DIGITAL TECHNOLOGIES AND THEIR IMPACTS ON SERVITIZATION STRATEGIES

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Marco Ardolino, Nicola Saccani, Paolo Gaiardelli & Mario Rapaccini

ABSTRACT
Purpose: The aim of the paper is to understand the role of digital technologies in the journey towards servitization of manufacturing firms. In particular, the paper addresses the following research questions: 1) which capabilities, among those enabled by the advent of digital technologies (hereafter, digital capabilities), are crucial to deliver product-service solutions? 2) how the advent of digital technologies such as IoT, cloud computing, predictive analytics, can affect and influence the servitization strategies of manufacturing firms?
Design/Methodology/Approach: A literature review has been carried out in order to identify the capabilities enabled by digital technologies of interest of this paper, namely: IoT, cloud computing and predictive analytics. How these capabilities are linked to servitization strategies have been defined thanks to conceptual reasoning and authors' experience from manifold collaborations with manufacturing companies undergoing servitization.
Findings: Eleven digital capabilities have been identified with their importance in enabling servitization strategies and provisioning different product-service solutions.
Originality/Value: This paper tries to fill the gap concerning the inadequate knowledge about the role of digital technologies in enabling the shift to service business of manufacturers.

KEYWORDS: Servitization, Digital technologies, Digital competences, Service-oriented strategy, Digital capabilities

1. INTRODUCTION

Scientific literature has debated broadly about the servitization of manufacturing firms (Oliva and Kallenberg 2003, Neely 2008, Baines et al. 2009). Digital technologies are described as a crucial aspect to help companies in the journey towards service-based business (Neu and Brown, 2005) For instance, Ulaga and Reinartz (2011) state that companies should leverage ICTs to collect, analyse and interpret field data from the installed base. However, Lightfoot et al. (2013) claim that still exists "a inadequate awareness of the usage of ICTs that are enabling firms to deliver sophisticated product-centric service offerings". In fact most contributions tell few words about how digital technologies can favour the shift towards a service-based business, and neglects how the advent of disruptive technologies can influence such a journey. In this paper we consider that the role of digital technologies strictly depends on the strategy companies adopt to servitize (Kowalkowski et al. 2015, Paiola et al. 2013). The paper addresses the following research questions: 1) which capabilities (enabled by digital technologies) are relevant in product-centric companies for the shift to service-based business? 2) what are the linkages among these capabilities and the different strategic profiles of servitization? Hereafter, the term capability takes the meaning of the "firm's capacity to deploy resources for a desired end result" (Helfat and Lieberman 2002), while digital capabilities is used to refer to resources that are made available, created and produced by digital technologies.

The rest of the paper is organised as follows: Section 2 introduces the main results of the literature review. In section 3 the frameworks is presented, while Section 4 discusses the results, draws conclusions and points out limitations and avenues of future research

2. LITERATURE REVIEW

To achieve a thorough understanding of the topics of our interest, in the next sub sections we present the results of the literature review (including the methodology adopted), giving an overview of the relevant findings on: 1) digital technologies that enable servitization and 2) strategic profiles of servitization.

2.1 Methodology

We reviewed systematically the scientific literature without time limitation (Denyer and Tranfield 2009). We searched for relevant contributions on ScienceDirect, Scopus, EBSCO, Emerald, Ingenta Connect, Sage, Tandf and Springer that contain either in their title, abstract or full text terms referring to technology-driven servitization of manufacturing companies. To assure that any studies pertaining to the investigated topics were included even if their authors employed ambiguous terminologies, we used manifold keywords such as "servitization", "service business orientation", "service infusion", "product-service system", "integrated solution", "hybrid solution", "product service offering", "integrated offering". These keywords were used in combination with words pointing out the role of new technologies, such as "digital technology", "ICT", "information system", "condition monitoring", "big data", "health management systems", "teleservice", "smart services", "technology innovation". In the next sub sections we give an overview of the relevant findings

