm in terms of servitization at all of its stages.

- **Technology Push:**

Another external force that affects the process of evolution of services is the **technology push** which can best be described as the role of technology in making way of innovation in the market. In simpler terms, when one talks about technology push, they're highlighting the role of technology evolution through Research and development in creating opportunities in the market and pushing the players to pursue innovative approaches. Here, the development of the technology within the company is what's revolutionizing the market without the target market explicitly expressing the need for such innovative products. According to the literature presented by Boyer & Kokosy (2022), this is one way of looking at industry 4.0 technology, a concept that we will get to in the next section. The other way to look at it is what they described as market pull, which is the same as the concept of customer pull that we will discuss as the next servitization progression force.¹⁴

Let's take the technology push concept and apply it to a servitization setting, and more specifically in the role of such a phenomenon in progressing towards more complex service structures: the more developed this force is within the organization, the swifter the move is from a simple product/service offering to a more developed one. If the necessary research is already underway and a substantial amount of investments were made over the years towards creating innovative approaches, the shorter it takes for the

¹⁴ Boyer, J. and Kokosy, A. (2022), "Technology-push and market-pull strategies: the influence of the innovation ecosystem on companies' involvement in the Industry 4.0 paradigm", *Journal of Risk Finance*, Vol. 23 No. 5, pp. 461-479. [link](#)

organization to reach more advanced phases in servitization.

- **Customer Pull:**

In the same token, another external force is the **customer pull** which was introduced briefly in the paragraph above. Customer pull refers to the effect of the demand in the market in creating the need for the progression of servitization within the firm. As opposed to the concept of technology pull, in this case, the market need is what is driving the evolution of servitization. In this case, the unsatisfied need of a customer is what is creating the demand for a more complex service which is, according to Slater and Narver (1995), prevalent in cases of market-driven organizations. According to the authors, such organizations are characterized by their attention to customer value, their understanding of the market's need, their ability to retain the loyalty of their customers as well as being proactive in determining the changes in the market and eventually developing innovative strategies to meet the needs of their customers.¹⁵

The two last forces discussed and their effect on servitization and innovation can be depicted in the diagram depicted below.

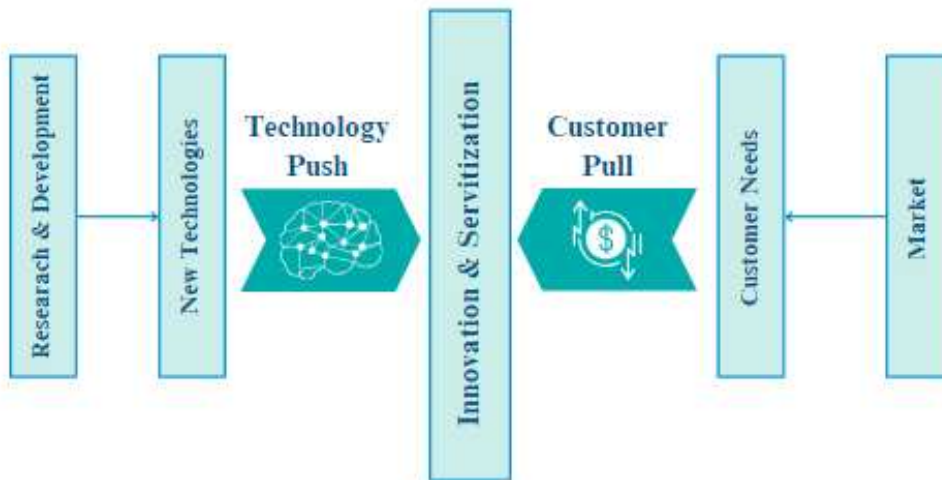


Fig 3: The Role of Technology Push and Customer Pull in Servitization

¹⁵ Slater and Narver (1995), "Market Orientation and Learning Organization." *Journal of Marketing*. 59. 63-74. 10.2307/1252120. [link](#)

Another interesting aspect that is of relevance to this section in particular is the participation of the customers in the development of new products. To have a deeper understanding of how this happens and the reasons behind these dynamics within an industry, it is worth looking into the study conducted by La Rocca et al (2016). According to the authors, new product development (NPD) goes beyond the traditional approach whereby the involvement of customers in the process is just considered as “knowledge management”.

Rather, a customer with whom a long-term and repeated relationship was built over time, is seen to be involved in developing innovative solutions (including both products, services, or even hybrid solutions) that are somewhat customized to meet their specific needs.

Applying the contribution above to the servitization study, it is imperative to note that, in the B2B context, servitization and digitalization strategies which are key subjects of our study should be in line with customer needs and be able to adapt quickly to provide them with offerings that meet their specific requirements. Another thing worth noting here is the importance of gathering and keeping track of customer data in order to analyze it and make informed decisions regarding the new product and solution development activities accordingly. These activities should be done continuously and should be aimed to provide sustainable value to the organization whose strategies should strive for continuous improvement in terms of their processes as well as their offerings.

However, more often than not, companies, especially Small and Medium Enterprises might find themselves in a situation where it is difficult to keep up with the technologies employed in the processes that lead to servitized and digitalized solutions. As a consequence, they might find it more convenient to partner and collaborate with compatible and more advanced players within more technology-heavy industries in which they lack knowledge or expertise. Such industries are volatile and undergo constant changes, and for a company such as a manufacturing company that is a late bloomer in the technological context, it is almost impossible to be able to internally develop the know-how needed to compete with other companies having developed more advanced digitalized solutions to be offered to the market. The next chapter of this paper will delve into the importance of such partnerships and the dynamics behind them.

In the section above, we defined the servitization journey from its inception and development throughout the exploration stage followed by the engagement, expansion, and exploitation phases. We also took a deeper look into the collection of internal and external forces affecting

this transformation process at each stage including organization commitment, organization readiness, value network positioning, technology push and customer pull. We also looked into the relationship between the last two forces mentioned beforehand in order to better understand how each of them directs the journey toward technological innovation through servitization. One cannot talk about technological innovation through servitization without introducing the concepts of digitalization and industry 4.0 which is what we will be discussing in detail in the next chapter.

The Dynamics Behind Product/Services Offerings

Now that the servitization roadmap is clearer, we will be moving the discussion towards a more microscopic view of the hybrid product/service offerings themselves. More specifically, the steps taken by an organization in order to successfully club together products and services and make way for hybrid offerings. This topic was developed in the literature presented by Ulaga & Reinartz (2011), where they aimed to find out not only the drivers of success in designing such offerings but also the sources of failure. After conducting their research, they identified the key resources and capabilities needed in order to develop such hybrid offerings within a manufacturing firm which they summarized in the table below.¹⁶

¹⁶ Ulaga and Reinartz (2011), “Hybrid Offerings: How Manufacturing Firms Combine Goods and Services Successfully.” *Journal of Marketing*. 75. 10.2307/41406856. [link](#)

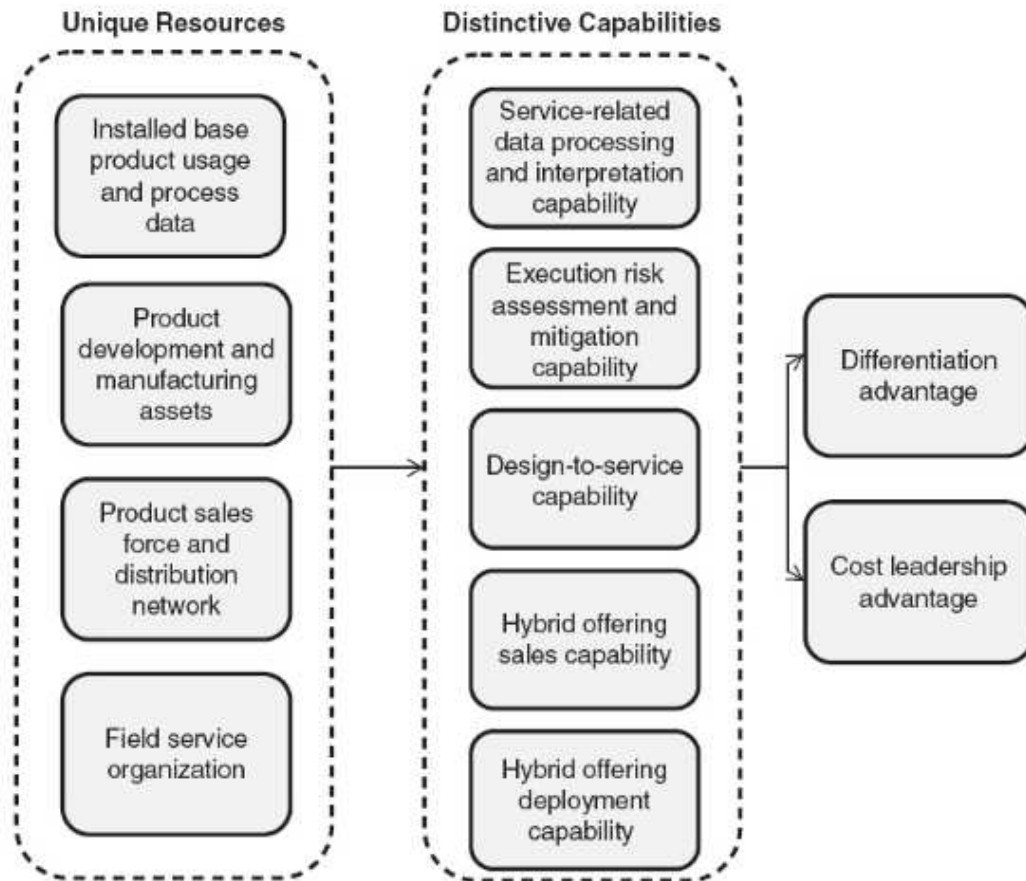


Fig 4: Manufacturer-Specific Resources and Capabilities for Successful Hybrid Offerings

When speaking about the installed base, it is important to understand that an information infrastructure cannot be developed from null. Rather, it is based on a source of existing data, which in the case of the installed base in question in our research would be the **product usage and process data** currently used in the firm.¹⁷ The key is collecting this data in a timely and organized manner and eventually turning this data into insightful information.

Another indispensable resource would be the **assets** in use for **product development**. In a competitive environment, it is important to keep working towards a more improved version of the existing products in order to stay ahead of the counterparts in the market.

Moreover, and as highlighted by the authors, having a **developed sales force** and access to a **profitable distribution network** is key in a business-to-business manufacturing firm. In their

¹⁷ Hanseth and Monteiro, "Inscribing behaviour in information infrastructure standards", *Accounting, Management and Information Technologies, Volume 7, Issue 4, 1997, Pages 183-211*. [link](#)

research, they found that one of the equipment manufacturers that were part of the sample attributed 90% of the sales to a single network consisting of over 2000 distributors who were described as independent and exclusive.¹⁸

Lastly, it is pivotal to mention **field service organization** which can be defined as activities conducted at the customers' sites to deliver and actually install the product there. It also includes other services provided to the customers, which are mainly after-sales services. The latter account for a substantial portion of the revenues generated by firms and hence is a source of value creation for the manufacturers if designed properly.

The resources described in the paragraph above, if designed well, will give rise to the capabilities needed by a firm in order to give rise to the right combination of product/service offerings to be put on the market together to serve the needs of the customers at different stages of the sales funnel starting from prospecting to follow-up based on the literature of Paschen et al. (2020).¹⁹

According to the framework presented by M. Kohtamäki, et al. (2019) which is based on a combination of previously developed literature, the characteristics of a servitized product offering vary based on three different dimensions which are solution **customization**, solution **pricing**, and **solution** digitalization as illustrated in the figure below.²⁰

¹⁸ Hanseth and Monteiro, "Inscribing behaviour in information infrastructure standards",

Accounting, Management and Information Technologies, Volume 7, Issue 4, 1997, Pages 183-211. [link](#)

¹⁹ Paschen et al., "Collaborative intelligence: How human and artificial intelligence create value along the B2B sales funnel", *Business Horizons, Volume 63, Issue 3, 2020, Pages 403-414* [link](#)

²⁰ Kohtamäki et al. (2019), "Digital servitization business models in ecosystems: A theory of the firm", *Journal of Business Research, Volume 104, 2019, Pages 380-392* [link](#)

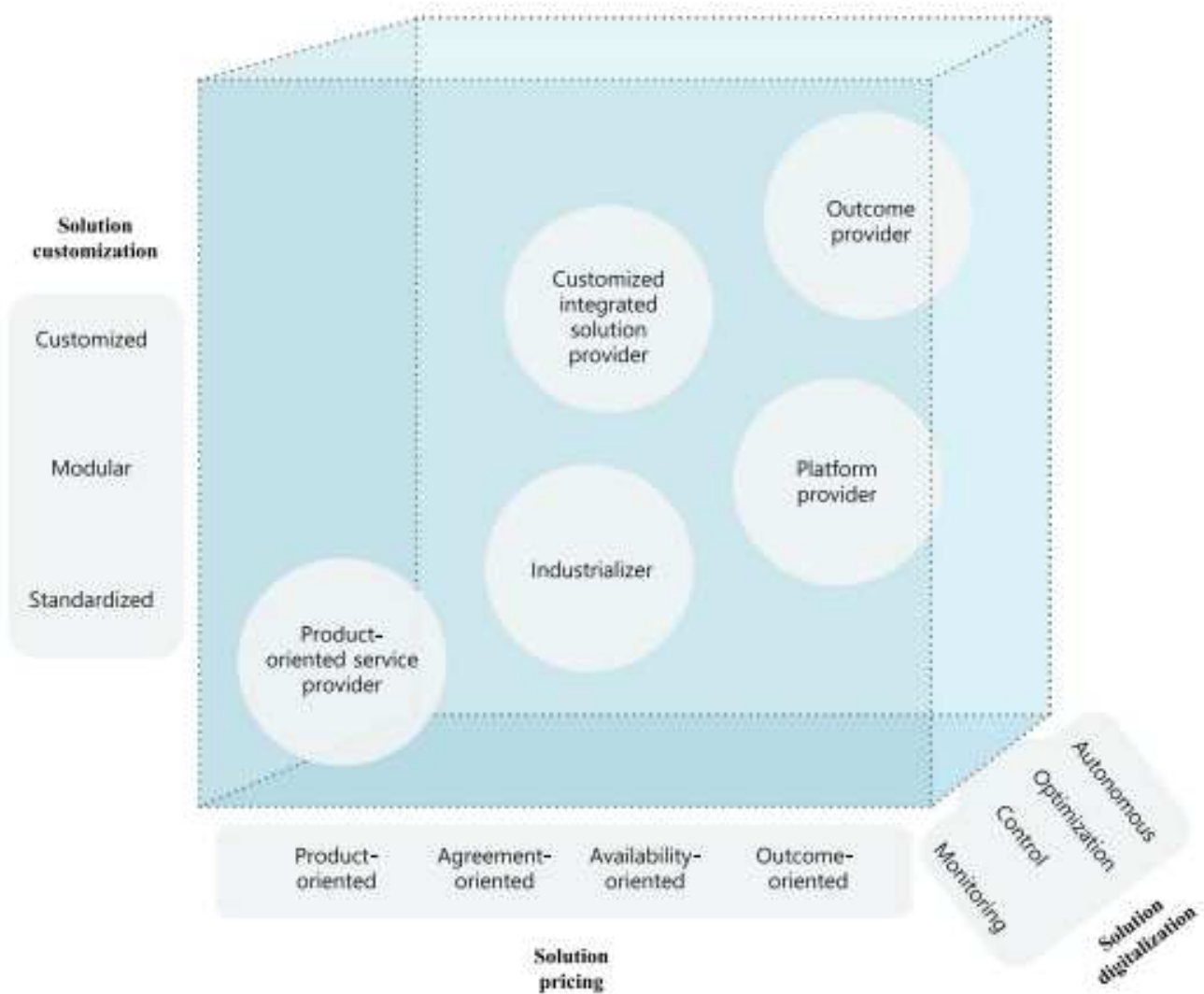


Fig 5. Understanding the characteristics of solution offerings in digital servitization business models.

