DIGITALLY-ENABLED ADVANCED SERVICES:
MANAGING THE JOURNEY FROM DATA TO VALUE

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ABSTRACT

Purpose: this paper proposes a novel model to describe how data collected from smart connected products(SCP) should be managed to generate customer value through digitally-enabled advanced services (DEAS).

Design/Methodology/Approach: literature integrative review and action research

Findings: there are connections between the configuration of the service system designed to deliver DEAS, and the value (net benefits in terms of efficiency, efficacy and focus) that different customers expect.

Originality/Value: the integration of literature on SCP, smart PSS, service science and sdl facilitates the understanding of mechanisms through which DEAS create customer value.

KEYWORDS:

1. INTRODUCTION

An increasing number of manufacturing firms differentiate their offerings, combining products and services to offer product-service systems (PSS) (Baines et al. 2007). As far as competition becomes fiercer this is no more sufficient and product-service offerings are additionally integrated with digital products (e.g. utilities, platforms, software applications, etc.) and smart services (e.g. condition monitoring, notification, diagnostic, analytical reports, etc.) (Gebauer et al. 2020). Core to this smart product-service systems (smart PSS) (Pirola et al. 2020) are Cloud Computing, IoT technologies and Predictive Analytics (Ardolino et al, 2018). These technologies are core to the concept of smart connected products (SCP) (Allmendinger and Lombreglia 2005, Porter and Heppelman 2014), and open rooms for data exploitation strategies in manufacturing companies (Opresnik and Taisch 2015). This is an emergent and underexplored topic (Zambetti et al. 2021). To fill this gap, this paper proposes a model that describe how data generate insights that are valuable for the customer business. In particular, we focus on different kinds of digitally-enabled advanced services (DEAS). This study integrates many domains of scientific literature such as servitization and digital servitization (Paschou et al. 2020), smart PSS (Pirola et al. 2020), service science (Maglio and Spohrer 2008), service dominant logic (Vargo and Lusch 2004). The paper is organized as follows: section 2 briefly presents the background and discuss the nature of customer value from DEAS; section 3 provides the conceptual model that is then applied in a global company operating in the printing sector through an action research presented in section 4. Finally, Section 5 draws some considerations about the research implications, its limits and future avenues.

2. BACKGROUNDS

2.1 Convergence of the literature on SCP and smart PSS.

Some studies (Allmendinger and Lombreglia 2005, Meyer et al. 2009) shed lights on how manufacturing firms can innovate their business models through SCP. Basically, SCP enable the collection of field data (e.g. operations, productivity, process and equipment conditions, health, faults, diagnostics) from a distributed sensor network, elaborate and exchange these data with external systems such as cloud platforms and remote control rooms (McFarlane et al. 2003). Data can be thus used for remote monitoring, control, and optimization of products and processes. Basically, field data constitutes a gold mine for the manufacturers, that can obtain new knowledge and insights about the needs of their customers. Finally, these knowledge is used to develop sophisticated algorithms and artificial intelligence, that can be embedded into products and industrial equipment (Porter and Hepplemann 2014). This latter is the case, for instance, of autonomous/unmanned vehicles, collaborative robots, and industrial cyber-physical systems (CPS) (Wiesner et al., 2016; Schneider 2018). It is not surprising that global manufacturers are greatly interested to the business opportunities that are disclosed by the advances of digital breakthrough such as sensing technologies, 5G connectivity, software automation and data analytics (Zheng et al., 2020). And this pushes more and more the scientific community doing research on SCP to focus on both technological enhancement and business innovation. The point, in fact, is to understand how value can be created transforming raw data into information, knowledge and insights. These insights fuel a plethora of smart services (hereafter, digitally-enabled advanced services, DEAS), that are then finalised to prevent customers problems or proactively respond to their needs (Oztemel and Gursev, 2020). Therefore, this research well intersects with the literature on smart PSS (Pirola et al. 2020) and digital servitization (Paschou et al. 2018), to form indistinguishable strands of this vast literature domain (Chiu et al. 2021). This is nothing new: since a decade scholars have explored how digital breakthroughs can enable new ways for creating values with digital/smart services in industrial contexts (Rymaszewska et al. 2017, Ardolino et al. 2018, Grubic 2018, Vendrell-Herrero et al. 2017, Evans and Annunziata 2012, Parida et al. 2014, Valencia et al. 2015, Watanabe et al. 2020). Common ground of this literature is exploring how data can reduce the uncertainty that affects the decision making process (Rowley, 2007), and therefore deliver different kinds of benefits to the customer process. This is discussed in the next section.