2.2 Digital technologies for servitization

Digital technologies are radically changing the way services are offered. Indeed, it is hard to deal with service innovation without considering technology (Ostrom et al. 2010), as "the service revolution and the information revolution are two sides of the same coin (Rust et al. 2004). In their shift to a service business, manufacturers introduce digital technologies to increase the efficiency of logistics support (Dekker et al. 2013), service delivery (Kowalkowski et al. 2008), as well as to raise the value of their offerings (Geum et al. 2011) rather than to differentiate it (Belvedere et al. 2013, Kowalkowski et al. 2009). Moreover, there is consensus that a certain kind of digital technologies, such as contact-centres and CRMs, are crucial to deliver customer services and customer support in a more efficient way (Storbacka 2011, Kowalkowski et al. 2014). Another example are mobile technologies that are able to digitize field service delivery processes, save resources, reduce paperwork and errors. Technology infusion in services is also expected to increase self-service (i.e. "Do it yourself") and super-service (i.e. "I do it for you") options (Campbell et al. 2011). Another stream of research focuses on those technologies that introduce awareness and connectivity on products, to support the provision of advanced services (Baines and Lightfoot 2013). Internet of Things enable the diffusion of connected products (Fano and Gershman 2002, Lyytinen and Yoo 2002). In addition, cloud computing and smartphones applications enable always-on anytime/everywhere channels, through which customers can demand for and receive digital services (Fano and Gershman 2002). As far as billions of field data are collected, on the one hand, manufacturers are expected to gain manifold insights about new business opportunities (Porter and Heppelmann 2014). On the other hand firms can make a big deal of money exploiting these data (Rijsdijk et al. 2007). In this way manufacturers are able to provide predictive analytics, predictive maintenance and condition monitoring services as standard dotation of industrial equipment (Grubic et al. 2011). Although previous studies show consensus on the relevance of digital technologies in the journey toward service business, a comprehensive view is still missing. In particular, it is not clear how technological improvements are central to develop key capabilities for business and service innovation (Akaka and Vargo 2014). To overcome this gap, this paper identifies which capabilities are introduced by the following innovations: 1) Internet of Things; 2) cloud computing; 3) predictive analytics. In the following, we provide a brief definition of each innovation.

- The term Internet of Things (hereafter, IoT) is frequently used to envision the Internet of the future, i.e. a network of billions of heterogeneously connected and communicating devices ('things'). Scientists claim that this network will extend the limits of the physical world, due to the possibility of empowering each connected thing with new capabilities, digital contents and virtual

- components. In this paper, IoT mostly includes sensing and connectivity technologies that enable manufacturers to gather and collect field data from their installed bases (Ulaga and Reinartz 2011).
- Cloud computing includes a bunch of technologies, services and applications that allow to seamlessly store, combine and share over the internet big amount of data in a very cost effective way, as it allows massive-scale complex computing without the need of installing expensive HW/SW infrastructure.
- Predictive analytics is based on techniques such as fuzzy logics, neural networks, evolutionary algorithms, machine learning, probabilistic reasoning, that are used to analyse field data, identify causal relationships among variables, generate reasoning and decision models. In this paper we use this term to identify those technology-enabled capabilities that are used to make diagnoses, predict behaviour, respond and adapt - even autonomously - to external *stimuli* (Porter and Heppelmann 2014), and to determine appropriate interventions (Lightfoot et al 2013).

Figure 1 depicts the structure of technological innovations considered in this paper, along with their basic functions.

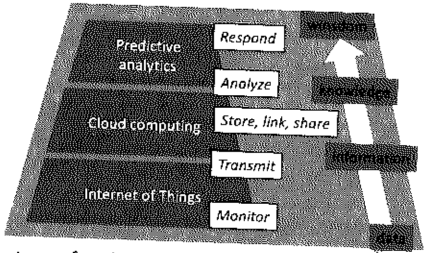

Figure 1: Structure of technological innovations considered in the paper

2.3. Servitization strategic profiles

The term "servitization" was introduced to describe the inclination of firms, which had previously been known strictly as manufacturers, to introduce Product-Service Solutions (PSSs), blending the traditional product offering with innovative services, to provide more value to the customer (Neely 2008, Baines et al. 2009). Many scholars have explored the importance of implementing integrated product-service offerings, considering them as a powerful source of competitive advantage (Lay et al. 2010) and different models have been proposed to illustrate how the change of product-service offering translates into differing levels of service sophistication (Lightfoot et al, 2013; Oliva and Kallenberg 2008). A common rationale described in literature, considers such a transformation as a continuum from pure-product to pure-service providers (Chase 1981). Essentially, the service transition concept assumes that companies moving along this continuum undertake a unidirectional repositioning (Tukker 2004). For instance, the model introduced by Lightfoot et al. (2013) distinguished service transformation along with three types of propositions, differing on the base of who is responsible for deciding when and why services should be provided. However, as argued by Kowalkowski et al. (2015) the established assumption underlying the service transition is problematic, since "servitization is more multifaceted and multidirectional than literature assumes". Therefore, the traditional product-service dichotomy is rejected because companies are used to combine different strategies and offerings, undertaking multiple positions along the continuum at the same time. On these premises, the trajectories proposed by the authors - i.e. moving from equipment supplier to availability or performance provider – can be viewed both as adequate transformations for service growth. Indeed, while in the second strategic profile the manufacturer bundles its core product with digital services to enhance the product accessibility and availability, becoming a performance provider requires to develop advanced services to assure that customere achieve the desired outcomes.