In order to have a quick overview of the model developed by the authors, it is worth tapping into each of the dimensions it includes:

1. **Solution Customization:**

As the naming delineates, solution customization refers to the extent to which the product/service offering mix designed by an organization is specific to the need of each customer. The scale goes from the least to the most customized, from *standardized* offerings to *modular* ones and eventually to the most advanced solutions that are

customized.²¹ A more customized solution does not necessarily mean a better solution, this depends on the needs of the customers, the resources available within the organization as well as the design and requirements of the products/services and the existing technologies to support them.

2. Solution Pricing:

The second dimension considered in the framework in question, solution pricing refers not only to the value the solution captures or to the traditional definitions of pricing models, rather, it goes beyond that to delineate the orientation of the pricing mechanism adopted by the firm for that specific solution.²²

The traditional pricing model is the product-oriented one which is somewhere in the middle between the value perceived by the customer which is defined as their willingness to pay, and the fixed and variable costs taken on to take the product to the market. Another type of pricing, that is one step beyond the traditional one in terms of complexity is agreement-oriented pricing which consists of a contractual, or in some cases, an implied agreement between the seller and the buyer to define the prices of offerings. Some common examples include volume discounts, service level pricing, and so on... A more advanced pricing mechanism is the availability pricing which varies depending on the uptime of a service-product offering. In cases of complicated offerings with various customers (specifically for B2C companies), there are some sophisticated algorithms in place to determine the pricing at a certain point in time, an example of that would be the yield management techniques implemented by airline companies around the world. Moving on to the most complex solution pricing model, the outcome-oriented model, it is a perfect fit for the more advanced service offerings which, do not consider the value of the product itself, but the value generated by its use.²³

²¹ Kohtamäki et al. (2019), “Digital servitization business models in ecosystems: A theory of the firm”, *Journal of Business Research*, Volume 104, 2019, Pages 380-392 [link](#)

²² Kohtamäki et al. (2019), “Digital servitization business models in ecosystems: A theory of the firm”, *Journal of Business Research*, Volume 104, 2019, Pages 380-392 [link](#)

²³ Gebauer et al., “Organizational capabilities for pay-per-use services in product-oriented companies”, *International Journal of Production Economics*, Volume 192, 2017, Pages 157-168 [link](#)

3. **Solution Digitalization:**

The third dimension taken into consideration to determine the characteristics of hybrid offerings is the level of digitalization implemented within the organization to develop and market such solutions.²⁴

The focus here is on the relationship between the level of technology employed in the business and the business model itself. As mentioned beforehand, IoT and innovative software have been key in the evolution of smart solutions, and such technologies can have different functions including monitoring, controlling, optimizing and even giving rise to autonomous machines or features in more progressive settings.²⁵

After defining the elements that make up the type of digital servitization solutions, there are two things left to highlight. First, there is no single optimal solution that is “one size fits all”, as there are different combinations of variants affecting the decision of a firm of which option to choose for each of the three dimensions, there might even be cases in which players in the same industry find it more suitable to adopt diverging offerings from their counterparts.²⁶ Second, a firm may adopt more than one type of servitization solution if it is a good fit for their business model, whether it consists of a different business unit, or a different product, or even just a different market segment, at times, this might seem as a good option to incorporate.²⁷

Roadmap to Servitization

In the last decade, cases of manufacturing firms placing their competitive advantage in their service offerings rather than traditional products have increased in frequency, thus raising the importance of the servitization phenomenon in such firms.

In this paragraph, we will be taking a closer look at the evolution of the types of services offered within a firm. In the shift between a product-oriented offering towards a more service-oriented one, there are different forms the services involved can take, and their so-called evolution should

²⁴ Kohtamäki et al. (2019), “Digital servitization business models in ecosystems: A theory of the firm”, *Journal of Business Research*, Volume 104, 2019, Pages 380-392 [link](#)

²⁵ Coreynen et al. (2017), "Boosting servitization through digitization: Pathways and dynamic resource configurations for manufacturers." *Industrial marketing management* 60: 42-53 [link](#)

²⁶ Osterwalder, Alexander, et al. "Business Model Generation: A handbook for visionaries, game changers and challengers." *African journal of business management* 5.7 (2011): 22-30. [link](#)

²⁷ Kohtamäki et al. (2019), “Digital servitization business models in ecosystems: A theory of the firm”, *Journal of Business Research*, Volume 104, 2019, Pages 380-392 [link](#)

be done step by step in order to ensure that the right measures are taken and that the stakeholders involved are ready for this transformation.

According to the literature of Baines & Lightfoot (2013), the level of complexity of a service offering is dependent on the needs of its customers and their ability to handle the services internally:²⁸

- The first level of customers can be characterized as the ones who would like to handle the services themselves. In this case, their only contact with the supplier would be to get a hold of the product and its spare parts.
- The second level of customers can be characterized as the ones who would like to handle the services together with their suppliers. In this case, they would be the ones doing the regular and simple maintenance activities by themselves, while relying on the suppliers for more complicated and unusual tasks.
- The third level of customers can be characterized as the ones who would like their suppliers to handle all the services associated with the product offered by them. The latter will be responsible for the performance of the product since the customer's interest will be merely result-based.

Looking into the classification of the customers above from top to bottom, we can understand that the forms taken by services are starting to be more complex. The more the reliance of the customer on the supplier for services, the more elaborate the service offering is expected to be. From here arose the classification of services in three categories mentioned in the same literature, respective of the complexity of the customer needs discussed above²⁹:

- the starting point and the simplest form would be the **base services** offered to customers who handle most services internally. Some common examples of that are spare part provisions and warranties, in such cases, the customer has the necessary know-how to handle all the rest of the activities internally.

²⁸ Baines, T. and W. Lightfoot, H. (2014), "Servitization of the manufacturing firm: Exploring the operations practices and technologies that deliver advanced services", *International Journal of Operations & Production Management*, Vol. 34 No. 1, pp. 2-35. [link](#)

²⁹ Baines, T. and W. Lightfoot, H. (2014), "Servitization of the manufacturing firm: Exploring the operations practices and technologies that deliver advanced services", *International Journal of Operations & Production Management*, Vol. 34 No. 1, pp. 2-35. [link](#)

- the next step would be the **intermediate services** that are in turn offered to clients who are reliant on their suppliers for some of their services. For instance, these services include predictive maintenance, training the operators of the machines, and monitoring the conditions of the equipment to ensure that the productivity standards are high. Here, the supplier is more involved in the operations, but their involvement is still limited by the scope of the needs of their clients.
- the final step would be **advanced services** that are present when users are interested in capabilities and are more interested in product usage than the activities underlying the management of the products of their suppliers. Cases of these types of services might include risk and reward-sharing contracts, or availability/capacity-based agreements.

Moreover, if we dissect the category of **advanced services** in order to better understand the dynamics behind it, it can be best described by the term “service paradox” introduced by Gebauer et al. (2005). This term is used to highlight the risk that the sizeable investments needed to adopt such advanced services are not always covered by the revenues generated by offering them to customers. And, according to the experiment conducted by Baines & Lightfoot (2013) regarding the matter, there are some factors that need to be considered such as facility locations and the level of Information and Communication Technologies (ICT) adoption in order to ensure the successful implementation of advanced services.

Another thing that was evidenced by Baines et al. (2011) is that advanced services such as the ones mentioned above in the context of manufacturing firms, are often supported by vertical integration. This is mainly due to the need for flexibility and adaptability that arises with the adoption of advanced services, where the firm would need to have the necessary infrastructure in place to handle unexpected events since they have an outcome-based agreement with their customers.³⁰

³⁰ Baines, et al. (2011), "Servitization within manufacturing: Exploring the provision of advanced services and their impact on vertical integration", *Journal of Manufacturing Technology Management*, Vol. 22 No. 7, pp. 947-954. [link](#)

Conclusion

In the chapter above, we defined the concept of servitization and developed an understanding of the phases a firm goes through while transitioning from a product-centric offering to a more service-centric offering and what factors affect this process. We also identified the required resources and capabilities needed by an organization in order to succeed in making the transition towards developing advanced service solutions profitable.

By doing so, we laid the foundation for the concepts of servitization and digitalization that have been prevalent over the last decades, by having an overview of the most important literature developed concerning this topic, and consequently, we can move on to take a closer look at more restricted aspects of this phenomenon and eventually understand the effect it has on the environment surrounding it, as well as what should be expected in terms of the market trends emerging as a result of the dynamics in question, topics which will be rudimentary to our empirical research.

Chapter 2:

Digital Servitization and the Ecosystem Surrounding Firms Undergoing The Process

Introduction

Over the past few decades, technological progress in countless industries has been exponential and continuously growing. Naturally, this improvement has also contaminated the identities and the business models of manufacturing companies forcing them to redefine their operations and adopt new and more evolved approaches in their production processes and consequently implementing industry 4.0 solutions to support the new systems needed to stay on track with the forces surrounding the company including the buyers the deal with, sellers they aim to serve as well as the firms they are competing with for market share.

As mentioned in various recent literature, many of which were mentioned in the preceding chapter, the servitization process goes hand in hand with the concept of digitalization. Even though the two latter phenomena can be implemented separately within a firm, there exists a notable convergence between them.³¹ In order to transition towards a servitized business model, an organization would need access to more advanced ICT (Information and Communications Technology) solutions which will allow it to manage the new and more complicated processes needed to develop service-centric hybrid offerings efficiently and not lose any data that could be utilized to better serve the target customer by tracking and understanding their behavior at different stages of their journey.³²

The overlap between servitization and digitalization gave rise to a new concept called digital servitization (DS). This chapter is aimed to understand digital servitization, understand the dynamics of Industry 4.0, and take a deeper look into the ecosystem surrounding all these concepts.

³¹ Frank et al. (2019), "Industry 4.0 technologies: Implementation patterns in manufacturing companies." *International Journal of Production Economics*. 210. 10.1016 [link](#)

³² Martín-Peña et al., (2020), "Servitization and digitalization in manufacturing: the influence on firm performance", *Journal of Business & Industrial Marketing*, Vol. 35 No. 3, pp. 564-574 [link](#)

Industry 4.0

The escalation of international competition which was caused by globalization has pushed manufacturing firms to enforce connectivity in their production processes because of their need for flexibility and data sharing³³. The integration of processes and inter-departmental communication and information sharing are key to optimizing the flow of operations. Not only should members of different departments in an organization be able to communicate with each other, but also, the new and developed technologies mentioned above should be able to communicate with each other as well as the members. This creates a phenomenon that can be described as a web of communicating parties including people, devices, technologies, and processes. This web, if managed properly and proactively, would provide firms with competitive advantages by giving them access to valuable and timely data to be used in day-to-day operations as well as a basis for high-level decision-making. This web is what is defined as IoT, which is short for Internet of Things which is the main building block of Industry 4.0.

The concept of Industry 4.0 was first introduced in Germany in 2011, which is now commonly referred to as the fourth industrial revolution following the IT and computer revolution that was dominant since the late 1990s. The primary features of this revolution include the role of such technologies in forming a bridge between machines, products, and people, otherwise defined as IoT (Internet of Things).³⁴

These technologies are highly reliant on data, which is not only used to connect machines to people but also to analyze and interpret the information at hand in a way to provides all relevant stakeholders with valuable insights that will help them make informed decisions regarding different aspects of the business. These aspects can include decisions such as marketing strategies, product design methodologies, and pricing mechanisms and even go further to tackle issues such as predictive maintenance, product bundling decisions, predictive analytics of customer behavior, and more. By doing so, not only will manufacturers become more efficient,

³³Fatorachian and Kazemi (2018), "A critical investigation of Industry 4.0 in manufacturing: theoretical operationalisation framework". *Production Planning & Control*. 29. 1-12. 10. [link](#)

³⁴Culot et al., "Behind the definition of Industry 4.0: Analysis and open questions", *International Journal of Production Economics*, Volume 226, 2020, 107617 [link](#)

but they will also decrease costs and reduce both material (products, inventory, defects, fuel for machines...) and immaterial waste (time, reputation...).

There is a substantial amount of recent literature aimed at categorizing and understanding the adoption of industry 4.0 technologies in Italian manufacturing firms, which is the focus of our empirical research described in the next chapter of this paper.

In their research, Zheng et al. (2021) focused on identifying where these companies stand in terms of understanding such technologies and being open to implementing them. A summary of the results of the survey they conducted in 102 firms is in Figure 6 below. They found that the size of the company appears to have an impact on the number of Industry 4.0 enabling technologies they have already adopted internally: the larger a company is, the more types of technologies they have actively adopted in their operations.³⁵

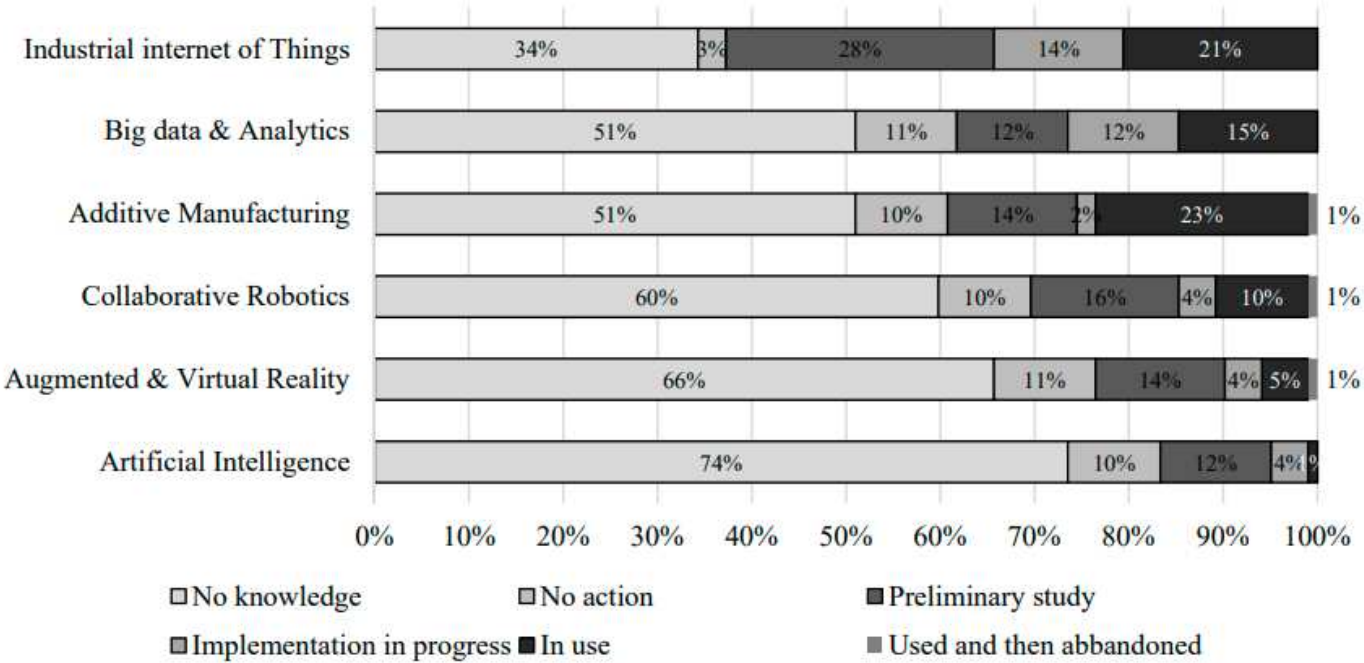


Fig 6: 14.0 enabling technology usage distribution in terms of company size

³⁵ Zheng et al. (2023), "The road towards industry 4.0: a comparative study of the state-of-the-art in the Italian manufacturing industry", *Benchmarking: An International Journal*, Vol. 30 No. 1, pp. 307-332 [link](#)

Having tapped into the basic definitions of Industry 4.0 and the development of the technologies within this sector, we can move on towards a more digitalized aspect of servitization called Digital Servitization which will be discussed in details in the section that follows.