2.2 Creating customer value with DEAS.

Service science states that value is co-created as far as the entities/counterparts of a service system purposefully and mutually interact, to share/integrate their own resources and competences, in order to reach common goals (Spohrer and Maglio 2010). This is in line with the premises of service dominant-logic (sdl) (Vargo and Lusch 2004). Sdl in fact assumes that value is co-created by means of resource integration, through 'the application of specialized competences (knowledge and skills), […] for the benefit of another entity or the entity itself' (Lusch et al. 2010, p. 15). Interactions can be either direct (among two or more operant resources/entities) or indirect (among one operant resource/entity and other operand resources/entities) (Campbell et al. 2011). In the digital world, both direct and indirect interactions may occur remotely. This has greatly enlarged the opportunities for self- and super-services (Campbell et al. 2011). However, digital collaboration platforms and meeting solutions have also enabled high-touch (i.e. people-to-people) interactions, that provide valuable (digital) experiences, in a way that is more efficient than in the past - since it is not required to convene in the same place for the customer (e.g. a patient) and the provider (e.g. its doctor) (Wünderlich et al. 2013, Sampson and Chase 2020). Finding the trade-off between the different options (i.e. machine-to-machine, human-to-machine, and human-to-human) for value co-creation in service system is of paramount importance (Lim and Maglio 2019). This paper explores how DEAS can deliver data-driven value in the customer context. The nature of benefits created by product-service offering in business contexts is manifold (Kowalkowsky and Ulaga 2017, Rapaccini and Visintin 2015). In line with the reviewed literature (Campbell et al. 2011), we assume that in most cases DEAS do not bring any new capabilities (so, they cannot be considered advanced services), but just produce some performance increases (e.g. recovery time, availability, productivity, quality) (Smith et al. 2012),. These improvements can have an impact on the business process in terms of efficiency (e.g. time and resource savings) and/or efficacy (e.g. better quality, higher volumes and productivity). Conversely, in other cases DEAS bring data science capabilities that are totally new for the customer's organization. In addition to improving some operational performance, in this situation there are also strategic gains (*focus*). This is better described in Table 1.

Table 1: Value dimensions from DEAS

Dimension	**Description.**

Efficiency	DEAS bring lower consumption of resources (input), that translates in cost savings. In other words, DEAS reduce the risk of producing the expected outcome in less efficient ways.
Efficacy	DEAS deliver outputs of higher quality and/or quantity. In other words, DEAS reduce the risk of either not reaching the expected outcome, or getting not satisfying outcomes.
Focus	These are situations in which alternatives to DEAS cannot be easily procured/implemented. DEAS provide therefore new capabilities (e.g. developing data-driven models through advanced statistics, simulation tools or machine learning algorithms) that allow the customer keeping its focus on core processes. In other words, DEAS reduce the risk of having to run a portion of the business without the required skills and/or resources.

3. CONCEPTUALIZING VALUE CREATION WITH DEAS

This section presents a model that explains how value is created with the DEAS included in a SCP/smart PSS offering. We elaborate further the model proposed by Lim et al. (2018), to show the journey of data in a DEAS process. In particular, we refer to the three phases depicted in Figure 1.