3. A conceptual framework to link digital technologies and strategic profiles

This section is grounded upon the literature review carried out in the previous sections and the conceptual elaboration of the authors, to develop the conceptual framework of this research. The objective is to investigate how technologies enable digital capabilities that are relevant in each strategic profile (Kowalkowski et al. 2015). The relationships among the technologies, the strategic profiles and the capabilities are depicted in the conceptual framework proposed in Figure 2. According to the literature review and to the authors' experience, hereafter we refer to eleven digital capabilities that have been identified as relevant for this study.

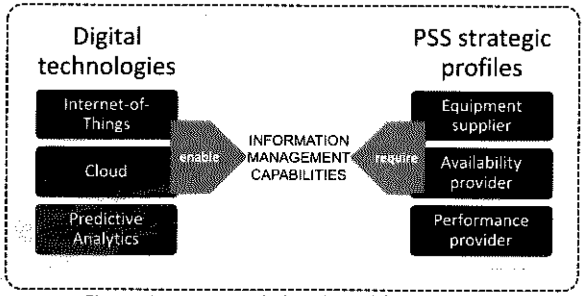

Figure 2: Framework developed for the study

Table 1 shows the digital capabilities and provides a detailed description of each capabilities, along with some examples coming from publicly available information as well as service innovation presentations that have been given in the last years at the ASAP Service Management Forum workshops (see Acknoledgements).

Table 1: Digital capabilities considered in this study

Capabilities	Description	Related question	Example
Identification (user)	Identification of the specific user of a product in each specific usage instance	Who is using the product in a specific time instance and/or usage instance?	Car2Go car sharing services: each customer has its unique personal ID to access to the service.
Identification (product)	Identification of the specific product (e.g. serial number) and its specific Bill-of-Materials	Which specific product instance and product configuration is under consideration?	Manifold consumer products and industrial equipment are identified through P/N or serial number. Records of maintenance interventions, substitutions of parts and fix & repair activities are stored in central database.
Geo-localisation	Association of a specific location to each product and usage or time instance	Where is the product located (in a specific time / usage instance)?	Connected drive" services from BMW: each car that needs repair services can be located on a map due to GPS technology
Timing assessment	Association of a certified timing (end, finish, duration) to each usage instance	When / for how long the product has been used (in a specific usage instance)? At what time a specific condition datum has been collected?	In short term rental services, time stamping is crucial for billing services to customers
Intensity assessment	Measure of the amount of usage of the product (e.g. how much time, km). It is related to the measurement unit used to	How much that product (or a specific part) has been used (overall or in a specific usage instance)?	Daily or weekly, multifunction connected printers send to remote platforms data and information about b/w and color

	determine the intensity of amount of usage of a product		copies, in order to enable pay-per-use invoicing.
Condition monitoring	Continuous monitoring of the state of relevant product parameters (e.g. pressure, temperature, speed)	How is the product (or a specific part) working? What are its working conditions?	GE Oil & Gas turbines under Contractual Service Agreements are continuously monitored to detect anomalies and incipient faults
Usage monitoring	Association of each usage instance to a specific mission or task	Why or What for is the product (or a specific part) used?	In the example above, customers receive notification if they are using their equipment unconventionally, and maintenance plans vary accordingly.
Prediction	Analysis and interpretation of condition (and usage) patterns, in order to predict the future condition of critical parameters	What then? What a specific product (or part, or parameter) condition will lead to?	Ferrari Racing Team developed sophisticated prediction models to estimate the life duration of critical engine components from field data
Adaptive (remote) control	It allows acting directly on the product parameters based on the Condition Monitoring and/or Prediction capabilities described above	How can the issue be solved or the user experience improved?	Depending on the alerts s/he receives, remote operators can make different actions on BMW connected drive cars, at least urge the driver to stop the car due to safety reasons.
Optimization	The usage of the information collected and analysed (both real-time or on historical data) to improve product efficiency	How things can be done better?	The functioning of an array of Kone elevators can be instantaneously adjusted from the remote surveillance center, to inhibit people access to certain area for security reasons.
Autonomy	Autonomous management of certain functions and connections with other product and systems performed by the product itself	How can the product do it by itself	Google Nest Thermostat automatically adapts as people habits and weather/ seasons change. It is sufficient to use it for a while, as it learns and programs itself.