Moving The Focus Towards Digital Servitization (DS)

Digital Servitization is a more specific stream of the servitization process and it refers to the digital technologies employed in the implementation of servitization activities and the development of product/service offerings, it consists of a more extensive adoption of digitalization which makes way for notable developments in the business strategy adopted by an organization.³⁶

In order to understand the idea of digital servitization, it is imperative to underscore the various factors listed below, which, according to C. Favoretto et al. (2022) emphasize how digitalization can be used to benefit and enhance servitization:

- Harnessing the available data
- The ability to promptly react to customer needs
- Exploring new revenue streams and improving efficiency
- External factors such as the level of technological turbulence in the industry or customer uncertainty levels.³⁷

Digital Servitization, as explained by Paschou et al (2020) in their literature, benefits various stakeholders in the right context including customers, providers as well as the environment, and society as a whole. These benefits could range from reducing costs to increasing value to even reducing energy consumption by supporting a circular economy.

As a matter of fact, IoT technologies can be considered a prerequisite of digital servitization by allowing the transfer of information between products and systems and building the right base to develop and implement more enhanced product features such as remote monitoring. These

³⁶Paschou et al., “Digital servitization in manufacturing: A systematic literature review and research agenda”, *Industrial Marketing Management*, Volume 89, 2020, Pages 278-292 [link](#)

³⁷ Favoretto et al., “From servitization to digital servitization: How digitalization transforms companies' transition towards services”, *Industrial Marketing Management*, Volume 102, 2022, Pages 104-121 [link](#)

features will save the organization a substantial amount of resources that could potentially be utilized elsewhere.³⁸

There are various factors, mostly external, influencing the level of DS that is optimal for a specific setting, which would call for different organizational structures as well as different environment-strategy-structure combinations relevant to the business model in question. Moreover, product companies need to adopt more advanced portfolios of their offerings that are interconnected, whether they consist of digital products or not, it is important to meet the latter condition in order to craft and follow a successful DS strategy. Such companies undergoing the digital servitization transition need to also have organizational configurations in place in order to efficiently share data and have a handle on the digital ecosystem. For instance, it is important to develop mechanisms that will enable quick and flexible decisions, as well as enforce collaboration between different stakeholders within the organization (both internal and external). When product companies are aiming beyond merely efficiency improvements and reaching for value-addition activities instead, DS would also require a revision of the existing research & development procedures in place, as well as a reassessment of the sales and delivery operations.³⁹

Digital Servitization, because of its more complex requirements in terms of capabilities in terms of digital platforms and management, calls for a more extensive ecosystem approach that involves various external stakeholders, a fact that will be discussed in detail in the next section of this chapter.⁴⁰

Digital Servitization Ecosystem

As mentioned above, this section's objective is to have a deeper understanding of the ecosystem surrounding firms undergoing the digital servitization transformation process. In fact, the sixth proposition of the literature presented by C. Favoretto et al. (2022), states the following:

³⁸ Ardolino et al.(2018), "The role of digital technologies for the service transformation of industrial companies", *International Journal of Production Research*, 56:6, 2116-2132 [link](#)

³⁹ Favoretto et al., "From servitization to digital servitization: How digitalization transforms companies' transition towards services", *Industrial Marketing Management*, Volume 102, 2022, Pages 104-121 [link](#)

⁴⁰ Kohtamäki et al. "Digital servitization business models in ecosystems: A theory of the firm." *Journal of Business Research* 104 (2019): 380-392. [link](#)

“Product companies implementing DS require an ecosystem perspective since takes place beyond the company boundaries and relies on an intensive stakeholder collaboration”.

Moreover, the extent to which digitalization affects the establishment is related to the digital level the DS project intends to achieve, consequently, the more advanced the digitalization phenomenon is within an organization, the higher its need for advanced servitization mechanisms. The latter entails the need for the development of more advanced services - defined in the first chapter of this paper- as well as the change of the organizational structures that support such product/service offerings.⁴¹

As stated in many recent literature including the research conducted by Sun & Zhang (2021), digital servitization initiatives fail to meet the expectations set by the relevant management because of the mismanagement of relationships within the ecosystem, hence, the failure to create and capture the value of such an undertaking.⁴² By correctly managing the collaborations with the ecosystem in question, the organization would pave the way to obtain technological abilities, as well as other forms of resources and innovative practices that will present as valuable to the firm.

The process of ecosystem transformation in support of digital servitization requires finding the right partners within the industry to fill the gaps that appear during the process, these gaps can include knowledge gaps, lack of technological resources, or at times ever more complex partnerships.⁴³ However, the task at hand is not a simple one when it comes to industrial manufacturers as they might encounter numerous challenges along the way including but not limited to cultural differences, diverging strategies or goals.⁴⁴

As brought forward by Breslin et al. (2021), as the number of players within the ecosystem increases, the management of such interdependent and divergent relationships registers a significant upsurge in its complexity as it becomes increasingly complicated to develop

⁴¹ Favoretto et al., “From servitization to digital servitization: How digitalization transforms companies' transition towards services”, *Industrial Marketing Management*, Volume 102, 2022, Pages 104-121 [link](#)

⁴² Sun and Zhang, “Building digital incentives for digital customer orientation in platform ecosystems”, *Journal of Business Research*, Volume 137, 2021, Pages 555-566 [link](#)

⁴³ Grandinetti et al.(2020), "Fourth industrial revolution, digital servitization and relationship quality in Italian B2B manufacturing firms. An exploratory study", *The TQM Journal*, Vol. 32 No. 4, pp. 647-671. [link](#)

⁴⁴ Tsujimoto et al., “A review of the ecosystem concept — Towards coherent ecosystem design”, *Technological Forecasting and Social Change*, Volume 136, 2018, Pages 49-58 [link](#)

strategies, maintain flexibility, coordinate all activities and communications, formulate policies, and evenly distribute the risks associated with each of the partners in the ecosystem.⁴⁵

In order to understand the drivers of the process of ecosystem transformation for digital servitization, M. Kolagar et al (2022) summarized all existing literature tackling this topic in the framework below:

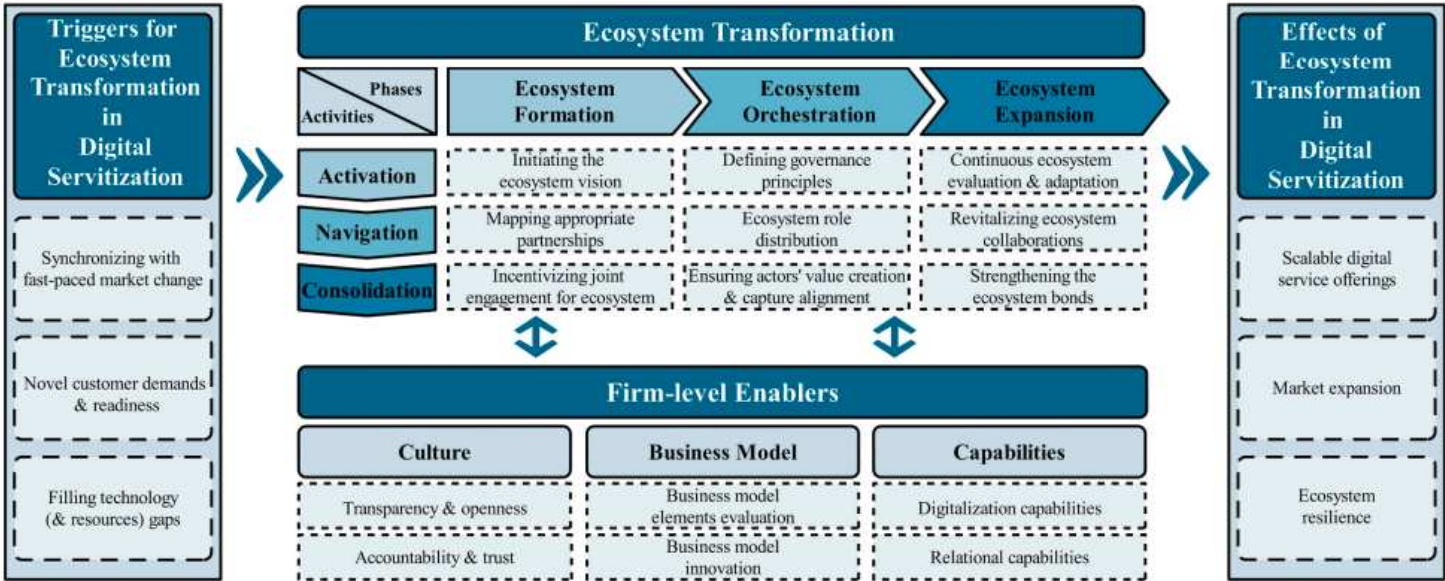


Fig 7: An integrative framework for ecosystem transformation in digital servitization

They first identified the three key drivers of for ecosystem transformation while undergoing the process of digital servitization:

Fist, the authors found that one of the many challenges encountered by organizations why implementing DS practices is *the synchronization with the rapidly changing market dynamics*.

⁴⁶By remaining flexible and making way for new partnerships, firms will be able to gain access to more advanced technologies in the market thus saving time and resources that they would have otherwise needed to develop such technologies. Moreover, by the time they develop the

⁴⁵ Breslin et al., “Developing a coevolutionary account of innovation ecosystems”, *Industrial Marketing Management*, Volume 98, 2021, Pages 59-68 [link](#)

⁴⁶ Kolagar et al., “Ecosystem transformation for digital servitization: A systematic review, integrative framework, and future research agenda”, *Journal of Business Research*, Volume 146, 2022, Pages 176-200 [link](#)

technologies discussed, in some cases, the latter can even already be outdated because of the fast-paced nature of the growth foreseen by this industry.⁴⁷ As argued by Ardolino et al. (2017), forming such partnerships with other players that are more advanced in terms of technology could in some cases even be the only way for the company to survive in such a competitive environment.⁴⁸

The second trigger pushing the need for changes in the ecosystem to support DS is new customer requirements and readiness. With the rise of DS, the requests of customers from their manufacturers appear to be more and more oriented towards digitalized offerings.⁴⁹ Customers are showing more interest in what can be categorized as an advanced service as described in the first chapter of this paper. These services could include predictive maintenance, pay-per-use contracts, and much more. Moreover, a manufacturing firm should remain agile in upgrading their offerings in terms of products and services to meet the ever-changing demands of their customers.⁵⁰

The third and final driver of the transformation of the ecosystem according to the authors is the need to *fill the gaps presented by technology and resources*. This is true for all manufacturers because, as mentioned earlier, there are fast-paced improvements in terms of technology, however, one cannot deny the fact that this is more visible in cases of manufacturing firms who, traditionally, have not focused on evolving their technologies.⁵¹

Moreover, the same authors also tackled the firm-level drivers of the ecosystem transformation in question which include the culture of the organization, the business model it employs, as well as the capabilities in its possession.⁵²

Moving the discussion toward the steps needed to go through the ecosystem transformation, the framework presented in Figure 5 identifies three phases which are *ecosystem formation, orchestration, and expansion*:

⁴⁷Lee et al. (2022), “Strategic servitization design method for Industry 4.0-based smart intralogistics and production”, *Expert Systems with Applications*, Vol. 204, 2022, 117480 [link](#)

⁴⁸Ardolino et al.(2018), “The role of digital technologies for the service transformation of industrial companies”, *International Journal of Production Research*, 56:6, 2116-2132 [link](#)

⁴⁹ Charro and Schaefer (2018), “Cloud Manufacturing as a new type of Product-Service System”, *International Journal of Computer Integrated Manufacturing*, 31:10, 1018-1033 [link](#)

⁵⁰Paiola and Gebauer, “Internet of things technologies, digital servitization and business model innovation in BtoB manufacturing firms”, *Industrial Marketing Management*, Volume 89, 2020, Pages 245-264 [link](#)

⁵¹ Kamalaldin et al. (2020), “Transforming provider-customer relationships in digital servitization: A relational view on digitalization”, *Industrial Marketing Management*. 89. 10.1016 [link](#)

⁵² Kolagar et al., “Ecosystem transformation for digital servitization: A systematic review, integrative framework, and future research agenda”, *Journal of Business Research*, Volume 146, 2022, Pages 176-200 [link](#)

1. Ecosystem Formation:

This phase of the process primarily aims toward designing an integrative and coordinated partnerships with related external actors in order to create more value as foreseen by both customers and partners. The steps needed to complete this ecosystem formation phase are first, defining the global vision of the group in question, then, identifying potential collaborators and paving the way for the most fruitful partnerships, and finally motivating other players in the ecosystem to join forces and work towards a mutual goal.⁵³

2. Ecosystem Orchestration:

The second phase of the process discussed in this section is focused on the management of the web of partnerships and relationships that were prevalent and newly formed within the ecosystem. The management of such complex relationships would call for enforced rules and regulations to police the actions of the players in the ecosystem.⁵⁴ The ecosystem orchestration consists of three main steps starting from the definition of the fundamental principles, followed by the appointment of the roles of each partner, and eventually, the value creation and capture incentives of all players are aligned towards the same direction.⁵⁵

3. Ecosystem Expansion:

The third and last phase of this journey undertaken by an organization which in a nutshell describes the development of novel partnerships with yet other resources and capabilities that could be of use to the organization. In this way, the ecosystem itself would broaden and evolve, and the prevalent relationships would be reshaped.⁵⁶ To accomplish the goals presented by the expansion phase, a firm would need to continuously assess the state of the ecosystem while adapting to the changes in its surroundings, after doing so, the next step would be renewing partnerships within the

⁵³ Kolagar et al., "Ecosystem transformation for digital servitization: A systematic review, integrative framework, and future research agenda", *Journal of Business Research*, Volume 146, 2022, Pages 176-200 [link](#)

⁵⁴ Williamson et al., "Ecosystem advantage: How to successfully harness the power of partners." *California management review* 55.1 (2012): 24-46 [link](#)

⁵⁵ Kolagar et al., "Ecosystem transformation for digital servitization: A systematic review, integrative framework, and future research agenda", *Journal of Business Research*, Volume 146, 2022, Pages 176-200 [link](#)

⁵⁶ Jovanovic et al., "Managing a blockchain-based platform ecosystem for industry-wide adoption: The case of TradeLens", *Technological Forecasting and Social Change*, Volume 184, 2022, 121981 [link](#)

ecosystem, and ultimately working on forging stronger ties with their business associates.⁵⁷

Furthermore, the same authors also solidified all the literature available when it comes to the consequences of ecosystem transformation within firms employing such practices, ranging from designing digital services that can easily be scaled, to expanding the market in general, to being truly considered as a resilient player in the ecosystem with capacities to react to obstacles efficiently which in its turn makes way for a competitive advantage that is difficult to match.