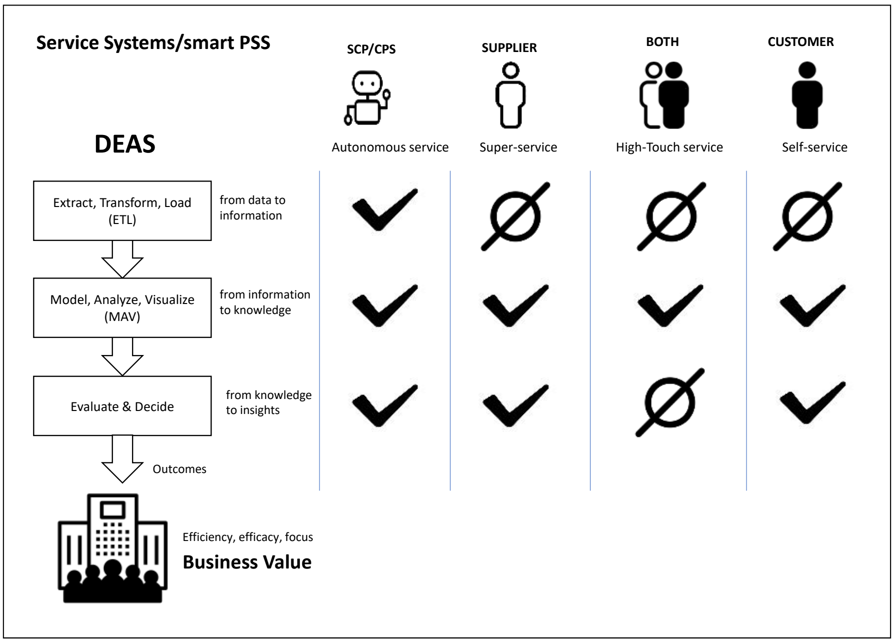

Figure 1: The data journey of DEAS based on SCP/smart PSS

The first stage of the data journey shown in Figure 1 concerns data collection from SCP, data elaboration/logging, data transfer (via internet/mobile network connectivity), data storage (in cloud platforms). This stage is usually fully automated by the spreading of SCP, cloud/industrial internet platform, low-cost connectivity, and cybersecurity. The second stage includes the intellectual activities put in place by professionals such as data scientists, business analysts, field service or maintenance engineers. In some cases, these tasks are under the responsibility of the provider (super-service), in other are performed by the customer in either isolation (self-service mode) or collaboration (high-touch service) with the provider specialists. The last phase depicts who is responsible of evaluating the impact of the data-driven decisions, making scenario analysis, comparing options and putting in place the corresponding actions (e.g. shipping a spare parts, doing a field intervention). While it is well known that at each stage DEAS can be delivered through different options/configurations (e.g. self-, super-, high-touch), for each configuration this paper explains the corresponding value proposition of the offered smart PSS. The next section sheds lights on our argument, recurring to the findings from an action research project.

4. FINDINGS FROM AN ACTION RESERCH

We have been involved in an action research project, in collaboration with researcher from the ASAP community, the University of Lucern, and the Italian subsidiary of Ricoh, the multinational manufacturer of office and production printers. We collaborated with the service department of Ricoh, whose managers were interested in exploiting the huge amount of data collected from the large fleet of connected printers (+50k in Italy), in order to improve the quality of the offered services, and eventually develop new DEAS (Table 2). Most of the installed base is serviced by a partner network, but there is also a good amount of connected printers of important customers (i.e. large accounts). These latter are assisted directly by the Ricoh service centres, spread on the territory. We have been involved in analysing and restructuring the procedure of the toners ordering system. This is particularly relevant in this business, since the cost of consumables accounts for some millions of Euros per year, within the pay-per-page commercial formulas through which this type of machines are offered by both direct and indirect sales channels.

Table 2: Summary of the context of the action research

Dimension	**Description.**
Unit of analysis	The service system configurations (e.g. options for value creation: autonomy, self-, high-touch, and self-service) in different contexts. Focus on the business propositions, and on the dimensions of customer value.
Smart PSS	Combination of printing equipment and traditional services (e.g. maintenance & spare parts, consumables), offered in the form of pay-per-page commercial formulas (all inclusive, fixed subscription (*annuity*) plus variable revenues on the base of the printed volumes). The printing equipment is connected to a cloud platform. Data collected from the connected fleet shows the operating condition/productivity of each printers, its problems/faults (datalogger of printer jams and major problems), alerts,
DEAS	Focus on the DEAS offered to different actors to reduce risks and uncertainties that affect business decisions and prevent printers stoppages. In particular, we have studied (and supported the improvement) through which data are collected, elaborated, and used to feed simple or sophisticated models, in order to visualize the machine states, receive notification, predict the best time for toner replacement or to deliver a maintenance intervention. These information are given in different cases to customers, service network, internal SOC (Service Operators Call-center).

As said, the collaboration was carried out by a multidisciplinary team of service design experts and data scientists from universities, and different professionals of the Ricoh organisation, from different department such as IT, service, logistic operations. Every week, the team had regular meetings to collect feedbacks and discuss about the research progress. Notes and follow-ups were systematically shared in order to validate the insights of this research. We had the opportunities of understanding how toners, field maintenance, fix and repair interventions and spare parts were managed for different kinds of applications, industrial sectors and customer needs. In particular, the toner validation procedure is blueprinted in Figure 2.