Table 2 graphically summarizes the relative importance of each technology in enabling the corresponding digital capability. We postulate that IoT is important for most of the capabilities identified in this paper, due to the fact that any other capabilities is grounded on data collected by sensors, as well as on the possibility of controlling the product by remote - through actuators. More specifically, we think that IoT has a crucial role for enabling adaptive (remote) control and autonomy features. In fact, on one hand connected products can continuously send and receive data, thus enabling service providers to remote and control its installed base remotely. Adaptation and autonomy are built upon IoT as well, as different products, devices and machines can communicate on the internet and "collaborate" to reach common objectives. Prediction and optimization are developed from data collected with IoT technologies, as far as predictive algorithms and soft computing techniques are applied to these data. Last, the role of cloud technology is essential to store huge amount of field data. In fact, cloud platforms are state-of-the-art technologies for continuously monitoring the conditions and the intensity of use of large installed base, as well as to manage and share information about customers, profiled users, product versions, etc.

Table 2: How high level technologies enable digital capabilities (++ = very important; + = important)

Capabilities	IoT	Cloud	Predictive analytics
Identification (user)	+	+	
Identification (product)	+	+	
Geo-localisation	+		
Timing assessment	+		
Intensity assessment	+	++	
Condition monitoring	+	++	
Usage monitoring	+	++	
Prediction			++
Adaptive (remote) control	++		+
Optimization			++
Autonomy	++		+

Table 3 provides the impacts of the capabilities identified in this paper for the different strategic profiles.

Table 3: Impacts of digital capabilities in different servitization strategic profiles

Capabilities	Equipment supplier	Availability provider	Performance provider
Identification (user)	Not particularly relevant	Useful for pay-per-use or access-based contractual scheme. Also important for fleet management issues to identify the responsible of the actions on the product.	It is an enabler of more advance capabilities (personalized analytics, optimization, ...)
Identification (product)	Enables a correct warranty management activity (it allows retrieving the warranty status of the product/part).	Same as "equipment supplier" and important particularly fleet management	Same as "availability provider" with the potentiality to enable the correct measure of actual performance against performance targets or agreed SLAs on single products
Geo-localisation	May enable a correct warranty management activity (for no-moving products)	Important for moving products, in particular for granting access to the product (e.g. car-sharing services) and for a correct maintenance contract management activity	May be useful for the identification of responsibilities for misuse (depending on the kind of product)
Timing assessment	Static information needed to trace purchase and end of warranty date, for warranty management activity	It is/may be required for activating a transaction and for pricing/billing purposes and correct maintenance contract management activity	Relevant to associate other information to a moment in time, to enable real time monitoring and/or historical data analysis
Intensity assessment	Not particularly relevant	Measuring the intensity of product usage in a specific instance (e.g. distance covered by a car; printed pages by a printer, minutes of call or data downloaded with a smartphone), ...	Same as Availability provider. Moreover, it allows measuring actual performance of the product/component and comparing it to targets (e.g. target vs. actual MTTF; target vs actual production rate).
Condition monitoring	Not particularly relevant	Important for pay-x-use contracts in order to maximize	It is fundamental to monitoring parameters when

		revenues for the manufacturer (the more the product is working, the more the product is used)	they are related to the achievement of the result promised in the company's offerings (target performance)
Usage monitoring	Equipment supplier: Not particularly relevant	It may be useful to understand the causes of problem in case of a fleet management contract	It supports the identification of the best (customized) solution to achieve customer objectives. It supports also the development of new standard services to support customers achieving their specific objectives
Prediction	Not particularly relevant	It is important for particular contracts related to fleet management and predictive maintenance	It is strategic for the manufacturer to predict likely problems on the product in order to respect the terms of contract (e.g. to respect SLA)
Adaptive (remote) control	Not particularly relevant	It enables maintenance contract management	Embedding or enabling real time intervention on the product in case of issues support the achievement of the agreed performance levels
Optimization	Not particularly relevant	Not particularly relevant	It supports the achievement of the performance targets
Autonomy	Not particularly relevant	Not particularly relevant	Depending on the kind of product, autonomy may be an important capabilities to respect terms of contracts and guarantee the performance

Table 4 tries to summarize the extent to which each capability has an impact on each strategic profiles for servitization.