In the same token, Parida, Oghazi, & Cedergren, in the research paper they published in 2016, argued that digitalization provokes the modifications in resources that are known as the **“embeddedness”** of both intrafirm and interfirm activities.⁵⁸ To make things clearer, embeddedness refers to the fact that networks of relations in the organizational setting have a great influence on both economic results and activities.⁵⁹ This reconfiguration of the resources mentioned beforehand includes both interfirm and intrafirm resources. It is worth noting that these changes affect the competitive arena within industries and hence derange existing ecosystems, the firm does not only face the competition of counterparts within industry boundaries but also that of players that were previously considered as external to the industry because of the advanced technologies that result in the convergence of multiple industries.⁶⁰

As a matter of fact, as seen in the last decades, in order to design and produce autonomous products, firms like Tesla, Rolls-Royce, Wärtsilä, Caterpillar, and numerous others, businesses are not capable of functioning in isolation. Instead, during the process of coming up with smart solutions, they need to operate collaboratively across organizational boundaries and include many stakeholders in their product development processes including customers, distributors, service providers, and any other third parties. Consequently, the integration of intelligent solutions beyond the confines of a single company is of paramount importance. This rapid evolution necessitates not only technological advancements but also innovative business models

⁵⁷Kolagar et al., “Ecosystem transformation for digital servitization: A systematic review, integrative framework, and future research agenda”, *Journal of Business Research*, Volume 146, 2022, Pages 176-200 [link](#)

⁵⁸ Parida et al., “Orchestrating industrial ecosystem in circular economy: A two-stage transformation model for large manufacturing companies”, *Journal of Business Research*, Volume 101, 2019, Pages 715-725 [link](#)

⁵⁹ Granovetter, M. (1992). “Economic Institutions as Social Constructions: A Framework for Analysis.” *Acta Sociologica*, 35(1), 33. [link](#)

⁶⁰ Yoo et al. (2012), “Organizing for Innovation in the Digitized World.” *Organization Science*. 23. 1398-1408 [link](#)

and collaborative approaches. Manufacturers often face challenges in adapting their business models and practices to facilitate effective cooperation.⁶¹

With the emergence of such new technologies and the effect they have on the firm internally as well as on the environment surrounding it, it is natural for new business models to emerge. Developments in the micro-environment of a firm more often than not structure, not only the firm itself but also the environment surrounding it, which can also be defined as the macro-level environment.⁶²

Knowledge-Intensive Business Services (KIBS)

According to Muller and Doloreux's publication in 2007, there has been a notable increase in the interest shown in the research about knowledge-intensive business services as of the mid-1990s, that we will refer to as KIBS going forward. Moreover, based on their empirical research, they confirmed that, at least up until 2005, most of the articles published on this topic were done so from Europe and that in most of the cases, the authors concentrated on one of the two disciplines: economics or management and business administration.⁶³

In the literature published by Bettencourt et al. (2002: 100-101), KIBS was defined as *“enterprises whose primary value-added activities consist of the accumulation, creation, or dissemination of knowledge for the purpose of developing a customized service or product solution to satisfy the client's needs”*.⁶⁴

There is a large array of companies that can be considered as KIBS, including but not limited to sellers of hardware and/or software, or more professional firms offering their expertise such as consultancy firms, law firms, accounting firms, software development companies and more.

⁶¹ Kohtamäki et al. (2019), “Digital servitization business models in ecosystems: A theory of the firm”, Journal of Business Research, Volume 104, 2019, Pages 380-392 [link](#)

⁶² Kohtamäki et al., (2014), “Making connections: Harnessing the diversity of strategy-as-practice research”, *International Journal of Management Reviews*, Vol. 24, Issue 2, Pages 210-232 [link](#)

⁶³ Muller and Doloreux, “The key dimensions of knowledge-intensive business services (KIBS) analysis: a decade of evolution.” No. U1/2007. *Arbeitspapiere Unternehmen und Region*, 2007 [link](#)

⁶⁴ Bettencourt et al. (2002), "Client co-production in knowledge-intensive business services.", California management review 44.4 (2002): 100-101 [link](#)

These firms can be broadly classified into two categories:

1. P-KIBS:

This classification entails firms providing their professional know-how such as consultancy firms, market research, certification of quality and processes, and much more. Services of this kind are more often than not tailored to the needs of each customer in order to satisfy their specific needs.⁶⁵

2. T-KIBS:

Firms categorized in this section include the companies that provide outcome-based technical services as well as providers of proprietary technologies that firms can outsource and use without having to spend the time and resources needed to develop them.⁶⁶ As opposed to the P-KIBS, firms classified as T-KIBS usually have one service package or technology solution that they offer to all their customers.⁶⁷

Many researchers in the field have explored the relationship between manufacturing firms and establishments with both kinds of KIBS offerings while undergoing the transition towards territorial servitization⁶⁸ by focusing on the process of sharing and absorbing valuable information among different firms involved within the ecosystem.⁶⁹ The manufacturing firms in question are also seen as key partners when it comes to developing business solutions targeting international markets.⁷⁰ This is mostly prevalent in the case of Small and Medium Enterprises (SMEs), given the fact that most of the time, the internal capacities and resources of manufacturers of the size do not suffice when it comes to developing a more service-based business model in their product-focused portfolios and therefore, resort to external parties known

⁶⁵Rapaccini et al., "Navigating disruptive crises through service-led growth: The impact of COVID-19 on Italian manufacturing firms", *Industrial Marketing Management*, Volume 88, 2020, Pages 225-237 [link](#)

⁶⁶ Rapaccini et al., "Navigating disruptive crises through service-led growth: The impact of COVID-19 on Italian manufacturing firms", *Industrial Marketing Management*, Volume 88, 2020, Pages 225-237 [link](#)

⁶⁷Consoli and Elche-Hortelano (2010), "Variety in the Knowledge Base of Knowledge Intensive Business Services", *Research Policy*, Vol. 39, No. 10 [link](#)

⁶⁸ Lafuente et al., "Territorial servitization: Exploring the virtuous circle connecting knowledge-intensive services and new manufacturing businesses", *International Journal of Production Economics*, Volume 192, 2017, Pages 19-28 [link](#)

⁶⁹ Tseng, Chun-Yao, Da Chang Pai, and Chi-Hsia Hung. "Knowledge absorptive capacity and innovation performance in KIBS." *Journal of Knowledge Management* 15.6 (2011): 971-983 [link](#)

⁷⁰ Xing et al., "Servitization in mergers and acquisitions: Manufacturing firms venturing from emerging markets into advanced economies", *International Journal of Production Economics*, Vol. 192, 2017, Pages 9-18 [link](#)

as KIBS to support and even fast-track their transition towards servitization.⁷¹ Furthermore, DS is primarily built upon an interconnected and sophisticated installed base that communicates with other technologies or databases within the organization.⁷² While going through the process of DS, many SMEs might find themselves lacking when it comes to information technology,⁷³ electronics, or even the crafting of effective digitalized customer experiences.⁷⁴ In conclusion, one could argue that KIBS fuels the development of novel digital technologies within the settings of SMEs.

Moreover, with the evolution of digitalization in general, the knowledge exchanged in such scenarios has also evolved to include sophisticated technologies and algorithms aimed at supporting a firm's offerings and processes. Che et al. (2022) highlighted the importance of creating an environment where employees within an organization feel safe enough to share unique and valuable information with their colleagues in other departments within the firm. Moreover, it is also important to put the right mechanisms in place to make room for an effective and smooth flow of information within the organization.⁷⁵ This could involve having regular intra-departmental meetings, having the right communication channels and software to interact on a daily basis, or even having the right ERP systems in place to be able to have access to information that might present itself as valuable.

In order to depict the flow of information resulting from KIBS activities, the framework below developed by Strambach in their publication dating back to 2001 summarizes the process⁷⁶:

⁷¹ Muller and Zenker (2001) Business Services as Actors of Knowledge Transformation: The Role of Kibs in Regional and National Innovation Systems. *Research Policy*, 30, 1501-1516. [link](#)

⁷² Porter and Heppelmann. "How smart, connected products are transforming competition." *Harvard business review* 92.11 (2014): 64-88 [link](#)

⁷³ Peillon and Dubruc, "Barriers to digital servitization in French manufacturing SMEs.", *Procedia Cirp* 83 (2019): 146-150 [link](#)

⁷⁴ Coreynen et al., "Boosting servitization through digitization: Pathways and dynamic resource configurations for manufacturers." *Industrial marketing management* 60 (2017): 42-53 [link](#)

⁷⁵ Che et al. (2022), "How Does Employee–Organization Relationship Affect Work Engagement and Work Well-Being of Knowledge-Based Employees?." *Frontiers in psychology* 13: 814324 [link](#)

⁷⁶ Strambach (2001), "Innovation Processes and the Role of Knowledge-Intensive Business Services (KIBS)", *Innovation Networks. Technology, Innovation and Policy*, vol 12. Physica, Heidelberg, p.64 [link](#)

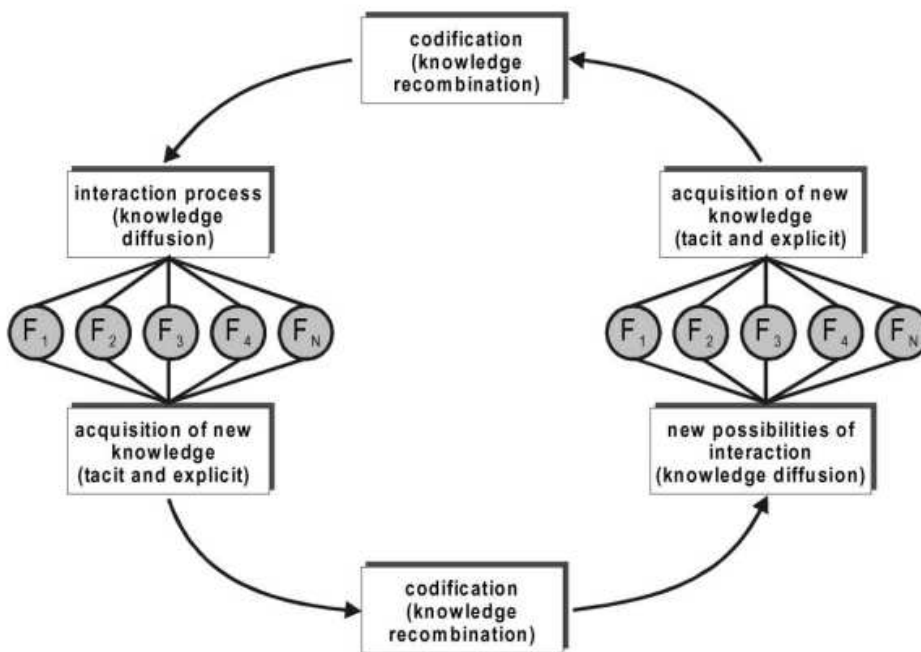


Fig 8: Knowledge production and diffusion as a result of KIBS activities (F1–FN: client firms)

The sharing of such valuable information makes way for novel growth and relationships within firms.⁷⁷ The content of the codified data mentioned above can range from creative, innovative, or even intellectual assets within the KIBS branch.⁷⁸

Moreover, as noted in various publications, another way in which servitization is supported by KIBS is the involvement of individuals in the KIBS setting. For instance, employees are involved in the development of new services since they are the ones who are in direct contact with the customers and are involved in day-to-day operations.⁷⁹ In the same token, and as mentioned in the sections above, the managers within an organization have the responsibility of reinforcing the transition towards servitization.⁸⁰ The two factors mentioned above support the

⁷⁷ Ayala et al. (2017), "Knowledge sharing dynamics in service suppliers' involvement for servitization of manufacturing companies." *International Journal of Production Economics* 193 (2017): 538-553 [link](#)

⁷⁸ Castaldi et al. (2013), "Co-innovation by KIBS in environmental services—A knowledge-based perspective." *International Journal of Innovation Management* 17.05 (2013): 1350020 [link](#)

⁷⁹ Gebauer et al. (2010), "Match or Mismatch: Strategy-Structure Configurations in the Service Business of Manufacturing Companies." *Journal of Service Research*, 13(2), 198–215 [link](#)

⁸⁰ Ulaga and Loveland (2014), "Transitioning from product to service-led growth in manufacturing firms: Emergent challenges in selecting and managing the industrial sales force", *Industrial Marketing Management*, Volume 43, Issue 1, Pages 113-125 [link](#)

fact that single actors within an organization can have a substantial impact on the avoidance of resistance in the face of servitization.⁸¹

Some of the core capabilities developed by these firms support the design of more advanced hybrid offerings which are key when moving towards a more service-oriented business model, these capabilities include

- the ability to process and interpret data related to service offerings
- the ability to evaluate and minimize risks associated with execution
- the ability to transition from design to service delivery
- the proficiency in the hybrid solutions' salesforce
- the proficiency in bringing the hybrid solutions to the market.⁸²

Another aspect worth mentioning that is caused by the popularity of KIBS in the last few decades was tackled by the research conducted by Vendrell-Herrero et al (2017), whereby the authors aimed to explain the relationship between digitalization and competitiveness. After analyzing the effects of digital dark matter on the music industry in ten countries, they noticed that the demand for digital dark matter was higher than its supply in all of them.

The finding mentioned in the preceding statement reflects the maximized benefits of digital technologies which suggests the need for private firms and institutions to further develop their portfolios to include more evolved offerings in terms of technology.⁸³ This idea was reinforced by the publication of Kamp et al (2017) implying that KIBS promotes competition within firms in an industry.⁸⁴

Additionally, looking closer into the regional aspects of KIBS activities, one can encounter various literature pointing out that KIBS-related startups have been emerging around areas with a high concentration of businesses, whereby Andersson and Hellerstedt (2009) found a positive

⁸¹Lenka et al. (2018), "Exploring the microfoundations of servitization: How individual actions overcome organizational resistance", *Journal of Business Research*, Volume 88, Pages 328-336 [link](#)

⁸²Uлага and Reinartz (2011), "Hybrid Offerings: How Manufacturing Firms Combine Goods and Services Successfully." *Journal of Marketing*, p.5, 75. 10.2307/41406856 [link](#)

⁸³ Vendrell-Herrero et al., "Servitization, digitization and supply chain interdependency." *Industrial Marketing Management* 60 (2017): 69-81 [link](#)

⁸⁴ Kamp et al. (2017), "Are KIBS beneficial to international business performance: Evidence from the Basque Country", *Competitiveness Review*, Vol. 27 No. 1, pp. 80-95 [link](#)

correlation between the market size and the emergence of entrepreneurs looking to develop KIBS-related businesses⁸⁵. This phenomenon can be formally framed by the term “agglomeration externalities”, which give rise to the need for knowledge and services provided by the KIBS industry.⁸⁶ This can be explained by the fact that the top customers of KIBS companies are manufacturing firms.⁸⁷ One can argue against this saying that frequent face-to-face encounter between manufacturers and KIBS firms is not necessarily needed, however, since there is a substantial amount of tacit knowledge in place, the partners in question may find the need to regularly interact in person in order to be able to retain customers and increase their lifetime value.⁸⁸

Given the fact that our empirical research is concentrated within specific industrial areas with a concentration of manufacturing firms, in the next sections, we will be studying the effect of such an environment on the emergence of KIBS. In order to do so, we will look into the current state of the firms in terms of services they have employed within their operations, while identifying areas that are yet to be explored in the industrial region in question in the region targeted by our research.