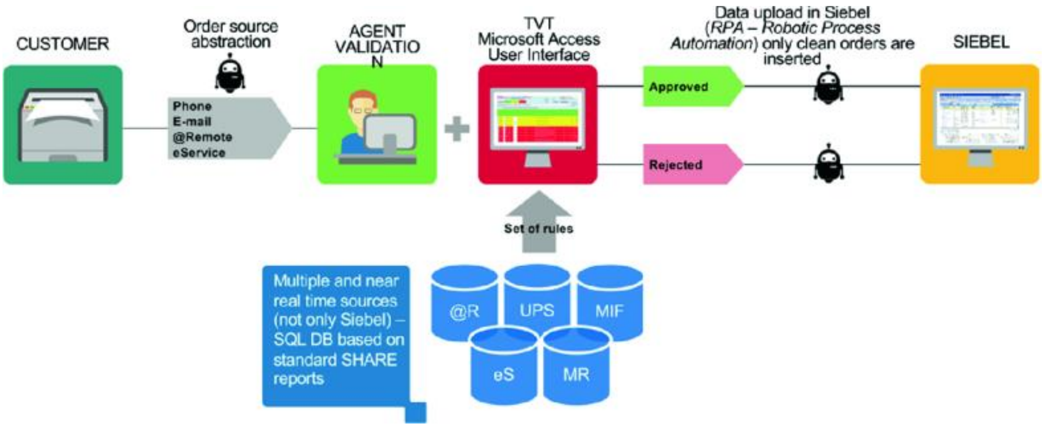

Figure 2: The data journey of the toner-request validation service [Stoll et al. 2020]

The described context is representative of a servitized manufacturer, that offer pay-per-use full-service contracts, including traditional (e.g. fix & repair, preventive maintenance) and digital (e.g. monitoring) services. Its service system has been designed to ensure that the interactions between the different players involved (e.g. service operation centre, product specialist, direct field force, network of service partners, customers) could take place in the most efficient and effective way. However, the product and service offering built on the rental of a printing equipment has many of the combinations shown in Figure 1. This allowed us to understand the linkages between the value expected by the different customer contexts, and the corresponding DEAS configurations. In particular, we noted the following configurations:

a) In some contexts, the process is fully automated. All products are connected, and collect and transfer daily their data log to an external cloud platform. These data concerns the amount and type of printed pages, the occurrence of machine faults and paper jams, the output of diagnostic routines, etc. through which the good functioning of each component can be analysed. Some of these data feed algorithmic models, even simple ones (e.g. *rule-based*) that automatically activate specific service workflows (e.g. shipping to the customer facility a toner for replacement, sending notification for a field repair to a field service technician of the service station). Human intervention in any of the DEAS phases of Figure 1 is very limited, if not completely absent. The characteristics of the business contexts that are served by these DEAS/smart PSS are as follows: customers are basically large organizations (*large accounts*) with plenty of resources in their IT or Facility Management service departments. They can therefore appoint some of their skilled personnel to oversee the correctness of the printing process. These can be trained about simple procedures for starting or setting up a service request. In other terms, they can be the organisational interface for help desk and field technicians, and they can do as well some simple tasks (e.g. replacement of a toner) in self-solve. Typically, these customers have large number of printers, and their printing/document management activities absorb a significant amount of resources and dedicated budgets. We are talking, for instance, of firms in financial and insurance sectors, telecommunication or postal services, education or public administration. The cost these firms incur for handling office document is, as said, particularly high due to the large size of their business. So, they are systematically looking for cost-savings. Conversely, they are not so much interested in increasing the quality (e.g. graphics, quality of colour prints) and quantity (e.g. machine productivity) of the process itself. In other terms, increasing the process output and performance is not considered a must-have in these contexts, since printing with a low-to-normal quality is sufficient to their business requirements. The order winner, therefore, is not having the best/most innovative printing technology/equipment. Instead, an attractive PSS offer is built on standardization of products (e.g. hardware, software, applications, drivers, utilities) and processes (e.g. operating procedures). For the mentioned reasons, these customers expect a combination of tangible and intangible resources that allow them to focus mostly on their core business, in which at the same time the services are delivered efficiently.

In these situations, automation is key. In its turn, this is enabled by technological standardization and setting up organizational interfaces and procedures, in each service process (DEAS/smart PSS, or traditional). This is the case of toner automatic replenishment, requests for repair intervention. It is responsibility of customers (and their own interest too) to provide resources to the service system, such as connectivity, equipment data exchange, functional integration of procedures and information systems. On their side, the service providers leverage automation and standardization to deliver the best cost/quality service ratio. Automation and standardization is beneficial to the customer resources, as they can handle the self-service activities without dedicating them particularly skilled/valuable people. These are therefore employed on the customer core business (*focus*).