Table 4: How digital capabilities impacts on each strategic profiles (++ = very important; + = important; (+) = important based on the industry)

Capabilities	Equipment supplier	Availability provider	Performance provider
Identification (user)		++	+
Identification (product)	+	++	++
Geo-localisation	(+)	+	(+)
Timing assessment	(+)	++	+
Intensity assessment		++	+
Condition monitoring		(+)	++
Usage monitoring			+
Prediction		(+)	++
Adaptive (remote) control		(+)	++
Optimization		+	++
Autonomy		(+)	(+)

4. Conclusions, limitations and further developments

In recent years several companies have moved towards a more service-oriented strategy, through the adoption of different strategic profiles, to face the increasing global competition (Neely, 2008; Tukker,

2004). The adoption of digital technologies has been recognized a key enabler of a servitization journey (Almendinger and Lombreglia 2005, Antioco et al. 2008, Belvedere et al. 2013, Kowalkowski et al. 2008, Lightfoot et al. 2013, Porter and Heppelmann 2014). Despite many contributions in literature have argued about digital technologies in the development of an integrated product-service strategy, the impacts of each technology is under-investigated (Akaka and Vargo 2014). This paper provides eleven key capabilities enabled by high level technologies such as IoT, cloud and predictive analytics. Concerning the servitization trajectories, we adopted the profiles identified by Kowalkowski et al. (2015), namely: equipment supplier, availability and performance provider. In previous sections, based on a literature review carried out on the topics of digital technologies and servitization strategies, we have described: 1) the impacts and the importance of each digital technology in the enablement of eleven key capabilities; 2) the likely effect of each capability for the development of a specific profile. As with any research, our study is not without limitations as the framework developed, in particular the relationships between the technologies and the strategic profiles, has not been validated by the application on real business cases. For this reason, considering future research trends, we are going to apply the presented framework on three particular business case studies in order to refine and validate both the capabilities identified and their relationships with the digital technologies and the different strategic profiles.

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BARRIERS TO CAPTURING THE VALUE OF ADVANCED SERVICES AND DIGITISATION IN THE ROAD TRANSPORT INDUSTRY

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ABSTRACT

Purpose: Servitization and digitization together provide significant opportunities to raise the performance and profitability of the road transport industry. To date these opportunities are only sparsely captured and the potential economic, social and environmental value is forgone. We set out to investigate the barriers to capturing the value of servitization and digitization in the road transport industry.

Design/Methodology/Approach: The road transport industry is conceptualized as an emerging business network of increasingly interdependent organizations. We first draw on Individual interviews to confirm the applicability of a network perspective before conducting an interaction-centred focus group to identify and prioritize the main barriers to value capture as a shared industry construct.

Findings: Four overarching barriers to value capture emerged: an inhibiting culture, the lack of available resources, lack of standards and the value uncertainty. The barriers are discussed together with their specific manifestations for the road transport industry.

Originality/Value: This study serves as a starting point for a longitudinal investigation into the role of servitization and digitization in the emergence of business networks and the approaches to overcoming the barriers to value capture. Implications for the literature on servitization, digital strategy and business network theory are discussed.

KEYWORDS: Servitization, advanced services, internet of things, business network

1. INTRODUCTION

In today's tightly interwoven economy changes to a firm's operational practice or business model are rarely discrete. The implications of organisational change cannot be fully grasped without considering the business network in which the organisation is embedded (Håkansson and Snehota 1989). A business network perspective adds an important theoretical lens to the investigation of the phenomena of *servitization* and *digitisation* which is referenced as a core enabler of servitization (Grubic 2014).

An important motivation for servitization and digitisation is the promise of shared value for service provider and service user (Gebauer and Friedli 2005). However, the literature on servitization is predominantly focused on individual organisations with only few studies exploring the implications from an inter-organizational perspective. Similarly, only few studies explore the implications an increased digitisation has on the wider network.

We adopt a business network perspective to investigate the barriers to capturing the value opportunities servitization and digitization provide. We focus on the road transport industry where, over the last years, new service models and digital innovation has created substantial opportunities for performance benefits although the benefits are not widely captured.

The study is based on a two-stage research process which first focused on individual stakeholders to confirm the applicability of a network perspective before focusing on the shared difficulties of capturing the benefits from these innovations. Our study contributes to an integration between the theories of servitization, digital business and business network and provides insights on the practical challenges these innovations create.