Conclusion

Throughout this chapter, we formed a better understanding of the digital servitization stream in particular by exploring the link between the two concepts of servitization and digitalization. We then moved on to take an upper-level look into the ecosystems surrounding firms undergoing the transition of DS. We looked into the relationships affected by such a transformation and explored the effect of this phenomenon on the surge of the demand in Knowledge-Intensive Business Solutions markets surrounding areas where DS is developing.

In the next chapter of this research, we will have a more empirical approach to understanding the correlation between KIBS and the manufacturing firms undergoing DS in specific regions.

⁸⁵Andersson and Hellerstedt (2009), “Location Attributes and Start-ups in Knowledge-Intensive Business Services”, *Industry and Innovation, Volume 16, Issue 1, P. 103-121* [link](#)

⁸⁶ Wood (2005), "A service-informed approach to regional innovation—or adaptation?." *The Service Industries Journal* 25.4 (2005): 429-445 [link](#)

⁸⁷ Muller and Doloreux (2009), "What we should know about knowledge-intensive business services." *Technology in society* 31.1 (2009): 64-72 [link](#)

⁸⁸ Von Hippel (1994), "'Sticky information" and the locus of problem solving: implications for innovation." *Management science* 40.4 (1994): 429-439 [link](#)

Chapter 3

Audience Definition: Understanding the Industry in Question

Introduction

After defining all related concepts and framing them by reverting to the available literature regarding the topics of servitization, digitalization, digital servitization, industry 4.0, the ecosystem surrounding all of the latter, as well as knowledge-intensive business solutions, we can move forward to discuss the research methodology employed in the empirical research conducted.

An important step before moving towards the empirical research would be to describe the audience of interest in our study and have a better understanding of where they stand at the moment in terms of digital servitization, and the service culture. In order to do so, we will have a deeper look into the territorial capital in this region.

Manufacturing Firms in Northern Italy

In this section we will be walking you through the the population of interest in our empirical research, we will also be going through a detailed analysis of the chosen industry's current state in terms of various characteristics.

As seen in the figure below, we will be starting with a general overview of firms in Northern Italy and discussing the drivers of the productivity of this region in general. Moving forward, we will take a closer look at the manufacturing firms in this region and the more specific territorial capital supporting this specific cluster. Then, we will zoom in further into the firms with their focus on B2B offerings and tap into the role of buyers/customers in the development of new solutions. After doing so, we will have a more detailed view of the solutions offered by these companies in terms of product/service mix. The target of our empirical analysis is the firms that meet all of the conditions below, we gathered the contact information of managers who, in our

opinion, could be involved or at least have knowledge of any service-related activities or planned activities that are taking place within the organization. We targeted mid and high-level managers who would have an overview of what tools and software are being used within the organization at that moment in time, and their servitization outlook for the near future.



Fig 10: Breakdown of firms that are of interest to this study

Before going through the empirical findings we came across by collecting the survey responses, it is imperative to take a look into the current state of the firms in question and understand the drivers of the industry as a whole, as well its strengths, weaknesses and the direction it is headed into. This is what we will be doing in the next section of this chapter by analyzing the territorial capital prevalent in the firms targeted by our research.

Territorial Capital in Manufacturing Firms in Northern Italy

The first and most principal step in conducting research into an industry in a specific geographical area is understanding the origin of its productivity and consequently determining the sources of regional competitiveness.

To have a better understanding of the above, it is worth mentioning the concept of **Territorial Capital (TC)** which has been re-launched by DG Regio of the Commission of the European Union to mention that each regional cluster has its own competitive advantage that enables it to stay ahead of others and generate a higher net value in specific investments. The form taken by such territorial assets may vary from one region to another, it can range from a concentration of

highly skilled human capital to having natural resources, to more immaterial advantages such as having established cooperation networks⁸⁹.

Having defined the general tenet underlying the notion of Territorial Capital, we can take a closer look at the firms in the North of Italy and their productivity drivers. In order to do so, it is worth examining the empirical research conducted in 2018 using data from 271,994 observations from the Northern region extracted from the database AIDA. The analysis consists of feeding a log-linear Cobb–Douglas production function with the data collected above, with the dependent variable being the company’s output level, determined by the number of people employed there, the tangible assets, as well as the intangible ones. According to the algorithm described above, and as shown in Figure 11 below, the primary drivers of Territorial Capital in the Northern part of Italy are the financial capital and the human capital, closely followed by the artistic and infrastructural capital, and then the social capital⁹⁰.

⁸⁹Camagni and Capello (2013) "Regional competitiveness and territorial capital: a conceptual approach and empirical evidence from the European Union." *Regional studies* 47.9 (2013): 1383-1402 [link](#)

⁹⁰Castelnovo et al. (2020), "Regional disparities and industrial structure: territorial capital and productivity in Italian firms." *Regional Studies* 54.12 (2020): 1709-1723 [link](#)

	North		Centre-south		North lag $t - 5$	Centre-south lag $t - 5$
	(1)	(3)	(2)	(4)	(5)	(6)
Technological capital	0.010 (0.013)	0.009 (0.011)	0.104*** (0.016)	0.103*** (0.013)	0.019 (0.042)	0.087** (0.027)
Human capital	0.057*** (0.013)	0.058*** (0.013)	-0.004 (0.007)	-0.006 (0.006)	0.119** (0.031)	-0.004 (0.009)
Social capital	0.027* (0.013)	0.028* (0.013)	-0.016** (0.007)	-0.007 (0.008)	0.073** (0.022)	-0.018* (0.008)
Institutional capital	0.007 (0.028)	0.008 (0.028)	-0.020 (0.013)	-0.010 (0.013)	0.073 (0.043)	-0.022 (0.014)
Natural capital	-0.001 (0.019)	-0.001 (0.019)	-0.014** (0.006)	-0.006 (0.008)	0.044 (0.048)	-0.012 (0.007)
Artistic capital	-0.048** (0.013)	-0.048*** (0.012)	0.011*** (0.003)	0.015*** (0.004)	-0.042 (0.030)	0.030 (0.018)
Financial capital	0.063*** (0.011)	0.060*** (0.011)	-0.029* (0.016)	-0.073** (0.026)	-0.030 (0.054)	-0.028 (0.033)
Infrastructure capital	0.045*** (0.010)	0.045*** (0.010)	-0.001 (0.005)	0.002 (0.004)	0.006 (0.020)	-0.005 (0.006)
Unemployment rate		-0.011 (0.021)		-0.120** (0.049)	-0.242 (0.123)	-0.021 (0.049)
Constant	4.288*** (0.051)	4.304*** (0.065)	4.159*** (0.027)	4.352*** (0.086)	4.711*** (0.218)	4.189*** (0.096)
R^2	0.231	0.231	0.228	0.228	0.238	0.226
Observations	271,994	271,994	147,467	147,467	125,631	71,289

Note: Standardized coefficients. Robust standard errors clustered by region are shown in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All specifications include firm's size and age, time, sector and regional dummies. Territorial capital is proxied using indicators in Table 1, column (1).

Fig 11: Impact of territorial capital on performance: North versus the rest of Italy: Dependent variable: total factor productivity.

As mentioned above, our focus for this paper will be on the manufacturing sector in the North of Italy. Next, we will be looking into the same empirical analysis to find the determinants of territorial capital, but this time distributed by the industry sector. As seen in Figure 2 showcased below, the manufacturing sector accounts for 195,129 of the overall observations, and the primary drivers of the regional productivity turned out to be the financial capital, followed by the infrastructure capital, as well as the social capital.

The overlap between the drivers of TC in the regional analysis and the sectorial analysis that is the focus of our study, that is, manufacturing firms in the North of Italy, is mainly the financial, the infrastructure, and the social capital⁹¹.

⁹¹Castelnovo et al. (2020), "Regional disparities and industrial structure: territorial capital and productivity in Italian firms." *Regional Studies* 54.12 (2020): 1709-1723 [link](#)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Manufacturing	Services	Wholesale and retail trade	Transport, storage and other services	Accommodation and food	Information and communication	Scientific research	Administration/ services
NACE code:	G		G	H	I	J	M	N
Technological capital	0.019 (0.013)	0.015 (0.013)	0.019 (0.015)	0.002 (0.016)	0.013 (0.033)	0.042*** (0.008)	0.001 (0.025)	0.030** (0.011)
Human capital	0.017 (0.012)	0.027* (0.015)	0.032* (0.016)	-0.008 (0.013)	0.040* (0.019)	0.023** (0.010)	0.029 (0.021)	0.021 (0.013)
Social capital	0.030* (0.016)	0.024* (0.014)	0.012 (0.017)	0.069*** (0.0112)	0.024 (0.026)	0.019 (0.012)	0.040 (0.026)	0.011 (0.013)
Institutional capital	-0.034* (0.017)	-0.043*** (0.014)	-0.071*** (0.017)	-0.100*** (0.014)	0.038 (0.023)	0.001 (0.011)	-0.046* (0.022)	-0.031** (0.011)
Natural capital	-0.010 (0.010)	-0.030*** (0.010)	-0.032*** (0.011)	-0.003 (0.010)	0.046* (0.025)	-0.021** (0.008)	-0.063*** (0.020)	-0.030*** (0.009)
Artistic capital	-0.003 (0.011)	0.003 (0.008)	0.009 (0.008)	0.017** (0.008)	0.007 (0.012)	-0.002 (0.008)	-0.028 (0.018)	-0.013 (0.009)
Financial capital	0.035* (0.018)	0.099*** (0.020)	0.099*** (0.020)	0.027 (0.027)	-0.025 (0.038)	0.105*** (0.013)	0.164*** (0.027)	0.163*** (0.021)
Infrastructure capital	0.032* (0.017)	0.047*** (0.014)	0.038* (0.018)	0.091*** (0.010)	0.000 (0.019)	0.020** (0.009)	0.063** (0.023)	0.048*** (0.010)
Unemployment rate	-0.068 (0.065)	0.037 (0.067)	0.024 (0.074)	-0.088 (0.057)	-0.156 (0.093)	0.075 (0.055)	0.138 (0.116)	0.141 (0.084)
Constant	4.955*** (0.119)	4.517*** (0.125)	5.168*** (0.145)	4.647*** (0.107)	5.477*** (0.169)	4.759*** (0.089)	4.107*** (0.281)	4.083*** (0.165)
R ²	0.272	0.194	0.267	0.230	0.385	0.217	0.168	0.108
Observations	195,129	224332	97,618	26,641	22,889	19,658	19,296	16,023

Fig 12: Territorial capital and productivity: industry evidence.

Next, let's take a closer look into each of the drivers of competitive advantage in the manufacturing firms in the territory of north Italy:

As expected, around 97% of the companies observed to build the algorithm mentioned above, can be categorized as Small and Medium Enterprises (SMEs)⁹². Moreover, according to the findings of Guiso et al. (2004), most SMEs and smaller-scale companies are reliant on local funding, as opposed to larger companies and corporations who look for sources of funds outside of their geographical boundaries⁹³.

The two latter statements support the fact that **financial capital** has a substantial impact on the good performance of the industrial regions in the North of Italy, which mainly consists of SMEs. Moreover, as noted in Chapter 2, it is important to stress the fact that such companies might find themselves in shortage when it comes to developing new technologies or capabilities to support

⁹² Castelnovo et al. (2020), "Regional disparities and industrial structure: territorial capital and productivity in Italian firms." *Regional Studies* 54.12 (2020): 1709-1723 [link](#)

⁹³Guiso et al.(2004), "Does local financial development matter?" *Quarterly Journal of Economics*,119(3), 929–969 [link](#)

their journey towards Digital Servitization, hence the need to outsource and utilize existing resources provided by firms whose main activities are offering KIBS to other partners in need.

Additionally, Arrighetti and Lasagni (2010) took a deeper look into the effect of the **social capital** aspect on Italian firms in particular and came to the conclusion that the most innovative and productive firms are clustered in the regions with “positive social capital”. The latter term is characterized by cultural traits and norms such as civicness, advanced social interactions as well and the lack of opportunism in the professional environment. All of the latter factors combined create room for an exchange of motivation between these environments which will result in the encouragement of information sharing forming a strong bond based on collaboration and good faith⁹⁴. It is worth adding here that knowledge spillover in such industries can be considered as yet another factor contributing to the added productivity in clustered industrial regions of this kind.

Last, but not least, we will be moving our discussion to **infrastructural capital**, which can simply be defined as the territorial region’s infrastructure and may be interpreted by looking into the availability and the types of means of transportation within the geographical area. According to research published in the Journal of Productivity Analysis concerning the infrastructure in Italy, an advanced core infrastructure such as the one found in the Northern regions, has been noted to have a positive effect on efficiency in everyday life in general, a fact that can also be applied in the business context and hence explain the clustered industrial regions in this same geographical area⁹⁵.

Another characteristic that needs to be highlighted in order to define the target of the empirical research conducted in this paper is the means of distinguishing between the business-to-business (B2B) and the business-to-consumer (B2C) offerings of firms in the manufacturing sector which we already defined above.

⁹⁴Arrighetti and Lasagni (2010), “Assessing the determinants of fast growth in Italy”, *Economics Department Working Papers 2010-EP07, Department of Economics, Parma University (Italy)* [link](#)

⁹⁵Mastromarco and Woitek (2006), "Public infrastructure investment and efficiency in Italian regions." *Journal of Productivity analysis* 25 (2006): 57-65 [link](#)

As the term implies, the business-to-consumer model aims to manufacture products that it intends to sell to customers who are the end users, in other terms, individuals in the mass market. Whereas the business-to-business model aims to have transactions with other businesses that intend to use the product/service, add value to it, and then sell it to other individuals or businesses in the market. To illustrate, an example of a B2B firm within the manufacturing industry can be a company crafting an industrial product to be used in factories such as industrial machines or even parts of industrial machines that will be used to design.

It is important to distinguish between the models abovementioned because it creates a great difference in terms of strategies, marketing approaches, R&D, and many more aspects related to a firm. The industry that is of interest to us in this paper is the servitization and digitalization phenomena related to the B2B context which will be a key characteristic of the population we will be sampling for the survey.

The next attribute that is of interest to us is the orientation of the B2B manufacturing firms in terms of product/service offerings. As noted in the first chapters, these two are not mutually exclusive, meaning, a firm can find itself bundling both products and services together as hybrid offerings. Moreover, an organization's service concentration level may vary based on many factors including but not limited to their service readiness, the culture that prevails, the amount of training that their employees have received, and most importantly the data they have aggregated throughout the years relevant to their installed base.

Lately, it has been almost impossible to come across a firm, even a B2B manufacturing firm that doesn't offer any kind of service whatsoever. The most basic services could include, after-sales service and maintenance, but in the last decades, the form taken by the services have developed to include more advanced data-reliant services such as predictive maintenance, and even the most complex forms such as the pay-per-use model which was initially introduced by Rolls Royce.

In the research conducted by Biemans & Griffin (2018), the authors found that an innovative strategy is more likely to be found in product-oriented firms than in service-oriented ones. They also found that the latter statement is applicable to the B2B setting as well as the B2C one. Moreover, looking into the service-oriented firms that do actually pursue an innovation strategy (which makes up 30.4% of all service-oriented firms), they noticed that their revenue targets for these strategies are much less ambitious compared to their product-focused counterparts.