b) In other cases, customers need continuous support from skilled technicians of the provider's organization, that provide in-house supervision. These are, for example, the situations of companies operating in the graphic arts, in transpromo and industrial printing (textiles, wood, furnitures), as well as in-house printing centers of multinationals firms and government agencies. In these cases, the service provided is based on PSS solutions called "managed print services" (in fact, it is an outsourcing service). On a continuous or occasional basis, the provider's technical personnel is staffed at the customer's premises, and take care of machine setting, configuration, operation and maintenance. For the mentioned tasks, the provider's digital tools and DEAS are also used by the staffed technicians. For example, activating specialistic support, running diagnostic tools, or replacing ink tanks. In this case, the customer's goal is to have either the best quality (e.g. in graphic arts industry) or productivity of the printing process (e.g. in the transpromo industry). In both cases, the provider ensures that the goals promised by (smart) PSS are effectively achieved, albeit the costs of the service contract – typically including fixed and variable fees – may be significant. Outsourcing the printing process (setting, running, servicing) to the provider, the customer receives strategic benefits (*focus*). These are situations in which contracts can be customized to a large extent, and the client is willing to have state-of-the-art technology in product and service applications. In those contexts (e.g. transpromo) in which there is a strong need of reaching maximum productivity, it is essential for the service provider and the customer to collaborate in scenario analysis (based on production and servicing data), in order to take the decisions that meet both service contract requirements and business needs.

c) Last, other cases have little room for either specialization and automation. In these contexts, customers operate mainly in self-service mode, at least they get support from data, information and tools that the provider makes available (e.g. call center, FAQs, diagnostic utilities, etc.). In some cases, office equipment are not even connected. Customers communicate self-reading by emails, or call free toll numbers to report running out of ink. These are situations where the customer is interested neither in quality services nor in increasing the productivity of their printing process. They just appreciate simple and cost-effective solutions. These are often the cases of small or mid-size businesses, in which minor/basic issues related to a printing device is self-solved by some internal staff. This is however perceived as the most convenient solution, since this staff represent a fixed cost for the organization, therefore assuming this kind of responsibility bring no marginal. In addition, there is no interest to employ this personnel in strategic activities, that are more core to the customer business. The primary benefit, then, is not strategic focus rather than good compromise between efficiency and effectiveness. On his side, the provider willingly leaves the management of simple activities to the client, in order to keep low customer intimacy of the service process. Alternatively, the inefficiencies could not be counterbalanced by the low margins of this kind of business.

5. CONCLUSIONS

Industrial equipment, fleet and vehicles become more and more equipped with microprocessors, sensors and digital features to connect to, and exchange data with industrial internet platforms. This is opening up new opportunities of value creation in business and consumer markets such as the provision of DEAS. In this case, the value for the customer is created as far as data are propriety managed by companies. Despite this acknowledged importance, the analysed literature on data-driven value creation through services seems still in its infancy and companies struggle to exploit the opportunities arising from DEAS. In particular, the mechanisms through which data can be transformed into DEAS that are attractive for their customers are not yet fully understood. To answer these questions, this paper proposes a novel model to describe how data collected from SCP should be managed to generate customer value. The model has been conceptualized taking inspirations from multiple domains of scientific research such as digital servitization (Paschou et al 2020), Smart Connected Products (SCP) (Porter and Heppelmann, 2014), smart PSS (Pirola et al., 2020), Service Science and Service Dominant Logic (Maglio and Spohrer 2008; Vargo and Lusch, 2004), Customer Value. Integrating different research stream, this paper shows promising avenues of research in the field of DEAS. The model is specifically designed for supporting the development of DEAS and takes into account the different phases of the lifecycle through which data is collected, stored, processed and visualized to give insights on product and process performances. The model can facilitate service design, guide technical and technological development, as it points out any issues arising from different actors of the complex service ecosystem. The proposed model therefore represents an original contribution of this work and respond to the emerging need of tools that systemically integrate different views, to unveil how value is co-created in DEAS. In this perspective, this model can also guide future research that is willing to shed more lights on specific aspects of service system configuration.

The proposed model has also been applied in Ricoh, a leading companies operating in the printing sector. The action research described in this paper shows how the model can facilitates also practical application as it is of great help in the service design phase. Its empirical applications, in fact, have shown its value in practice, as a design and management tool, that help the development of DEAS.

Thus, this paper provides implications from both research and managerial point of view. This paper comes also with limitations. The most relevant is the fact that the proposed model is built on an integrative literature review and by the authors' long experience in digital servitization projects and initiatives, such as the mentioned action research. Thus, it would require extensive field research to achieve validation. This is also the avenue that we suggest for future research.

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