Another interesting aspect that they confirmed with their research, was that the B2B firms with mixed categories of product/service mixes are spending the most on implementing radical innovation strategies, dedicating a higher percentage of their budget towards research & development on their existing hybrid offering, as consequently, they have adopted more advanced technology⁹⁶.

If we take a step further and apply the findings above to the North of Italy B2B manufacturing firm context which is the niche of interest to our research, one could argue that the territorial capital that this region has can be of great importance in supporting the strategies of such firms. The financial, social, and infrastructural capitals, as explained in the section above, are the pillars on which the industrial areas of the region in question are built.

The availability of funding for the firms (financial), the “positive social capital”, as well as the efficiency affiliated with having a developed infrastructural capital push these B2B manufacturing firms in the North of Italy towards the right direction in terms of innovative strategies aimed to create and sustain competitive advantage in this environment.

Most of the survey responses were already gathered through MailChimp through a database of contacts. However, through our network of personal contacts who have direct access to companies that could be of interest to our study and who fit all of the criteria that we laid out in the sections above, we also managed to get 5 more responses. After doing so, we ended up with an overall amount of 52 responses to our survey, all of which we found to meet the criteria we had set for our empirical research, hence, we decided to use all of the cases to build our model.

⁹⁶Biemans and Griffin (2018), “Innovation practices of B2B manufacturers and service providers: Are they really different?”, *Industrial Marketing Management*, Vol. 75, 2018, Pages 112-124 [link](#)

Conclusion

In this chapter, we also laid the boundaries of the industrial region that is of our interest, and we continued narrowing down the focus of our study to include B2B manufacturing firms within the North of Italy, and more specifically within the Veneto region.

Now that we formed an understanding of the firms that are the focus of our research, we can finally move on to build our empirical framework that is designed based on data gathered by the firms discussed in this chapter.

The next chapter of this paper would be to use the information gathered from the survey distributed to these firms and analyze the results in order to form an understanding of the state of the manufacturing firms in question in terms of servitization and the development of digital solutions and take a deeper look as to whether they are open to partnerships to fulfill their needs where they lack internally.

Chapter 4

Research Findings & Empirical Analysis

Introduction and Research Question

In each of the chapters above, we discussed each of the building blocks needed to move the discussion towards a more empirical front and build our framework. We first discussed the servitization journey and the types of services that could be seen in organizations today, after which, we took a closer look at the digital servitization phenomenon in particular and the role of the ecosystem in developing such a system. Finally, in order to paint a clearer picture of the subjects of our study, we dedicated the third chapter to understanding the firms we explored for our empirical study and the current state of the industry in which they operate.

Now that the theoretical grounds of our study are covered, it is time to move to the empirical study and formulate our research question:

“ What are the key factors that drive the development and enhancement of advanced services within an ecosystem of digital solutions?”

In order to answer this question, the questionnaire was formulated with four main parts, each describing a specific aspect of a firm. It was then distributed to firms in the Northern region of Italy which is where we decided to conduct our study since it is not yet a fully developed region in terms of digital servitization.

In the next sections of this chapter, we will be describing the steps followed to conduct the empirical research starting from the survey formulation, then moving towards cleaning the data, selecting the variables, building our model, and finally interpreting the results and discussing them.

Survey Description

In this section, we will be describing the flow of the survey and explain the goal that is set to be achieved through it. To begin with, it is worth mentioning that this survey was originally designed by the Digital Transformation Lab in the Department of Economics and Management (dSEA) of the University of Padova. The main goal of the survey was to analyze the situation of services within manufacturing companies and in particular investigate the state of advanced service offerings and digital solutions. Before going into details about the content of the questionnaire, it should be noted that it was written in Italian, since most employees within organizations in North Italy, which was the target of our study, feel more comfortable speaking and writing in their native language.

The framework shown in the figure below was designed in order to have a more descriptive view of the information we wish to gather by the means of the survey mentioned throughout this section:

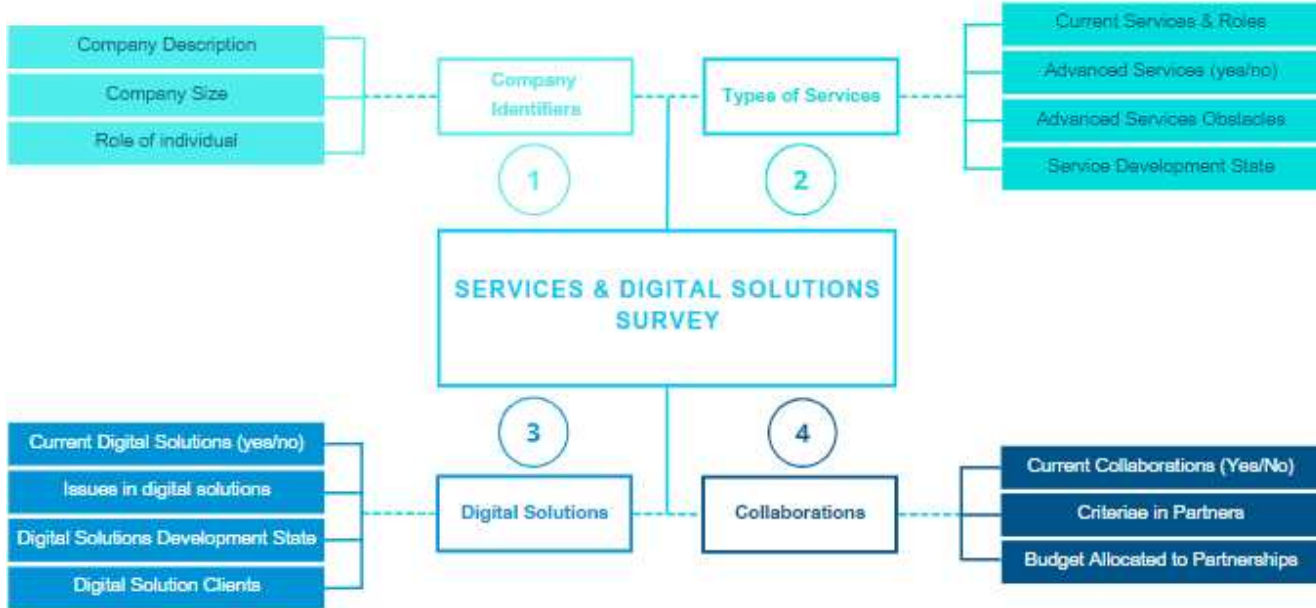


Fig 9: Objectives of the survey used in the empirical research

As depicted in the figure above, the survey aims to gather information on four general categories, each identified as a quadrant:

1. **The first quadrant** consists of attributes that will help us understand the distribution of the companies taking part in our sample.
2. **The second quadrant** tackles the topics related to the service offerings within the companies, the current state, and their future goals.
3. **The third quadrant** focuses on the digital solutions utilized within the organization and whether or not they plan on developing them further.
4. **The fourth and final quadrant** aims to gather information about the potential collaborations made with other companies to develop the offerings mentioned in the two previous quadrants.

The tool used to create the survey was Google Forms, and after some thought and research in the market, we realized that a lot of companies would be reluctant to respond as they refrain from sharing sensitive information regarding the paths that the organization envisions to take in the future. For practical reasons, we left the “Company Name” section as optional and instead, kept the “Company Description” section as mandatory.

First Quadrant: Company Identifiers

Other than the company description, there is another identifier that is included that could give an idea regarding the size of the company, which is *the number of employees within the organization*. This question consists of a multiple choice question with each choice referring to a specific range.

Furthermore, before moving to the questions indicating the current state of the organization, the questionnaire tackles yet another important thing, which is the role of the individual filling it. While constructing the database, the aim was to target upper-level management roles, or roles related to operations or services such as COO, Operations Manager, and CEO. In a nutshell, the ideal respondents would be users who are decision-makers, or at would be informed on important decisions or forecasted changes that the company is aiming to implement. This person also needed to have knowledge about the technological information being used at the moment within the organization, as well as the services currently being offered along with their products.

Second Quadrant: Types of Services

After having an idea of the above, the next aim of the survey was to understand the current state of the company in terms of readiness for digital solutions and innovation in general. To do so, the next question for survey fillers consisted of their opinion on the current state of innovative services employed within the organization with a rating from 1 to 7.

In order to make the above clearer and more data-reliant, there is another question in place to understand the technological solutions employed by the company to manage their activities, such as ERP systems, Office automation systems to share data regarding daily activities, CRM software, Field Service software, Data analysis solutions using AI technologies, or even MES solutions relying on industry 4.0.

After which, there is an additional section where it was required for the user to rate the modernity of the hardware and software implemented within the company and the propensity of the digital culture within the members of the organization.

Since this section is somewhat subjective to the person filling the survey, the next question aims to reveal the percentage of the revenue generated by after-sales services, out of the total revenue generated by all activities carried out by the organization. This could later help confirm and quantify the current state of the company.

The next step of this empirical analysis is to understand the upper-level strategy of the companies in question, by inquiring about the importance of services to the overall strategy today compared to the one in the short-term future (here assuming a period of 3 years). After doing so, the next inquiry was regarding the services currently in place and being offered to customers actively, and whether these services include what we described as **advanced services** in our first chapter.

- For companies offering advanced services, they were asked to share the types of these services that are currently included in their product/service offerings in addition to the year in which they implemented these services and how many clients are they offering such services to. Moreover, another interesting aspect tackled by this questionnaire was identifying who was responsible for the sales of these services, and whether there are dedicated salespeople in place for such advanced services.

In order to sum up all the above, they were also required to specify what stage they believe they are at in the development of strategies leaning towards more advanced services.

- For companies not offering advanced services, the survey requested information about the reasons why they do not include that in their offerings, at least not yet. This question aims to understand whether or not these firms are finding any difficulties in planning and eventually implementing a more service-centric approach when it comes to designing their offerings.

Third Quadrant: Digital Solutions

Moving to the next section, it aims to understand the status of the firms being questioned in terms of their digital solution offerings to their installed base.

- For users who do not offer digital solutions to their installed base, the survey aims to identify the reasons behind the absence of such offerings and whether they have difficulty supporting that because of costs, lack of potential partners, or if they found some resistance that can be attributed to the deficiency in the service culture within the organization's identity.
- In the case of companies that have digital solutions employed to serve their installed base, further information was requested concerning the type of these solutions. After this, the individuals were also asked to specify what solutions they have implemented such as virtual assistants, remote client monitoring, predictive maintenance using machine learning technologies, and more. As with the advanced services, it would be interesting to see if there is a specific team in place to manage these solutions and how many clients they are currently utilizing these offerings. The two latter pieces of information would help us understand in a clearer way which stage the company is in developing such solutions.

In order to develop this section further, there are also some general questions regarding the development of digital solutions such as the advantages perceived by the managers that pushed their strategies to include such offerings in their portfolio, as well as the obstacles they came across in the process.

Moreover, the questionnaire also aimed to understand the pricing mechanisms behind such solutions in order to understand where they stand in terms of the “free to fee” scale. This was followed by some general and subjective questions to understand if digital solutions are imprinted in the organizational culture and have been introduced as a regular phenomenon in the day-to-day activities.

Fourth Quadrant: Collaborations

Throughout the last section of the survey, the goal was to get some clarification in comprehending whether the companies in our sample are willing to cooperate with partners in order to develop their digital solutions or if they are already doing so.

- For users who are already collaborating with partners:
As discussed in the second chapter of this paper, more often than not, SMEs do not have the means or the time to develop such solutions from scratch and would need to partner with players in the KIBS industry. In this token, it was also interesting to have an idea of the criteria that lead these firms to select their KIBS partners, as well as the budget they are spending to receive their offerings.
- For users who are not collaborating with partners but are thinking about it:
They were asked to provide us with details about the amount they would be willing to spend on such offerings and their expectancy in terms of the time range they think is proper for their company to develop digital solutions. As with the companies who are already collaborating with KIBS partners, the ones who aren't were also asked about the characteristics they would look for if they were to search for other companies to partner with.

The Qualitative Comparative Method Selection

In the last couple of decades, there has been a rise in the use of the Qualitative Comparative Model, and more specifically the Fuzzy-Set Qualitative Comparative Model, also referred to as fsQCA, and more particularly in studies related to business and organizational research.⁹⁷ This model can be used to discover causal relationships between the variables taken into account based on the premises of equifinality, it also assumes conjunctural causation, as well as multifinality.⁹⁸ The aim of the QCA approach in general is recognizing the sufficient as well as the necessary conditions for the dependent variable to occur. Each case, which in our case consists of the companies who replied to the questionnaire, is considered as a path that reflect causes (the independent variables) that are leading to a certain result (the dependent variable).⁹⁹

One of fsQCA's advantages, as opposed to the traditional methods such as Multiple Regression analysis, is that it does not need a large number of independent variables in order for the model to be accurate and statistically significant. Rather, and because of its asymmetric relations, one could end up with a good model with just a few variables. The fsQCA model aims to identify causal recipes, that consist of different combinations of the chosen independent variable (both positives and negatives) that are leading to the existence or absence of the outcome variable. Moreover, the fact that this model also assumes equifinality, makes it more realistic in a real-world setting, it stresses the fact that there can be more than one path leading to the same outcome, which is the case in most practical cases.¹⁰⁰

Additionally, fsQCA is widely used in analyzing datasets that have a sample size that is too wide for a simple statistical analysis of the cases, and at the same time too narrow for complex models such as multiple regression.¹⁰¹ In our case, we managed to gather responses from 52 companies, making for a number of instances that are within the acceptable range for the choice of the fsQCA method.

⁹⁷ Schneider et al. (2010). "Qualitative comparative analysis (QCA) and fuzzy-sets: Agenda for a research approach and a data analysis technique." *Comparative Sociology*, 9(3), 376-396. [link](#)

⁹⁸ Wu et al., (2014). "Applying complexity theory to deepen service dominant logic: Configural analysis of customer experience-and-outcome assessments of professional services for personal transformations." *Journal of business research*, 67(8), 1647-1670. [link](#)

⁹⁹ Schneider & Wagemann (2012). "Set-theoretic methods for the social sciences: A guide to qualitative comparative analysis." Cambridge University Press. [link](#)

¹⁰⁰ Greckhamer et al., 2008. "Using qualitative comparative analysis in strategic management research: an examination of combinations of industry, corporate, and business-unit effects." *Organ. Res. Methods* 11 (4), 695–726. [link](#)

¹⁰¹ Ragin (2009). "Redesigning social inquiry: Fuzzy sets and beyond." *Chicago: Univ.* [link](#)

As can be seen in the application of the fsQCA to our dataset, the first thing that needs to be done before running the model is calibrating the variables to meet the conditions required by the model in question. The variables need to be calibrated as numbers between 0 and 1, whereby a value of one is associated with the existence of the condition relative to that specific variable. As with our case, the variables can have two forms: CRISP-set and FUZZY-set. The first one can be referred to as what is commonly known as a boolean set consisting of 0 and 1. Whereas the second one could include any values in between.¹⁰²

Afterwards, the first analysis that needs to be done on the variables is the necessary condition analysis to identify which variables are the most important ones for the occurrence of the outcome variable. However, it is best practice to eliminate any variable with a necessity threshold of over 0.9, since it suggests the absence of conditions that are necessary for the outcome variable to occur. The next step would be to build a truth table with the selected independent variables in order to understand the scenarios in terms of causal relationships with the dependent variable chosen.¹⁰³

After doing so, a standard analysis must be conducted in order to identify the sufficient conditions that need to be for the outcome variable to occur, for each path, we will have a better understanding of their consistencies and coverages. In this analysis, there are three possible approaches that could be adopted which are the complex solutions (relying on empirical data), the parsimonious ones (which include logical remainders), in addition to the intermediate solutions (which can be considered as a combination of the two previous approaches). In our model, we will be focusing on the intermediate solutions, which consider both empirical methods as well as theoretical methods to include the concept of logical remainders.¹⁰⁴

¹⁰² Schneider et al.. (2010). “Qualitative comparative analysis (QCA) and fuzzy-sets: Agenda for a research approach and a data analysis technique.” *Comparative Sociology*, 9(3), 376-396. [link](#)

¹⁰³ Mas-Verdú et al., (2015). “Firm survival: The role of incubators and business characteristics. *Journal of Business Research*”, 68(4), 793-796. [link](#)

¹⁰⁴ Fiss (2011). “Building better causal theories: A fuzzy set approach to typologies in organization research.” *Academy of management journal*, 54(2), 393-420. [link](#)

Correlation Analysis and Variable Selection

Before doing any work to build our model using the results gathered throughout the survey described above, it is imperative to clean the data and recode the variable whenever needed. After a careful overview of all the responses, we decided that all of them could be used and do not seem lacking or weak in terms of the data they provided. Some of the companies preferred staying anonymous and not providing their names and emails but that is not an issue, because the survey was only sent to people who were within our targeting range to begin with. Moving forward, we carefully looked into each of the questions that were asked and made a selection as to which of them could be used as potential variables in our fsQCA model after some modifications.

The [first table in the appendix](#) summarizes the survey questions, the types of variables, as well as the decisions made regarding each of the variable selections without running any statistical tests on them. Based on our preliminary overview, we eliminated the variables that had missing instances, there were quite a lot of them because some of the questions were conditional, meaning, they were shown if the answer to a previous question was yes or no. We also removed all of the open-ended questions which we realized could not be coded to be used in FSQCA, and we also thought that they could be biased or just wrong because not all of the members of the company have access to information such as the amount the company would be willing to spend to develop advanced digital solutions.

At this point, two of the variables on the questionnaire underwent major changes that need further explanation. The first one was the creation of a new variable called “Number of Service Related Tech Solutions” which is a subset of the variable “Number of Tech Solutions”. In the sixth question of our questionnaire, we asked the companies to select which of the solutions they currently offer among a list we provided them with, which includes:

1. Office automation and data and document sharing instruments (e.g. MS Office 365)
2. ERP system accessible via Internet - VPN
3. Workflow management, notifications, and schedules (e.g. LotusNotes)
4. CRM management (e.g. Salesforce)
5. Field service management (e.g. ServiceMax)
6. Help- and service-desk ticketing systems (e.g. Zendesk))
7. Solutions for data analysis and Artificial intelligence (e.g. MS Azure, AWS, IBM Watson, PTC Teamworks;...)
8. Business Intelligence systems (e.g. Qlik, Tableau)
9. MES factory management systems 4.0 (e.g. Siemens, Wonderware)

Among the technological solutions mentioned above, we decided that only the service-related ones are of interest to our study, and hence drove our focus towards the options from 4 to 8 consisting of a total of five technological solutions to choose from. For each company, we counted the number of solutions they selected in the questionnaire and included this in our new variable called “Number of Service Related Tech Solutions”.

The second variable in question is the number of employees. We thought it would be interesting to differentiate the companies between those that can be considered as Small and Medium Enterprises, and those that can be considered as big companies. After careful consideration of what is seen as an SME, we decided to consider the definitions given by OECD in 2005, whereby companies having less than 250 employees are considered as SMEs.¹⁰⁵ We decided to go with a binary variable being considered as a big company (0), if it has more than 250 employees, and an SME (1) if it has 250 employees or less. We called this variable “SMEs” and, as the name indicates, it defines whether a company consists of an SME or not. After getting this task done, the next step was conducting a correlation analysis with the 23 variables we were left with. After running the correlation analysis in RStudio, we came up with the correlation matrix which can be seen in the table below:

¹⁰⁵ OECD (2005), SME and Entrepreneurship Outlook 2005 , *OECD*, Paris [link](#)



Fig 10: Correlation matrix including all variables where correlations above 0.5 are highlighted for further analysis. And the sign "*" refers to the statistical significance of the correlation (t-test).

Subsequently, we took a closer look at the variables that had a Pearson correlation coefficient higher than 50% by running a correlation test on each pair of variables that met the latter criteria. To do so, we used an in-built function on Rstudio which consists of a “Test for Association/Correlation Between Paired Samples” utilizing Pearson's product moment correlation coefficient, all of the results showed a p-value less than a significance level of 5%. Meaning, that we were able to reject the null hypothesis in all cases, confirming the alternative hypothesis which suggests that a correlation does exist between each pair of variables. Overall, we conducted this test on 19 pairs of variables that were confirmed to be correlated with each other. Afterward, the aim was to disregard some correlated variables and choose some among them to use in the fsQCA model. We noticed that the correlated variables could be clustered in four groups.

The first cluster that we took into consideration was mainly about the willingness of the companies to collaborate with outside partners, and what criteria they feel are important while looking for potential partners since they had to rate each of these criteria from 1 to 7 in the questionnaire: quality/price relation, speed of realization, support during and after implementation, and support formation and consulting after the implementation of the digital solutions.

As a first try, and after taking a second look into the questionnaire as well, we decided to keep only the first variable and called it **Partner Collaboration**. After eliminating 4 variables, we are now left with 19 variables. This is a preliminary analysis, and in later stages, we might switch up some of these variables among each other if we notice that this action would improve the performance of the model.

Moving on to the **second cluster** of variables that we found were correlated with each other, they consist of the importance of services in short-term strategy, the importance of services now, the number of digital solutions that are offered, and whether or not digital solutions are offered. The last two variables should logically be correlated, however, we didn't remove one of them at a previous stage to better understand their relationships with the rest of the variables.

Looking into this cluster, we can understand that we need to eliminate one of the variables: importance of services now or importance of services ST. Since the second has a higher correlation with the remaining variables in the table, we decided to remove it. Moreover, we also decided to remove the variable digital solutions offered, the number of digital solutions offered

would by default be 0 if there are no digital solutions present within the company. We reasoned that the variable number of digital solutions is more descriptive and could give us more insights into the state of digital solutions within the company. We called this variable **Digital Solutions**. After refining this second group, we were left with 17 variables to consider.

Moving on to the **third and last cluster** of variables we examined to understand the correlation between them, it consists of a combination of 6 variables. The first two are the state of the digital culture within a firm, as well as their overall organizational culture which had to be rated from 1 to 7. The third and fourth variables were whether or not the organization has a separate BU for services, and whether or not they consider service revenue as a separate source. The last two variables considered here were how advanced the software and hardware used by the organization are on a scale of 1 to 7.

As a first step, we removed the organizational culture variable which is the degree of advancement of the organizational culture within the companies. The rationale behind this decision was driven by the fact that this variable is highly correlated with the variable digital culture, and we prefer keeping the latter because it is more relevant to our studies and this research paper in general. Next, we wanted to investigate the relationship between the two variables services as a separate Business Unit, and services as a separate revenue stream. However, we decided that we could keep both and merge them into one variable. If a company meets both conditions, they will score as 1, if they meet one of the conditions, they will score as 0.5, and if they do not meet any of the two conditions, they will score as 0. We called this new variable **Separated Services**.

The next decision was regarding the two variables that are designed to provide us information about how up-to-date the hardware and software are within the organization, we decided to merge these variables and codify them by summing up the scores of these variables. The ones that are above the overall average were considered to be 1, and the ones below the average were considered to be 0 in the upcoming analyses.

The last thing we looked at before moving our focus toward the dependent variable, was the correlation between the two potential independent variables “Number of Tech Solutions” and “Number of Service Related Tech Solutions”. As the second is a subset of the first one mentioned in the previous statement, we expected a correlation between these two variables, a fact which was confirmed as we observed a correlation of 0.86 among them which also passed our statistical test. Consequently, we decided to keep the second variable, which is more focused on the service-related technological solutions employed within the firms in question, making it more relevant to our study.

After omitting the variables based on the correlation analysis and statistical test conducted above, we were left with 14 variables, including the dependent variable.

We noticed another thing that could be done to refine the dataset further and prepare it for our Fuzzy-set Qualitative Comparative Analysis: First, we have a question that was asked in two ways, whether a company is offering advanced services was both asked in a yes/no question and a multiple choice question. Furthermore, this multiple choice question included 3 options that describe the service offering of the company: whether they’re offering basic services, intermediate services or advanced services. These 3 variables can easily be merged into one variable that we called **Level of Service Advancement** by following the logic below:

- If the company’s most evolved service offering consists of basic services (such as installation, guarantees and spare parts), assume that it has a score of 0 in this new fuzzy-set variable;
- If the organization’s most evolved service offering consists instead of an intermediate service (such as helpdesk, maintenance, repair, overhaul, monitoring), assume that it has a score of 0.5 in this same fuzzy set
- And finally, if it does have advanced services implemented (such as performance-based contracts, or pay-per-use model) - which were introduced and described in details in the first chapter of this paper - then consider this variable as being set to 1 in the corresponding fuzzy-set.

Having gone through all of these steps which required a combination of the elimination of some variables, the merging of some other variables, as well as the coding of some of them in order to meet the requirements of the fsQCA model, we were left with 10 options for the independent variables and 1 dependent variable which is the **Level of Service Advancement**. This is in line with the research question we introduced in the first section of this chapter which aims at identifying the key factors contributing to the evolution of services and the development of advanced services within manufacturing firms. Next, we will study each of the variables selected through the logic described above (our independent variables), and plot them into our model to understand their effect on the development of advanced services, which will be constituting our dependent variable.

fsQCA: Building The Model

After conducting the preliminary analysis, it was time to code the independent variables to and calibrate them to match the FUZZY-SET structure which consists of sets between 0 and 1.

- Some of the variables (*Innovation Propensity, Service Tech Solutions, Updated Hardware & Software, Digital Culture, Importance of Service Now, Number of Digital solutions*) were turned into CRISP variables by checking whether each company scores higher or lower than the average of the sample for the respective conditions.
- The variable *SMEs* was turned into a CRISP variable by looking into the number of employees that an organization has based on the responses to the questionnaire, where a number above 250 reflects that the condition of SME is met so it's set to 1.
- The variable *Separated Services* was kept as a FUZZY Set, by scoring 1 for highly separated, 0,5 for somewhat separated and 0 for not separated.
- The variable *Partner Collaboration* was based on whether the companies currently have partners to support them with their digital solutions. This was also kept as a FUZZY set, scoring 1 for organizations already collaborating, 0.5 for the ones thinking of collaborating, and 0 for the ones who do not wish to do so.
- Finally, the dependent variable *Level of Service Advancement* was also scored kept as a FUZZY. A score of 1 refers to advanced services, 0.5 to intermediate services, and 0 to basic services.

A summary of the logic followed to recalibrate and codify the variables that were used in the initial necessary condition analysis can be found in the table below:

Variable Name	Variable Meaning	Description	Calibration
SMEs	Company is considered as an SME	Reflects the size of the company based on the number of employees	$\geq 250 = 0$ $< 250 = 1$
Innovation Propensity	Above average innovation propensity	Reflects the innovation propensity of the company based on the person filling the survey (Scale 1-7)	Average = 5.8 $> 5.8 = 1$ $\leq 5.8 = 0$
Separate Services	Highly separated services in terms of BU & revenue source	Reflects whether the company has a separate BU & sep. revenues (yes/no answer for each)	[1,1] = 1 [1,0]=[0,1]=0.5 [0,0]=0
Number of Digital Solutions	Above average number of digital solutions offered to IB	Reflects the number of digital solutions selected among 10 options	Average = 3.65 $> 3.65 = 1$ $\leq 3.65 = 0$
Partner Collaboration	Th collaboration with partners offering digital solutions	Reflects the answer chosen in the questionnaire (already collaborating, thinking about it, don't want to)	yes = 1 maybe = 0.5 no = 0
Level of Service Advancement	Offering advanced, intermediate or basic solutions	Reflects the current offering of services (Advanced = A, Intermediate = I, Basic = B)	A = 1 I = 0.5 B = 0
Service Tech Solutions	Above average service tech solution offerings	Reflects the number of service tech solutions offered among a selection of 5 options	Average = 2.83 $> 2.83 = 1$ $\leq 2.83 = 0$
Updated Hardware & Software	Above average level of advancement of hardware & software	Reflects the sum of the ratings of hardware & software based on the person filling the survey (Scale 1-7 each)	Average = 9.37 $> 9.37 = 1$ $\leq 9.37 = 0$
Digital Culture	Above average digital culture within the firm	Reflects the digital culture present in the firm based on the person filling the survey (Scale 1-7)	Average = 4.1 $> 4.1 = 1$ $\leq 4.1 = 0$
Importance Service Now	High importance of service to the existing strategy	Reflects the importance of services in the existing strategy based on the person filling the survey (Scale 1-7)	Average = 4.46 $> 4.46 = 1$ $\leq 4.46 = 0$

*Fig 11: Calibrated variables considered to build the fsQCA model, and used for the necessary condition analysis. * Highlighted in green is the outcome variable, and highlighted in gray are the independent variables that are later chosen for the final model**

After uploading the cleaned dataset to the fsQCA software, the first step to take was building and analyzing our truth table including all of the variables. In order to start with the variable selection, we conducted a necessary condition analysis including all the possible options that could be selected as independent variables. The solution of the preliminary necessary condition analysis can be found in the table below ordered from the highest to the lowest consistency.

	Consistency	Coverage
InnovationPropensity	0.877193	0.543478
PartnerCollaboration	0.719298	0.66129
NumberofDigitalSolutions	0.631579	0.682308
SeparatedServices	0.614035	0.648148
SMEs	0.596491	0.607143
ImportanceServiceNow	0.526316	0.625
ServiceTechSolutions	0.491228	0.636364
DigitalCulture	0.473684	0.519231
UpdatedHardware&Software	0.403509	0.5

*Fig 12: Necessary condition analysis of all possible options of independent variables considered
*Highlighted in gray are the independent variables selected for the final model**

In order to build our model, we aimed to include at least one variable that was present in each of the four quadrants of the survey: Company Identifiers, Services, Digital Solutions & Collaboration. We started by choosing among the variables from each quadrant with the highest consistency of the necessary condition and looking for models following that logic. After looking for combinations of different variables and adding/removing variables, we decided to go with the following model:

$$\text{LevelofServiceAdvancement} = f(\text{SMEs}, \text{InnovationPropensity}, \text{SeparatedServices}, \text{PartnerCollaboration}, \text{NumberofDigitalSolutions})$$

First and foremost, we constructed the truth table relative to the abovementioned model with the default frequency cut-off of 0.8, the result can be summarized in the following table:

<i>SMEs</i>	<i>Innovation</i>	<i>Sepa. Services</i>	<i>Partner Collab</i>	<i>Dig. Solutions</i>	<i>Cases</i>	<i>Advanced Services</i>	<i>raw consist.</i>	<i>PRI consist.</i>	<i>SYM consist.</i>
1	1	0	1	1	4	1	0.91	0.88	1
1	1	1	1	0	1	1	0.86	0.75	0.75
0	1	1	0	1	4	1	0.85	0.75	1
1	1	1	0	0	1	0	0.71	0.33	0.5
0	1	1	1	1	4	0	0.69	0.43	0.6
1	1	0	1	0	2	0	0.67	0.40	0.5
1	0	1	1	0	1	0	0.67		
0	1	1	1	0	1	0	0.67		
0	1	0	0	1	1	0	0.67	0.50	1
0	1	0	1	1	2	0	0.60		
1	1	0	0	0	1	0	0.43	0.00	0
0	1	0	1	0	3	0	0.00	0.00	0
0	0	0	0	0	1	0	0.00	0.00	0
0	1	0	0	0	1	0	0.00	0.00	0

Fig 13: Truth Table summarizing the variable compositions giving us a level of advanced services of one (Independent variables including: SMEs, Innovation Propensity, Separated Services, Partner Collaboration, Number of Digital Solutions)

highlighted are the rows consisting of paths with a raw consistency above 0.8

After looking into these, we continued to conduct a standard analysis using these variables. The intermediate solutions of the results of the analysis can be found in the table below:

MODEL		LevelofServiceAdvancement = f(SMEs, InnovationPropensity, SeparateServices, PartnerCollaboration, NumberOfDigitalSolutions)	
PATHS		Raw Coverage	Raw Coverage
~SMEs*InnovationPropensity*SeparatedServices*~PartnerCollaboration*NumberOfDigitalSolutions		0.192982	0.192982
SMEs*InnovationPropensity*SeparatedServices*PartnerCollaboration*~NumberOfDigitalSolutions		0.105263	0.105263
SMEs*InnovationPropensity*~SeparatedServices*PartnerCollaboration*NumberOfDigitalSolutions		0.175439	0.175439
SOLUTION		Raw Coverage	
Solution coverage		0.473684	
Solution consistency		0.870968	

Fig 14: fsQCA summary of selected model (intermediate solutions)

Once the model has been chosen, the next section of this paper will aim to interpret the result and each path it provided us with. By doing so, we will have an understanding of the relation between the empirical analysis with the theoretical grounds we put together in the first three chapters of this paper.

Result Interpretation

As explained in detail in the section above, with a total of five independent variables considered, we were able to identify three paths that can be considered to give us a positive result, in order words, the conditions that we found to be associated with companies that have advanced services already employed in their strategies. In the next section of this research, we will be analyzing the three paths that we came through with the empirical research we conducted. For the sake of simplicity and clarity, we put together the following table summarizing the paths that we identified throughout our model-building process following the fsQCA guidelines.

	Path 1	Path 2	Path 3
SMEs	~	●	●
Innovation Propensity	●	●	●
Separated Services	●	●	~
Partner Collaboration	~	●	●
Number of Digital Solutions	●	~	●
Legend: ~ = doesn't exist ● = exists			

Fig 15: fsQCA solution paths (intermediate solutions)

Path 1: Innovative Large Companies with Digital & Service Culture

The first path considered in our model, considers companies in Italy that go beyond the definition of SMEs, having more than 250 people employed based on the responses to the questionnaire. According to our model, the first condition that needs to be met for such large companies to have advanced services is the existence of the propensity to innovate within the firm in terms of researching innovative solutions (including digital solutions) to continuously ameliorate the company's activities. Such companies always look for ways to stay ahead of the competition and one could argue that they have specific roles or even teams in place to meet this function.

The second condition taken into account is the fact that these companies have separate business units dedicated to services and even separate revenue streams that are considered to stem from services. These companies also have several digital solutions exceeding the average of the sample used, which goes in line with the first condition which was the innovation propensity. Moreover, what is interesting to see here is the condition relative to the last quadrant of the survey, which is the one relative to the external partners. These large companies who have advanced services adopted, do not resort to external partners and are not looking to collaborate with them.

Path 2: Innovative SMEs with Service Culture

The second path considered in the same model consists of companies that are considered SMEs, having 250 employees or less. These companies also have an innovation propensity when it comes to finding original and inventive solutions, aiming for continuous improvement in their strategies. They also track the revenues of services separately and have distinct business units allocated towards services and the activities they necessitate. Contrary to the large companies discussed in the first path, these SMEs look for partner collaborations, and the digital solutions they have implemented are less than the average of the sample we took into consideration in our empirical analysis.

Path 3: Innovative SMEs with Digital Culture

Moving the discussion towards the third path, which also consists of SMEs, these companies, also have a propensity for innovation, however, they do not have autonomous business units and revenue streams allocated solely to services. However, what they do have is many digital solutions implemented that are higher than the average of the overall sample of organizations considered. These companies also look for partner collaborations.

The conditions that need to be met for advanced services to exist within firms according to our research can be summarized in the logical framework below:

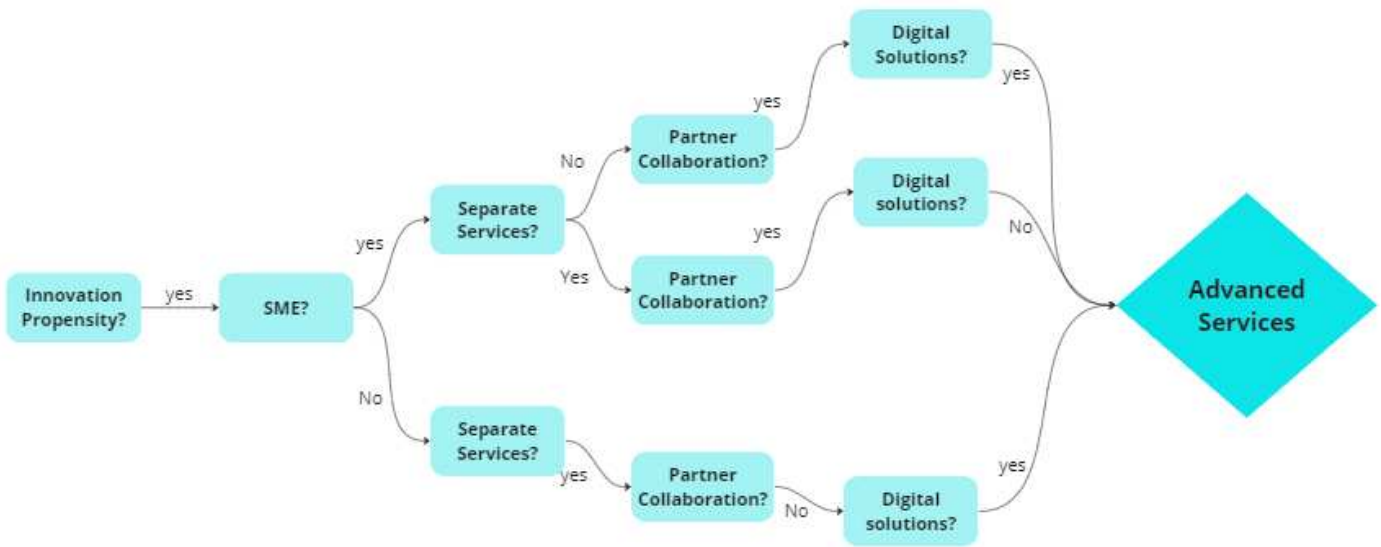


Fig 16: Logical framework for conditions supporting advanced services

Based on the theoretical research conducted in the first chapters, paired with the empirical framework developed above, we will be moving the discussion toward the propositions that can be developed.

First and foremost, innovation propensity is a necessary condition for the existence of advanced services, regardless of the other factors considered in our model. Meaning, that whether a company consists of an SME or a large company, or no matter what structures it possesses internally related to digital solutions, an innovative culture is necessary for a company to evolve in its service offerings.

To talk about the second proposition, a distinction that should be made is dependent the company consists of an SME or not. More specifically, highlights the fact that partner collaboration is a necessary factor for SMEs to develop advanced services, however, it is not the case for large companies. We can argue here that this is because these large companies possess the required resources internally to be self-reliant and develop digital solutions, as well as the necessary segregated service structures internally.

Finally, SMEs that lack either in their digital solutions or the existence of separate mechanisms related to businesses internally, can compensate by looking for external partnerships. This is in line with the discussions that were made in the second chapter of this research while tackling the topic of KIBS and the external ecosystem of developing firms in regions such as the ones that were the subject of our study.

Conclusion

In conclusion, based on the empirical findings we came across by applying the fsQCA model to our dataset of companies in the North of Italy, there are three different recipes that can lead to the adoption of advanced services within a firm undergoing the servitization journey towards more evolved services. These paths are summarized in the three statements below:

S1. *Innovative culture is a must for all firms looking to adopt advanced services.*

S2. *Large firms can develop their digital solution and service structures internally and do not find the need for partner collaborations in the development of advanced services.*

S3. *SMEs can compensate their deficit in either digital solutions or separate service structures by outsourcing these activities to outside partners they choose to collaborate with, while developing advanced services.*

In order to identify the ingredients for this recipe, a distinction should be made between SMEs and large firms. The main influence this distinction has is on whether an organization needs an external partner or not: SMEs do need an external partner to compensate for their lack of resources in a certain field, whereas it is better for a larger organization to develop these needs internally and stay clear of collaborations with outside partners. The existence of these SMEs, who are in need of providers of digital solutions to be used in parallel with their services or a more service-oriented view of their activities, creates the need for partner firms that can be considered in the category of knowledge-intensive business solutions (KIBS).

Moreover, we can confirm that regardless of the size of the company, the existence of an innovative propensity in general, and more specifically when it comes to creativity and primacy in adopting technological and digital solutions with respect to the peers in the environment they operate in, is a must regardless of the size of the company.

However, this distinction, as well as the innovative propensity with respect to others is a measure that is relative to the industry an organization operates in. For instance, we cannot deny the fact that some regions are more advanced in terms of digital solutions than others and are the first adopters of such technologies, the opposite can also be true. That is why, it is important to measure a variable such as innovation propensity, by taking into account the ecosystem surrounding a firm.

Appendix

Appendix A: Table summarizing the survey questions, their types, and the chosen variable names for the correlation analysis.

Question in English	Type	Variable Name
Number of employees	Multiple Choice	SMEs
Role of the person filling the survey	Open Question	N/A
How do you rate your company's innovative propensity (search for innovative/digital solutions to improve the business)?	Rate from 1 to 7	Innovation
Which of the following technological solutions (hardware-software) are used by your company?	Select among 10 options	Tech. Solutions
The hardware equipment is recent and complete	Rate from 1 to 7	Updated Hardware
The software equipment is updated and functional to the current and future needs of the business	Rate from 1 to 7	Updated Software
The digital culture is updated and widespread throughout the company	Rate from 1 to 7	Digital Culture
The organizational culture is modern and adapted to current and future challenges	Rate from 1 to 7	Modern Org. Culture
What is the current share of turnover relating to after-sales services (total after-sales also including field service and maintenance contracts)?	Open Question	N/A
There is an organizational unit (business unit, or group company) dedicated exclusively to services	Yes/No Question	Separated Service BU
This organizational unit is a revenue center (i.e. it has its own balance sheet/income statement)	Yes/No Question	Separated Service Revenue
How important is the services business to your strategy? [Today]	Rate from 1 to 7	Important Services Now
How important is the services business to your strategy? [In the next 3 years]	Rate from 1 to 7	Important Services ST
What types of services do you offer to your customers?	Multiple Choice	Level of Service Advancement
Do you offer your customers advanced services?	Yes/No Question	Advanced Services IB
Difficulty in finding a balance between the development of new skills related to customer needs and the innovation capabilities of the machines	Rate from 1 to 7	N/A
Difficulty in adapting our product culture to the service mentality	Rate from 1 to 7	N/A

Difficulty in balancing development resources internal and external to the organization	Rate from 1 to 7	N/A
Difficulty in reconciling the profit logic of the traditional machinery business with the growth of services	Rate from 1 to 7	N/A
What advanced services do you offer to your customers?	Multiple Choice	N/A
What year did you introduce your first advanced service contract?	Open Question	N/A
How many customers do you have for advanced services?	Open Question	N/A
Who sells advanced services?	Multiple Choice	N/A
What stage of evolution do you consider yourself to be at with respect to the development of advanced services?	Multiple Choice	N/A
Do you currently have digital solutions on offer for your installed base?	Yes/No Question	Offering Dig. Solutions
Reasons: Costs and times related to technologies and knowledge development]	Rate from 1 to 7	N/A
Reasons [Lack of digital culture and competence to manage and fully exploit digital solutions]	Rate from 1 to 7	N/A
Reasons [Difficulty in finding partners and external collaborations for development]	Rate from 1 to 7	N/A
Reasons [Difficulty selling the solution and making a profit from it]	Rate from 1 to 7	N/A
In what year did you start dedicating resources to the development of digital solutions?	Open Question	N/A
What services are your digital solutions connected to?	Multiple Choice	Basic Services Intermediate Services Advanced Services
Which of the following digital solutions do you offer to your customers?	Select among 10 options	Numb. Dig. Solutions
Who deals with the sale of digital solutions?	Multiple Choice	N/A
How many of your customers currently use digital solutions	Open Question	N/A
Benefits [These are requested by our end customers]	Rate from 1 to 7	N/A
Benefits [Competition pushes us to include them to keep up]	Rate from 1 to 7	N/A
Benefits [These are opportunities to differentiate the product and support its price]	Rate from 1 to 7	N/A
Benefits [These are opportunities to increase sales of basic services (e.g. spare parts and assistance)]	Rate from 1 to 7	N/A
Benefits [These are opportunities to reduce costs by analyzing installed base data]	Rate from 1 to 7	N/A

Benefits [These are opportunities to improve product design thanks to the analysis of installed base data]	Rate from 1 to 7	N/A
Benefits [These are opportunities to develop advanced services (contracts based on performance or use)]	Rate from 1 to 7	N/A
Benefits [Costs related to technologies and development]	Rate from 1 to 7	N/A
Obstacles [Development and implementation times]	Rate from 1 to 7	N/A
Obstacles [Development and maintenance skills shortage]	Rate from 1 to 7	N/A
Obstacles [Difficulty in selling the solution (our market is not very sensitive to the use of solutions)]	Rate from 1 to 7	N/A
Obstacles [Lack of collaboration (e.g. assistance, training) from the company providing the digital solution]	Rate from 1 to 7	N/A
Obstacles [Difficulty accessing installed base data (customer does not connect or does not want to share data)]	Rate from 1 to 7	N/A
How are digital solutions priced?	Multiple Choice	N/A
In your company, which department is mainly responsible for proposing, developing, and implementing (also with external collaborations) digital solutions?	Multiple Choice	N/A
Would you be willing to collaborate with an external partner, equipped with the appropriate knowledge and tools, who can offer you support for the development of digital solutions?	Multiple Choice	Willingness to partner
Partner Choice Criteria [Value for money]	Rate from 1 to 7	Partner: quality/price
Partner Choice Criteria [Speed of realization]	Rate from 1 to 7	Partner: speed
Partner Choice Criteria [Appropriate support during development and following implementation of the digital solution]	Rate from 1 to 7	Partner: Support
Partner Choice Criteria [Post-implementation training and consultancy of the solution]	Rate from 1 to 7	Partner: Consulting
What is the overall budget of the digital solutions development project in your company?	Open Question	N/A
In terms of budget, how much would your company be willing to invest in creating one or more of the digital solutions mentioned?	Open Question	N/A
What time limit do you think is appropriate for the development of a digital solution for your company?	Open Question	N/A

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